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Trajectories of Math Expectancies for Success and Values in Latinx and Asian Students

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The heterogeneity in the developmental trajectories of math motivational beliefs (i.e., expectancies for success and subjective task value beliefs) was examined among Asian and Latinx male and female students from Southern California across Grades 8 through 10 ($n = 2{,}710$; 50% female; 85% Latinx; 15% Asian; $M_{\text{age}} = 13.77$). By conducting growth mixture modeling, we identified two classes of stable trajectories for expectancies for success; five classes of stable, decreasing, or increasing trajectories for interest and utility value; and three classes of stable, decreasing, or increasing trajectories for attainment value. The group comparisons demonstrated that variability exists in adolescents' motivational belief development at the intersection of their race/ethnicity and gender for some trajectories. For example, Latina adolescents were more likely to maintain moderate expectancies for success than high expectancies for success compared to Latino and Asian male adolescents, but Asian female adolescents did not differ in their level of expectancies for success from the two male groups. Also, we found Latina adolescents displayed smaller decreases in interest compared to Asian female adolescents and in utility value compared to Latino adolescents. The findings from the present study challenge traditional stereotypes in math and highlight positive motivational belief development in students who are marginalized in math (e.g., Latina adolescents).

Public Significance Statement

This study suggests that there are multiple, distinct patterns of students' math motivational belief development during the transition from middle to high school and that Asian/Latinx male/female students do not always display decreases in their motivational beliefs across adolescence. Our findings suggest that interventional efforts employed during middle and high school have the potential to foster students' motivational beliefs. Additionally, our findings help guide applied efforts to address the societal and systematic challenges in science, technology, engineering, and math by displaying the issues of marginalization and privilege based on race/ethnicity and gender.

Keywords: expectancy-value theory, motivation, math, racial/ethnic differences, gender difference

Supplemental materials: https://doi.org/10.1037/dev0001687.supp

High school students' math motivational beliefs are important determinants of their subsequent science, technology, engineering, and math (STEM) educational and occupational choices (Jiang et al., 2020; Seo et al., 2019). Though scholars have historically found that adolescents' math motivational beliefs typically decrease (e.g., Fredricks & Eccles, 2002; Jacobs et al., 2002; Watt, 2004), recent research suggests that this average trend masks multiple distinct underlying developmental trends, including stability and increases (e.g., Gaspard et al., 2020; Guo et al., 2018). However, this research has largely focused on White populations—a group who holds a position of privilege in STEM (Martin, 2009; McGee, 2018). Given that we know less about the motivational processes among other racial/ethnic groups and the patterns may not generalize across groups (Hsieh et al., 2021; Starr, Tulagan, & Simpkins, 2022), research charting math motivational development for diverse youth in the United States is necessary for our society to better support the STEM success of all youth, particularly those who have been historically marginalized.

Race/ethnicity and gender are two social position factors in the United States that shape individuals' development in profound ways (Coll et al, 1996). Math is no exception; stereotypes and structural barriers based on race/ethnicity and gender privilege some groups in math, including Asian and male students, and marginalize other groups, including Latinx and female students (Hsieh et al., 2021; Wang & Degol, 2017). Though scholars have argued for the need to study development at the intersection of race/ethnicity and

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Glona Lee-Poon served as lead for conceptualization, formal analysis, methodology, writing–original draft, and writing–review and editing. Sandra D. Simpkins served in a supporting role for conceptualization, formal analysis, methodology, and writing–review and editing.

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gender (Crenshaw, 2019), it has received less attention in math. Examining race/ethnicity and gender separately not only keeps some marginalized groups invisible (e.g., Latina students), but fails to address key theoretical questions, such as whether Asian male and female students equally benefit from the model minority stereotype or if Asian female students are still hindered by the traditional gender stereotypes (Hsieh et al., 2021; Starr, Gao, et al., 2022). Theoretically, the development of individuals' motivational beliefs should vary based on whether they are members of privileged or marginalized groups in math due to their race/ethnicity, gender, or both (McGee, 2018).

In accordance with the current call to examine the intersection of race/ethnicity and gender in motivation research (Eccles & Wigfield, 2020; Graham, 2020; Wigfield & Koenka, 2020), we explored motivational belief development among middle and high school students who had different combinations of privilege and marginalization in math based on their race/ethnicity and gender. Specifically, we focused on Asian and Latinx male and female adolescents. Even though Latinxs and Asians are both members of racial/ethnic minority groups in the United States, these two groups differ in terms of math stereotypes—with Latinx students being more likely to experience negative stereotypes about their math abilities and the opposite for Asian students (Else-Quest et al., 2013). In this study, we aimed to address theoretical questions on privilege and marginalization based on race/ethnicity and gender, and to contribute to the field's limited understanding of motivational belief development among Asian and Latinx youth as more research has focused on White and Black youth to date (Rubach et al., 2022; Starr, Tulagan, & Simpkins, 2022).

The Complex Changes in Adolescents' Math Motivational Beliefs

Situated expectancy-value theory is one of the prominent theories used to examine the development of individuals' motivational beliefs and the correlates of those beliefs. According to this theory, individuals' motivational beliefs—specifically, their expectancies for success and subjective task value beliefs—are the most immediate determinants of their STEM performance and choices (Eccles, 2009; Eccles & Wigfield, 2020). Expectancies for success are defined as individuals' beliefs about their ability to succeed. Subjective task value beliefs include several theoretically and empirically distinct beliefs: interest (i.e., enjoyment of the task), utility value (i.e., perceived usefulness of the task), and attainment value (i.e., perceived importance of the task based on one's identity). These four motivational beliefs in math positively predict subsequent math achievement, math course-taking, STEM college majors, and STEM career choices (Guo et al., 2015; Hsieh & Simpkins, 2022; Jiang et al., 2020; Seo et al., 2019; Simpkins et al., 2015b; Wang et al., 2015).

Historically, theories and research suggest that motivational beliefs should decline over time due to individual- and setting-level processes (e.g., Jacobs et al., 2002; Wigfield & Cambria, 2010). At the individual level, compared to childhood, adolescence is when individuals become better at self-assessing their own ability (Wigfield et al., 2015) and develop a better sense of who they are as well as the social and cultural expectations of them (Brown & Bigler, 2005; Wang & Degol, 2013). For example, the developmental model of children's perception of discrimination suggests that adolescents can categorize themselves into social groupings and discern the racial and gender stereotypes associated with those social groups (Brown & Bigler, 2005). Adolescents' motivational beliefs can decline if they internalize society's belief that their racial/ethnic or gender group is less skilled in a domain (Fredricks & Eccles, 2002; Wigfield et al., 2015). At the setting level, the transition to high school (Grades 8–10) can cause declines in motivational beliefs due to the increasingly challenging coursework, academic tracking, and stage-environment mismatches (e.g., increasing need for autonomy that is not met by high schools; Eccles, 1993; Wigfield et al., 2019). Collectively, these theoretical tenets suggest adolescents' math motivational beliefs should decline and that the declines may be larger for groups who have been historically marginalized in math. Much of the prior research that describes the average trajectory for a sample suggests that youth's math motivational beliefs, on average, decline over time (e.g., Fredricks & Eccles, 2002; Jacobs et al., 2002; Nagy et al., 2010; Watt, 2004).

However, more recent research suggests the developmental progression of individuals' math motivational beliefs may be more nuanced and complex during adolescence (Musu-Gillette et al., 2015), which might be the result of historical differences and/or new analytic methods (e.g., growth mixture modeling [GMM]) that can capture heterogeneous trajectories in a sample. For example, adolescents' math trajectories were found to vary across the four motivational beliefs with decreases in math interest and utility value, but stability in math expectancies for success from Grades 7–12 making it important to test the developmental trends of the four motivational beliefs separately (Petersen & Hyde, 2017). Not only across beliefs, but other research suggests that there is an important variability across individuals where the developmental trends qualitatively vary across subgroups (Archambault et al., 2010; Gaspard et al., 2020; Guo et al., 2018; Musu-Gillette et al., 2015). Guo et al. (2018), for example, found that, although most students displayed decreases in their subjective task value beliefs from Grades 9 through 11 in a variety of domains (i.e., math and science, Finnish, social studies), some students displayed increases in their math and science subjective task values. Across math and language arts, Gaspard et al. (2020) found three distinct developmental patterns in students' interest from Grades 1 through 12 including trajectories showing strong decreases, moderate decreases, and moderate stability. In both studies, male students were more likely to display a stable or increasing trajectory than female students, who were more likely to display decreasing patterns. These studies that utilized person-centered approaches highlight that subgroups of individuals display qualitatively different developmental trends in their math motivational beliefs. Estimating one average trajectory makes other developmental trends invisible, has the potential to perpetuate the assumption of declining trends in math, and overlooks students who have stable or increasing math motivation over time. Thus, we utilized a person-centered approach (i.e., growth mixture models) to chart the development of Latinx and Asian adolescents' math motivational beliefs.

Motivational Belief Development of Latinx and Asian Adolescents

Recently, Eccles and Wigfield renamed the theory to situated expectancy-value theory to emphasize that individuals and these motivational processes are situated within a particular cultural milieu and their immediate settings (Eccles & Wigfield, 2020; Wigfield &

Eccles, 2020). The cultural milieu includes societal expectations and stereotypes about who is good at certain domains, such as math, and which endeavors are considered appropriate for various groups (e.g., traditional gender roles). Latinx and Black students have been stereotyped to have lower math ability compared to Asian and White students (Else-Quest et al., 2013; Hsieh et al., 2021). As a result, these groups may experience different educational contexts when it comes to their math learning (Martin, 2009). For example, they may vary in their math coursework (i.e., course tracking) and their experiences in those courses (Simpkins et al., 2006; Wang, 2012), which have been linked to students' math motivational beliefs (Frenzel et al., 2010). Similarly, female students often experience more demotivating treatment than male students given the stereotype that math is a male domain (Lazarides & Ittel, 2012; McKellar et al., 2019). These societal beliefs about race/ethnicity and gender shape the beliefs, behaviors, and messages of socializers in adolescents' lives (e.g., parents, teachers), which influence their developing motivational beliefs (Else-Quest et al., 2013; Nosek & Smyth, 2011).

Existing cross-sectional findings align with these expectations concerning racial/ethnic differences between Latinx and Asian adolescents. For example, Latinx students displayed lower math expectancies for success, interest, and attainment value, but not utility value, compared to Asian and White students in middle school (Safavian & Conley, 2016; Umarji et al., 2021). In high school, some studies suggested similar patterns of lower math expectancies for success for Latinx students compared to non-Latinx students (Grades 9 and 10; Umarji et al., 2021), whereas other studies showed that Latinx students had similar math expectancies for success and subjective task values as Asian students (Grade 10; Else-Quest et al., 2013). Not only is there limited research on these populations, but the findings from the prior studies are mixed, cross-sectional, and include students at varying grade levels. To understand potential racial/ethnic differences in the developmental changes, studies need to chart math motivational belief development across adolescence among Latinx and Asian youth.

Gender differences in math motivational beliefs have been studied extensively. Though most researchers have found female students display more negative math motivational belief trajectories than male students (e.g., Gaspard et al., 2020; Watt, 2004), others have noted minimal gender differences (Fredricks & Eccles, 2002; Jacobs et al., 2002; Nagy et al., 2010; Petersen & Hyde, 2017). In fact, a recent meta-analytic study showed a substantial degree of heterogeneity in the effects across gender for math expectancies for success, interest, utility value, and attainment value, highlighting the potential role of other factors, such as race/ethnicity, that also shape motivational beliefs (Parker et al., 2020). Additionally, some scholars have argued that the variability within each gender is larger than between genders (e.g., Hyde & Mertz, 2009). Guo et al. (2018), for instance, found through a person-centered approach that some male students' motivational beliefs were low and increasing over time whereas other male students' motivational beliefs displayed the opposite pattern of starting high and decreasing over time. The variability within each gender suggests other processes in addition to gender-related ones also shape students' motivational beliefs and calls for studies that consider the intersectionality of gender and other factors, such as race/ethnicity.

There is a need to jointly examine gender and racial/ethnic differences in motivational belief development (e.g., Gaspard et al., 2020; Graham, 2020; Wigfield & Cambria, 2010; Wigfield & Koenka, 2020). Prior cross-sectional findings suggest that differences exist at the intersection of race/ethnicity and gender. For example, Seo et al. (2019) found no gender differences in math expectancies for success among Asians, but lower math expectancies for success for Latina students compared to Latino students in Grade 10. In one recent study, male students displayed higher math competence-related beliefs than female students among Asian students and among Latinx students across all grade levels in high school across six different U.S. data sets (Rubach et al., 2022). Hsieh et al. (2021) found that Asian female students were more likely to be overrepresented in high motivational belief group than other patterns, but Latina students were underrepresented in the high motivational belief group. Though these findings demonstrate the importance of studying differences at the intersection of race/ethnicity and gender, they are based on data at one-time point and do not provide information on development. Accounting for both race/ethnicity and gender is critical to understanding the diverse experiences of individuals that are influenced by their multiple social identities (Causadias et al., 2018).

Several theoretical questions remain on whether race/ethnicity or gender might be more marginalizing and whether there is an intersectional effect (Else-Quest & Hyde, 2016). Because math is a domain where race/ethnicity and gender identities can both influence one's experiences (e.g., Joseph et al., 2017), comparisons between Latinx female and male adolescents compared to Asian female and male adolescents can address if gender has a similar effect among both racial/ethnic groups whose cultures espouse traditional gender roles, but also vary in terms of their marginalization or privilege in math. In addition, the differences between Latino male and Asian female adolescents can provide insight into whether race/ethnicity or gender might be more marginalizing in math. Finally, examining the patterns by both race/ethnicity and gender will help us to highlight individuals' experiences based on multiple social categories (Else-Quest & Hyde, 2016). Especially, testing to see whether groups who are marginalized due to both their race/ethnicity and gender, such as Latinas, demonstrate the largest declines or patterns where they remain low and stable across adolescence, will give insights into the potential multiple marginalizing experiences they face in math. Examining the similarities and differences among Latinx and Asian male and female students afford multiple insights into critical theoretical tenets that will help move research forward so that society can support the math success of all youth. Thus, we tested differences in the development of math motivational beliefs at the intersection of race/ethnicity and gender among Latinx and Asian adolescents to address theoretical tenets of the cultural milieu in shaping motivational beliefs as specified in situated expectancy-value theory (Eccles & Wigfield, 2020; Wigfield & Eccles, 2020). If racial/ethnic and gender differences exist, our study will demonstrate a need to address the societal and systematic issues to close the gaps in math motivational belief development.

The Current Study

Though prior studies have often shown average decreasing trends in motivational belief development, less research has examined the heterogeneity in the trends using a person-centered approach and among racially/ethnically minority groups. In one prior study, Umarji et al. (2021) utilized the same data as this study and modeled the average trajectory for the sample using hierarchical linear modeling. They found that subjective task value beliefs in math decreased across both middle (Grades 7–8) and high school (Grades 9–10), whereas math expectancies for success increased in high school. Though Umarji et al. (2021) examined the development of motivational beliefs using the same data, they did not use person-centered approaches like GMM to examine if subgroups of adolescents displayed qualitatively different trends as suggested by recent research. In addition, they tested whether race/ethnicity and gender each separately predicted differences in the initial levels of adolescents' motivational beliefs; they did not test whether the changes over time varied across groups nor intersectionality. We extended prior work by estimating growth mixture models to identify the unique developmental trends present among subgroups within the Latinx and Asian adolescents. Testing intersectionality in the current article extends prior work by addressing key theoretical questions and focusing on potentially vulnerable groups (e.g., Latinas) who are invisible when race/ethnicity and gender are tested separately.

Our investigation on adolescents' motivational belief development at the intersection of race/ethnicity and gender may demonstrate that adolescents display multiple, qualitatively unique trajectories (Eccles & Wigfield, 2020; Wigfield et al., 2015). Given the exploratory approach, specific numbers of trajectories were not hypothesized a priori. Based on prior literature (e.g., Guo et al., 2018; Musu-Gillette et al., 2015), however, we expected trajectories that showed stability, decreases, as well as increases over time in their motivational beliefs across Grades 8–10.

By comparing the four groups, we expected Asian male students to display the most positive math motivational trajectories (e.g., high initial levels that are stable), Latina students to display the most negative math motivational trajectories (e.g., strong decreases or low initial levels that are stable), and Asian female and Latino students to display modest patterns in-between the other two groups. Nevertheless, we expected gender differences among Asians to be minimal given the strong model minority stereotype that Asians experience in math which may counter the gender stereotypes (Hsieh et al., 2021; Trytten et al., 2012). In our analyses, we controlled for relevant background variables that may influence students' motivational beliefs, such as parents' education level, math course, performance, and cohort (Else-Quest et al., 2013; Simpkins et al., 2015b).

Method

Participants

Data were drawn from the California Achievement Motivation Project, a cross-sequential study on the relations between students' motivational beliefs and their academic outcomes. The study involved four school districts in Southern California where students were predominantly Latinx and Asian. Students were surveyed on their motivational beliefs at four time points in October and May of the 2004–2005 and 2005–2006 school years. We focused on 3,343 students ($M_{\text{age}} = 13.76$) from two cohorts, who were between Grades 8 and 10 (i.e., Cohort 1 = Grades 8–9; Cohort 2 = Grades 9–10) because we were particularly interested in examining adolescents' motivational belief development during their transition to high school. The sample was 50% female, 39% low income, 65% English as Second Language students, 69% Latinx, 12% Asian, <1% American Indian or Alaskan Native, 1% Pacific Islander, 14% White, and 2% Black. Racial/ethnic percentages of the sample were representative of the districts. We excluded participants who selected race/ethnicity other than Asian and Latinx due to our focus on understanding the motivational belief development in these two largest growing racial/ethnic minority groups in the United States. The final analytic sample consisted of 2,710 students ($M_{\text{age}} = 13.77$) who were 50% female, 43% low-income, 78% English as Second Language students, 85% Latinx, and 15% Asian (predominantly Southeast Asian). The use of human participants was approved for this project at the participating institutions.

A comparison of the analytic sample and the excluded sample is provided in the online supplemental materials (Table S1). Of the 29 comparisons, only two demonstrated a small effect or larger; compared to the excluded sample, students in the analytic sample reported higher math utility value in the fall of Grade 9 ($d = 0.29$) and were more likely to have parents with lower education levels ($d = 0.69$).

Measures

Students' motivational beliefs (i.e., expectancies for success, interest, utility value, and attainment value) were assessed using a survey administered by trained research assistants in math class to students who gave assent and had parental consent. The items used to measure students' motivational beliefs have demonstrated high validity and reliability in previous studies (e.g., Conley, 2012; Safavian, 2019; Safavian & Conley, 2016; Umarji et al., 2021). We conducted measurement invariance tests and confirmed that the constructs have similar measurement properties (a) across grade levels (i.e., Grades 8–10) and (b) across the four racial/ethnic and gender groups (i.e., Asian and Latinx male and female students) (Table S2 in the online supplemental materials).

Expectancies for Success

Students reported their expectancies for success using four items on a 5-point scale ($\alpha = .78$–$.84$): (a) "How certain are you that you can learn everything taught in math?" (b) "How sure are you that you can do even the most difficult homework problems in math?" (c) "How confident are you that you can do all the work in math class, if you don't give up?" and (d) "How confident are you that you can do even the hardest work in your math class?" (1 = *not at all certain/sure/confident*, 5 = *very certain/sure/confident*).

Subjective Task Value Beliefs

The three subjective task values were interest, utility value, and attainment value. Though interest, utility value, and attainment value are all values, they are theoretically unique constructs (Eccles & Wigfield, 2020; Wigfield & Eccles, 2020), which has been supported by empirical work (e.g., Guo et al., 2016). The development of these three subjective task values has been shown to vary, such as high math interest but low math attainment values (Hsieh et al., 2021; Parker et al., 2020; Safavian & Conley, 2016). Particularly relevant to these analyses, some work suggests the changes in students' math and science motivational beliefs also vary across these three value beliefs (Hsieh & Simpkins, 2022; Parker et al., 2020). Therefore, we examined each of the three subjective task values separately in this study.

Interest value was measured using six items on a 5-point scale ($\alpha = .94$–$.95$): (a) "I enjoy the subject of math," (b) "I like math," (c) "I am fascinated by math," (d) "I enjoy doing math," (e) "Math is exciting to me," and (f) "How much do you like doing math?" (1 = *not at all true for me/not at all*, 5 = *very true for me/very much*).

Utility value was measured using seven items on a 5-point scale ($\alpha = .86$–$.90$): (a) "In general, how useful is what you learn in math?" (b) "Being good at math will be important when I get a job or go to college," (c) "How useful is learning math for what you want to do after you graduate and go to work?" (d) "Compared to most of your other school subjects, how useful is what you learn in math?" (e) "Math helps me in my daily life outside of school," (f) "Math concepts are valuable because they will help me in the future," and (g) "Math will be useful for me later in life" (1 = *not at all true for me/not at all useful*, 5 = *very true for me/very useful*).

Attainment value was measured using seven items on a 5-point scale ($\alpha = .88$–$.91$): (a) "Thinking mathematically is an important part of who I am," (b) "It is important to me to be a person who reasons mathematically," (c) "I feel that, to me, being good at solving problems which involve math or reasoning mathematically is," (d) "It is important for me to be someone who is good at solving problems that involve math," (e) "Being someone who is good at math is important to me," (f) "Being good at math is an important part of who I am," and (g) "Compared to most of your other school subjects, how important is it for you to be good at math" (1 = *not at all true for me/not at all important*, 5 = *very true for me/very important*).

Gender and Race/Ethnicity

Students' gender (0 = *male*, 1 = *female*) and race/ethnicity were obtained from the school district data. Primary race/ethnicity was indicated as Hispanic or Latino, Black or Black (not of Hispanic origin), White (not of Hispanic origin), Asian (e.g., Vietnamese, Chinese, etc.), Pacific Islander (e.g., Samoan, Native Hawaiian, etc.), or American Indian or Alaskan Native. In this study, we included participants who identified as either Hispanic/Latino or Asian.

Background Variables

Demographic variables, specifically parents' education level (1 = *not a high school graduate*, 5 = *graduate school/postgraduate training*), students' prior achievement at the first time of the survey in Grade 8 or Grade 9 (students' math performance on California Standards Test; 1 = *far below basic*, 5 = *advanced*), cohort (0 = *Cohort 2 [i.e., Grades 9–10]*, 1 = *Cohort 1 [i.e., Grades 8–9]*), and the level of students' math course at the first time of survey in Grade 8 or 9 (a course which the California Standards Test was administered on; 1 = *general math*, 7 = *Algebra II*) were added as background variables in the analyses. This demographic information was obtained from the school district data.

Plan of Analysis

Descriptive statistics were obtained using Stata 15 and all other analyses were conducted using Mplus8 (Muthén & Muthén, 1998–2017). Missing data were handled using the full-information maximum likelihood method (Kline, 2015). In both cohorts, most of the missingness in the analytic sample was due to missing one or more motivational beliefs at later time points. All students in the analytic sample had information on their motivational beliefs at one or more time points across the four possible time points. When students in the analytic sample with complete data (Cohort 1: $n = 303$; Cohort 2: $n = 505$) were compared with students in the analytic sample who had at least one piece of missing data (Cohort 1: $n = 931$; Cohort 2: $n = 973$), only one out of the 42 comparisons demonstrated a small effect or larger; in Cohort 2, students with complete data were more likely to be enrolled in more advanced math courses than students with some missing data ($d = 0.27$; Table S3 in the online supplemental materials).

GMM was used to describe the within-person changes over time and the between-person differences in these changes (Grimm et al., 2017). GMM is a method that can be used to identify groups (or classes) of individuals who display unique trajectories and determine class membership of the individuals based on the observed trajectory post hoc (Grimm et al., 2017; Ram & Grimm, 2009). We decided to use GMM over other conventional methods, such as latent growth curves, because prior research suggested subgroups of individuals demonstrated qualitatively unique developmental trends, such as decreases, increases, or stability (Jung & Wickrama, 2008). Our aim was to describe the fundamental differences in individuals' motivational belief development. By conducting a person-centered approach, we were able to identify the unique developmental trends without making assumptions about the number of trends and what those trends looked like (Frankfurt et al., 2016).

Following the steps of GMM estimation (Ram & Grimm, 2009), we first identified the optimal baseline shape of the average trajectories for each of the four math motivational beliefs on the full sample (Grimm et al., 2017). The intercept was centered at the spring of Grade 9 because we expected greater individual differences once students encounter changes in school environments by transitioning to high school (Grimm et al., 2017). Subsequently, we identified the unique trajectories for each of the four math motivational beliefs across Grades 8–10 using the default growth mixture model suggested by experts, which specifies that the means are free to vary, and variances are fixed to be equal across classes (Frankfurt et al., 2016; Grimm et al., 2017; Muthén & Muthén, 1998–2017).

We determined the optimal GMM solution using multiple indicators as suggested by statistical experts (Ram & Grimm, 2009) along with the theoretical alignment. Lower Bayesian information criterion (BIC), Akaike information criterion (AIC), and adjusted BIC (ABIC) values are considered indicators of a better-fitting model (Ram & Grimm, 2009). Statistically significant p-values on the Vuong–Lo–Mendell–Rubin likelihood ratio test (VLMR), Lo–Mendell–Rubin likelihood ratio test (LMR), and Bootstrap likelihood ratio test (BLRT) suggest that the model with a greater number of classes demonstrates an increase in model fit and should be selected over the model with fewer classes (Grimm et al., 2017). Entropy was examined but not used as a criterion for model selection because scholars have posited that though entropy close to 1 may imply more accurate distinction of classes, class assignment can still contain a high degree of error by chance for models with a greater number of latent classes (Masyn, 2013). We increased the number of classes until the information criteria displayed worse model fit, convergence problems were encountered, or until the number of individuals in one of the classes was too small ($n < 30$; Ferguson et al., 2020; Grimm et al., 2017).

Given that GMM is an exploratory analysis, one concern is whether the findings (i.e., the number of classes) are in fact a true representation of the data (Grimm et al., 2017; Ram & Grimm, 2009). For cross-validation, we tested whether the trajectories replicated across two random subsamples of the data as suggested by the experts and found similar shapes of trajectories (Figures S1–S4 in the online supplemental materials; Ram & Grimm, 2009).

Subsequently, we examined racial/ethnic and gender differences in adolescents' math motivational belief trajectories by including three dichotomized indicators that represent three of the four groups of this study defined by race/ethnicity and gender (i.e., Asian/Latinx male/female adolescents) as predictors of the latent class membership in the GMM (Masyn, 2013). For example, dichotomized indicators for Asian female adolescents, Latino adolescents, and Latina adolescents were added as predictors to determine their likelihood of belonging to one trajectory compared to Asian male adolescents. The models were reestimated with different reference groups so all comparisons across the four groups were considered. Thus, all comparisons between the four groups were estimated. In line with the recent recommendation on adding predictors while avoiding the error of misclassification (Asparouhov & Muthén, 2014; Nylund-Gibson et al., 2014), a three-step specification was implemented using the R3STEP command on Mplus (Asparouhov & Muthén, 2014). The three-step procedure involves estimating an unconditional model, assigning individuals to the most likely class assignments using the latent class posterior distribution, and reestimating a mixture model with parameters fixed to the values from the prior step and predictors being added as auxiliary variables (Asparouhov & Muthén, 2014). The models were estimated with a host of covariates, including parents' education level, students' prior achievement, the level of students' math course, and cohort; they were added at this stage to not interfere with the process of class determination (Grimm et al., 2017). To avoid listwise deletion of the observations missing on the covariates, the three-step procedure was implemented manually, and the variances of the covariates were estimated. As supplemental analyses, these models were also estimated without covariates.

For this study, the models were estimated with the TYPE = MIXTURE command to indicate that it is a mixture model and with varying numbers of classes (Grimm et al., 2017). The models were estimated with the %OVERALL% statement where all model parameters were specified (i.e., slope, intercept, covariances, and residual variances). Subsequently, class-specific model statements were added where we respecified the model parameters.

Results

Descriptive statistics and the correlations among the key variables are shown in Tables 1 and 2. Generally, adolescents displayed declines in the mean levels of their motivational beliefs across the four groups (i.e., Asian/Latinx male/female adolescents). As expected, adolescents' motivational beliefs were positively correlated with each other ($r = .15$–$.75$, $p < .001$). Though minimal, being female was often negatively correlated with expectancies for success ($r = -.08$ to $-.10$, $p < .001$) and taking higher math courses ($r = .12$, $p < .001$). Also, being Asian was often positively correlated with motivational beliefs, prior achievement, math course, and higher parent education ($r = .07$–$.33$, $p < .001$). When correlations were examined within the four groups, similar positive associations among motivational beliefs were mostly observed (Tables S4 and S5 in the online supplemental materials). Additionally, we tested for differences in the background variables between the four groups. Across the four groups, we found significant group differences for parents' education level, $F(3, 1992) = 75.68$, $p < .001$, prior math achievement, $F(3, 2530) = 102.75$, $p < .001$, and math course level, $F(3, 2522) = 53.92$, $p < .001$. Post hoc analyses using the Scheffé method displayed significantly higher parents' education level and math performance among Asian male/female adolescents compared to Latino/a adolescents. All groups displayed significantly different levels of math course with Asian female adolescents taking the most advanced math course, followed by Asian male adolescents, Latina adolescents, and Latino adolescents (see Table 1 for *M* and *SD* for each group).

Latinx and Asian Adolescents' Math Motivational Belief Trajectories

In order to test whether adolescents in our study display various trajectories of motivational beliefs over time (i.e., stability, decreases, and increases), we first identified the optimal shape of the average trajectory for each math motivational belief on the full sample. We found that linear trajectories displayed a better fit than the no growth trajectories (i.e., intercept only models) for the four motivational beliefs, namely expectancies for success, interest, utility value, and attainment value (Table S6 in the online supplemental materials). Quadratic trajectories were also tested, but the quadratic and linear models fit the data equally well and the quadratic slopes were not statistically significant. Thus, linear trajectories were selected for the GMMs.

Second, we sought to identify the distinct underlying trajectories for each motivational belief. The fit indices of the GMM models as well as our final decision on the number of classes are reported in Table 3. The unique trajectories for the four motivational beliefs are reported in Figure 1 and Table S7 in the online supplemental materials. The two-class model was always a better fit than the one-class model, which suggested that there were at least two qualitatively different trends in the development.

For math expectancies for success, the two-class model was selected over the three-class model for several reasons. First, the three-class model displayed statistically significant pVLMR and pLMR values, but also had higher BIC and ABIC values compared to the two-class model (Table 3). Second, one of the classes in the three-class model only included five adolescents, which did not meet the criterion of having at least 30 individuals in each class (Ferguson et al., 2020). The models with four or more classes had higher BIC and ABIC values as well as nonsignificant pVLMR and pLMR values, indicating that solutions with four or more classes did not improve the fit of the model. The unique trajectories for math expectancies for success included high and stable and moderate and stable trajectories (Figure 1). The high and stable trajectory started with a comparatively higher mean level of expectancies for success than the moderate and stable trajectory and displayed no significant changes over time, $n = 1,161$, $M(SE)_{\text{intercept}} = 3.58\ (0.10)$, $p < .001$, $M(SE)_{\text{slope}} = -0.10\ (0.07)$, *ns*. The moderate and stable trajectory started with a moderate mean level of expectancies for success and displayed no significant changes over time, $n = 1,549$, $M(SE)_{\text{intercept}} = 2.79\ (0.07)$, $p < .001$, $M(SE)_{\text{slope}} = 0.08\ (0.10)$, *ns*.

For math interest, the five-class model was chosen as the final model. For the five-class model, we set the variance of the latent slope factor of the classes to .001 to handle model convergence issues as recommended by the experts (Jung & Wickrama, 2008; Ram & Grimm, 2009). By comparing the model fit, we noticed

Table 1
Descriptives Statistics

Indicator	Analytic sample		Asian male adolescents		Asian female adolescents		Latino adolescents		Latina adolescents	
	n	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*M* (*SD*)
Expectancies for success										
Grade 8 fall	1,014	3.30 (0.87)	90	3.47 (0.78)	95	3.48 (0.78)	439	3.34 (0.89)	390	3.17 (0.89)
Grade 8 spring	1,051	3.27 (0.88)	84	3.59 (0.85)	89	3.51 (0.76)	451	3.28 (0.88)	427	3.15 (0.88)
Grade 9 fall	2,004	3.24 (0.87)	142	3.49 (0.75)	136	3.35 (0.76)	841	3.28 (0.90)	885	3.14 (0.87)
Grade 9 spring	1,935	3.27 (0.92)	145	3.55 (0.84)	130	3.36 (0.81)	815	3.33 (0.95)	845	3.15 (0.91)
Grade 10 fall	1,008	3.16 (0.86)	75	3.36 (0.82)	72	3.14 (0.75)	404	3.22 (0.90)	457	3.08 (0.84)
Grade 10 spring	947	3.28 (0.91)	66	3.44 (0.91)	68	3.27 (0.73)	383	3.37 (0.95)	430	3.19 (0.89)
Interest										
Grade 8 fall	1,014	2.75 (1.19)	90	3.12 (1.15)	95	3.15 (1.07)	439	2.67 (1.18)	390	2.65 (1.22)
Grade 8 spring	1,051	2.52 (1.11)	84	2.69 (1.05)	89	2.88 (0.96)	451	2.46 (1.09)	427	2.47 (1.15)
Grade 9 fall	2,004	2.67 (1.15)	142	3.00 (1.07)	136	2.76 (1.11)	841	2.65 (1.13)	885	2.63 (1.18)
Grade 9 spring	1,932	2.59 (1.11)	144	2.86 (1.15)	130	2.71 (1.01)	813	2.56 (1.08)	845	2.54 (1.14)
Grade 10 fall	1,006	2.49 (1.07)	75	2.59 (1.14)	72	2.56 (0.92)	402	2.52 (1.09)	457	2.43 (1.07)
Grade 10 spring	942	2.55 (1.09)	66	2.69 (0.99)	67	2.51 (0.91)	381	2.52 (1.09)	428	2.55 (1.14)
Utility value										
Grade 8 fall	1,014	4.01 (0.74)	90	3.91 (0.83)	95	4.07 (0.69)	439	3.99 (0.75)	390	4.06 (0.71)
Grade 8 spring	1,051	3.82 (0.81)	84	3.80 (0.85)	89	4.07 (0.67)	451	3.78 (0.85)	427	3.81 (0.77)
Grade 9 fall	2,004	3.83 (0.81)	142	3.83 (0.78)	136	3.83 (0.81)	841	3.77 (0.82)	885	3.88 (0.81)
Grade 9 spring	1,932	3.63 (0.88)	145	3.68 (0.83)	130	3.71 (0.86)	813	3.59 (0.88)	844	3.65 (0.89)
Grade 10 fall	1,006	3.52 (0.89)	75	3.37 (0.90)	72	3.48 (0.78)	402	3.46 (0.87)	457	3.61 (0.91)
Grade 10 spring	943	3.51 (0.91)	66	3.35 (0.97)	67	3.52 (0.76)	381	3.48 (0.86)	429	3.54 (0.95)
Attainment value										
Grade 8 fall	1,015	3.28 (0.86)	91	3.35 (0.78)	95	3.39 (0.74)	439	3.24 (0.88)	390	3.27 (0.90)
Grade 8 spring	1,051	2.98 (0.89)	84	3.03 (0.87)	89	3.26 (0.77)	451	2.93 (0.89)	427	2.96 (0.92)
Grade 9 fall	2,006	3.09 (0.92)	142	3.25 (0.88)	136	3.17 (0.85)	842	3.05 (0.91)	886	3.09 (0.94)
Grade 9 spring	1,935	2.91 (0.93)	145	3.04 (0.98)	130	3.07 (0.85)	815	2.88 (0.92)	845	2.87 (0.93)
Grade 10 fall	1,008	2.82 (0.91)	75	2.88 (0.83)	72	2.94 (0.83)	404	2.82 (0.92)	457	2.80 (0.92)
Grade 10 spring	948	2.83 (0.96)	66	2.91 (0.94)	68	3.01 (0.88)	383	2.83 (0.93)	431	2.79 (1.01)
Background variables										
Math prior achievement	2,532	2.81 (1.01)	203	3.53 (0.99)	194	3.63 (0.85)	1,046	2.68 (0.97)	1,090	2.64 (0.95)
Math course	2,525	2.38 (1.32)	201	2.81 (1.47)	194	3.27 (1.69)	1,041	2.11 (1.15)	1,089	2.41 (1.28)
Parents' education level	1,995	1.98 (1.09)	147	2.75 (1.22)	157	2.85 (1.19)	801	1.86 (1.02)	890	1.81 (0.98)

that the fit continued to improve with more classes, indicated by smaller AIC, BIC, and ABIC values, as well as statistically significant pVLMR, pLMR, and pBLRT values (Table 3). The pVLMR and pLMR values were no longer statistically significant for the six-class model, which indicated that the six-class model was not a significant improvement over the more parsimonious five-class model. The unique trajectories for interest included low and stable, moderate and stable, moderate with large decreases, high with small decreases, and moderate with increases trajectories (Figure 1). The low and stable trajectory started with a lower mean level of interest compared to the moderate and stable trajectory and maintained a similar low average level over time, $n = 1{,}089$, $M(SE)_{\text{intercept}} = 1.74$ (0.04), $p < .001$, $M(SE)_{\text{slope}} = -0.05$ (0.03), *ns*. The moderate and stable trajectory started with an average mean level of interest and maintained a similar moderate level, $n = 864$, $M(SE)_{\text{intercept}} = 2.92$ (0.05), $p < .001$, $M(SE)_{\text{slope}} = -0.11$ (0.06), *ns*. For the high with small decreases trajectory, the group had the highest mean level of interest but displayed small decreases over time, $n = 342$, $M(SE)_{\text{intercept}} = 4.17$ (0.17), $p < .001$, $M(SE)_{\text{slope}} = -0.17$ (0.06), $p < .01$. The moderate with large decreases trajectory started with a lower mean level of interest than the high with small decreases trajectory but displayed comparatively larger decreases than the high with small decreases trajectory, $n = 283$, $M(SE)_{\text{intercept}} = 2.62$ (0.15), $p < .001$, $M(SE)_{\text{slope}} = -0.98$ (0.07), $p < .001$. A small group of individuals were found to start with an average mean level of interest but increased in their interest over time, $n = 132$, $M(SE)_{\text{intercept}} = 3.04$ (0.28), $p < .001$, $M(SE)_{\text{slope}} = 1.07$ (0.19), $p < .001$. We called this group moderate with increases trajectory.

For math utility value, the five-class model was selected as the final model. After handling convergence issues for the four- and five-class models by fixing the variance of the latent slope factor of the classes to .001, we compared the model fit. The model fit was worse for the three- and four-class models compared to the two-class model as demonstrated by either larger AIC, BIC, and ABIC values or nonsignificant pVLMR and pLMR values for the three- and four-class models (Table 3). However, the five-class model had significant pVLMR and pLMR values and lower AIC, BIC, and ABIC values compared to the other models, including the two-class model, indicating a significant improvement in the model. We selected the five-class model instead of the six-class model because the six-class model had nonsignificant pVLMR and pLMR, values. The five trajectories included high with moderate decreases, high with small decreases, moderate and stable, high with increases, and moderate with large decreases trajectories (Figure 1). The high with moderate decreases trajectory started with an average mean level of utility value but displayed moderate decreases over time, $n = 1{,}064$, $M(SE)_{\text{intercept}} = 3.46$ (0.05), $p < .001$, $M(SE)_{\text{slope}} = -0.48$ (0.03), $p < .001$. The high with small decreases trajectory started with a high mean level

Table 2
Bivariate Correlations for the Analytic Sample

Indicator	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Expectancies for success																													
1. Grade 8 fall	—																												
2. Grade 8 spring	.54*	—																											
3. Grade 9 fall	.48*	.63*	—																										
4. Grade 9 spring	.34*	.46*	.59*	—																									
5. Grade 10 fall	—	—	.46*	.60*	—																								
6. Grade 10 spring	—	—	.44*	.51*	.62*	—																							
Interest																													
7. Grade 8 fall	.57*	.40*	.38*	.31*	—	—	—																						
8. Grade 8 spring	.37*	.53*	.46*	.37*	—	—	.66*	—																					
9. Grade 9 fall	.38*	.41*	.56*	.40*	.29*	.34*	.63*	.75*	—																				
10. Grade 9 spring	.31*	.37*	.37*	.57*	.35*	.33*	.52*	.66*	.66*	—																			
11. Grade 10 fall	—	—	.33*	.39*	.53*	.44*	—	—	.53*	.65*	—																		
12. Grade 10 spring	—	—	.33*	.36*	.40*	.56*	—	—	.49*	.59*	.68*	—																	
Utility value																													
13. Grade 8 fall	.41*	.25*	.18*	.15*	—	—	.44*	.30*	.23*	.18*	—	—	—																
14. Grade 8 spring	.21*	.40*	.28*	.20*	—	—	.34*	.49*	.36*	.33*	—	—	.50*	—															
15. Grade 9 fall	.20*	.28*	.41*	.24*	.24*	.19*	.29*	.37*	.50*	.32*	.30*	.27*	.41*	.62*	—														
16. Grade 9 spring	.18*	.22*	.28*	.42*	.29*	.23*	.27*	.33*	.38*	.51*	.37*	.34*	.35*	.49*	.58*	—													
17. Grade 10 fall	—	—	.20*	.29*	.43*	.30*	—	—	.30*	.38*	.51*	.38*	—	—	.50*	.65*	—												
18. Grade 10 spring	—	—	.22*	.27*	.32*	.45*	—	—	.30*	.38*	.39*	.52*	—	—	.43*	.56*	.65*	—											
Attainment value																													
19. Grade 8 fall	.56*	.36*	.31*	.23*	—	—	.62*	.44*	.39*	.30*	—	—	.67*	.40*	.34*	.33*	—	—	—										
20. Grade 8 spring	.31*	.49*	.37*	.31*	—	—	.43*	.62*	.48*	.43*	—	—	.41*	.66*	.48*	.41*	—	—	.56*	—									
21. Grade 9 fall	.34*	.41*	.51*	.34*	.25*	.28*	.42*	.52*	.64*	.42*	.38*	.37*	.35*	.49*	.68*	.44*	.39*	.37*	.50*	.67*	—								
22. Grade 9 spring	.22*	.31*	.35*	.52*	.32*	.28*	.34*	.43*	.47*	.65*	.47*	.43*	.25*	.41*	.42*	.67*	.50*	.43*	.40*	.59*	.59*	—							
23. Grade 10 fall	—	—	.27*	.35*	.43*	.34*	—	—	.34*	.45*	.63*	.47*	—	—	.37*	.48*	.69*	.46*	—	—	.51*	.67*	—						
24. Grade 10 spring	—	—	.29*	.34*	.35*	.49*	—	—	.37*	.47*	.49*	.68*	—	—	.32*	.42*	.50*	.67*	—	—	.48*	.59*	.65*	—					
Background variables																													
25. Female	−.07	−.07	−.08*	−.10*	−.09	−.10	.00	.02	−.02	−.02	−.04	.00	.06	.05	.06	.03	.09	.04	.02	.03	.02	.00	.00	−.01	—				
26. Asian	.09	.14*	.09*	.08*	.04	.03	.15*	.11*	.07	.07*	.03	.02	−.02	.07	.00	.03	−.05	−.03	.05	.09	.05	.07	.04	.06	−.01	—			
27. Achievement	.29*	.34*	.28*	.26*	.20*	.19*	.20*	.15*	.13*	.16*	.10	.12*	.05	.04	.01	.05	.03	.05	.12*	.05	.04	.09*	.05	.11*	−.01	.33*	—		
28. Math course	.15*	.07	.12*	.10*	.11*	.09	.17*	.09	.13*	.12*	.07	.05	.02	.00	.03	.02	.00	.04	.09	.03	.10*	.09*	.04	.08	.12*	.21*	.14*	—	
29. Parents' education	.05	.13*	.07	.03	.05	.03	.00	.03	.01	−.03	−.04	−.01	−.01	.00	−.02	−.07	−.06	−.08	.05	.05	.01	−.03	−.04	.02	.−.02	.32*	.16*	.13*	—

Note. The correlations between Grades 8 and 10 motivational beliefs are missing due to the cross-cohort design of the data set.
* $p < .001$.

Table 3
Fit Indices From the Growth Mixture Modeling for Each Motivational Belief

Number of classes	AIC	BIC	ABIC	pVLMR	pLMR	pBLRT	Class *ns*
Expectancies for success							
1	18,606.131	18,641.559	18,622.495				2,710
2	**18,559.376**	**18,612.518**	**18,583.922**	**.045**	**.050**	**<.001**	**1,549, 1,161**
3	18,556.907	18,627.763	18,589.636	.012	.014	.120	1,173, 5, 1,532
4	18,553.614	18,642.185	18,594.525	.835	.839	.500	1,301, 133, 614, 662
5	18,549.074	18,655.359	18,598.167	.645	.657	.429	560, 733, 9, 33, 1,375
Interest							
1	21,316.910	21,352.998	21,333.274				2,710
2	21,192.426	21,245.568	21,216.972	<.001	<.001	<.001	983, 1,727
3	21,121.914	21,192.770	21,154.642	<.01	<.05	<.001	1,106, 547, 1,057
4	21,113.354	21,196.020	21,151.538	<.01	<.01	<.001	338, 1,165, 280, 927
5	**21,090.510**	**21,184.985**	**21,134.148**	**<.05**	**<.05**	**<.001**	**1,089, 864, 283, 132, 342**
6	21,065.637	21,177.826	21,117.457	.06	.06	<.001	315, 108, 300, 758, 256, 973
Utility value							
1	17,547.202	17,582.631	17,563.567				2,710
2	17,426.305	17,479.447	17,450.851	<.05	<.05	<.001	614, 2,096
3	17,434.194	17,499.146	17,464.195	<.01	<.01	<.001	1,181, 1,154, 375
4	17,386.869	17,463.630	17,422.325	.23	.23	<.001	219, 1,038, 321, 1,131
5	**17,358.152**	**17,452.627**	**17,401.790**	**<.05**	**<.05**	**<.001**	**232, 223, 1,007, 1,064, 184**
6	17,331.055	17,443.245	17,382.876	.30	.31	<.001	455, 120, 851, 128, 275, 881
Attainment value							
1	18,714.362	18,749.790	18,730.726				2,710
2	18,694.404	18,747.547	18,718.951	<.01	<.01	<.001	932, 1,778
3	**18,678.372**	**18,749.229**	**18,711.101**	**<.001**	**<.001**	**<.001**	**1,732, 915, 63**
4	18,665.419	18,753.989	18,706.330	.13	.14	<.001	57, 449, 1,336, 867
5	18,658.405	18,764.690	18,707.498	.19	.20	.01	302, 795, 1,010, 557, 46

Note. Bold indicates the selected model. The best model was selected based on AIC, BIC, and ABIC; *p*-values on the VLMR, LMR, and BLRT; as well as the number of class proportions. AIC = Akaike information criterion; BIC = Bayesian information criterion; ABIC = adjusted BIC; VLMR = Vuong–Lo–Mendell–Rubin likelihood ratio test; LMR = Lo–Mendell–Rubin likelihood ratio test; BLRT = bootstrap likelihood ratio test.

of utility value and displayed comparatively smaller decreases than the high with moderate decreases trajectory, $n = 1{,}007$, $M(SE)_{\text{intercept}} = 4.31$ (0.04), $p < .001$, $M(SE)_{\text{slope}} = -0.08$ (0.02), $p < .001$. The moderate and stable trajectory started with an average mean level of utility value and maintained a similar level over time, $n = 232$, $M(SE)_{\text{intercept}} = 2.61$ (0.08), $p < .001$, $M(SE)_{\text{slope}} = -0.10$ (0.15), *ns*. The high with increases trajectory started with an above-average mean level of utility value and increased over time, $n = 223$, $M(SE)_{\text{intercept}} = 3.66$ (0.07), $p < .001$, $M(SE)_{\text{slope}} = 0.41$ (0.13), $p < .01$. The moderate with large decreases trajectory started with an average mean level of utility value and showed larger decreases than the high with moderate decreases and the high with small decreases trajectory, $n = 184$, $M(SE)_{\text{intercept}} = 2.33$ (0.19), $p < .001$, $M(SE)_{\text{slope}} = -0.95$ (0.19), $p < .001$.

For math attainment value, the three-class model was chosen as the final model. The model fit continued to improve up to the three-class model, which was indicated by smaller AIC, BIC, and ABIC values, as well as statistically significant pVLMR, pLMR, and pBLRT values (Table 3). The pVLMR and pLMR values were no longer statistically significant for the four-class model, suggesting that the four-class model was not a significant improvement over the three-class model. The three-classes were moderate with decreases, $n = 1{,}732$, $M(SE)_{\text{intercept}} = 2.56$ (0.05), $p < .001$, $M(SE)_{\text{slope}} = -0.37$ (0.03), $p < .001$, high and stable, $n = 915$, $M(SE)_{\text{intercept}} = 3.57$ (0.06), $p < .001$, $M(SE)_{\text{slope}} = -0.10$ (0.06), *ns*, and moderate with increases, $n = 63$, $M(SE)_{\text{intercept}} = 3.38$ (0.16), $p < .001$, $M(SE)_{\text{slope}} = 1.05$ (0.13), $p < .001$, trajectories (Figure 1).

Overall, we found two classes of stable trajectories for expectancies for success. We also found that adolescents were relatively equally split in their belongingness to these two classes. For interest, utility value, and attainment value, varying numbers of classes of stable, decreasing, and increasing trajectories were identified. For interest, five classes were identified with the largest group of adolescents belonging to the low and stable trajectory. Out of the five classes for utility value, most of the adolescents belonged to the high with small decreases or high with moderate decreases trajectory. Across the three classes for attainment value, the largest group of adolescents displayed a moderate with decreases trajectory.

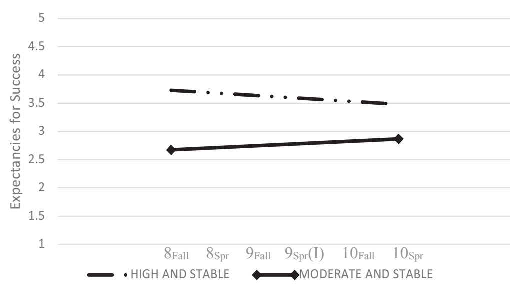
Gender and Racial/Ethnic Differences

We hypothesized that adolescents' motivational belief trajectories would differ by their racial/ethnic and gender membership across all four groups (i.e., Asian/Latinx female/male adolescents). We hypothesized that Asian male adolescents would display the most positive motivational beliefs, followed by Asian female and Latino adolescents, then Latina adolescents. We also hypothesized that the differences between Asian male and female adolescents may be small given the strong model minority stereotype in math for Asians (Hsieh et al., 2021; Trytten et al., 2012). The differences were tested while controlling for parents' education level, as well as students' prior achievement, math course, and cohort.

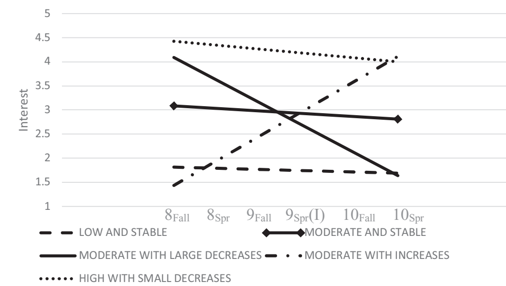
For math expectancies for success (Table 4), significant differences were found between Latina adolescents compared to both groups of male adolescents. Latina adolescents had a higher likelihood of belonging to the moderate and stable group than the high and stable group compared to Asian male, $\beta = 1.73$ (0.74), $p < .05$, and Latino, $\beta = 0.97$ (0.23), $p < .001$, adolescents. That is, Latina

Figure 1

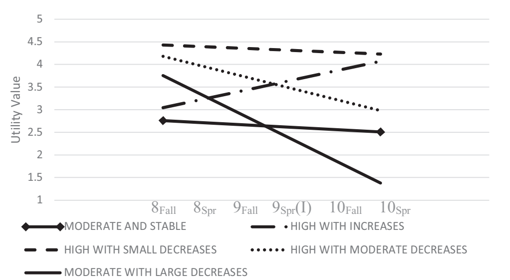
Unique Trajectories of the Final Growth Mixture Modeling for Each Motivational Belief



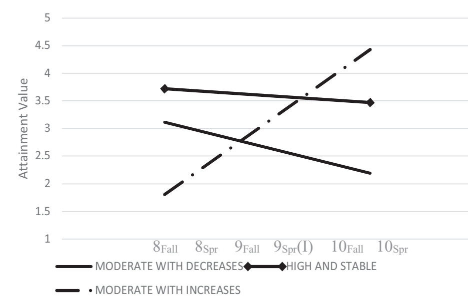
	High and Stable (n = 1,549) Mean (S.E)	Moderate and Stable (n = 1,161) Mean (S.E)
Intercept	3.58 (.10) ***	2.79 (.07) ***
Slope	- .10 (.07)	.08 (.10)



	Low and Stable (n = 1,089) Mean (S.E)	Moderate and Stable (n = 864) Mean (S.E)	Moderate with Large Decreases (n = 283) Mean (S.E)	Moderate with Increases (n = 132) Mean (S.E)	High with Small Decreases (n = 342) Mean (S.E)
Intercept	1.74 (.04)***	2.92 (.05)***	2.62 (.15)***	3.04 (.28)***	4.17 (.07)***
Slope	-.05 (.03)	-.11 (.06)	-.98 (.07)***	1.07 (.19)***	-.17 (.06)**



	Moderate and Stable (n = 232) Mean (S.E)	High with Increases (n = 223) Mean (S.E)	High with Small Decreases (n = 1,007) Mean (S.E)	High with Moderate Decreases (n = 1,064) Mean (S.E)	Moderate with Large Decreases (n = 184) Mean (S.E)
Intercept	2.61 (.08)***	3.66 (.07)***	4.31 (.04)***	3.46 (.05)***	2.33 (.19)***
Slope	-.10 (.15)	.41 (.13)**	-.08 (.02)***	-.48 (.03)***	-.95 (.19)***



	Moderate with Decreases (n = 1,732) Mean (S.E)	High and Stable (n = 915) Mean (S.E)	Moderate with Increases (n = 63) Mean (S.E)
Intercept	2.56 (.05)***	3.57 (.06)***	3.38 (.16)***
Slope	-.37 (.03)***	-.10 (.06)	1.05 (.13)***

Note. I = intercept at spring of Grade 9; spr = spring.

adolescents, on average, were more likely to maintain average expectancies for success over time compared to Asian male or Latino adolescents who were more likely to maintain higher math expectancies for success over time. No other significant group differences were found across the four groups.

For math interest (Table 5), we found racial/ethnic differences within female adolescents. Latina adolescents had a lower likelihood of belonging to the moderate with large decreases group than the high with small decreases group compared to Asian female adolescents, $\beta = -2.09$ (0.95), $p < .05$. In addition, we found that there were no Asian male adolescents who belonged to the moderate with increases trajectory. No other differences were found across the four groups with high with small decreases trajectory as the reference group.

For math utility value (Table 6), we found gender differences among Latinx adolescents. Latinas were less likely to belong to the high with moderate decreases group than the high with small decreases group compared to Latinos, $\beta = -0.41$ (18), $p < .05$. In addition, we found that there were no Asian female adolescents who belonged to the high with increases trajectory. No other differences were found across the four groups with high with small decreases trajectory as the reference group.

For math attainment value (Table 7), we did not find significant group differences with high and stable trajectory as the reference group except that there were no Asian male adolescents who belonged to the moderate with increases trajectory.

Results Without Controlling the Background Variables

Additionally, we tested racial/ethnic and gender differences without controlling for parents' education level, students' prior achievement, math course, and their cohort (Tables S8–S11 in the online supplemental materials). Though the findings discussed largely replicated, there were two main differences. The first key difference from the main findings was that both Latino and Latina adolescents were more likely to display lower math expectancies for success and interest than Asian adolescents, which did not emerge in the main analyses. That is, whereas we found that only Latina adolescents were more likely to belong to the moderate and stable group than the high and stable group for math expectancies for success compared to Asian male adolescents, Latino adolescents also displayed the same pattern as Latina adolescents without controlling for the background variables, $\beta = 1.44$ (0.42), $p < .01$. Similarly, both Latino and Latina adolescents were more likely to be in the low and stable group than the high with small decreases group for math interest compared to Asian male adolescents, $\beta = 1.01$ (0.29), $p < .001$ for Latinos; $\beta = 0.81$ (0.28), $p < .01$ for Latinas. This pattern was not found in the main analyses. Second,

Table 4
Logistic Regression Results Predicting Trajectories of Expectancies for Success by Race/Ethnicity and Gender

	Reference group = high and stable	
	Moderate and stable	
Predictor	β (*SE*)	OR [95% CI]
Compared to Asian male adolescents		
Asian female adolescents	1.51 (0.85)	4.54 [0.86, 23.97]
Latino adolescents	0.76 (0.72)	2.14 [0.52, 8.79]
Latina adolescents	**1.73 (0.74)***	**5.65 [1.33, 24.03]**
Compared to Asian female adolescents		
Asian male adolescents	−1.51 (0.85)	0.22 [0.04, 1.17]
Latino adolescents	−0.75 (0.47)	0.47 [0.19, 1.18]
Latina adolescents	0.22 (0.46)	1.24 [0.51, 3.05]
Compared to Latino adolescents		
Asian male adolescents	−0.76 (0.72)	0.47 [0.11, 1.92]
Asian female adolescents	0.75 (0.47)	2.12 [0.85, 5.32]
Latina adolescents	**0.97 (0.23)*****	**2.64 [1.68, 4.16]**
Background variables		
Parents' education level	0.01 (0.11)	1.01 [0.81, 1.25]
Math achievement	**−1.22 (0.15)*****	**0.30 [0.22, 0.40]**
Math course	−0.**30 (0.12)****	**0.74 [0.59, 0.93]**
Cohort	0.12 (0.65)	1.13 [0.66, 1.94]

Note. Bold indicates significant differences. CI = confidence interval.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Asian female adolescents were more likely to belong to the moderate with large decreases group than the high with small decreases group compared to Asian male adolescents for interest, β = 1.82 (0.85), $p < .05$, which was a pattern that did not emerge in the main analyses.

Discussion

Despite Asian and Latinx groups being the two largest racial/ethnic minority groups in the United States, little is known about their motivational belief development (Rubach et al., 2022; Starr, Tulagan, & Simpkins, 2022). In this study, we described the developmental trends of math motivational beliefs among Asian and Latinx adolescents and tested differences at the intersection of race/ethnicity and gender to highlight the development of groups who have often been invisible in prior research (e.g., Latinas and Asian females). One of the central contributions of this study is that Asian and Latinx adolescents' math motivational beliefs did not always demonstrate decreases, which historically have been highlighted in research (e.g., Jacobs et al., 2002); in fact, we found two stable trajectories for expectancies for success as well as varying patterns of decreases, increases, and stability for each of the three subjective task values. A second central contribution is that certain groups defined by the intersection of race/ethnicity and gender displayed different developmental trends, which went undetected in prior work examining race/ethnicity and gender separately (e.g., Umarji et al., 2021). We discuss the theoretical and applied implications of our findings in more detail below.

Latinx and Asian Adolescents' Math Expectancies for Success

We found two stable trajectories for expectancies for success. Though theories, like stage-environment fit theory (Eccles, 1993), and prior empirical evidence suggest math expectancies for success decrease from childhood through adolescence (e.g., Jacobs et al., 2002), the current study that involved Asian and Latinx adolescents demonstrated that expectancies for success may be stable during middle and high school, a pattern that has also been noted in other recent research focused specifically on adolescence (e.g., Petersen & Hyde, 2017). These conflicting findings concerning developmental declines versus stability could be the result of historical timing as the studies noting stability are more recent or developmental timing as the trajectories illustrating stability only span adolescence. Decreases have often emerged when researchers estimated one growth function from childhood through adolescence. During adolescence, both setting- and individual-level processes may promote stability in students' math expectancy beliefs (e.g., Wigfield et al., 2015). Course tracking based on students' math ability often starts in middle school and continues throughout high school, which may keep students in a similar track across both school levels. Simultaneously, individuals' views of their abilities shift from more optimistic views during childhood to more realistic views that are tied to their actual performance and ability over time (Fredricks & Eccles, 2002). Continuity in math track placement could inform adolescents' stronger sense of their math competency. These results suggest that scholars examining the changes in Asian and Latinx youth's math expectancy beliefs over longer periods of time might consider quadratic or cubic terms that allow growth to accelerate (or decelerate) over time or spline models that can accommodate different growth functions for separate developmental periods.

The differences at the intersection of race/ethnicity and gender among the two stable trajectories for expectancies for success have several important implications. Specifically, Latina adolescents were more likely to maintain moderate expectancies for success than maintain high expectancies for success compared to Latino and Asian male adolescents. In contrast, Asian female adolescents did not differ from Latino and Asian male adolescents. These differences across the groups highlight the importance of an intersectional lens. Prior work based on the same data found gender differences but no racial/ethnic differences (Umarji et al., 2021). Based on that work, we would have expected similarities between Asian female and Latina adolescents and differences between Asian female and male adolescents—both of which did not emerge. Our approach helped uncover that Latina adolescents may be less likely to display high math expectancies for success due to experiencing double marginalization in math by both race/ethnicity and gender (Else-Quest et al., 2013; Hsieh et al., 2021). The model minority stereotype that Asians are good in math might have buffered Asian female adolescents' expectancies for success (Hsieh et al., 2021; McGee, 2018); similarly, the notion that math is a male domain might have buffered Latino adolescents' expectancies for success even though Latinxs are marginalized in math due to their ethnicity (Lazarides & Ittel, 2012; McKellar et al., 2019). Given that we observed these patterns above and beyond several background variables (e.g., prior math achievement, math course difficulty), Latina adolescents' experiences of double marginalization in math may be strongly related to their expectancies for success development. Latinas, a group who is invisible when gender and race/ethnicity are examined separately, might be a group who would benefit from applied efforts to bolster structural supports.

Because social position factors, including gender and race/ethnicity, are associated with numerous contextual factors, such as experiences

Table 5
Logistic Regression Results Predicting Trajectories of Interest by Race/Ethnicity and Gender

	Reference group = high with small decreases							
	Low and stable		Moderate and stable		Moderate with large decreases		Moderate with increases[a]	
Predictor	β (*SE*)	*OR* [95% CI]	β (*SE*)	*OR* [95% CI]	β (*SE*)	*OR* [95% CI]	β (*SE*)	*OR* [95% CI]
Compared to Asian male adolescents								
Asian female adolescents	0.80 (1.03)	2.22 [0.29, 16.77]	0.63 (1.18)	1.88 [0.19, 18.97]	2.02 (1.22)	7.52 [0.68, 82.53]	—	—
Latino adolescents	0.23 (0.61)	1.26 [0.39, 4.13]	−0.17 (0.72)	0.84 [0.21, 3.44]	0.55 (1.05)	1.73 [0.22, 13.48]	—	—
Latina adolescents	−0.18 (0.62)	0.84 [0.25, 2.84]	−0.86 (0.73)	0.42 [0.10, 1.78]	−0.07 (1.04)	0.93 [0.12, 7.18]	—	—
Compared to Asian female adolescents								
Asian male adolescents	−0.80 (1.03)	0.45 [0.06, 3.41]	−0.63 (1.18)	0.53 [0.05, 5.37]	−2.02 (1.22)	0.13 [0.01, 1.46]	—	—
Latino adolescents	−0.56 (0.94)	0.57 [0.09, 3.59]	−0.81 (1.06)	0.45 [0.06, 3.57]	−1.47 (.99)	0.23 [0.03, 1.59]	−2.65 (8.58)	0.07 [0.00, *****]
Latina adolescents	−0.97 (0.84)	0.38 [0.07, 1.97]	−1.49 (.95)	0.23 [0.04, 1.45]	**−2.09 (.95)***	**0.12 [0.02, 0.80]**	−1.29 (3.06)	0.28 [0.001, 111.23]
Compared to Latino adolescents								
Asian male adolescents	−0.23 (0.61)	0.79 [0.24, 2.59]	0.17 (0.72)	1.19 [0.29, 4.86]	−0.55 (1.05)	0.58 [0.07, 4.51]	—	—
Asian female adolescents	0.56 (0.94)	1.76 [0.28, 11.08]	0.81 (1.06)	2.24 [0.28, 17.83]	1.47 (0.99)	4.35 [0.63, 30.11]	2.65 (8.58)	14.16 [0.00, *****]
Latina adolescents	−0.41 (0.31)	0.67 [0.36, 1.23]	−0.68 (0.37)	0.51 [0.24, 1.05]	−0.62 (0.49)	0.54 [0.21, 1.40]	1.36 (6.71)	3.90 [0.00, *****]
Background variables								
Parents' education level	0.18 (0.19)	1.19 [0.83, 1.71]	0.04 (0.23)	1.04 [0.66, 1.64]	0.28 (0.25)	1.33 [0.81, 2.16]	0.67 (0.65)	1.96 [0.55, 7.01]
Math achievement	**−1.05 (0.33)****	**0.35 [0.18, 0.67]**	**−0.91 (0.45)***	**0.40 [0.17, 0.97]**	−0.65 (0.37)	0.52 [0.25, 1.08]	−1.01 (3.34)	0.36 [0.001, 254.22]
Math course	−0.14 (0.12)	0.87 [0.69, 1.10]	0.06 (0.14)	1.06 [0.80, 1.41]	0.05 (0.16)	1.05 [0.76, 1.44]	−0.46 (0.54)	0.63 [0.22, 1.82]
Cohort	0.72 (0.44)	2.06 [0.88, 4.83]	0.66 (0.60)	1.93 [0.60, 6.25]	0.94 (0.56)	2.56 [0.86, 7.61]	−1.37 (11.06)	0.25 [0.00, *****]

Note. Bold indicates significant differences. CI = confidence interval; ***** indicates a large number.
[a] There were no Asian male adolescents who belonged to the moderate with increases trajectory.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6

Logistic Regression Results Predicting Trajectories of Utility Value by Race/Ethnicity and Gender

	Reference group = high with small decreases							
	High with moderate decreases		Moderate and stable		High with increases[a]		Moderate with large decreases	
Predictor	β (*SE*)	*OR* [95% CI]	β (*SE*)	*OR* [95% CI]	β (*SE*)	*OR* [95% CI]	β (*SE*)	*OR* [95% CI]
Compared to Asian male adolescents								
Asian female adolescents	−0.29 (0.39)	0.75 [0.35., 1.61]	−0.49 (0.63)	0.61 [0.18, 2.10)	—	—	−1.29 (1.69)	0.28 [0.01, 7.58]
Latino adolescents	−0.07 (0.33)	0.93 [0.49, 1.78]	0.11 (0.60)	1.11 [0.34, 3.64]	−0.71 (0.73)	0.49 [0.12, 2.06]	0.36 (0.80)	1.44 [0.30, 6.96]
Latina adolescents	−0.48 (0.33)	0.62 [0.33, 1.18]	−0.08 (0.62)	0.92 [0.27, 3.13]	−1.33 (0.95)	0.26 [0.04, 1.71]	0.21 (0.85)	1.23 [0.24, 6.49]
Compared to Asian female adolescents								
Asian male adolescents	0.29 (0.39)	1.34 [0.62. 2.88]	0.49 (0.63)	1.63 [0.48, 5.58]	—	—	1.29 (1.69)	3.63 [0.13, 100.08]
Latino adolescents	0.22 (0.31)	1.25 [0.68, 2.29]	0.60 (0.54)	1.82 [0.63, 5.27]	—	—	1.65 (1.70)	5.34 [0.19, 147.35]
Latina adolescents	−0.19 (0.55)	0.83 [0.45, 1.52]	0.41 (0.57)	1.51 [0.50, 4.59]	—	—	1.50 (1.75)	4.49 [0.15, 138.08]
Compared to Latino adolescents								
Asian male adolescents	0.07 (0.33)	1.07 [0.56, 2.05]	−0.11 (0.60)	0.90 [0.28, 2.93]	0.71 (0.73)	2.04 [0.49, 8.57]	−0.36 (0.80)	0.70 [0.14, 3.37]
Asian female adolescents	−0.22 (0.31)	0.80 [0.44, 1.47]	−0.60 (0.54)	0.55 [0.19, 1.60]	—	—	−1.65 (1.70)	0.19 [0.01, 5.40]
Latina adolescents	**−0.41 (0.18)***	**0.67 [0.47, 0.94]**	−0.19 (0.30)	0.83 [0.46, 1.49]	−0.62 (0.51)	0.45 [0.20, 1.47]	−0.15 (0.33)	0.86 [0.45, 1.63]
Background variables								
Parents' education level	−0.07 (0.10)	0.93 [0.77, 1.12]	0.01 (0.18)	1.01 [0.71, 1.42]	0.00 (0.32)	1.00 [0.54, 1.87]	**0.35 (0.15)***	**1.42 [1.05, 1.92]**
Math achievement	−0.10 (0.09)	0.91 [0.76, 1.08]	−0.05 (0.21)	0.96 [0.64, 1.44]	−0.44 (0.23)	0.64 [0.41, 1.01]	−0.37 (0.22)	0.69 [0.45, 1.06]
Math course	0.06 (0.08)	1.06 [0.91, 1.23]	0.24 (0.20)	1.27 [0.85, 1.88]	0.17 (0.19)	1.19 [0.82, 1.73]	−0.15 (0.27)	0.87 [0.51, 1.46]
Cohort	0.29 (0.21)	1.34 [0.89, 2.02]	**0.85 (0.42)***	**2.34 [1.02, 5.37]**	**2.29 (0.73)****	**9.89 [2.37, 41.29]**	0.35 (0.50)	1.43 [0.53, 3.81]

Note. Bold indicates significant differences. CI = confidence interval.
[a] There were no Asian female adolescents who belonged to the high with increases trajectory.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7
Logistic Regression Results Predicting Trajectories of Attainment Value by Race/Ethnicity and Gender

	Reference group = high and stable			
	Moderate with increases[a]		Moderate with decreases	
Predictor	β (*SE*)	*OR* [95% CI]	β (*SE*)	*OR* [95% CI]
Compared to Asian male adolescents				
Asian female adolescents	—	—	−0.06 (0.43)	0.94 [0.41, 2.18]
Latino adolescents	—	—	0.36 (0.35)	1.44 [0.72, 2.85]
Latina adolescents	—	—	0.24 (0.34)	1.28 [0.66, 2.49]
Compared to Asian female adolescents				
Asian male adolescents	—	—	0.06 (0.43)	1.06 [0.50, 2.47]
Latino adolescents	2.16 (2.83)	8.66 [0.03, 2,225.63]	0.42 (0.36)	1.53 [0.75, 3.12]
Latina adolescents	1.99 (2.97)	7.34 [0.02, 2,467.20]	0.31 (0.35)	1.36 [0.68, 2.70]
Compared to Latino adolescents				
Asian male adolescents	—	—	−0.36 (0.35)	0.70 [0.35, 1.38]
Asian female adolescents	−2.16 (2.83)	0.12 [0.00, 29.66]	−0.42 (0.36)	0.66 [0.32, 1.34]
Latina adolescents	−0.17 (0.66)	0.85 [0.23, 3.07]	−0.12 (0.19)	0.89 [0.61, 1.30]
Background variables				
Parents' education level	0.21 (0.35)	1.24 [0.62, 2.47]	0.05 (0.10)	1.05 [0.87, 1.27]
Math achievement	−0.46 (0.33)	0.63 [0.33, 1.20]	**−0.36 (0.11)****	**0.70 [0.57, 0.86]**
Math course	**0.40 (0.20)***	**1.49 [1.00, 2.21]**	0.07 (0.08)	1.07 [0.91, 1.27]
Cohort	**1.48 (0.61)***	**4.37 [1.34, 14.31]**	**1.56 (0.25)*****	**4.78 [2.94, 7.75]**

Note. Bold indicates significant differences. CI = confidence interval.
[a] There were no Asian male adolescents who belonged to the moderate with increases trajectory.
* $p < .05$. ** $p < .01$. *** $p < .001$.

and access to resources in the United States (Coll et al., 1996), it is important to consider group differences based on these social position factors with and without controls (e.g., parent education, math course difficulty). As expected, more significant differences emerged in the analyses without covariates. In the case of math expectancies for success, there were racial/ethnic differences within each gender where Latino adolescents displayed lower expectancies for success compared to Asian male adolescents with parallel differences among Latina and Asian female adolescents. Asian and Latinx adolescents' math achievement and the rigor of their math courses were significant predictors of their expectancies for success in the analyses with covariates and provide insight into some of the individual and contextual factors that should be considered. The development of Latinx adolescents' expectancies for success may be strongly related to their placement in lower math course tracks or lower math performance compared to Asian adolescents (National Science Foundation, 2019). The pattern of findings with and without controls suggests that negative social and academic experiences of Latinxs, including lower course placement or achievement gaps, may affirm negative societal stereotypes in math. Structural barriers in math, stigma associated with lower course tracking, or varying class quality are some of the issues that may need to be addressed to close the racial/ethnic gaps in expectancies for success development in math (Crisp et al., 2015; Murphy & Zirkel, 2015).

Latinx and Asian Adolescents' Math Interest, Utility Value, and Attainment Value

For all three subjective task value beliefs, we found subgroups of Asian and Latinx adolescents who demonstrated stable (72% for interest; 9% for utility value; 34% for attainment value), decreasing (23% for interest; 83% for utility value; 64% for attainment value), or increasing (5% for interest; 8% for utility value; 2% for attainment value) trajectories. Though our study focused only on Latinx and Asian groups, similar trajectories have emerged in other studies on students' math interest (Gaspard et al., 2020; Musu-Gillette et al., 2015), utility value (Musu-Gillette et al., 2015), and overall subjective task values (Guo et al., 2018) involving White U.S. students in the 1980s and 1990s (Gaspard et al., 2020; Musu-Gillette et al., 2015) and Finnish students in 2000s (Guo et al., 2018). For example, Guo et al. (2018) found decreasing and increasing trajectories across high school in adolescents' overall math subjective task values, which combined their math interest, importance, and usefulness. The current findings extend this work by demonstrating that similar patterns are found among Asian and Latinx U.S. adolescents for each of the three subjective task values.

Testing the three subjective task value beliefs separately in this study also extends prior findings by highlighting differences across the three beliefs. For example, the largest group of adolescents varied across the three beliefs with the decreasing groups being the largest for utility value (83%) and attainment value (64%) whereas the two stable groups were the largest for interest (72%). The characteristics of math courses, including when it is required, may contribute to these different prevalent patterns. Asian and Latinx adolescents may perceive math to be useful or important to them as it is a required part of the core curriculum in middle and the beginning of high school; additionally, they may display moderate or high initial levels of utility and attainment value because their socializers, such as their parents also demonstrate high values in math (Simpkins et al., 2015a). However, Asian and Latinx adolescents' value of math may wane as they are introduced to more diverse topics during high school. As they explore their options and start making more concrete decisions about their future, they may find math to be less central to how they see themselves or useful for what they want to do. Their interest in math, however, may not change as much during this period because it has already become individualized and relatively enduring given that adolescents have already taken math for many years (Hidi & Renninger, 2006). Though learning environments can facilitate developmental changes in interest, the classes in middle and high school may be less interesting as they traditionally involve less teacher–student interaction and less personalized learning experiences, leading to relatively stable patterns of interest development during this developmental stage (Eccles, 1993). Overall, our findings suggest interventional efforts to increase interest or prevent utility value and attainment value from decreasing may be particularly helpful in addressing some of the disparities we see in Asian and Latinx adolescents' motivational belief development in math.

Analyzing the data with a person-centered approach highlighted groups who are often overlooked with a variable-centered approach; one example from the current study is the group of Asian and Latinx individuals whose subjective task values increased over time. Documenting these increases contributes to motivation theory and calls in question the leaky STEM pipeline metaphor that assumes people who leave STEM do not return and that no one switches from non-STEM into STEM fields. The findings from this study and others (e.g., Hsieh & Simpkins, 2022; Starr, Carranza, & Simpkins, 2022) suggest that the pathways in and out of STEM are more fluid with some students moving toward STEM during high school. It also suggests that middle and high school are not too late to spark Asian and Latinx students' math motivational beliefs. Adolescents' exposure to positive sociocultural environments, such as receiving parent support in STEM, may strengthen their motivational beliefs (Eccles & Wigfield, 2020; Starr, Tulagan, & Simpkins, 2022; Wang & Degol, 2013). More studies are needed to explore what may spark, increase, and maintain positive motivational beliefs among Asian and Latinx adolescents.

In contrast to the findings for expectancies for success in math, Latina adolescents did not display lower levels of subjective task values compared to the other groups. It may be that the double marginalization in math is less related to Latina adolescents' subjective task value development compared to their expectancies for success. For example, one study indicated that Latina adolescents were more likely to belong to a profile with low identity and expectancies for success but relatively high interest and utility values (Hsieh et al., 2021). In addition, both Latino and Latina students were found to display an above-average level of subjective task values in Grade 10 (Else-Quest et al., 2013). Studies show that Latinx students have robust family support systems that foster strong academic values (Alfaro et al., 2006). Latina adolescents' choice to not pursue STEM may be more strongly associated with their math expectancies for success, or other factors, such as cost or stronger interests in other domains.

Asian adolescents in this study were more likely to endorse high levels of subjective task values as they entered high school and display decreasing trajectories than increasing trajectories. Asian adolescents may display declines because even though the model minority stereotype might help them to perform better in math, the pressure to conform to the stereotype could also lead to more negative academic attitudes, such as their interest (McGee, 2018). Future studies could involve testing the trajectories across a longer time span or exploring underlying mechanisms that may lead to varying developmental trajectories.

One notable difference found in our analyses with and without covariates is that, without covariates, both Latino/a adolescents were more likely to display lower expectancies for success and interest compared to the Asian male adolescents. The disparities in math may be a result of varying quality in classes or access to resources that are experienced by the adolescents of different racial/ethnic backgrounds (Martin, 2009). Our findings suggest that when some of the effects from these structural barriers are controlled for (e.g., math course-taking, achievement, and parents' education level), Latinx adolescents, especially Latino adolescents, often displayed developmental patterns that were similar to Asian adolescents. Based on these findings, our next steps may entail exploring ways to target the systematic and structural issues that exist in academic and social experiences of marginalized groups in math.

Though we focused on discussing the variability that exists in motivational belief development based on adolescents' race/ethnicity and gender, many of the group differences were not statistically significant. Based on the traditional stereotypes, we speculated that Latinx adolescents (and Latinas specifically) who are marginalized in math would evidence the most negative developmental trends (e.g., low and stable or decreasing beliefs) and that Asians (and Asian male adolescents specifically) would display the most positive developmental trends (Else-Quest et al., 2013; McGee, 2018). However, our findings debunk many of these long-held assumptions by demonstrating that some marginalized adolescents (e.g., Latina adolescents) displayed more positive developmental trajectories than other groups in some cases, and that several racial/ethnic and gender differences in the trajectories for Asian/Latinx male/female adolescents were not statistically significant. These findings suggest a need to explore beyond the average trends within certain group memberships and to test heterogeneity within groups (e.g., gender differences within race/ethnicity). By doing so, we will be able to highlight the complexity in the development of Asian and Latinx individuals that are shaped by their multiple social identities and roles (e.g., Causadias et al., 2018).

Limitations and Future Directions

Despite the significant contributions of this study, it is not without limitations. Our study involved charting the motivational belief development of Asian and Latinx adolescents between Grades 8 and 10, and thus cannot address trends at other developmental ages. Also, our data was collected in Southern California where there are large Latinx and Asian populations, which may limit its generalization to other areas. Moreover, our Asian sample was primarily Southeast Asians and the Latinx sample involved those who identified as Hispanics or Latinos without further distinction. We recognize the within group differences in these populations, such as the diversity that exists within the Asian pan ethnic group (i.e., East Asians vs. Southeast Asians) or Latinx/Hispanic group (i.e., Mexicans, Puerto Ricans, etc.), as well as their differences, including differences in their academic achievement (Pang et al., 2011; Pew Research Center, 2023). Future research could explore diversity within racial/ethnic groups using various indicators (e.g., socioeconomic status, achievement level). Lastly, our sample consisted of more Latinx than Asian students. Though the results might be biased due to the high representation of Latinx population, we note that the sample was representative of the school districts from which students were recruited. With GMM, experts posit that the identification of subgroups accounts for many factors, including but not limited to relative group sizes (Ram & Grimm, 2009).

Therefore, we believe that our findings are meaningful despite the differences in the sample composition, but future studies could involve testing whether the results replicate among samples with a larger number of Asian students.

Replicating these patterns across historical time, developmental period, and in other studies will be critical. Though recent work suggests racial/ethnic and gender differences in adolescents' math motivational beliefs have not changed since the 1980s (Rubach et al., 2022), the developmental changes might differ by historical time. Additionally, researchers can test if the developmental trends in youth's motivational beliefs are the same when one growth function is estimated from childhood through adolescence versus models where more dynamic growth functions are estimated. Finally, researchers can incorporate other studies to test if they find similar patterns, such as stable or increasing trajectories as suggested by this and other works on racially/ethnically diverse populations (e.g., Hsieh & Simpkins, 2022).

In some of the models for interest and utility value, we had to fix the variance of the slope factor to .001 to aid with model convergence. Even though experts recommend fixing the variance of the growth factors to handle model convergence issues in GMM (Jung & Wickrama, 2008; Ram & Grimm, 2009), models with fixed variances should be interpreted with caution given that overextraction can be more common when the variances are constrained to be homogeneous (Infurna & Grimm, 2018). Thus, even though we followed the procedures recommended by statistical experts and selected our final models based on multiple indicators, theoretical alignment, and after cross-validating our findings among subsamples, we note the caution (Ram & Grimm, 2009).

Conclusion

This study highlights the unique patterns of Asian and Latinx students' math motivational belief development during the transition from middle to high school. Our findings also add to the limited literature on Asian and Latinx adolescents and help guide applied efforts to address the gaps that exist across students of diverse backgrounds by displaying the issues of marginalization and privilege at the intersection of race/ethnicity and gender. One critical implication of our findings is that researchers might utilize various analytic strategies to examine the potential multiple trajectories that underlie the average trends. By using a person-centered approach, we were able to identify patterns that challenge the long-held stereotypes concerning the leaky STEM pipeline, declines in math motivational beliefs, and that marginalized adolescents display larger decreases in their motivational beliefs than adolescents privileged in math. This study suggests that motivation researchers can move forward to explore the rich diversity that exists within racial/ethnic and gender groups to document not only those who are falling behind but also those who are succeeding. By doing so, we will be able to highlight the strengths of marginalized groups, provide more targeted support, and help identify specific ways to address the societal and systematic issues that exist in STEM, such as in math, to create a more equitable learning environment for all youth.

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