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EMPIRICAL ARTICLE

Mindsets, contexts, and college enrollment: Taking the long view on growth mindset beliefs at the transition to high school

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Abstract

Socioeconomic disparities in academic progress have persisted throughout the history of the United States, and growth mindset interventions—which shift beliefs about the malleability of intelligence—have shown promise in reducing these disparities. Both the study of such disparities and how to remedy them can benefit from taking the "long view" on adolescent development, following the tradition of John Schulenberg. To do so, this study focuses on the role of growth mindsets in short-term academic progress during the transition to high school as a contributor to longer-term educational attainment. Guided by the Mindset × Context perspective, we analyzed new follow-up data to a one-year nationally representative study of ninth graders (National Study of Learning Mindsets, $n = 10{,}013$; 50% female; 53% white; 63% from lower-SES backgrounds). A conservative Bayesian analysis revealed that adolescents' growth mindset beliefs at the beginning of ninth grade predicted their enrollment in college 4 years later. These patterns were stronger for adolescents from lower-SES backgrounds, and there was some evidence that the ninth-grade math teacher's support for the growth mindset moderated student mindset effects. Thus, a time-specific combination of student and teacher might alter long-term trajectories by enabling adolescents to develop and use beliefs at a critical transition point that supports a cumulative pathway of course-taking and achievement into college. Notably, growth mindset became less predictive of college enrollment after the onset of the COVID-19 pandemic, which occurred in the second year of college and introduced structural barriers to college persistence.

KEYWORDS
context, growth mindset, life-course perspective

INTRODUCTION

In the United States, college education can boost earnings and improve health, family stability, and social connectedness (see Hout, 2012), but young people from more socioeconomically disadvantaged backgrounds are less likely to enroll in and graduate from college, in large part due to structural barriers in the education system (National Center for Education Statistics, 2014; National Student Clearinghouse, 2021a; Sirin, 2005). Even though college matriculation is a discrete "event," it is embedded in a much longer educational career through an education system that is complex, cumulative, and stratified (Crosnoe & Muller, 2014). As a result, socioeconomic disparities in college-going need to be studied in the context of that career, following the "long view" of adolescent development emphasized by Schulenberg (Schulenberg et al., 2018). Applying this long view to the question of college enrollment considers the key transitions, developmental disturbances, and turning points through adolescence in which individual actions and broader social forces converge to eventually lead adolescents to (or away from) college (see Elder, 1998; Elder et al., 2003; Lerner & Busch-Rossnagel, 2014; Schulenberg et al., 2003; Schulenberg & Maggs, 2002).

One promising avenue for influencing socioeconomic and other disparities in academic progress during adolescence is suggested by the *Mindset* × *Context* framework (see Bryan et al., 2021; Hecht et al., 2021; Hecht, Murphy

Celebrating the Legacy and Work of John Schulenberg: Taking the Long View on Adolescence.

et al., 2023; Walton & Yeager, 2020; Yeager & Dweck, 2020). This framework is centered on individuals' *mindsets*, which refer to situation-general beliefs, assumptions, or perspectives that shape how youth interpret their own capabilities and the world around them (see Dweck, 2017; Harackiewicz & Priniski, 2018; Walton & Wilson, 2018; Yeager & Walton, 2011). For example, teaching adolescents the growth mindset view that intelligence is malleable (rather than fixed) has led to greater academic achievement in secondary school (e.g., Blackwell et al., 2007; Yeager et al., 2019, 2022). This psychological aspect of adolescents' schooling, however, is contextualized within larger social settings and systems (i.e., *contexts*) that either block or facilitate the translation of mindsets into academic progress. The Mindset × Context framework, therefore, makes predictions about where and for whom such potentially adaptive mindsets will be most strongly associated with positive outcomes (see Bryan et al., 2021; Hecht et al., 2021; Hecht, Murphy et al., 2023; Walton & Yeager, 2020). Much like the general study of educational disparities, Mindset × Context research would also benefit from taking long view, such as by considering whether there are critical periods and places in which the interplay of mindset and context can have more or less enduring consequences for educational attainment.

Taking this long view, it is important to consider whether the Mindset × Context dynamics implicated in socioeconomic disparities in academic progress persist over time, while also considering how socioeconomic disparities in college-going have roots in more distal processes. To do so, the present research examined how the interplay of mindsets and contexts during one key developmental and educational transition (the start of high school) set the stage for a subsequent developmental and educational transition (the first year of college), with a particular focus on the experiences of young people from more vulnerable groups (e.g., those from more socioeconomically disadvantaged backgrounds). This inquiry drew on the National Study of Learning Mindsets (NSLM), a unique longitudinal dataset with a nationally representative sample of ninth graders that, informed by life course and life span approaches, recently added follow-up data on educational attainment years after ninth grade. Applying a Bayesian machine-learning algorithm to these rich data allowed tests of the complex multilevel interactions at the heart of this dynamic Mindset × Context approach while minimizing the likelihood of type I error. Importantly, these follow-up data allowed us to also consider how the COVID-19 pandemic, which occurred 5 years after the NLSM began, destabilized the path from Mindset × Context dynamics at the start of high school to eventual college enrollment.

An overview of growth mindsets in adolescents' educational careers

Adolescents with growth mindsets—those who believe that their intellectual abilities can be improved through hard work, good strategies, and help from others—tend to do better academically than adolescents who have a *fixed mindset* view of intelligence as unchangeable (see Dweck & Yeager, 2019; Yeager & Dweck, 2012). Ample experimental research, including evaluations of mindset interventions, document these effects across a wide variety of academic outcomes in the United States (e.g., Aronson et al., 2002; Blackwell et al., 2007; Dweck, 2006; Dweck & Leggett, 1988; Good et al., 2003; Paunesku et al., 2015; Yeager, Romero et al., 2016; Yeager et al., 2019, 2022; for a meta-analysis see Burnette et al., 2022). Recent international comparisons have also demonstrated wide generalizability of such patterns across 72 out of the 74 developed nations that participated in the Programme for International Student Assessment, or PISA (OECD, 2021). The average correlation between growth mindset beliefs and academic test scores across these countries was approximately .20, and the correlation in the United States was greater than .30 (see Yeager & Dweck, 2020). These correlations persist even when controlling for a rich set of covariates and when data are collected by independent third parties (Claro & Loeb, 2024).

Historically, the academic effects of adolescents' growth mindsets have been interpreted through cognitive and psychological processes. The idea is that these mindsets encourage adaptive learning-oriented behaviors—such as seeking (vs. avoiding) challenging material and responding in an effortful (vs. helpless) way to failure (Molden & Dweck, 2006; Robins & Pals, 2002)—by facilitating adolescents' formation of *meaning systems*, which refer to the collections of goals, attributions, and other related beliefs that either support or impede academic thriving (see Dweck & Yeager, 2019; Molden & Dweck, 2006; Yeager & Dweck, 2020 for reviews). For example, adolescents with more of a growth mindset may answer questions such as "What am I trying to accomplish here?" and "Why did I do poorly on that test?" in ways that attribute failure to controllable factors (e.g., use of ineffective strategies) rather than fixed characteristics (e.g., a lack of innate talent), and imply a positive role of effort (see Dweck & Yeager, 2019; Yeager & Dweck, 2020).

The Mindset × Context framework has expanded this traditionally psychological perspective on mindsets by recognizing that there are some groups of people and situations in which mindsets should be especially beneficial to academic pursuits (see Hecht et al., 2021; Yeager & Dweck, 2020). This framework highlights three social circumstances likely to facilitate the translation of mindsets, including growth mindsets, into more positive academic outcomes. First, mindsets are expected to matter for adolescents whose social or academic positions suggest greater risk of experiencing academic problems. Groups of students who have a higher probability of poorer outcomes, such as those who have less prior academic preparation or have experienced academic setbacks in the past, tend to profit most from a potentially beneficial mindset (Harackiewicz et al., 2016; Murphy et al., 2020; Okonofua et al., 2016, 2020; Reeves et al., 2020; Stephens, Hamedani & Destin, 2014; Walton et al., 2015; Walton & Cohen, 2007, 2011; Williams

et al., 2020; Yeager et al., 2019; Yeager, Romero et al., 2016; see Burnette et al., 2022 for meta-analytic support). Such adolescents have more room to improve in any given academic domain and fewer resources to draw upon in these pursuits overall, which increases the likelihood of positive mindsets serving as a compensating force (see Ross & Mirowsky, 2006). Second, mindsets are predicted to matter more when adolescents are in environments that signal that the relevant mindset is a valid and useful guide for how to behave within the context, such as a classroom in which teachers employ pedagogical practices that reinforce the mindset and suggest that it will be rewarded, or schools in which peer norms support challenge-seeking (Yeager et al., 2019, 2022; see Hecht et al., 2021; Walton & Yeager, 2020; Yeager & Dweck, 2020). These "psychological affordances" (Walton & Yeager, 2020) not only validate the beliefs themselves, but also encourage adolescents to act more consistently on those beliefs (Hecht, Dweck et al., 2023; see also Yeager et al., 2022). Third, mindsets are thought to matter more when adolescents' circumstances provide more opportunities to make decisions and choices that will advance their academic interests, such as greater freedom to choose course-taking pathways (Rege et al., 2020) or the lack of financial barriers that constrain college enrollment decisions. These "structural affordances" remove barriers to action that are outside of the adolescent's control, providing opportunities for students to make academic decisions that are consistent with their mindset beliefs (see Bryan et al., 2021; Hecht et al., 2021); conversely, contexts that add more structural barriers to action should weaken links between mindsets and outcomes (Rege et al., 2020).

In line with the Mindset × Context framework, meta-analyses and large cross-context studies have found that growth mindsets tend to have heterogeneous effects across the adolescent population in ways that match the prior theoretical expectations (e.g., Burnette et al., 2022; Yeager et al., 2019, 2022). For example, the NSLM has revealed that a growth mindset intervention was more impactful for adolescents with a history of poorer academic performance, in classrooms headed by teachers who endorsed growth mindsets, and in schools in which peer norms were more aligned with growth mindsets (e.g., Yeager et al., 2019, 2022; Yeager, Walton et al., 2016). In other words, adolescents' growth mindsets have the potential to improve their academic outcomes, but these benefits are not uniform.

Taking the long view of Mindset × Context dynamics in adolescence

The Mindset × Context framework has helped to push mindset research in new directions by emphasizing the interplay of person and place in adolescents' academic progress. The framework could play an even greater explanatory role by investigating the temporal, dynamic nature of this interplay. This long view of adolescence, as advocated by Schulenberg (2016) in his 2016 Presidential Address for the Society for Research on Adolescence, draws on core concepts of life course and life span theories of human development. The idea of this long view is that a young person's life unfolds in the form of a long-term trajectory that is structured by key transitions whose impact is colored by their timing. This trajectory is also influenced by the dance between adolescents' own agency and their location within a series of structural and interpersonal constraints over time (see Elder et al., 2003).

In this long view, a growth mindset can be academically beneficial not just at a proximate point in the educational career but also by setting adolescents on much longer trajectories through the educational system, particularly if the growth mindset is held at a well-timed transition point (see Crosnoe & Johnson, 2011; Morgan, 2005). The centerpiece of this view is that growth mindsets held during the transition into high school at ninth grade will facilitate college-going years later. In the United States, ninth graders encounter a complex curriculum that is more highly differentiated, challenging, high-stakes, and cumulative than their previous schooling. How adolescents navigate the initial steps in terms of their achievement and course selections, therefore, sets them on a path that becomes increasingly self-sustaining. This means that any resource that helps adolescents at this transition point has great potential for promoting more enduring benefits. Because the math curriculum is the *most* differentiated, challenging, high-stakes, and cumulative for many adolescents in high school, ninth-grade math courses are where resources could have especially large implications for long-term impact (Allensworth & Easton, 2005; Crosnoe & Muller, 2014). One such resource is adolescents' growth mindset beliefs, which would position the challenges at this transition as an opportunity to improve their intellectual abilities, rather than a signal that they lack "natural" ability (see Yeager & Dweck, 2012).

This hypothesized connection between growth mindsets in ninth grade and eventual college-going outcomes should, in turn, be contextualized in the past, present, and future. Regardless of who is more likely to hold a growth mindset at this time, it is critical to ask: Who is most likely to benefit if they do? As noted, adolescents who have grown up in more socioeconomically disadvantaged families are not afforded resources that undergird the academic pursuits of their more advantaged peers (e.g., high-quality learning materials, technology, tutoring services, test preparation programs, interpersonal networks). This disparity can be exacerbated among adolescents from racial/ethnic minority populations that also face extensive bias and discrimination in the educational system regardless of their resources (see Carter et al., 2013). If any single resource has heightened benefits for those who lack more resources overall and is more redundant for those who have more resources, then developing a growth mindset in ninth grade should be more likely to set adolescents from more socioeconomically disadvantaged backgrounds onto a long-term pathway through the cumulative curriculum of high school to college, relative to more advantaged peers. We focus on socioeconomic background as a demographic risk factor that may moderate the relationship

between growth mindset and college enrollment, given that (a) the largest group-based disparities in postsecondary enrollment in the United States are along socioeconomic lines (Reber & Smith, 2023) and (b) previous research finds larger benefits of a growth mindset for students from lower socioeconomic status backgrounds (Burnette et al., 2022; Claro et al., 2016). (See Appendix S1 for secondary analyses that examine growth mindset moderation by race/ethnicity).

The value of having a growth mindset resource during a critical window of adolescence, however, depends on where adolescents from different family and academic backgrounds are located within the educational system. Teachers deliver curricula, teach skills, evaluate students, and offer (or withhold) social and psychological support. A growth mindset is likely to wither in a classroom led by a teacher who does not share this mindset and/or who engages in practices that deny opportunities for enacting it (see Hecht et al., 2021; Hecht, Murphy et al., 2023).

Of course, life course and life span perspectives on adolescence—which capture the long view advocated by Schulenberg—advocate for considering time historically and not just developmentally (see Elder, 1999; Elder et al., 2003; Lerner & Busch-Rossnagel, 2014; Shanahan et al., 1998). A recent example is the COVID-19 pandemic, which introduced unforeseen economic and social changes that discouraged many adolescents from persisting into or through college (see Long & Douglas-Gabriel, 2020; National Student Clearinghouse, 2021a, 2021b; United States Census Bureau, 2020). For instance, widespread job losses, the switch to online learning, and the extreme stress of the times may have made college less affordable, desirable, or endurable, even if only temporarily (see Long & Douglas-Gabriel, 2020; Ryan, 2023). Once students stop attending college, it can be difficult for them to restart. Thus, the disruptions of the COVID-19 pandemic may have introduced barriers—from the structural to the psychological—that prevented adolescents from capitalizing on the college-going boost of paths of academic progress through high school curricula that might have arisen from holding a growth mindset early in high school. Reductions in the benefits of a growth mindset may have been especially pronounced among adolescents from more socioeconomically disadvantaged backgrounds, for whom the pandemic served as a greater barrier to college enrollment (see Long & Douglas-Gabriel, 2020). These possibilities would be reflected in interactions between growth mindset, time, and socioeconomic status when predicting college enrollment.

The present research

Figure 1 presents the conceptual model for this study, which refined the Mindset × Context framework with a life course lens in the spirit of Schulenberg's long view of adolescence. This conceptual model generated four main testable hypotheses:

1. Adolescents' growth mindset beliefs at the transition to high school will predict their subsequent enrollment in college.
2. This long-term link between early mindsets and later college-going will be stronger for adolescents from more socioeconomically disadvantaged backgrounds.

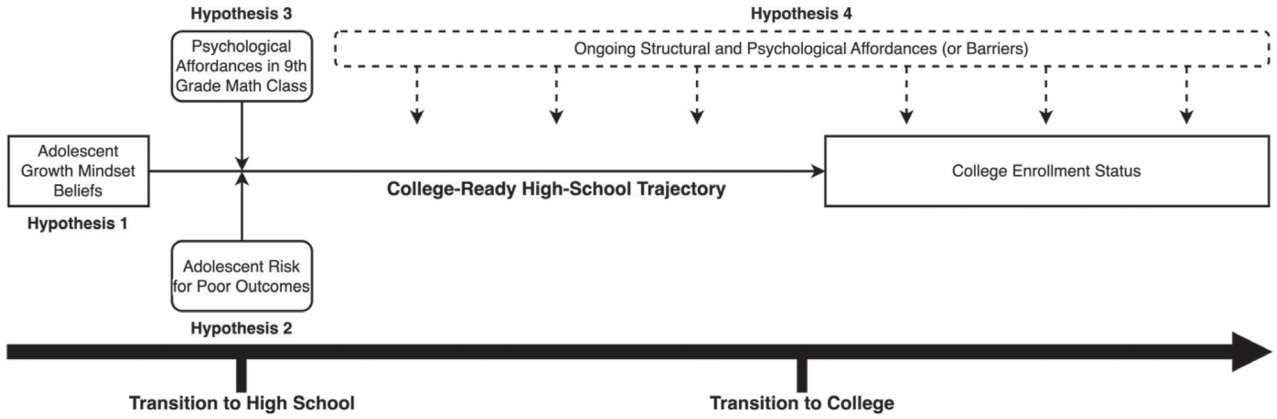

FIGURE 1 Integrative model of how adolescents' growth mindset beliefs at the transition to high school may affect subsequent college enrollment and persistence. The model first predicts that adolescents' growth mindset beliefs in ninth grade will predict a college-going academic trajectory, leading to higher rates of initial enrollment in college (Hypothesis 1). Second, the model predicts that the magnitude of this association will depend on adolescents' prior risk for poor academic outcomes (Hypothesis 2). Here, we focus on adolescents from lower socioeconomic status backgrounds, but also explore adolescents taking a lower-level ninth-grade math course as an additional potential at-risk group. Third, the model predicts that the magnitude of this association will depend on the psychological affordances in adolescents' ninth-grade math classes (Hypothesis 3). Here, we focus on their teacher's support for the growth mindset. Lastly, the model predicts that the potential benefits of a growth mindset for college enrollment will depend upon the ongoing presence of structural affordances in adolescents' environments, which could be disrupted by a major destabilizing event like the COVID-19 pandemic (Hypothesis 4a). The model predicts that this reduced benefit of a growth mindset may be especially pronounced for groups that are most starkly impacted by such a destabilizing event, such as students from lower socioeconomic status backgrounds in the case of the COVID-19 pandemic (Hypothesis 4b).

3. Associations between early mindsets and later college-going, in general and within vulnerable groups of adolescents, will be stronger when adolescents are in ninth-grade math classes led by teachers who were perceived to be more supportive of a growth mindset (i.e., those with more psychological affordances).
4. This association between early mindsets and later college-going will be attenuated in the first full academic term after the onset of the COVID-19 pandemic (Hypothesis 4a), especially for young people from more socioeconomically disadvantaged backgrounds (Hypothesis 4b).

The NSLM is uniquely equipped to test these hypotheses because it (a) was conducted in a nationally representative sample with high longitudinal response rates, which promotes generalizability, (b) contains relevant measures of all focal concepts, and (c) followed a cohort in which the COVID-19 pandemic occurred as adolescents on a normative academic trajectory were entering their second year of college. Of note, the NLSM did include a growth mindset intervention in ninth grade (see Yeager et al., 2019). Here we focus on adolescents' measured growth mindsets while controlling for their exposure to the treatment to better capture the many sources of variability in mindsets beyond intervention impact.

METHOD

Participants

Data for this study come from the NSLM. The NSLM included 16,302 students from a random sample of 76 regular public high schools in the United States. Students completed two questionnaires during the 2015-2016 school year. (Students were also randomly assigned to an intervention or a control group, not discussed here.) Additional details on recruitment, procedures, and materials from the NSLM are provided by Yeager et al. (2019). The original study was approved by the IRBs at the University of Texas at Austin, Stanford University, and ICF International.

Of the 16,302 adolescents surveyed, 10,948 attended schools that provided sufficient administrative records for students to be matched with a single ninth-grade math teacher (see Appendix S1 for details). Note that this number is larger than the 8,775 adolescents matched to ninth-grade math teachers in a previous analysis of the NSLM (Yeager et al., 2022). This sample was larger because (a) we received new transcript data that allowed us to match more adolescents to their math teachers and (b) unlike the previous analysis, it was not necessary to exclude adolescents missing particular variables such as math grades. Of the 10,948 matched adolescents, 224 were excluded due to missing data for the focal independent variables (growth mindset beliefs, adolescent SES, ninth-grade math course, and perceived teacher support for the growth mindset). An additional 711 adolescents were excluded because their college enrollment data could not be obtained. The final sample thus included 10,013 adolescents nested within 312 math teachers.

Of the 10,013 adolescents in the analytic sample (M_{age} = 14.76 years), 72% were in Algebra I or a math course below that level and 28% were in a math course above Algebra I. The sample was 50% female and racially diverse: 15% of adolescents were Black, 22% Hispanic or Latino/a/x, 5% Asian, 5% Native American, Pacific Islander/Native Hawaiian, or Middle Eastern, and 53% white. Sixty-three percent of adolescents did not have a mother with a bachelor's degree. Among the teachers, 59% were female, 88% were white, 54% had earned at least a master's degree, and they had an average of 13.56 years of teaching experience (SD = 9.67).

Measures

The outcome, focal predictor variable, each moderator, and all covariates are described below. Correlations and descriptive statistics for all focal measures are provided in Table 1.

Outcome

The outcome of this study was adolescents' enrollment in college over time from fall 2019 (i.e., the academic term an adolescent in this sample on the normative trajectory would have begun college) through fall 2021 (i.e., the latest term of data that have been processed to date). College enrollment data were collected from the National Student Clearinghouse (NSC) and included information about (a) adolescents' enrollment status (e.g., full-time, part-time, not enrolled) and (b) the type of institution in which they were enrolled (e.g., 4-year, 2-year). We used these data to create an ordinal coding of adolescents' enrollment status for each academic term: 0 = not enrolled; 1 = enrolled, not full-time; 2 = enrolled full-time at a 2-year college; 3 = enrolled full-time at a 4-year college. This measure was computed to capture how early high-school experiences were related to post-secondary outcomes that could shape subsequent workforce outcomes, which requires accounting not only for whether adolescents were enrolled in college, but also the selectivity of their post-secondary institution (see Goyer et al., 2017 for a similar indicator). See Appendix S2 for detailed information on how this outcome was coded.

Focal predictor variable

The key predictor in this study was adolescents' growth mindset beliefs in ninth grade. Growth mindset beliefs were measured on an initial student survey (administered 1–5 weeks into the school year) with the same composite that has been used in previous analyses of the NSLM data (Yeager et al., 2019, 2022). This composite consists of three items rated on a 6-point scale from 1 = *Strongly disagree* to 6 = *Strongly agree* ("Your intelligence is something about you

TABLE 1 Correlations and descriptive statistics for major variables in the study.

Variable	1	2	3	4	5	6	7	8
1. Ninth-grade growth mindset	–							
2. Ninth-grade math course level (1 = above Algebra I, 0 = Algebra I or below)	0.15***	–						
3. Ninth-grade math teacher affordances	0.04***	0.14***	–					
4. College enrollment status (fall 2019)	0.14***	0.33***	0.07***	–				
5. College enrollment status (spring 2020)	0.14***	0.35***	0.08***	0.90***	–			
6. College enrollment status (fall 2020)	0.09***	0.33***	0.04***	0.70***	0.74***	–		
7. College enrollment status (spring 2021)	0.09***	0.34***	0.05***	0.67***	0.71***	0.90***	–	
8. College enrollment status (fall 2021)	0.09***	0.35***	0.05***	0.65***	0.68***	0.83***	0.86***	–
N	10,013	10,013	10,013	10,013	10,013	10,013	10,013	10,013
M	3.95	0.28	3.74	1.31	1.25	0.98	0.92	0.90
SD	1.13	0.45	0.31	1.33	1.33	1.28	1.27	1.28

***$p < .001$.

that you can't change very much," reversed, "You have a certain amount of intelligence, and you can't do much to change it," reversed, "Being a math person or not is something you really can't change. Some people are good at math and other people aren't," reversed; α = .72). There were 71 adolescents who did not report on these items in survey 1. These adolescents' self-reported mindset beliefs were instead taken from survey 2 (~5 weeks later), using the same scale.

Primary moderators

Primary moderators in this study were adolescent SES and perceived teacher support for the growth mindset.

Consistent with previous analyses of the NSLM data (Destin et al., 2019), we operationalized adolescent SES in terms of maternal education because adolescents tend to accurately report their mother's education level and this measure is consistently associated with academic outcomes (see Entwisle & Astone, 1994). In particular, psychological research on SES focuses on parents' college education as a cultural experience that affects adolescents' cultural capital and socialization within the education system (Stephens, Markus & Phillips, 2014). Therefore, we distinguish whether adolescents' mother received a bachelor's degree (higher-SES) or did not (lower-SES). We filled in missing information about mother education ($n_{missing} = 480$) using administrative reports on adolescents' free- or reduced-price lunch (FRL) status (FRL imputed as lower-SES, not FRL imputed as higher-SES), as FRL is another established indicator of SES that has been found to behave similarly to maternal education in the NSLM (Destin et al., 2019). The few adolescents who did not report maternal education *and* did not have data on FRL ($n = 28$) were imputed as lower-SES as previous analyses found that adolescents who did not know their mothers' education levels were similar to those whose mothers did not complete a bachelor's degree on several background measures including grade point average (Destin et al., 2019).

Perceived teacher support for the growth mindset was measured in terms of adolescents' perceptions of their teachers' mindsets and responses to students who are perceived to have (or lack) "natural" ability (see Hecht et al., 2021; Hecht, Murphy et al., 2023). Adolescents reported these perceptions during the second survey session (approximately 6–10 weeks into the school year), after they had formed impressions of their math teachers. The measure included four items on a 5-point scale from 1 = *Not at all true* to 5 = *Extremely true* ("My math teacher believes that everybody in my class can be very good at math," "My math teacher seems to believe that only a few students will understand the hardest problems," reversed, "My math teacher seems to like you better if you are good at math," reversed, "My math teacher calls you smart if you are good at math" reversed; α = .61). We aggregated these reports to the teacher level, using the "leave-one-out" method. That is, for each adolescent, we calculated the class average perceived teacher support for the growth mindset, excluding the given adolescent's own rating of the teacher from the mean. Note that relatively little variance in perceived teacher support for the growth mindset was accounted for by teachers (ICC = .06). We use this teacher-aggregated measure because our hypotheses concern a teacher-level construct, but see Appendix S7 for secondary analyses that used a student-level measure and found similar results.

Exploratory moderator

We explored the moderating role of an additional variable that could alternatively capture adolescents' risk for low enrollment in college (Hypothesis 2): adolescents' ninth-grade math course level. This measure differentiated between adolescents taking Algebra I or below and those taking a course above Algebra I. These data were gathered from administrative records. Missing values ($n = 649$) were filled using adolescents' self-reported highest math class.

JOURNAL OF Research on Adolescence

Covariates

We accounted for several covariates that might confound the relationship between adolescents' growth mindset beliefs and enrollment status (and therefore should be accounted for in a model seeking to isolate the impact of growth mindset). These covariates included demographic characteristics (i.e., gender, race/ethnicity), prior achievement (i.e., adolescents' grade point averages in eighth grade), intervention condition (to remove any potential intervention effects from this analysis), and dummy codes indicating the high school in which a given adolescent was enrolled at the outset of the study. We also accounted for several teacher-level characteristics that might confound the moderating influence of teacher support for the growth mindset. These covariates—measured on a separate survey completed by math teachers—included teachers' accessible pedagogical content knowledge measured with the Classroom-Video-Analysis assessment (Kersting et al., 2014), fluid intelligence measured with an abbreviated version of Raven's Progressive Matrices, and implicit racial bias measured with the Affect Misattribution Procedure (Payne & Lundberg, 2014). Additional details on these measures are provided in Appendix S4 and by Yeager et al. (2022).

Analytic approach

Analyses proceeded in two phases. In the first phase, we conducted a descriptive analysis to summarize levels of college enrollment over time as a function of growth mindset beliefs and adolescent SES, illustrating the patterns of enrollment evident in the raw data. In the second phase, we tested our full set of hypotheses using a conservative Bayesian machine-learning analysis that is designed to explore patterns of moderation while reducing the likelihood of false-positive results. This method was well-suited to test the diverse moderators in our conceptual model (Figure 1) while also ruling out a variety of confounds and thoroughly testing the robustness of the association between growth mindset and college enrollment.

DESCRIPTIVE ANALYSIS

Approach to descriptive analysis

Recall that college enrollment was scored on a 0 (not enrolled) to 3 (enrolled full-time at a 4-year college) scale in this study. Table 2 displays the percentage of adolescents in each category of enrollment across the five academic terms. To examine how college enrollment varied as a function of adolescents' growth mindset beliefs and socioeconomic status, we compared percentages in each of the four enrollment categories between adolescents with high (i.e., top tercile) versus low (i.e., bottom tercile) growth mindset beliefs and from higher-versus lower-SES backgrounds in each of the three key academic terms (Figure 2): fall 2019 (the first term in which adolescents on a normative academic trajectory would be enrolled in college), fall 2020 (the first full term after the onset of the COVID-19 pandemic), and fall 2021 (the last available term of potential enrollment in the data).

Findings from descriptive analysis

Adolescents who reported high (vs. low) growth mindset beliefs in ninth grade had higher levels of enrollment in fall 2019 (Figure 2a). This difference was descriptively larger among lower-SES adolescents (Cohen's $d = 0.32$) as compared to higher-SES adolescents (Cohen's $d = 0.20$). Lower-SES adolescents were 14 percentage points more likely to be enrolled in any sort of college when they had reported high (vs. low) growth mindset beliefs, whereas higher-SES adolescents were 7 percentage points more likely to be enrolled in any sort of college when they had reported high (vs. low) growth mindset beliefs. However, growth mindset was similarly associated with full-time enrollment in a 4-year college across socioeconomic groups. For both groups, students who had reported high levels of growth mindset beliefs were 11 percentage points more likely to be enrolled full time in a 4-year college than those who had reported low levels of growth mindset beliefs (Figure 2a).

Adolescents who reported high (vs. low) growth mindset beliefs in ninth grade also had higher levels of enrollment in fall 2020 (Figure 2b)—the first full term after the onset of the COVID-19 pandemic—but the magnitude of this apparent benefit of a growth mindset was somewhat muted (Cohen's $d = .09$ among higher-SES adolescents; Cohen's $d = .21$ among lower-SES adolescents). In the academic term after the pandemic began, adolescents from higher-SES backgrounds showed similar overall levels of enrollment regardless of ninth-grade growth mindset (2 percentage point difference between those with high and low growth mindset beliefs), but those with high (vs. low) growth mindset beliefs remained 6 percentage points more likely to be enrolled full-time in a 4-year college.

TABLE 2 Percentage of adolescents within each category of enrollment status by academic term.

Enrollment status	Fall 2019 (%)	Spring 2020 (%)	Fall 2020 (%)	Spring 2021 (%)	Fall 2021 (%)
Not enrolled	44	47	58	62	63
Enrolled, not full-time	13	12	10	9	9
Enrolled full-time, 2-year	9	8	7	5	3
Enrolled full-time, 4-year	33	32	25	24	25

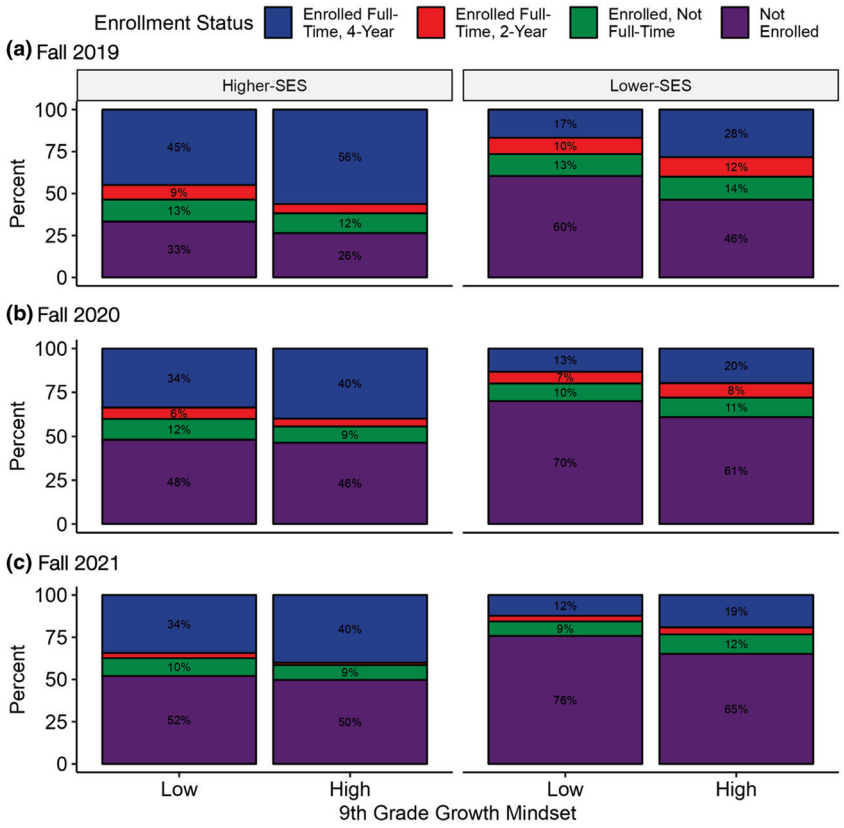

FIGURE 2 Percentages of adolescents in each category of enrollment as a function of ninth-grade growth mindset beliefs (low = bottom tercile, high = top tercile) and socioeconomic status (SES) in fall 2019 (a), fall 2020 (the first full term after the onset of the COVID-19 pandemic; b), and fall 2021 (c). Text not included for percentages ≤5%.

Lower-SES adolescents with high levels of growth mindset beliefs were 9 percentage points more likely to be enrolled in college at all and 7 percentage points more likely to be enrolled full-time in a 4-year college than those with low levels of growth mindset beliefs. These patterns remained similar in fall 2021 (Figure 2c) for both higher-SES (Cohen's $d = 0.09$) and lower-SES (Cohen's $d = 0.23$) adolescents, except that the difference in being enrolled in any type of college between lower-SES adolescents with high (vs. low) growth mindset beliefs became somewhat larger than in fall 2020 (11 percentage point difference).

Interpretation of descriptive analysis

These raw descriptive statistics suggested that rates of college enrollment were higher, on average, among adolescents who reported high levels of growth mindset beliefs in ninth grade, relative to those who reported lower levels of growth mindset (i.e., more fixed mindsets). Next, by dividing the outcome variable into four different levels of college enrollment, it was also possible to examine where differences by mindset were most pronounced. This answer seemed to depend, in part, on adolescents' socioeconomic status. Among adolescents from higher-SES families, the largest difference between the mindset groups appeared with respect to full-time enrollment in a four-year university. Because these adolescents were more likely to have access to financial and sociocultural resources and advantages relative to students from lower-SES backgrounds (Attewell et al., 2007; Lareau, 2003; Weininger et al., 2015), the former group's baseline rates of college enrollment tended to be very high. Indeed, fully 71% of higher-SES adolescents in the sample were enrolled in college in the fall of 2019. For these higher-SES adolescents, a growth mindset in ninth grade may have done more to affect the *type* of college they ended up attending (e.g., a 4-year college), rather than whether they attended college at all.

Conversely, the largest growth mindset-related differences among lower-SES adolescents appeared with respect to whether they enrolled in college *at all*. Baseline rates of enrollment tended to be much lower among adolescents from lower-SES backgrounds. Only 46% of lower-SES adolescents in the present sample were enrolled in any college in the fall of 2019. Thus, for these adolescents, a growth mindset in ninth grade may have done more to affect whether they ended up enrolling in any sort of college than it did for higher-SES adolescents.

These descriptive results illustrated how adolescents' rates of college enrollment dramatically decreased in the fall of 2020, after the onset of the COVID-19 pandemic, while also providing suggestive evidence for the protective

role of adolescents' ninth-grade growth mindset beliefs. For example, lower-SES adolescents with high levels of growth mindset beliefs in ninth grade remained enrolled through the pandemic at a higher rate than those with low levels of growth mindset beliefs.

Overall, this descriptive analysis illustrated important differences in college enrollment depending on adolescents' growth mindset beliefs that were measured 4 years prior, at the start of high school. This type of analysis, while illustrative, has important limitations. First, adolescents' growth mindset beliefs in ninth grade may be correlated with a variety of important factors (e.g., history of academic performance) that may confound the relationship between these beliefs and subsequent college enrollment. These possible confounds should be accounted for in statistical models before strong conclusions about growth mindset beliefs can be drawn. Second, a descriptive analysis cannot simultaneously evaluate the complex set of relationships specified in our conceptual model (Figure 1). In the following section, we addressed these key limitations using a conservative Bayesian analysis. This analysis allowed us to assess whether the relationships reported here were robust even when rigorously accounting for the role of potential confounds, using a best-in-class propensity score and regression tree method, while also enabling us to test the variety of moderators foreshadowed by the Mindset × Context perspective in a way that guards against false-positive moderation results.

HYPOTHESIS TESTING WITH BAYESIAN CAUSAL FOREST

Bayesian causal forest models

Our primary analyses used multilevel Bayesian causal forest (BCF) models (Hahn et al., 2020), with adolescents (level 1) nested within teachers (level 2), to examine the association between ninth-grade growth mindset beliefs and college enrollment. BCF is a Bayesian machine-learning algorithm that has emerged as a leading method to estimate quasi-experimental causal effects while reducing the likelihood of false positive results (Dorie et al., 2017). It does this, in part, by incorporating the data with prior distributions that are centered at zero (i.e., assuming that the target variable does not have an effect). As a result, estimates from BCF tend to be smaller (often substantially smaller) than those produced by frequentist models, and the distribution of estimates is more likely to overlap with zero.

Consistent with the classic BCF models (Dorie et al., 2017), our model incorporated a propensity score to estimate the partial contribution of growth mindset beliefs, above and beyond moderators and covariates in the model. If these moderators and covariates accounted for all possible confounds in the link between growth mindset beliefs and college enrollment status, then the link estimated in the model could be interpreted as an estimate of the true causal effect. For our purposes, it is not necessary to assume that this is the case because we do not make strong causal claims. Nevertheless, the use of the propensity score improves our ability to isolate the effect of growth mindset beliefs, as has been shown in past studies evaluating the BCF approach (Dorie et al., 2017; Hahn et al., 2020). In addition, BCF flexibly incorporates covariates and models their relationship to the outcome (e.g., accounting for nonlinearities and interactions) in a manner that reduces statistical noise while also including parameters that discourage overfitting of the model to the data. This further reduces the modeling decision space for researchers and thus helps to reduce the likelihood of type I error (cf. Simmons et al., 2011). This approach therefore allows us to rigorously test the robustness of the association between growth mindset beliefs and college enrollment.

BCF's prior distributions also assume that effects are not moderated and thus shrink differences in an estimate across subgroups toward zero. This makes BCF an especially effective tool for identifying sources of heterogeneity in developmental and life-course research on observed constructs such as growth mindset. Longitudinal research that examines a variety of person and environmental factors at many timepoints involves multiple comparisons which, using frequentist approaches, could inadvertently inflate levels of type I error (see Gelman & Loken, 2013). BCF's conservative algorithm allows researchers to examine the range of moderating variables hypothesized to contribute to a long-term developmental process while reducing the likelihood of reaching spurious conclusions.

We estimated multilevel BCF models for enrollment in each academic term that nested adolescents within math teachers by including a random intercept and a random slope for growth mindset beliefs. These models treated adolescents' growth mindset beliefs as a continuous "treatment" variable (i.e., the focal independent variable; see Carroll et al., 2023; Hecht, Dweck et al., 2023 for related research that used this approach). We included adolescent SES and perceived teacher support for the growth mindset as potential moderators. We also explored adolescents' ninth-grade math course level as an additional moderator reasoning that, similar to lower-SES adolescents, adolescents in lower ninth-grade math courses may have been at greater risk for not enrolling in college and may thus have benefitted from holding growth mindset beliefs at this timepoint. Lastly, the models included each of the other predictors described in the Measures section as covariates. Consistent with previous mindset studies using BCF (e.g., Carroll et al., 2023; Hecht, Bryan & Yeager, 2023; Yeager et al., 2019), missingness for covariates (<46% for each covariate) was handled with mean/mode imputation and the inclusion of dummy-coded missingness indicators in the covariate regression trees (see Allison, 2001).

The models were fit with 10,000 burn-in iterations and using a thinning interval of 4. Once the model was fit, BCF generated 2000 synthetic values for each parameter for each participant, yielding a posterior distribution of the

association between adolescent growth mindset beliefs and college enrollment (presented as *b*s). We summarize the posterior distribution by reporting the average of these estimates (as in a conventional regression analysis), overall and within subgroups.

To test for moderation, we subtract the estimated association in one subgroup from that in another to generate a posterior distribution of the difference. This allows us to examine whether the magnitude of the association meaningfully differs between subgroups (see Carroll et al., 2023; Hecht, Bryan & Yeager, 2023; Hecht, Dweck et al., 2023; Hecht, Gosling et al., 2023; Yeager et al., 2019, 2022 for other examples of published research that have used this approach to hypothesis testing). In addition, we compare estimated parameters (i.e., associations and differences between associations) between academic terms (subtracting the distribution in one term from another) to examine whether the magnitude of these parameters was meaningfully reduced (a) immediately after the onset of the COVID-19 pandemic and (b) an additional year later.

For each of these estimates (or difference in estimates), we report the proportion of the distribution for each estimate that is greater than zero, which can be interpreted as the estimated probability that the association is greater than zero [reported as "pr()"]. Consistent with our registered standards for interpreting BCF output (https://osf.io/ncxtm), we do not interpret estimates with a posterior probability of less than 75% to be meaningful. We report estimates with probabilities greater than 75% continuously (Gelman, 2016; McShane et al., 2019), rather than at a significance threshold as in classical statistics. Higher probabilities indicate a greater likelihood of a meaningful association (or difference in associations). We also report the interval of the distribution of each estimate from the 10th to 90th percentile. As in the descriptive analysis section, we report results from the three fall terms in the main text. We report results on the two spring terms in Appendix S5 and graph results from all five terms in Figure 3.

Bayesian causal Forest results

The BCF analyses, summarized below, test our hypotheses about how the moderating variables altered the relationship between ninth-grade growth mindset beliefs and college enrollment. See Appendix S6 for results from a multilevel linear model that simultaneously examines growth mindset and each of the moderators and covariates as predictors of

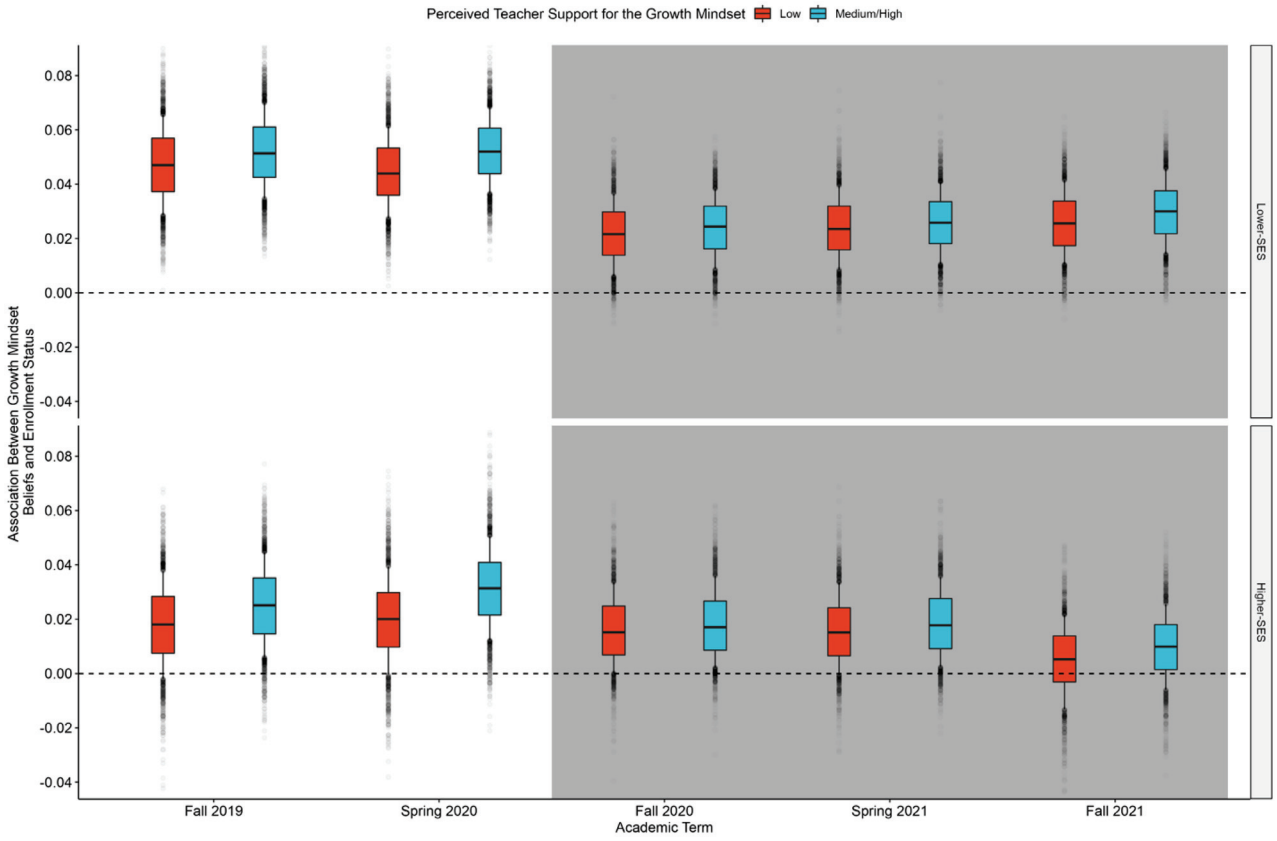

FIGURE 3 Association between adolescents' ninth-grade growth mindset beliefs and college enrollment status as a function of adolescent SES, perceived ninth-grade math teachers' support for the growth mindset (low = bottom quintile, medium/high = top four quintiles), and academic term, as estimated by Bayesian causal forest. Boxes display the interquartile range of the estimated association, whiskers display the interval from the 10th to 90th percentile of the posterior distribution, and points represent draws from the posterior distribution outside of that range. Gray areas represent full terms after the onset of the COVID-19 pandemic.

enrollment. The BCF-estimated association between growth mindset beliefs and enrollment as a function of adolescent SES, ninth-grade course level, perceived teacher support, and academic term are reported in Table 3 and graphed in Figure 3.

Hypothesis 1. Was ninth-grade growth mindset associated with initial enrollment in college? Consistent with the descriptive analysis reported above, BCF found that adolescents' growth mindset beliefs in ninth grade were positively associated with the level of initial enrollment in college (i.e., in fall 2019) after controlling for a variety of adolescent- and teacher-level covariates via the propensity score adjustment, $b = .041$ [.027, .055], $\text{pr}(b > 0) > 0.99$.

Hypothesis 2. Did the association between growth mindset and initial college enrollment vary by adolescent SES? There was a positive association between ninth-grade growth mindset and the level of initial enrollment for both higher- and lower-SES adolescents [$\text{pr}(b > 0) > 0.95$ for each subgroup; see Table 3]. However, consistent with the descriptive analysis above, this association was larger among lower-SES adolescents as compared to higher-SES adolescents [interaction effect: $\text{pr}(\text{Diff}_{bs} > 0) = 0.94$].

Secondary BCF models found that the association between growth mindset and full-time enrollment in a 4-year college (yes = 1, no = 0) did not meaningfully differ between higher- and lower-SES adolescents [interaction effect: $\text{pr}(\text{Diff}_{bs} > 0) = 0.65$]. However, the association between growth mindset and being enrolled in *any* sort of college (yes = 1, no = 0) was greater among lower-SES adolescents, $b = .014$ [.007, .021], $\text{pr}(b > 0) > 0.99$, as compared to higher-SES adolescents, $b = .002$ [−.006, .008], $\text{pr}(b > 0) = 0.64$ [interaction effect: $\text{pr}(\text{Diff}_{bs} > 0) = 0.97$]. Thus, consistent with the descriptive analysis, the socioeconomic difference in the association between ninth-grade growth mindset beliefs and subsequent college enrollment status seemed to be driven primarily by differences in whether adolescents enrolled in college at all, rather than their enrollment in a more selective college.

Alternative indicator of adolescent risk for low enrollment

Our conceptual model (Figure 1) predicts that adolescents with higher levels of risk for poor outcomes will benefit more from holding growth mindset beliefs. We therefore explored whether another indicator of risk for low college enrollment—taking a lower-level ninth-grade math course—might also moderate the association between growth mindset beliefs and initial college enrollment. There was a positive association between growth mindset and initial enrollment in fall 2019 regardless of ninth-grade math course [$\text{pr}(b > 0) > 0.99$ at each course level], and this association did not meaningfully differ between adolescents who took Algebra I or below and those who took a course above Algebra I [interaction effect: $\text{pr}(\text{Diff}_{bs} > 0) = 0.68$]. This lack of moderation persisted across each of the academic terms in the study (see Table 3).

Hypothesis 3. Did the association between growth mindset and initial college enrollment depend on perceived teacher support for the growth mindset? We examined the association between ninth-grade growth mindset beliefs

TABLE 3 Association between ninth-grade growth mindset beliefs and college enrollment over time as a function of subgroup.

Moderator	Subgroup	Fall 2019	Fall 2020	Fall 2021
SES	Lower-SES	$b = .051$, $\text{pr}(b > 0) > 0.99$	$b = .023$, $\text{pr}(b > 0) = 0.98$	$b = .029$, $\text{pr}(b > 0) > 0.99$
	Higher-SES	$b = .024$, $\text{pr}(b > 0) = 0.95$	$b = .018$, $\text{pr}(b > 0) = 0.93$	$b = .008$, $\text{pr}(b > 0) = 0.77$
	$\text{pr}(\text{Diff}_{bs} > 0)$	0.94	0.66	0.91
Course level	Algebra I or below	$b = .043$, $\text{pr}(b > 0) > 0.99$	$b = .020$, $\text{pr}(b > 0) = 0.98$	$b = .021$, $\text{pr}(b > 0) = 0.99$
	Above Algebra I	$b = .036$, $\text{pr}(b > 0) > 0.99$	$b = .024$, $\text{pr}(b > 0) = 0.96$	$b = .022$, $\text{pr}(b > 0) = 0.92$
	$\text{pr}(\text{Diff}_{bs} > 0)$	0.68	0.41	0.55
Perceived teacher support	Medium/high	$b = .042$, $\text{pr}(b > 0) > 0.99$	$b = .022$, $\text{pr}(b > 0) = 0.99$	$b = .023$, $\text{pr}(b > 0) = 0.99$
	Low	$b = .036$, $\text{pr}(b > 0) > 0.99$	$b = .020$, $\text{pr}(b > 0) = 0.98$	$b = .018$, $\text{pr}(b > 0) = 0.97$
	$\text{pr}(\text{Diff}_{bs} > 0)$	0.80	0.66	0.77

Note: Associations are *b*s estimated from a conservative Bayesian analysis. Note: $\text{Pr}(b > 0)$ = posterior probability that an association was greater than zero; $\text{pr}(\text{Diff}_{bs} > 0)$ = posterior probability that the difference in the association between two subgroups was greater than zero (subtracting the group listed second from that listed first); low perceived teacher support = bottom quintile, medium/high perceived teacher support = top four quintiles.

and initial college enrollment within each quintile of perceived teacher support. Note that testing differences across different parts of the distribution, such as quintiles, does not inflate false positive probabilities because summarizing the posterior distribution does not affect the underlying model parameters (Woody et al., 2021). There was a positive association at each level of perceived teacher support [pr($b > 0$) > 0.99 within each quintile]. However, the association was somewhat weaker among students with the least supportive teachers (i.e., the bottom quintile of teachers) as compared to those whose teachers were at least somewhat supportive of the growth mindset [i.e., top four quintiles; interaction effect: pr($\text{Diff}_{bs} > 0$) = 0.80; see Table 3]. The association did not meaningfully vary between any of the top four quintiles [interaction effect: pr($\text{Diff}_{bs} > 0$) < 0.74 for each pairwise comparison], suggesting that the association between adolescents' mindset beliefs and subsequent college enrollment may have been muted by the least supportive ninth-grade math teachers, but not differentially increased by especially supportive teachers.

Exploring the combined role of adolescent SES and perceived teacher support

The association between ninth-grade growth mindset beliefs and initial college enrollment was strongest among lower-SES adolescents whose ninth-grade math teacher was relatively more supportive of the growth mindset (i.e., top four quintiles), $b = .052$ [.035, .070], pr($b > 0$) > 0.99, and weakest among higher-SES adolescents whose teacher was less supportive of the growth mindset (i.e., bottom quintile), $b = .017$ [−.002, .038], pr($b > 0$) = 0.87 [pr($\text{Diff}_{bs} > 0$) = 0.97; see Figure 3].

Hypothesis 4a. Was the overall magnitude of the association between ninth-grade growth mindset and college enrollment reduced after the onset of the COVID-19 pandemic? As with initial enrollment in college, adolescents' growth mindset beliefs were positively associated with enrollment in college in fall 2020, after the onset of the COVID-19 pandemic. However, consistent with the descriptive analysis above, the size of this association was smaller at this timepoint, $b = .021$ [.008, .034], pr($b > 0$) = 0.99. The posterior probability of a reduction in the magnitude of this association between fall 2019 and fall 2020 was 0.92 (see Figure 3).

Hypothesis 4b. Was the magnitude of the difference in the growth mindset–enrollment association depending on adolescent SES reduced after the onset of the COVID-19 pandemic? Whereas the association between growth mindset beliefs and college enrollment was especially pronounced among lower-SES adolescents in fall 2019, this was not the case in fall 2020 [interaction effect: pr($\text{Diff}_{bs} > 0$) = 0.66; see Table 3]. The probability of a reduction in the difference in the association depending on adolescent SES from fall 2019 to fall 2020 was 0.83. However, secondary BCF models found that—similar to fall 2019—while the association between growth mindset and full-time enrollment in a 4-year college (yes = 1, no = 0) did not meaningfully differ between higher- and lower-SES adolescents [interaction effect: pr($\text{Diff}_{bs} > 0$) = 0.72], the association between growth mindset and being enrolled in *any* sort of college (yes = 1, no = 0) was greater among lower-SES adolescents, $b = .008$ [.001, .014], pr($b > 0$) = 0.95, as compared to higher-SES adolescents, $b = .001$ [−.004, .007], pr($b > 0$) = 0.63 [interaction effect: pr($\text{Diff}_{bs} > 0$) = 0.87].

Exploratory research questions

In addition to testing our primary hypotheses, we explored two additional research questions. First, we investigated whether differences in the association between ninth-grade growth mindset beliefs and college enrollment as a function of perceived teacher support changed after the onset of the COVID-19 pandemic. The difference in the association between ninth-grade growth mindset and college enrollment depending on perceived teacher support was smaller in fall 2020 [interaction effect: pr($\text{Diff}_{bs} > 0$) = 0.66] as compared to fall 2019 (see Table 3). However, the predicted probability of a decrease in this difference between academic terms was only 0.66.

Our second exploratory research question concerned whether the association between ninth-grade growth mindset and college enrollment rebounded in fall 2021 or remained at a similar level as in fall 2020. The overall magnitude of the association between growth mindset and college enrollment remained at a similar level in fall 2021, $b = .022$ [.009, .033], pr($b > 0$) > 0.99, as compared to fall 2020 (probability of an increase from fall 2020 to fall 2021 = 0.51; probability of a decrease from fall 2019 to fall 2021 = 0.92). Interestingly, however, in fall 2021 the difference in this association depending on adolescent SES rebounded [interaction effect: pr($\text{Diff}_{bs} > 0$) = 0.91]. This difference in the association was greater than that in fall 2020 (probability of an increase between academic terms = 0.76) and not meaningfully different from that in fall 2019 (probability of a reduction between academic terms = 0.61). See Table 3.

JOURNAL OF Research on Adolescence

DISCUSSION

A large body of research suggests that adolescents' growth mindset beliefs can play an important role in their academic decisions and outcomes (see Dweck & Yeager, 2019; Yeager & Dweck, 2012). However, this research has not yet examined what features must be in place for adolescents to profit from these beliefs over time. Here, we examined how adolescents' growth mindset beliefs in ninth grade predicted their paths into and through college while investigating features of individuals and contexts that were expected to moderate this relationship. Our predictions were guided by a model that refined the Mindset × Context framework with a long view of adolescence, drawing on life course and life span perspectives (Figure 1). This model predicted that ninth graders' growth mindset beliefs would be associated with their subsequent enrollment and persistence in college. In addition, the model predicted that growth mindset beliefs would play a larger role in college enrollment for adolescents who were at greater risk of not enrolling in college because these adolescents had more to gain from this psychological resource. The model also predicted that adolescents' growth mindset beliefs would be able to shape their academic trajectory to a greater extent if these beliefs were supported and reinforced in their ninth-grade math classes, which play an essential role in high school students' course-taking and preparation for college (Crosnoe & Muller, 2014). Lastly, the model predicted that destabilizing historical events in the life course could potentially derail the beneficial effects of a growth mindset, at least temporarily.

Results indicated that, indeed, adolescents' ninth-grade growth mindset beliefs were associated with subsequent enrollment in college, immediately after high school and up to an additional 2 years later. Critically, we used highly conservative Bayesian models to assess whether the association would still be detected after rigorously accounting for confounds that may explain it. Indeed, these models estimated a very high probability of a relationship between ninth-grade growth mindset beliefs and college enrollment across all five academic terms (probability of a positive association > 0.98 for each term). We interpret these results as strong evidence of a relationship between adolescents' beliefs about intelligence in ninth grade and their enrollment in college 4 years later and beyond.

In addition, as hypothesized, the association between growth mindset and college enrollment was stronger for adolescents from lower-SES backgrounds, who are among the most at-risk groups for not enrolling in college. This SES difference seemed to be driven largely by growth mindset-related increases in lower-SES students' enrollment in any sort of college, whereas for higher-SES students, a growth mindset seemed to predominantly predict full-time enrollment in a 4-year college. Due to higher-SES adolescents' higher baseline rates of enrollment in college, a growth mindset in ninth grade may not have affected their trajectory toward college enrollment, but instead their trajectory toward enrolling in a more *selective* college. Among lower-SES adolescents, on the other hand—who lack many of the resources and advantages available to higher-SES adolescents (Attewell et al., 2007; Lareau, 2003; Weininger et al., 2015)—a growth mindset may have done more to help set them on some sort of college-going pathway rather than none at all.

Interestingly, although the association was also descriptively stronger for adolescents who took a lower-level ninth-grade math course, the association did not meaningfully differ as a function of course level. Thus, although growth mindset beliefs may have served as a valuable resource for ninth-grade students—especially among adolescents from lower-SES backgrounds—the potential benefits of holding more of a growth mindset seemed to be similar whether adolescents took more or less advanced math courses.

The association between adolescents' growth mindset beliefs and subsequent college enrollment also depended, to some extent, on their ninth-grade math teacher. When ninth graders had a math teacher who was perceived to be unsupportive of the growth mindset (i.e., teachers in the bottom quintile of growth mindset support), the association between growth mindset beliefs and later college enrollment was somewhat diminished. These teachers may have made adolescents less comfortable acting upon their growth mindset beliefs in ninth-grade math (see Hecht et al., 2021). Conversely, with more supportive teachers, adolescents may have been comfortable acting upon their growth mindset beliefs and, subsequently, felt more emboldened to take the types of math and science courses in high school that would place them on a college-going academic trajectory.

Together, findings concerning the moderating role of adolescent SES and teacher support suggest that growth mindset beliefs may play an especially important role among adolescents for whom a college-going future is less certain, and that these benefits may be amplified by teachers who create a supportive environment for students to embrace these beliefs and put them into practice while learning challenging material.

Critically, the association between ninth-grade growth mindset beliefs and college enrollment became substantially smaller in fall 2020, after the onset of the COVID-19 pandemic (see Figure 3). In addition, this reduction in the association was amplified for lower-SES adolescents for whom the pandemic may have introduced especially strong barriers to college enrollment (e.g., higher rates of unemployment that made college less affordable). Together, these findings speak to the influence destabilizing events may have in the life course when they introduce structural barriers to important decisions and behaviors. These findings underscore that, when considering the impact of major events in the life course, it is essential to consider how these events may affect individuals differently depending on their experiences and life circumstances (see Shanahan & Elder, 2002).

Another interesting exploratory finding is that the comparative benefit of a growth mindset for lower-SES adolescents rebounded to some extent by fall 2021, just

over a year after the onset of the pandemic. It is possible that when adolescents from lower-SES backgrounds held more of a growth mindset, the pandemic served more as a developmental disturbance that temporarily derailed their college attendance, rather than serving as a turning point that more permanently impeded this path. Future research should continue to investigate whether and how growth mindset beliefs at an earlier point in the life course can help to make adolescents more resilient to events that threaten to destabilize their academic outcomes and decisions (see also Yeager & Dweck, 2012).

This work has important limitations that should be addressed in future research. First, this work is correlational. Thus, although the longitudinal associations in our analyses are largely consistent with our theoretical model, and although we used a propensity score approach to minimize the influence of confounds, we cannot draw causal inferences about the role of adolescents' growth mindset beliefs in college enrollment decisions. Second, although our measure of perceived teacher support for the growth mindset had a moderating influence in the expected direction, the scale had fairly low internal reliability ($\alpha = .61$). We are developing improved indicators of teachers' support for students' growth mindset beliefs in ongoing work that we expect to show greater reliability and to be useful in future research (see Trzesniewski et al., 2021).

This research demonstrates the value of jointly considering timing, individual characteristics, and contextual factors to understand how group-based inequalities are perpetuated (or may be reduced) over time (see Elder et al., 2003; Schulenberg et al., 2018). The present research provides one model of how key psychological and structural affordances may moderate the influence of one particular individual characteristic (the growth mindset) across sensitive developmental transitions in the domain of education (Figure 1). In addition, using a Bayesian machine-learning analysis, this research provides a conservative test of that model. We hope that this work provides a useful framework for other researchers who seek to answer similar questions regarding where, when, and for whom other beliefs that are critical in the development process—such as hostile attribution biases (Dodge & Coie, 1987), beliefs about aggression (Huesmann & Guerra, 1997), and group-based stereotyping (Diesendruck, 2021; Goudeau & Cimpian, 2021; Levy & Dweck, 1999; Mulvey et al., 2010)—may influence the trajectory of individuals' lives.

This work also has implications for practice. On the one hand, this study contributes to previous research suggesting that instilling growth mindset beliefs can help to propel adolescents along a positive academic trajectory (see Yeager & Dweck, 2012). But on the other hand, this work suggests that instilling a growth mindset may not be as beneficial as possible if features of the context do not align with and support this way of thinking. It may be important to also shape learning environments, such as teachers' practices (see Hecht, Bryan & Yeager, 2023 for an example) to support and reinforce growth mindset effects. Furthermore, to the extent possible, it may be essential to ensure that structural factors do not stand in the way of adolescents' pursuit of a college degree (see Bryan et al., 2021; Hecht et al., 2021). Although natural disasters and pandemics may be beyond the reach of practitioners and policymakers, the present results provide a dramatic example of how structural barriers can stifle an otherwise promising academic trajectory. Taking steps to maximize the accessibility and affordability of college (e.g., through financial aid programs and scholarships) may thus be important to ensure that adolescents' psychological resources at the transition to high school can translate into positive long-term outcomes.

In sum, this research bears on the question of where, when, and for whom adolescents' growth mindset beliefs might be most beneficial for setting them on a trajectory toward enrollment and persistence in college. Attending jointly to timing and the role of varying contextual factors across the lifespan provides valuable insight that can shed new light on how adolescents navigate the path to and through college.

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CONFLICT OF INTEREST STATEMENT

D.S.Y. has disseminated growth mindset research to public audiences via paid speaking engagements or consulting and has complied with institutional financial interest disclosure requirements; currently no financial conflicts of interest have been identified.

DATA AVAILABILITY STATEMENT

Documentation for the National Study of Learning Mindsets is available from ICPSR at the University of Michigan (https://doi.org/10.3886/ICPSR37353.v1). Student-level data are protected by data sharing agreements with the participating school districts. De-identified data and syntax can be accessed by researchers who agree to terms of data use, including required training and approvals from the University of Texas Institutional Review Board and analysis on a secure server. Researchers should contact mindset@prc.utexas.edu to request access to the data.

CONSENT STATEMENT

In the majority of schools, this experiment was conducted as a program evaluation carried out at the request of the participating school district. When required by school districts, parents were informed of the program evaluation in advance and given the opportunity to withdraw their children from the research. Informed assent was obtained from all participating adolescents.

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SUPPORTING INFORMATION

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