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Growth mindset as a protective factor for middle schoolers at academic risk

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Abstract

Growth mindset has been shown to predict academic achievement in a variety of student populations, though the strength of the relationship can vary depending on the characteristics of the students examined. Using a large-scale sample of middle school students from a diverse district in the United States, we examine how multiple facets of students' experiences and background characteristics may interact to impact the relation between mindset and academic achievement. We consider whether the risk factors of socioeconomic status (including a student's daily experience of that status) and recent school transition interacted with mindset in predicting academic achievement. We show that mindset is most predictive of academic achievement in students with two academic risk factors. These results highlight the importance of context when considering how mindset might be used to improve academic achievement for students at the greatest academic risk.

Keywords Mindset · Academic achievement · Academic risk · Middle school

1 Introduction

Since first proposed in 1999, growth mindset, or the belief that personal characteristics can be improved (Dweck, 1999; Dweck & Leggett, 1988; Yeager & Dweck, 2012), has represented an important opportunity for educational practices. Namely, both correlational and intervention-based research has linked a growth-oriented

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mindset with positive academic outcomes (Blackwell et al., 2007; Paunesku et al., 2015; Romero et al., 2014; Stipek, 1996; Yeager, Hanselman, Walton, et al., 2019). Further, effective interventions to encourage a growth mindset can be conducted more quickly (e.g., 1 h) and more cost-effectively (e.g., without teacher training) than more traditional intensive interventions (Aronson et al., 2001; Blackwell et al., 2007; Good et al., 2003; Miller, 2019; Paunesku et al., 2015; Yeager et al., 2016) However, there is still debate and controversy as to whether such interventions have an effect and if that effect is large enough to merit pursuing (Miller, 2019; Sisk et al., 2018; Yeager & Dweck, 2020). To address these concerns, mindset scholars have shifted from understanding the overall benefits of a growth mindset across all students to mapping the boundaries for whom a growth mindset is most likely to benefit, when, and in what ways (Cartwright & Hardie, 2012; Qin et al., 2021; Schochet et al., 2014). More specifically, Yaeger and colleagues put forth the Mindset×Context Theory, which emphasizes understanding the context in which growth mindset is being applied or what environmental variables might impact the effectiveness of a growth mindset intervention (Yeager, Hanselman, Muller, et al., 2019). Within this framework, we conducted the current study, examining how growth mindset interacts with multiple risk factors for academic success, including family socioeconomic status (SES) and students' perception of their SES, and transition from elementary to middle school to predict academic achievement.

Prior work has established growth mindset varies significantly across many student characteristics, with the students most likely to show a fixed mindset being those from low-achieving schools with a high percentage of students from low SES backgrounds and English-language learners, who are historically underserved (Claro & Loeb, 2019; Sisk et al., 2018; Snipes & Tran, 2017). However, to date, much of the previous work has examined a limited number of student characteristics at one time, and the potential interactions between characteristics are understudied. For example, studies have focused on only socioeconomic status and math achievement scores (King & Trinidad, 2021) or students from a single grade level (Destin et al., 2019; Qin et al., 2021). While such studies add to our understanding of which characteristics might interact with mindset in predicting academic achievement, such studies do not allow for an examination of how the myriad student experiences coalesce to influence academic outcomes together. A notable exception is work by Claro and Loeb (2019) who examined a large-scale longitudinal study of students across four grade levels. This study showed a growth mindset positively predicted both math and English Language Arts test scores across students, even after controlling for student background characteristics including special education status, socioeconomic background, race, and prior academic achievement. This study represents one of the largest and most comprehensive examinations of growth mindset and academic achievement in students younger than high school to date. However, this study did not examine potential interactive effects between background characteristics. As such, whether context and student characteristics can compound to impact the relationship between academic achievement and growth mindset is currently unclear. In the present study, we use a similar population, analytic strategy, and outcome measure (i.e., standardized test scores) as Claro and Loeb (2019) but apply a framework of understanding the potential for mindset as a protective factor

for students with two different academic risk factors. Below we outline the risk factors we focus on in more detail.

1.1 Academic risk factors

1.1.1 School transitions

Much of the prior research on the potential benefits of mindset in the United States has focused on high school students, as this period represents a significant academic transition (Yeager et al., 2016; though see Blackwell et al., 2007). However, moving from elementary (approximately age 11) to middle school (approximately age 12) also represents a significant transitional period for United States students. Considerable social, academic, environmental, and developmental challenges associated with the transition to middle school have been linked with a decline in academic motivation and performance, particularly for those students at risk for academic failure without additional intervention (Hughes & Cao, 2018). The middle school transition is difficult for many students for several reasons. First, in the United States, the transition from elementary to middle school coincides with a significant developmental shift from childhood to early adolescence. Students must cope with puberty and an enhanced sensitivity to peers while navigating a new school environment (Eccles & Roeser, 2011). Second, middle school requires more independent work from students. During this time there is an increase in workload and academic expectations—students are expected to manage their own learning with less monitoring from parents and teachers (Lane et al., 2015). Third, students move from a single home-room teacher to many teachers with whom students must establish relationships with individually (Goldstein et al., 2015). It is also during this time that, students' self-concepts s around different school subjects (e.g., being 'good at' math, but a 'poor' science student) tend to become more stable and reliable (Guay et al., 2003). This combination of factors may be related to a decline in students' self-concepts that have been demonstrated to occur with school transitions to middle or junior high school (Wigfield et al., 1991, 2015). Successful adjustment during this transition can have long-term impacts on subsequent academic performance (Goldstein et al., 2015; Lane et al., 2015), so it is critical to identify factors that promote academic achievement during this time.

1.1.2 Socioeconomic status (SES)

The middle school transition is a time of heightened vulnerability for all students, but may be particularly challenging for students from lower SES backgrounds who are historically underserved. A large body of literature shows a significant achievement gap between students from lower SES backgrounds and their peers from higher SES backgrounds (see Sirin, 2016 for meta-analytic review). While evident as early as Kindergarten, this gap persists through high school (National Center for Education Statistics, 2019). The socioeconomic achievement gap is driven by a host of factors, including a lack of systemic structural support and a history of inequitable

opportunities in the United States (see Carnevale et al., 2019 for a more thorough discussion). For example, research on socioeconomic differences in the type and amount of support children receive as they transition into Kindergarten showed parents from low-SES backgrounds are less likely to be involved in the school transition and thus receive less support (likely due to structural constraints of economic hardship; Cooper et al., 2010).

In addition to structural and systemic inequity, SES can also impact academic achievement through psychological mechanisms (as discussed in Destin et al., 2019). That is, a person's lived experiences are likely to influence their perception of their abilities or outlook on life. Thus, a student's socioeconomic background represents a risk to achievement not only in terms of the inequity of available educational opportunities, but also in how they approach their education. To better understand the effect of such psychological mechanisms, it is important to consider a student's perception of their SES in addition to objective measures (e.g., income, parental education). In the current study, we include a measure of students' perception of their background via the Family Affluence Scale (FAS; Boudreau & Poulin, 2009). The FAS correlates strongly, but not perfectly, with more traditional indices of SES, indicating this scale indeed captures a distinct component (Corell et al., 2021). Here, we combine more objective indices of SES with this more subjective measure from the student's perspectives to better understand how psychological mechanisms of SES might influence achievement and mindset. Such insights can help us understand how we might use multi-pronged approaches to help close the achievement gap, i.e., designing interventions that include both structural changes to the education system as well as methods to address the psychological mechanisms of SES experienced by students.

1.2 Mindset as a protective factor for students at academic risk

Prior work has shown that a growth mindset can be protective (and a fixed mindset detrimental) for students who are more academically at-risk than other students (Aditomo, 2015; Paunesku et al., 2015). Students with a more growth-oriented mindset were shown to be more resilient and achieve higher grades in a challenging academic transition of middle school (Blackwell et al., 2007). Further, Romero and colleagues (2014) showed that growth mindset at middle school entry predicted academic and emotional functioning trajectories from 6 to 8th grade. A large-scale sample of high school students in Chile further suggests that mindset serves as a protective factor for students from lower SES backgrounds (Claro et al., 2016). Their work showed that although high school students from lower-income families were less likely to hold a growth mindset than their wealthier peers, those students who did hold a growth mindset were buffered against the effects of poverty on achievement. Specifically, students in the lowest 10th percentile of family income who exhibited a growth mindset showed academic performance as high as that of fixed mindset students from the 80th income percentile (Claro et al., 2016). Claro & Loeb's, 2019 work with middle school students in the United States, though, suggests growth mindset may not play such a protective role for younger students. In contrast to prior

work with older students (Claro et al., 2016; Sisk et al., 2018; Yeager, Hanselman, Walton, et al., 2019), this analysis showed mindset tended to be more impactful for more advantaged students. This finding was replicated in a nationally representative of 10th-grade students in the United States (King & Trinidad, 2021). The conflicting results across large-scale studies both within and across varying grade levels point to the need to continue examining the potential additive effects of risk factors for students.

1.3 Current study

The current study investigates the relation between growth mindset, academic risk factors (low SES background and school transition period), and academic achievement for both math and ELA standardized test scores in middle school students from a diverse school district in the United States. We first examined the academic risk associated with different factors such as socioeconomic status and school transition period as well as the under-examined factor of English language fluency status. We then examined how these different risk factors interacted to impact the relationship between mindset and academic achievement in the context of other student background variables such as race/ethnicity. We expected mindset to act as a protective factor for students who had two vulnerabilities to academic risk given their SES background and experiences transitioning from elementary to middle school. Specifically, we expected a growth-oriented mindset to provide the most benefit to 6th graders from lower SES backgrounds who recently made the transition from elementary to middle school more than either 8th graders who did not experience such a recent transition or students from higher SES backgrounds. The results of this study will add to the growing body of work aimed at determining for whom growth mindset interventions might be beneficial and when.

2 Methods

All experimental procedures were approved by the Institutional Review Board at the University of California, San Francisco (IRB#13–10,917). Written consent was obtained from each student's parent or guardian, and students gave verbal assent before every interaction with researchers.

2.1 Participants

The current study used data collected as part of project iLEAD, an in-school, longitudinal executive function, and academic database (Younger et al., 2023). The study was approved by the university's Institutional Review Board and conducted in accordance with the relevant guidelines and regulations. Written parental or guardian consent was obtained from all participants at the beginning of the study, and verbal assent from all participants was obtained before all in-class data

collection sessions. At the end of the study, all students in participating class-rooms received snacks and stickers, regardless of participation.

Data from 6th- and 8th-grade students with both survey data (student-provided) and standardized test scores (district-provided) data were considered for analysis ($n = 538$). We excluded students who were missing data for mindset score, parent education level, and survey data ($n = 60$). We further excluded students currently enrolled in English language classes ($n = 47$) due to potential differences in the interpretation of the mindset questionnaire (Dweck, 2006) and differing accommodations during standardized testing. We further excluded students receiving special education classes ($n = 16$) due to differing accommodations during standardized testing.

The final sample included 380 middle school students from two middle schools in Northern California, with 116 6th graders ($M_{age} = 11.6$ years, $SD = 0.58$ years) and 261 8th graders ($M_{age} = 13.6$ years, $SD = 0.49$ years). One school was considered Title 1, with 53% of students qualifying as low income (see Household Income Qualification below), while the other school had only 27% of students qualifying. The sample was approximately equally split between male (46%) and female (54%) students, and across all students, 27% of participants came from low-income families. The sample was racially diverse, with 52% Asian ($n = 195$), 24% Hispanic or Latino ($n = 91$), 18% white ($n = 68$), and 6% other race students ($n = 22$). All students were considered fluent in English, with 46% ($n = 174$) of students having previously taken English Language classes. See Table 1 for more detailed demographic data.

Table 1 Participant demographics

Grade	6th		8th	
n	115		261	
Gender: *n* (% female)	59	54.8%	139	53.5%
Age: mean years (sd)	11.6	0.59	13.6	0.50
Race: *n* (%)				
Asian	69	60.0%	126	48.3%
Hispanic or Latino	22	19.1%	69	26.4%
White	21	18.3%	21	18.0%
Other	5	4.4%	17	6.5%
English language fluency: *n* and % never required English language classes	67	58.3%	135	51.7%
Income status: *n* and % low-income	29	25.2%	71	27.2%
Mindset score: mean and *SD**	4.61	1.18	4.69	1.08
SES score: mean and *SD**	0.15	0.78	-0.05	0.82

*Score ranges are presented in description of data collection instruments below

2.2 Data collection instruments

2.2.1 District data

District data were obtained from the school district for participants whose parents or guardians opted into sharing their de-identified demographic and school data. District data used for the current study included parent education level, state standardized test scores, English language fluency level, and low-income qualification.

2.2.2 Parent or guardian education level

The district reported the highest education level obtained by either parent or guardian. Education level was reported as 1 of 5 different categories: not a high school graduate, high school graduate, some college, college graduate, graduate school. This information was used in the factor score of SES (see below).

2.2.3 Low-income qualification

The district reported whether or not students' households qualified as low-income. The state of California defines low-income households as families earning less than 70% of the State Median Income. This information was used in the factor score of SES (see below).

2.2.4 State standardized test scores

Participants completed California Smarter Balanced Assessment Consortium (SBAC) standardized testing during the spring of each school year. These online, adaptive tests are aligned to state common-core curriculum standards. These state standardized test scores from the 2017–2018 academic school year in math and English Language Arts (ELA) were used as metrics of academic achievement. Scores from the 2016–2017 academic school year were used to measure previous academic achievement as a control.

2.2.5 English language fluency status

School districts reported four levels of English language fluency status: English Only, Initially Fluent English Proficient (IFEP), Redesignated Fluent English Proficient (RFEP), English Learner. As described above, students designated as an English Learner were excluded from the current analyses. IFEP students are students who primarily speak a language other than English at home but have tested as proficient in English based on the California English Language Development Test (CELDT). RFEP students are students who were previously English learners and received English language instruction but later tested as fluent in English after achieving a grade-level appropriate level of English language proficiency, as measured by results on the CELDT test, the English Language Arts portion of the California Standards Test (CST), and teacher and parent input.

2.2.6 Questionnaires

We administered both the mindset and Family Affluence Scale questionnaires during the spring of the 2017–2018 school year. Teachers distributed paper and pencil questionnaires to all the consenting participants. Questionnaires were de-identified with only a researcher-assigned student ID number on the questionnaire. Participants were instructed to answer the questionnaires on their own time to ensure anonymity and encourage honest answers. De-identified questionnaires were anonymously submitted to participants' teachers and were later collected by research assistants. These questionnaires were then entered into an electronic database by two separate research assistants. Discrepancies in data entry were resolved by a third researcher.

2.2.7 Mindset

Dweck's shortened Implicit Theory of Intelligence Scale was used to assess mindset (Cain & Dweck, 1995; Dweck, 2006). Participants rated the degree to which they agreed or disagreed with three statements about intelligence being fixed on a 6-point scale. ("Your intelligence is something that you can't change much."; "You have a certain amount of intelligence, and you really can't do much to change it."; "You can learn new things, but you can't change your basic intelligence."). The ratings of the three statements were then averaged to create a "mindset score" for each participant to represent the degree to which they endorsed a fixed mindset (score of 1) versus a growth mindset (score of 6; Cain & Dweck, 1995; Dweck, 2006).

2.2.8 Family Affluence Scale

The Family Affluence Scale is intended as a more proximal indicator of how socio-economic status is experienced in the everyday life of the child. We adapted the Boudreau & Poulin's FAS II survey for the current study (Boudreau & Poulin, 2009) We used the four questions: "How many vehicles does your family own?"; "Do you have your own bedroom for yourself?"; "During the past 12 months, how many times did you travel away on holiday with your family?"; "How many computers does your family own?", but slightly modified the wording for a U.S. rather than a European student population ("vacations" instead of "holiday"). Given that the scale was published a decade ago and technology changes rapidly, we updated the scale to include an additional question, "How many tablets or smartphones does your family have?" with the aim of improving internal validity.

Because this scale was developed and validated for European populations, we aimed to determine the validity of the FAS scale in our population of students from the United States using a larger sample of data from Project iLEAD that included students in fourth, sixth, and eighth grades. This larger sample included all Project iLEAD students who completed the FAS questionnaire ($n = 693$). We first assessed external validity of each FAS scale item by determining whether item scores were related to other measures of affluence and home environment collected as part of this data set: low-income qualification and parent education level. The four original items showed significant positive correlations between score and parent education

level (Spearman's r_s range 0.17–0.372) and distinguished between students who did and did not qualify as coming from a low-income family (Welch's two sample t range 4.10–9.18, d range 0.43–0.77). The new item about tablets and smartphones did not show significant relationships with these other variables ($r_s = .06$ for parent education level and $t = 2.06$ for low-income status, $d = 0.22$). The tablet item was thus removed from further analysis.

We then established internal validity of the remaining items by examining correlation matrices of the four remaining items. While scores on all four test items were intercorrelated, vehicle, vacation, and computer scores showed a low correlation ($r_s < = .2$) with the score indicating whether a child had their own bedroom, suggesting this item does not reliably capture the same construct as the other three items. This item was thus dropped from further analysis, as has been done in other studies examining the construct validity of the FAS (Haft et al., 2019; Kehoe & O'Hare, 2010).

Following the item-level validation procedures, we generated a final composite score by summing the scores of the three remaining items (vehicle, vacation, and computer items). The resulting composite score could thus range from 0 to 8. This composite score showed significant positive correlations with district-reported parent education level ($r_s = .34$, $p < .001$) and households that qualified as low-income had significantly lower scores than households who did not qualify ($t = 7.60$, $p < .001$, $d = 0.75$), indicating good construct validity. This new FAS composite score was then used in the factor score of SES (see below).

2.2.9 Socioeconomic Status Score

To measure SES status, we chose to use a metric that would draw on multiple indicators of student's household income and experiences that captures the larger construct of SES. As such, we used confirmatory factor analysis (CFA) to create a latent variable with three points of data concerning family background: parent education level, low-income status, and (student-reported) family affluence score as indicators. Data from all 693 participants, including fourth graders, were used for this model. In this way, the common, shared variance of these three measures was captured and used as the measures of SES. Indeed, CFA results of the just-identified model indicated that all three components did not contribute to the latest variable of SES equally; standardized factor loadings ranged from 0.33 (low-income status) to 0.981 (parent education level). A factor score was estimated for each participant and used as the SES score in further analyses.

2.3 Analyses

To understand academic achievement in the context of potential risk factors, we tested for a correlation between SES and state standardized test scores and tested whether or not different English language fluency groups had significantly different mean test scores. To understand how mindset score may influence the relationship between academic achievement and academic risk factors, we separately modelled

standardized test scores for both math and ELA. These linear mixed models tested for main effects of and interactions between mindset and two risk factors, SES score and recent transition from elementary to middle school. We mean-centered and scaled (z-scored) standardized test scores using the California's state mean and standard deviation of performance for each grade level to ensure that scores could accurately be compared across grades. All models controlled for previous year test scores, race/ethnicity, English language fluency, and the random intercept of school. Planned follow-up analyses to determine the directionality of effects included linear models of test score using mindset and SES score within each grade separately. Models were run using the 'lme4' package in R (Bates et al., 2014) and significance of each variable was evaluated using Satterthwaite's degree of freedom method as implemented in the 'lmerTest' package in R ((Kuznetsova et al., 2017).

3 Results

3.1 Academic achievement in the context of SES

A Pearson correlation between SES score and state standardized test scores collapsed across grade level revealed a significant positive correlation for both math, $r(374) = 0.51$, $p < .001$, and ELA, $r(374) = 0.46$, $p < .001$, (see Fig. 1). These effects are not likely driven by similarity in performance within students from the same school as the intracluster correlation coefficients in both cases was < 0.001. For both 6th and 8th graders, a higher SES score was correlated with higher state standardized test scores across subject matter, indicating that, without considering other
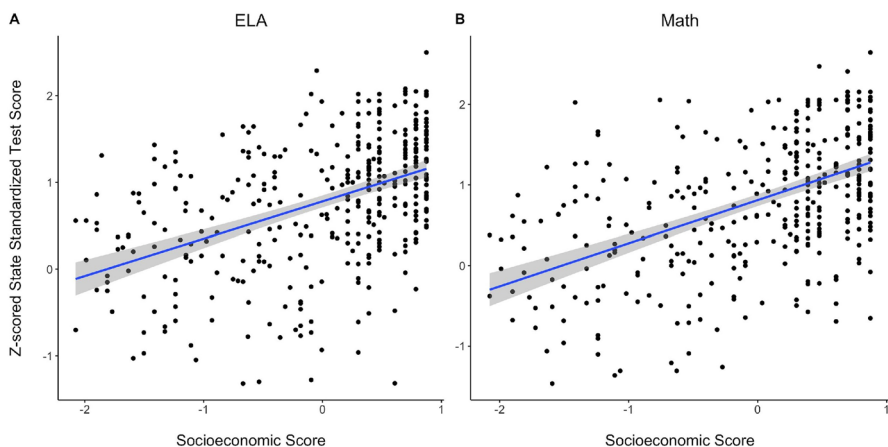
Fig. 1 Correlation between socioeconomic status (SES) scores on state standardized test scores of English Language Arts (ELA; **A**) and math (**B**). Across all students, a higher SES score was correlated with higher state standardized test performance across both subjects. Standardized test performance is graphed as z-scored test scores

demographic variables, low SES status is a risk factor for achievement on standardized test scores.

3.2 Academic achievement in the context of English language fluency

English language fluency classification (IFEP, RFEP, English Only) was not a risk factor for low academic achievement; none of the three language fluency groups had an average score below the state average for either math or ELA state standardized test scores (see Fig. 2). A one-way ANOVA with ELA test scores as the outcome variable revealed no significant effect of English language fluency classification, $F(2, 373) = 0.63$, $p = .54$; $\eta^2 < 0.00$. The same was true with math test scores as the outcome variable, $F(2, 273) = 2.04$, $p = .13$, $\eta^2 = 0.01$. Although English language fluency classification is not a risk factor, it is included as an additional control variable to understand the role of mindset when this factor is accounted for.

3.3 Mindset as a protective factor for students at risk

Across both ELA and math state standardized test scores, ANOVA on linear models showed the variable with the strongest association was the previous year's test scores, in line with previous literature, ELA: $F(1,344) = 467.82$, $p < .001$, math: $F(1,344) = 906.80$, $p < .001$. Further, English Language Fluency was predictive of both ELA, $F(1,344) = 3.92$, $p = .027$, and math, $F(1,344) = 5.04$, $p = .007$. However, there were no significant main effects of SES factor score, mindset, or significant interactions between SES factor score and mindset (all p values $> .1$, minimum $p = .30$) on ELA state standardized test scores. That SES is no longer significantly predictive of ELA scores in the presence of other background characteristics such as
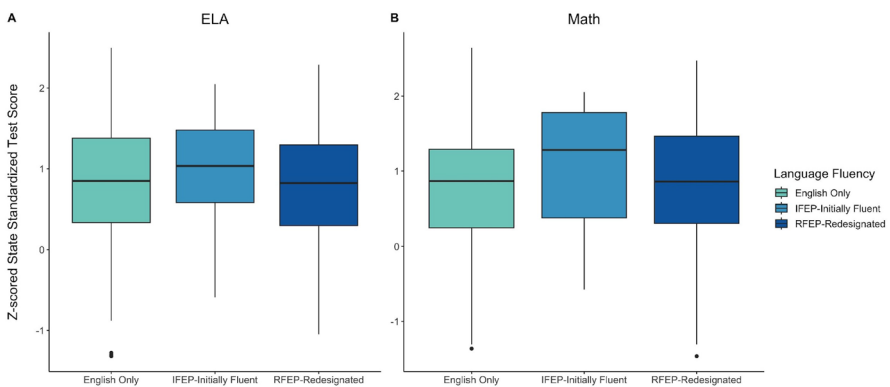
Fig. 2 Distribution of state standardized test scores for each group of English language fluency in and English Language Arts (ELA; **A**) and math (**B**). English language fluency classification had no significant effect on standardized test performance in either subject. None of the English language fluency groups had an average score below the state average in either subject. Standardized test performance is graphed as z-scored test scores

previous year test scores and English Language Fluency highlights the importance of considering multiple variables that might better explain the relation between two variables. In models of math state standardized test scores, though, ANOVA revealed a significant main effect of SES score, $F(1, 344) = 11.83$, $p < .001$, indicating that across both grade levels, students from more lower SES backgrounds attained overall lower test scores, even after controlling for previous year performance. While the main effect of mindset across grade and SES was not significant, $F(1,344) = 0.74$, $p = .390$, there was a significant three-way interaction between mindset, SES score, and grade, $F(1, 344) = 7.39$, $p = .007$. See Table 2 for full ANOVA results including η^2 for each variable.

To further contextualize the predictive power of these interactions, we constructed a series of models to understand the additive effects of including mindset and its interactions with the two potential vulnerabilities, SES and grade level. In the first model, we include only the main effects of grade level and SES along with the control variables of previous year test scores, race/ethnicity, English language fluency, and the random intercept of school. In the second model, the main effect of mindset was added, and in the third model, the interactive term between mindset, grade level, and SES were included. For models of ELA state standardized scores, including mindset as an additional variable significantly improved the model, $\chi^2(1) = 10.62$, $p = .001$, but the interactive terms did not, $\chi^2(4) = 3.57$, $p = .467$, aligning with the lack of significant effect of any interactive terms. In contrast, for models of math state standardized test scores, the second model adding mindset significantly improved the main effects only model, $\chi^2(1) = 11.58$, $p < .001$, and the third model including the interactive terms in turn represented a significant improvement to the second model, $\chi^2(4) = 17.83$, $p = .001$. These findings underscore that mindset and the way it interacts with additional student characteristics does indeed

Table 2 Results of analysis of variance (ANOVA) tables on linear models for ELA and math state standardized test scores covariate entered into linear model
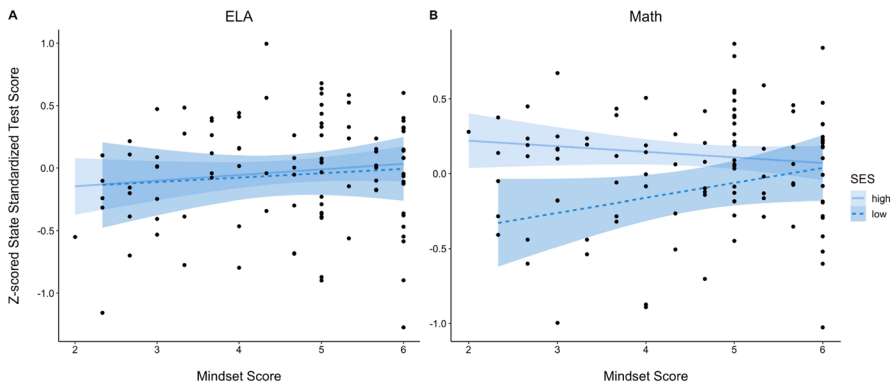
	df	English language arts			Math		
		F value	Pr (>F)	η^2	F value	Pr (>F)	η^2
Mindset	1	0.37	0.545	0.000	0.74	0.390	0.001
SES score	1	0.20	0.658	0.000	11.83	<0.001 ***	0.009
Grade	1	0.67	0.412	0.001	2.57	0.110	0.002
English language fluency	2	3.92	0.021*	0.009	5.04	0.007 **	0.008
Race	3	2.10	0.101	0.008	0.31	0.820	0.001
Z-scored 2017 standardized test performance	1	467.82	<0.001***	0.564	906.80	<0.001***	0.695
Mindset × SES score intx	1	0.19	0.664	0.000	7.86	0.005**	0.006
Mindset × grade intx	1	1.09	0.296	0.001	1.87	0.172	0.001
SES score × grade intx	1	0.31	0.576	0.000	10.54	0.001**	0.008
Mindset × SES × grade intx	1	0.39	0.533	0.000	7.40	0.007**	0.006

intx interaction

$p < .001***$; $p < .01**$; $p < .05*$
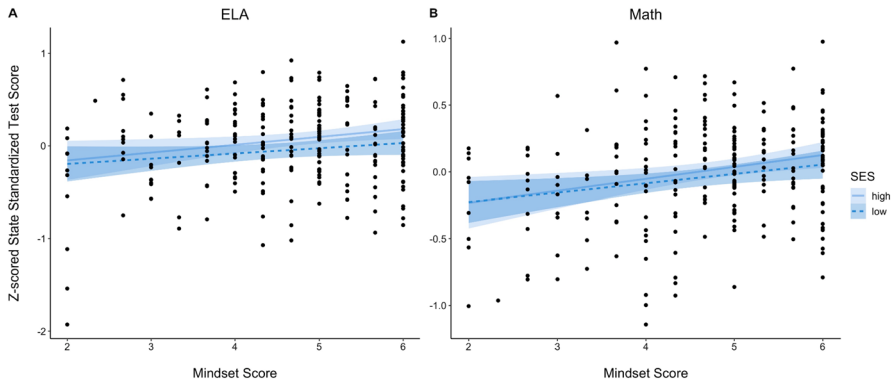
Fig. 3 Relations between mindset, socioeconomic status (SES) scores, and state standardized test scores of English Language Arts (ELA; **A**) and math (**B**) for 8th-grade students. For 8th graders, a more growth-oriented mindset tended to benefit both ELA and math test scores regardless of SES score. Standardized test performance is graphed as the residuals after all control variables are accounted for. For graphing purposes, we performed a median split on SES score. Line shading represents the 95% confidence interval

Fig. 4 Relations between mindset, socioeconomic status (SES) scores, and state standardized test scores of English Language Arts (ELA; **A**) and math (**B**) for 6th-grade students. For 6th graders, there was no significant relationship between ELA test scores, mindset, or SES score. Significant interactions between mindset score and SES score seen in the 6th grade population indicated students from lower SES backgrounds (solid line) had stronger positive relations between mindset score and math test score compared to the above SES score group (dashed line). Standardized test performance is graphed as the residuals after all control variables are accounted for. For graphing purposes, we performed a median split on SES score. Line shading represents the 95% confidence interval

meaningfully improve predictions of students' academic performance beyond other variables that may have stronger relations with academic performance such as previous year's test scores.

Relations between SES, mindset, and test scores for each grade level are illustrated in Figs. 3 and 4. Follow-up analyses of math-test score achievement within each grade level separately revealed only a significant effect of mindset for the

8th-grade group, $F(1,244) = 14.11$, $p < .001$, $\eta^2 = 0.016$ (see Fig. 3). Within the 6th-grade group, analyses showed a significant effect of SES score, $F(1,94) = 12.92$, $p = .005$, $\eta^2 = 0.034$, and a significant interaction between mindset and SES score, $F(194) = 6.81$, $p = .011$, $\eta^2 = 0.018$. Examination of the 6th-grade model estimate showed the direction of effect for the mindset score by SES interaction was such that students with lower SES scores had greater benefits from having a growth mindset compared to students with higher SES scores (see Fig. 4). Together, these results indicate that a more growth-oriented mindset score is more impactful on math achievement for more academically vulnerable students, 6th-grade students who recently transitioned into middle school and were from lower SES backgrounds.

4 Discussion

The current study examined the association between mindset and academic achievement in the context of several demographic and background variables to help clarify our understanding of the circumstances under which mindset may be more related to students' academic achievement as measured by state administered standardized tests of achievement in ELA and math. We first replicated previous work (Claro & Loeb, 2019; Claro et al., 2016) by showing lower SES is indeed associated with lower academic achievement, but that a growth mindset can lead to higher academic achievement for these at-risk students, supporting growth mindset as a protective factor. Further, we provide additional support for the Mindset×Context Theory (Yeager, Hanselman, Muller, et al., 2019); mindset did not equally predict achievement across academic subject matter, grade levels, or socioeconomic backgrounds. Finally, our findings suggest that mindset is most protective for students with two vulnerabilities that affect achievement above and beyond individual risk factors of SES or school transition status alone.

Across different student factors, we showed a stronger relationship between mindset and math scores compared to English Language Arts. This finding contrasts prior work examining both math and English achievement, which have typically found a similar effect for both academic subjects (Claro & Loeb, 2019; Claro et al., 2016; Costa & Faria, 2018; Warren et al., 2019). Indeed, in Claro and colleagues' examination of a similar population with similarly strong demographic controls, the predictive power of mindset was slightly stronger for English Language Arts than math (2019). Here, we found stronger relationships between ELA score and other student background characteristics, most notably English Language Fluency Status, rather than either SES or mindset. Further, in our sample, which did not include students currently enrolled in English Language classes, we showed that English Language Fluency status was not a risk factor. Not only were there no statistical differences in ELA score achievement across English Language Fluency groups, but numerically, students who spoke an additional language outperformed students who only spoke English. Finally, fewer students in our sample performed below the proficient level in ELA compared to math, signalling a relatively high level of performance in ELA in our sample. These differences in sample achievement between the current study and study conducted by Claro and Loeb (2019) may explain the difference in results

across the two investigations. Claro and Loeb did control for English Language Fluency Status and showed mindset had less of an effect on that sub-sample of students compared to students who were never enrolled in English Language Learning classes. However, it is unclear how these two groups of students compared on their scores regardless of mindset, as such comparisons were not within the scope of their analyses. The lack of relationship between mindset and ELA in our sample is consistent with the theory that mindset has a positive effect in specific contexts for populations that are more vulnerable in that context. The students in our sample did not particularly struggle with ELA test score performance, therefore, mindset may not have been particularly impactful for this group in this context. However, caution should be taken in overinterpreting a null result, and further research should be conducted to explicitly test this hypothesis with additional potential groups and contexts with appropriate statistical analyses, such as Bayesian statistics, which can provide evidence to support the null hypothesis.

The grade-level differences in the strength of the relationship between mindset and academic achievement further underscore the importance of examining specific effects for specific contexts. Collapsed across grade, we showed a significant interaction between SES and mindset, yet follow-up analyses showed only a significant interaction within 6th graders. A strength of our study is the explicit examination of differences between students completing their first year in a new school setting (6th graders) and those in their last year of that setting (8th graders). Mindset as a protective factor for school transition has been supported by work with students in the United States transitioning to the high school setting (Yeager et al., 2016), but, to date, has not yet been explicitly examined with younger students. Though our sample overlaps largely with the grade levels examined in Claro and Loeb, (2019), we additionally examined students in the last year of their middle school experience, 8th grade. We also explicitly compared the interactive effect of mindset, demographic variables, and grade level to reveal significant grade-related differences in the predictive relationship of mindset on academic achievement. The three-way interaction between SES, mindset, and grade level in predicting academic achievement scores particularly speaks to the importance of understanding the constellation of student characteristics that can impact both a student's mindset and its effect on academic achievement. If all three factors had not been considered simultaneously, the overall relationship between mindset and academic achievement would have been weak. Instead, the results of this study further hone our understanding of the circumstances in which a mindset intervention might be most impactful.

Finally, this study further extends our understanding of the relationship between SES and mindset by introducing a method for measuring a student's background that considers both a student's environment (parental education and income status) as well as their perception of their environment (according to Family Affluence Score). To date, extant research has been contradictory as to whether students from more disadvantaged (Claro et al., 2016; Sisk et al., 2018; Yeager, Hanselman, Muller, et al., 2019) or more advantaged backgrounds (Claro & Loeb, 2019; King & Trinidad, 2021) are likely to show a stronger relationship between mindset and academic achievement. In these studies, SES has been determined by a variety of measures, such as parental education, qualification for free or reduced lunch, or

parent's income. Such measures are appropriate proxies for SES, given students are still economically dependent on their parents during the adolescent stage (Currie et al., 2008). However, by employing an additional measure of student-reported family affluence, the present study captures SES as it is experienced by students (Traynor & Raykov, 2013). The factor score reflecting these different perspectives of background (state-determined low-income status, parental education, and student reported family affluence scale), therefore, may have captured a proxy of SES more relevant to the psychological mechanism underlying the association between SES and academic achievement. Future work should test whether such factors as student perception of SES may play a role in accounting for individual differences in resilience for students from such at-risk environments. For example, work examining whether adults believed socioeconomic status itself was malleable showed that individuals who believed they could change their social class had higher ratings of overall well-being (Zhao et al., 2021). These findings together support that interventions on the psychological mechanisms of SES on academic achievement could be a fruitful and expedient way to support vulnerable students even as the much-needed structural mechanisms for support work their way through the political system.

A key finding from this work is advancing our understanding of how mindset interventions might be used to close the opportunity gap between students from advantaged and disadvantaged backgrounds through messaging. Converging reports have shown that students from low SES households are more likely to have a fixed mindset than their peers from higher SES backgrounds (Snipes & Tran, 2017), yet, having a growth mindset may particularly benefit students from low SES backgrounds. With the results from analyses such as these that help piece together which student and environmental factors prime students for the benefits of a growth mindset, educators and researchers can begin shifting and revising interventions to meet students where they are and provide maximal benefit. There is an opportunity to shift the story students are told about learning. Growth mindset can be a low-cost, effective intervention if done correctly, namely that they are developed with the students and their particular context in mind (Yeager, Hanselman, Walton, et al., 2019; Zhang et al., 2022). The results of this study support mindset as one protective factor for students at academic risk, and the potential for growth mindset interventions to help equalize the schooling environment and opportunities for students from historically underserved backgrounds.

4.1 Limitations

While this study helps extend our understanding of the boundary space of for whom mindset interventions might work and when, results should be considered in light of several limitations. First, while large-scale, this study only examined one school district in one state, which may not generalize to other academic settings and geographic areas. Of note, the sampled school district incorporated growth mindset into their strategic plan for 2021–2026 (though it was not explicitly mentioned in district documentation at the time of the current study in 2017–2018). Student participants here had likely been exposed to the idea of mindset and therefore more likely

to endorse growth-oriented attitudes, and we cannot account for potential response bias. However, there was still variability in the degree to which students endorsed these beliefs, and students with a fixed mindset were in this sample. Similarly, while sampling students with a similar range of socioeconomic status as previous work (Claro & Loeb, 2019), our overall sample skewed towards higher SES. For example, only 24% of our sample qualified for free or reduced lunch, compared to 77% of the sample in Claro and Loeb (2019). While using a factor score and treating SES as a continuous variable mitigates some concern, such differences in samples are important to consider when comparing the effects of mindset across studies.

Finally, in the current study, the abbreviated form of the Implicit Theory of Intelligence Scale was used to measure growth mindset. This shortened scale, only assesses the degree to which a participant endorses a 'fixed mindset' and does not include the degree to which a participant endorses a 'growth mindset'. This shortened form was used in project iLEAD in part to limit student fatigue in completing questionnaires, as these questions were only part of a larger set of questionnaires administered to students as part of the study. Additionally, this use of the shortened form is consistent with much of the mindset research, as the growth mindset questions are more likely to be seen as socially desirable, leading to bias in participant response (Erdley et al., 1997). However, more recent meta-analysis of the scale has shown the scale is best modelled as consisting of two separate but correlated scales (fixed and growth mindset; Scherer & Campos, 2022). Further, there is evidence that individuals can hold both a fixed and a growth mindset (Lüftenegger & Chen, 2017). As such, the current study does not provide a complete examination of students' theories of intelligence. Just as we advocate for taking into account more factors of a student's background to understand the potential protective role of mindset, the additional factor of the degree to which a student holds a growth mindset should be examined along with the degree to which they hold a fixed mindset.

4.2 Future directions

This study highlights the importance of taking a whole student approach in understanding the relationship between mindset and academic achievement. It is not enough to consider whether students with one certain characteristic are likely to show positive associations between mindset and achievement. Future work should therefore consider additional risk factors that could compound student vulnerability and assess potential third causes of these suspected vulnerabilities. The reason some experiences are likely to put students at academic risk may be more straightforward than others. For example, school absences and suspensions likely put students at academic risk because they are not in their educational environment and therefore not receiving the same educational experiences as their peers. Conversely, school transition may be a risk factor that serves as a proxy for a different vulnerability—puberty. In the United States, the transition to middle and high school coincides with puberty for a large portion of the student population. It may be that transitions during this development period put students at greater risk than if they were not to co-occur. By assessing students that may have transitioned to a new school for

non-traditional reasons (e.g., relocating) and accounting for pubertal stage in analyses, we might gain insight into when students are more vulnerable or resilient. With this knowledge, we can begin developing ways to mitigate student vulnerability through small-scale efforts such as introducing a growth mindset during transition periods or larger, policy-based efforts such as shifting the timing of these educational environment transitions.

4.3 Conclusion

Growth mindset continues to be an important factor in student achievement, even though effects may be specific to interactions between particular contexts and students. Given the multitude of studies documenting varying effects of growth mindset across different student populations, it is pertinent to continue to investigate the circumstances in which a growth mindset does benefit students. This way, resources can be appropriately allocated to provide students with the supports they most need at each stage of development.

Declarations

Conflict of interest The authors declare no competing interests.

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