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ARTICLE

Growth Mindset, Sense of Control, and Academic Anxiety: The Longitudinal Relations Among Early Adolescents in China

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ABSTRACT: Objectives: Academic anxiety is a prevalent emotional challenge among adolescents and has been linked to intelligence beliefs. Although prior research connects growth mindset to academic anxiety, the role of perceived control remains unclear. This longitudinal study aimed to examine whether sense of control mediates the relationship between growth mindset and academic anxiety in early adolescents. **Methods:** A three-wave longitudinal design was conducted with 407 early adolescents ($Mean_{age}$ = 13.75, 61.18% female) recruited from two public middle schools in southern China. Participants completed self-report measures of growth mindset, sense of control, and academic anxiety at three time points over six months. Cross-lagged panel models were fitted using structural equation modeling to examine prospective relationships and mediating effects. **Results:** Growth mindset was positively related to sense of control ($rs \geq 0.15$, $ps < 0.01$), which was in turn negatively related to academic anxiety ($rs \leq -0.12$, $ps < 0.05$). T1 growth mindset positively predicted T2 sense of control ($\beta = 0.12$, $p < 0.01$), while T2 sense of control negatively predicted T3 academic anxiety ($\beta = -0.16$, $p < 0.01$). T2 sense of control partially mediated the relationship between T1 growth mindset and T3 academic anxiety ($\beta = -0.019$, 95% CI = [−0.114, −0.012]). **Conclusion:** The findings indicated that sense of control mediated the relationship between growth mindset and academic anxiety over time. These findings suggest that school-based interventions targeting both growth mindset and perceived control may help prevent academic anxiety in early adolescents.

KEYWORDS: Early adolescents; academic anxiety; growth mindset; sense of control

1 Introduction

Academic anxiety, defined as the persistent tension and fear students feel in academic contexts due to concerns about their ability to meet goals or cope with challenges [1], has become a significant issue impacting the mental health and academic development of adolescents globally. According to a cross-national survey [2], approximately 37% of early adolescents reported persistent anxiety symptoms due to exam stress. In China, a similar investigation revealed that the main causes of emotional problems among adolescents are academic anxiety or academic pressure [3]. Academic anxiety not only interferes with cognitive functions [4] and weakens emotion regulation self-efficacy [5], but also may lead to a decline in academic performance [6,7], creating a negative cycle of "anxiety—avoidance—worsening performance" [8]. In the long term, this may damage individuals' subjective well-being [9] and increase the risk of depression [10] and even suicidal tendencies [11,12].

While interventions like cognitive-behavioral therapy and mindfulness training have shown some promise in reducing academic anxiety, they tend to focus mainly on symptom relief. These methods also come with notable limitations—they can be time-consuming, less efficient, and costly, which makes them difficult to use widely in school settings [13]. Therefore, exploring more widely applicable, prevention-oriented interventions that focus on developing positive psychological resources has become an important direction for current school mental health initiatives.

One promising positive psychological resource in alleviating academic anxiety is the growth mindset, which is a belief that abilities can be developed through effort and strategies [14]. Studies have found that students with a growth mindset are more likely to view challenges as opportunities for growth. This helps them stay psychologically stronger when dealing with stress [15], which in turn leads to steady improvements in academic performance [16]. However, the specific mechanisms through which a growth mindset influences academic anxiety remain unclear and require further investigation.

Sense of control, which refers to a perception of one's ability to influence outcomes through their actions [17], may be a crucial mediating factor linking growth mindset to academic anxiety. Students with a high sense of control are more likely to perceive difficulties as manageable challenges, reducing threat assessments and anxiety experiences [18]. Research suggests that a growth mindset strengthens students' belief that they can control their own learning, which in turn increases their confidence in dealing with academic challenges [16,19]. A sense of control not only serves as a cognitive-emotional buffer in stressful situations [20] but also helps students use adaptive strategies, which may stop anxiety from getting worse [8].

Drawing on control-value theory and related evidence, a growth mindset may reduce academic anxiety by first enhancing students' sense of control. However, support for this mediation pathway relies largely on cross-sectional evidence, which cannot establish the temporal sequence necessary for causal inference. In such designs, the proposed sequence—where mindset builds control, which then lowers anxiety—cannot be distinguished from alternative explanations, such as the possibility that pre-existing anxiety undermines both perceived control and growth beliefs. Although several longitudinal studies have begun to explore related dynamics. For example, tracking fixed mindset and distress [21] or self-control [22] over time, or examining mediators such as smartphone use [23]. No research has used a multi-wave design to simultaneously trace the interplay among growth mindset, sense of control, and academic anxiety in a general adolescent sample.

Therefore, this study tried to use a three-wave cross-lagged panel design to test whether sense of control mediates the longitudinal relationship between growth mindset and academic anxiety. Unlike prior cross-sectional or two-wave studies, which could only test correlated associations or indirect associations without full temporal separation. The three-wave design provides the first empirical test of whether sense of control transmits the protective effect of earlier growth mindset onto later academic anxiety. By clarifying the direction and timing of these effects, the findings will not only advance theoretical understanding of how these constructs interact over time but also offer concrete, evidence-based guidance for designing school interventions that strategically foster both a growth mindset and a sense of control to reduce academic anxiety.

2 Theoretical Background and Literature Review

2.1 The Relationship between Growth Mindset and Academic Anxiety

According to the mindset theory [14], individuals' beliefs about their abilities have a profound impact on their emotions and behavioral outcomes. The mindset theory divides mindsets into two types: (1) a

fixed mindset, where people think abilities are born and can't be changed, and (2) a growth mindset, where abilities are believed to be developed through effort and strategy [14].

A growth mindset, as a positive cognitive framework, plays a crucial role in students' academic adjustment and emotional well-being. Research has shown that a strong growth mindset is linked to lower academic anxiety [19]. When faced with academic setbacks, students with a growth mindset focus more on improving their skills and acquiring knowledge, rather than solely focusing on the outcome of their grades [24]. This cognitive orientation helps students adopt positive coping strategies, such as seeking help and adjusting their approaches, which reduces the perceived threat of failure [25] and effectively alleviates anxiety [26]. Moreover, a growth mindset encourages students to attribute failure to insufficient effort rather than a lack of ability, which reduces the fear of failure [27]. A growth mindset also helps students set realistic learning goals, thereby avoiding the excessive pressure that may arise from overly ambitious goals. Intervention studies further indicate that short-term mindset training aimed at enhancing a growth mindset may significantly reduce academic anxiety [28]—this has even been seen in specific subjects like math [15,29].

On the other hand, academic anxiety may also influence the development of students' mindsets in the opposite direction. High levels of academic anxiety could disrupt cognitive functions [4] and consume limited working memory resources, which may foster a negative belief that abilities are fixed and unchangeable [30]. Students who stay anxious for a long time are more likely to get stuck in a harmful cycle of "anxiety—avoidance—declining performance" [31], leading to a decrease in their self-efficacy [5] and reinforcing the tendency to avoid challenging tasks [32]. This process may weaken their ability to recover from difficulties [33] and further solidify a fixed mindset [34].

In summary, there appears to be a dynamic, bidirectional relationship between growth mindset and academic anxiety: growth mindset helps alleviate anxiety by shaping positive cognitive and behavioral patterns, while long-term anxiety may weaken the growth mindset, creating a negative cycle. Thus, we propose Hypothesis 1: There is a long-term bidirectional predictive relationship between growth mindset and academic anxiety.

2.2 The Relationship between Growth Mindset and Sense of Control

Sense of control refers to individuals' belief in their capacity to influence life outcomes through personal actions [17]. As core psychological constructs, both growth mindset and sense of control have been independently linked to academic achievement [15] and mental health [35]. However, emerging evidence suggests that these constructs may be dynamically interrelated [14,18].

A growth mindset may enhance individuals' sense of control through several mechanisms. Those who believe abilities are changeable tend to attribute setbacks to controllable factors like effort [24], which helps maintain confidence in their ability to influence outcomes [14]. This cognitive orientation promotes active coping strategies when facing challenges [36], with successful experiences further reinforcing one's sense of control. Experimental studies confirm that growth mindset interventions could significantly strengthen students' confidence in controlling their learning processes [37].

Conversely, a sense of control may also facilitate the adoption of a growth mindset. When individuals feel capable of influencing academic results [18], they are more likely to see difficulties as chances to improve [16]. This perception enhances cognitive flexibility and intrinsic motivation, creating conditions conducive to embracing growth beliefs. Previous research demonstrates that enhancing students' classroom control sense significantly increases their growth mindset levels, particularly among disadvantaged

groups [38]. Thus, we propose Hypothesis 2: Growth mindset and sense of control exhibit bidirectional predictive relationships over time.

2.3 The Relationship between Sense of Control and Academic Anxiety

Previous research suggests that the relationship between sense of control and academic anxiety may be bidirectional, forming a dynamic feedback system consistent with triadic reciprocal determinism, wherein personal factors and environmental experiences interact continuously [39].

A sense of control serves as a critical protective factor against academic anxiety. According to the control-value theory [40], students' academic emotions are jointly determined by their perceived control over learning activities and their subjective valuation of achievement outcomes. When students believe they can influence their grades through effort and strategy, they are more likely to perceive challenges as manageable tasks rather than threatening events, thereby reducing anxiety responses [41,42]. Empirical evidence has found that a sense of control and academic anxiety are negatively related [18,43]. For example, students with a stronger sense of control usually feel less anxious about exams [44] and cope better with stress. Intervention studies further confirm that enhancing students' perceived control could effectively alleviate academic anxiety symptoms [45].

Conversely, academic anxiety may undermine students' sense of control in several ways. The attentional control theory posits that anxiety impairs working memory and executive functions, reducing cognitive efficiency [6]. Within self-regulated learning frameworks [46], such cognitive interference can disrupt important learning processes, such as planning, monitoring, and strategy adjustment. When students are anxious, they often start to think that failure is caused by things they cannot change [47], which makes them feel more helpless. According to the control-value theory, this creates a cycle that is hard to break: "anxiety $\rightarrow$ cognitive impairment $\rightarrow$ reduced sense of control $\rightarrow$ heightened anxiety" becomes reinforced over time [48]. Empirical evidence confirms that highly anxious students typically demonstrate both a low sense of control and a low growth mindset [49]. Thus, we propose Hypothesis 3: Sense of control and academic anxiety may have bidirectional predictive relationships over time.

As core components of cognitive appraisal [50], growth mindset and sense of control may jointly influence academic anxiety through sequential cognitive evaluation processes [51]. A growth mindset primarily functions at the primary appraisal stage by shaping how students interpret academic challenges. Students with a growth mindset tend to see difficulties as chances to improve, rather than as threats to their self-worth [16], thereby reducing initial anxiety triggers. A sense of control operates predominantly at the secondary appraisal stage, where students evaluate their capacity to handle academic demands. Strong control beliefs lead to confident assessments of one's ability to overcome challenges through appropriate strategies [52].

Critically, a growth mindset may enhance a sense of control by encouraging active strategy use and persistence [53], while a heightened sense of control may reciprocally reinforce growth beliefs through successful mastery experiences. This synergistic relationship suggests sense of control may serve as a key mechanism through which a growth mindset reduces academic anxiety. We therefore propose Hypothesis 4: Sense of control mediates the longitudinal relationship between growth mindset and academic anxiety.

3 Methods

3.1 Participants and Procedures

Participants were drawn from two middle schools in southeastern China using cluster and convenience sampling. Data were collected at three time points over six months, with approximately three-month

intervals. The questionnaires were administered during class sessions at three time points: September 2022 (T1), December 2022 (T2), and March 2023 (T3). At Time 1, 450 students participated. Retention rates were 95.56% at Time 2 and 90.44% at Time 3. Attrition was due to school transfers or student absences on the day of assessment. Ultimately, 407 students ($Mean_{age}$ = 13.75 years, SD = 1.09; 61.18% female) completed all three waves. We performed a post hoc power analysis in G*Power (Version 3.1.9.4) [54] for linear multiple regression (testing R^2 increase), setting a conservative medium effect (f^2 = 0.15), α = 0.05, and power = 0.95. The required minimum sample was 107. Our final sample (n = 407) exceeds the minimum sample size requirement, confirming adequate power to detect the hypothesized effects.

The current study received ethical approval from the Ethics Committee of Jiaying University (No. JYU20250710) and all participating schools. We obtained informed consent from parents and students before data collection. Using paper-and-pencil questionnaires administered during class by trained research assistants, we collected data anonymously. Participants were assured of data confidentiality, accessible only to the research team, and were informed of their right to withdraw at any time without penalty.

3.2 Measures

3.2.1 Growth Mindset

Growth mindset was assessed using a Chinese adaptation of Yeager et al.'s [55] Growth Mindset Scale, which was widely used in Chinese adolescent samples. The scale consists of 10 items designed to measure individuals' beliefs about the malleability of intelligence. Six items reflect a growth mindset (e.g., "People can improve their intelligence through continuous learning"), while four items reflect a fixed mindset (e.g., "A person's intelligence is fixed and cannot be changed"). Participants rated each item on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The four fixed-mindset items were reverse-coded prior to analysis, such that higher total scores indicated a stronger growth mindset. The scale demonstrated good psychometric properties in the current sample, with confirmatory factor analysis showing excellent model fit (CFI = 0.99, TLI = 0.98, RMSEA = 0.05). Internal consistency was good across three waves (α = 0.81, 0.84, 0.89), consistent with previous validation studies among Chinese adolescents [56].

3.2.2 Academic Anxiety

Academic anxiety was measured using a Chinese adaptation of the anxiety subscale from the Adolescent Academic Emotion Questionnaire [57]. The scale consists of seven items designed to capture students' negative emotional experiences related to academic situations. The items assess two interconnected aspects of academic anxiety: test-related anxiety (e.g., "I feel nervous before exams") and learning process anxiety (e.g., "I often experience setbacks in my studies"). Additional items capture social-evaluative concerns (e.g., "Sometimes I feel I let my family and teachers down because of poor performance") and negative self-appraisals (e.g., "I feel distressed when my academic performance is worse than my peers"). This subscale utilizes a 5-point Likert format (1 = strongly disagree, 5 = strongly agree), with higher scores reflecting greater academic anxiety. This widely used measure has demonstrated strong psychometric properties in Chinese adolescent samples [57]. In this study, it showed good reliability across three time points (α = 0.82, 0.86, 0.87).

3.2.3 Sense of Control

Sense of control was evaluated using the Chinese version of Lachman and Weaver's [58] Scale, adapted by Li [59]. This 12-item scale measures individuals' beliefs about their capacity to influence and shape life outcomes, comprising two interrelated dimensions: personal mastery and perceived constraints. The

personal mastery subscale consists of four items assessing individuals' beliefs in their own efficacy and ability to achieve desired outcomes (e.g., "I can do just about anything I really set my mind to"). The perceived constraints subscale includes eight items measuring the extent to which individuals believe there are obstacles or factors beyond their control that interfere with reaching goals (e.g., "There is little I can do to change the important things in my life"). Participants rated each item on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). The scale has been widely used in Chinese adolescent samples and has demonstrated sound psychometric properties [60,61]. After reverse-coding nine negative items, higher scores indicate a stronger sense of control. The scale demonstrated acceptable and stable internal consistency across all waves (α = 0.76, 0.80, 0.81).

3.3 Data Analysis

Data were analyzed in several stages using SPSS 24.0 and AMOS 24.0 (IBM Corp., Armonk, NY, USA). Before the main analysis, missing scale items were imputed using the mean of adjacent measurement points, a method chosen to preserve the temporal continuity and response patterns within closely spaced assessments. Harman's single-factor test was conducted to check for common method bias. Descriptive statistics and Pearson correlation analyses were conducted to examine the initial associations among growth mindset, sense of control, and academic anxiety. Structural equation modeling (SEM) was employed to test the proposed longitudinal relationships. Before estimating the cross-lagged models, longitudinal measurement invariance was assessed to ensure that the latent constructs were comparable across time points. Following established criteria [62], model fit was considered acceptable with CFI values > 0.90 and RMSEA < 0.08. Subsequently, a cross-lagged panel model was specified to examine potential bidirectional effects, followed by a longitudinal mediation model to test whether sense of control mediated the predictive relationship between growth mindset and later academic anxiety.

4 Results

4.1 Common Method Bias Assessment

Harman's single-factor test was conducted separately for each of the three measurement waves. The analysis extracted 8, 6, and 6 factors with eigenvalues greater than one, respectively. Importantly, the first (or largest) factor accounted for 24.35%, 27.96%, and 30.12% of the total variance across waves. Since all these values fall below the recommended critical threshold of 40%, the results indicate that significant common method bias was not present in the self-report assessments [63].

4.2 Correlation Analysis among Variables

As shown in Table 1, significant positive correlations were observed for growth mindset ($rs \geq 0.36$, $ps < 0.001$), sense of control ($rs \geq 0.50$, $ps < 0.001$), and academic anxiety ($rs \geq 0.46$, $ps < 0.01$) from T1 to T3, indicating strong temporal stability of these constructs. Growth mindset was negatively correlated with academic anxiety across time points ($|rs| \geq 0.12$, $ps < 0.05$), except for the nonsignificant association between T2 growth mindset and T1 academic anxiety. Sense of control showed consistently significant negative correlations with academic anxiety ($|rs| \geq 0.25$, $ps < 0.01$) and positive correlations with growth mindset ($rs \geq 0.15$, $ps < 0.01$) across all waves. Age was negatively correlated with T3 growth mindset ($r = -0.12$, $p < 0.05$) and positively correlated with sense of control ($rs \geq 0.10$, $ps < 0.05$) from T1 to T3. Gender was positively correlated with T1 ($r = 0.15$, $p < 0.01$) and T3 ($r = 0.24$, $p < 0.001$) academic anxiety. Therefore, given their systematic associations with the core study variables, both age and gender were included as covariates in all subsequent cross-lagged and longitudinal mediation models.

Table 1: Descriptive statistics and correlations among variables.

Variables	1	2	3	4	5	6	7	8	9	10	11
1. T1 GM	-										
2. T2 GM	0.43***	-									
3. T3 GM	0.36***	0.40***	-								
4. T1 AA	−0.13**	−0.08	−0.16***	-							
5. T2 AA	−0.16**	−0.15**	−0.21**	0.54**	-						
6. T3 AA	−0.19***	−0.14**	−0.12*	0.46**	0.54***	-					
7. T1 SC	0.28***	0.15**	0.18***	−0.42**	−0.28***	−0.26***	-				
8. T2 SC	0.25***	0.32***	0.24***	−0.25**	−0.43***	−0.34***	0.50***	-			
9. T3 SC	0.26***	0.29***	0.36***	−0.27**	−0.33***	−0.47***	0.52***	0.51***	-		
10. Age	0.03	−0.06	−0.12*	0.02	−0.01	−0.004	0.15**	0.12*	0.10*	-	
11. Gender	−0.01	−0.01	−0.04	0.15**	0.08	0.24***	−0.02	−0.03	−0.04	−0.02	-
Mean	3.68	3.64	3.58	3.67	3.56	3.48	3.00	3.00	3.02	13.75	-
SD	0.41	0.45	0.5	0.69	0.74	0.72	0.45	0.41	0.38	1.10	-

Note: n = 407; *SD* = Standard deviation; T1 = time 1; T2 = time 2; T3 = time 3; Gender is a dummy variable, with male = 0 and female = 1; GM = Growth Mindset; AA = Academic Anxiety; SC = Sense of Control; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

4.3 Cross-Lagged Panel Analysis

We examined longitudinal measurement invariance for growth mindset, academic anxiety, and sense of control [64]. For each construct, the models demonstrated configural, metric (weak), and scalar (strong) invariance, with all fit indices meeting conventional thresholds (CFI/TLI > 0.90, RMSEA < 0.08; Table 2). Although strict invariance was not fully achieved, recent methodological perspectives suggest that meeting scalar invariance is sufficient for substantive longitudinal comparisons, as strict invariance is often not a necessary prerequisite for testing cross-lagged relationships [65,66]. Accordingly, all subsequent cross-lagged panel analyses were conducted based on the scalar (strong) invariance model, which was retained as the final measurement structure.

A cross-lagged panel model was then used to explore the reciprocal relationship between academic anxiety and growth mindset. The model demonstrated good fit: $\chi^2 = 5.48$, $df = 2$, CFI = 0.99, TLI = 0.95, RMSEA = 0.06, 90%CI = [0.001, 0.134]. Results (see Fig. 1) revealed that T1 growth mindset significantly predicted a reduction in academic anxiety at both T2 ($\beta_{T1GM \rightarrow T2AA} = -0.09$, $p < 0.05$) and T3 ($\beta_{T1GM \rightarrow T3AA} = -0.12$, $p < 0.01$). Additionally, T2 academic anxiety significantly predicted a decrease in T3 growth mindset ($\beta_{T2AA \rightarrow T3GM} = -0.11$, $p < 0.05$). These findings suggest a bidirectional predictive relationship between growth mindset and academic anxiety, supporting Hypothesis 1.

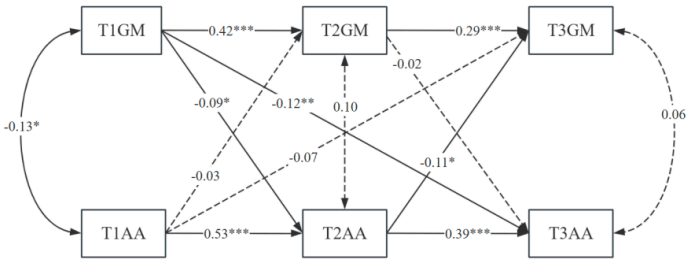

Figure 1: Cross-lagged panel model of growth mindset and academic anxiety across three time points. Note: GM = Growth Mindset; AA = Academic Anxiety. T1, T2, T3 = Time 1, Time 2, Time 3. All parameters of the report are standardized, Single-headed arrows represent cross-lagged and autoregressive paths (→); double-headed arrows represent within-time correlations (↔); dashed arrows indicate nonsigniffcant regression paths (- - →). $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 2: Longitudinal measurement invariance tests for each scale.

Variables	Model	χ^2	*df*	CFI	TLI	RMSEA	90% CI	Model Comparison	ΔCFI	ΔRMSEA
GM	M1	83.81	24	0.97	0.94	0.05	[0.04, 0.06]	-	-	-
	M2	101.04	34	0.97	0.96	0.04	[0.03, 0.05]	M2-M1	−0.004	−0.005
	M3	108.74	36	0.96	0.95	0.04	[0.03, 0.05]	M3-M2	−0.003	0.001
	M4	182.55	48	0.93	0.94	0.05	[0.04, 0.06]	M4-M3	−0.031	0.007
SC	M1	55.28	33	0.99	0.98	0.02	[0.01, 0.03]	-	-	-
	M2	82.71	45	0.98	0.98	0.03	[0.02, 0.04]	M2-M1	−0.008	0.002
	M3	87.36	47	0.98	0.98	0.03	[0.02, 0.04]	M3-M2	−0.001	0.001
	M4	233.54	61	0.91	0.91	0.05	[0.04, 0.06]	M4-M3	−0.076	0.021
AA	M1	116.56	36	0.98	0.96	0.04	[0.03, 0.05]	-	-	-
	M2	132.88	48	0.97	0.97	0.04	[0.03, 0.05]	M2-M1	−0.002	−0.005
	M3	134.33	50	0.97	0.97	0.04	[0.03, 0.05]	M3-M2	0.000	−0.001
	M4	195.00	64	0.96	0.96	0.03	[0.03, 0.06]	M4-M3	−0.014	0.004

Note: GM = Growth Mindset; AA = Academic Anxiety; SC = Sense of Control M1 = Configural invariance model; M2 = Metric invariance model; M3 = Scalar invariance model; M4 = Strict invariance model. CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; 90% CI = 90% confidence interval for RMSEA. ΔCFI and ΔRMSEA represent changes in fit indices compared to the preceding model. All constructs achieved configural, metric, and scalar invariance ΔCFI < 0.01, ΔRMSEA < 0.015 [60]. Strict invariance was not required for cross-lagged analyses and was therefore not retained [61,62].

4.4 Longitudinal Mediation Analysis

To examine the mediating role of sense of control in the longitudinal relationship between growth mindset and academic anxiety, we constructed a cross-lagged mediation model. The model demonstrated good fit: $\chi^2 = 15.45$, $df = 7$, CFI = 0.99, TLI = 0.91, RMSEA = 0.05, 90%CI = [0.04, 0.10].

Path analysis revealed that a growth mindset had a stable positive predictive effect on sense of control across time points (see Fig. 2). Specifically, growth mindset at T1 significantly predicted a higher sense of control at T2 ($\beta_{T1GM\rightarrow T2SC} = 0.12$, $p < 0.01$), and growth mindset at T2 significantly predicted a greater sense of control at T3 ($\beta_{T2GM\rightarrow T3SC} = 0.17$, $p < 0.001$). In contrast, the reverse predictive pathway was not statistically significant, suggesting a unidirectional influence. Thus, Hypothesis 2 was not supported.

The results indicated bidirectional predictive effects between sense of control and academic anxiety. On the one hand, sense of control at T2 was negatively associated with academic anxiety both concurrently ($\beta_{T2SC\rightarrow T2AA} = -0.37$, $p < 0.001$) and longitudinally at T3 ($\beta_{T2SC\rightarrow T3AA} = -0.16$, $p < 0.01$). On the other hand, academic anxiety at T2 significantly predicted a decline in sense of control at T3 ($\beta_{T2AA\rightarrow T3SC} = -0.17$, $p < 0.001$), providing empirical support for Hypothesis 3.

Furthermore, T1 growth mindset had a significant positive predictive effect on T2 sense of control ($\beta_{T1GM\rightarrow T2SC} = 0.12$, $p < 0.01$), and T2 sense of control had a significant negative predictive effect on T3 academic anxiety ($\beta_{T2SC\rightarrow T3AA} = -0.16$, $p < 0.001$). Mediation analysis indicated a significant indirect predictive effect of T1 growth mindset on T3 academic anxiety via T2 sense of control ($\beta = -0.019$, 95% CI = [−0.114, −0.012]). The direct path (see Fig. 1) from T1 growth mindset to T3 academic anxiety was significant ($\beta = -0.12$, $p < 0.01$). Therefore, a sense of control served as a partial mediator in this longitudinal relationship. This supports Hypothesis 4 and confirms that sense of control serves as a longitudinal mediator between growth mindset and academic anxiety. Notably, the reverse pathway—from T1 academic anxiety to T3 growth mindset through T2 sense of control—was not supported, highlighting the directional specificity of the mediation effect.

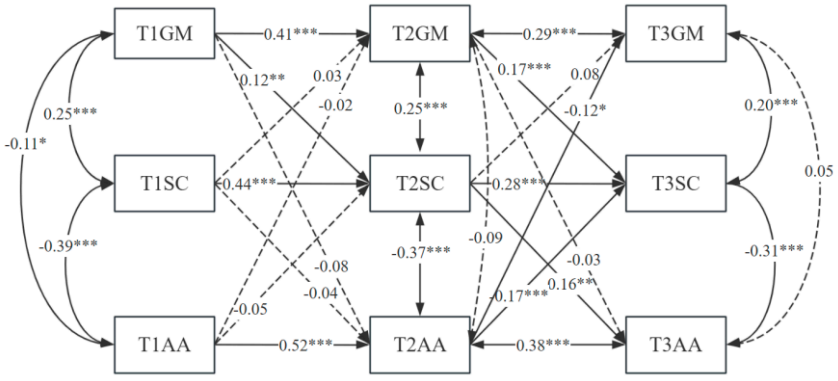

Figure 2: Standardized path coefficients for the longitudinal mediation model. Note: GM = Growth Mindset; AA = Academic Anxiety; SC = Sense of control. T1, T2, T3 = Time 1, Time 2, Time 3. All parameters of the report are standardized. Single-headed arrows represent cross-lagged and autoregressive paths (→); double-headed arrows represent within-time correlations (↔); dashed arrows indicate nonsigniffcant regression paths (- - →). $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

5 Discussion

This six-month longitudinal study reveals that a growth mindset significantly and negatively predicts subsequent academic anxiety, with the sense of control serving as a partial mediator in this relationship.

Mechanistically, the protective effect of a growth mindset may work by enhancing students' sense of control, which in turn reduces their academic anxiety. Conversely, a weakened sense of control not only relates to a more severe academic anxiety but also to a weaker growth mindset over time. These results highlight the key role of sense of control in the relationship between adolescents' growth mindset and academic emotional experiences, thereby providing a robust empirical foundation for interventions that simultaneously target growth mindset and perceived control to prevent academic anxiety.

5.1 The Relations between Growth Mindset and Academic Anxiety

Our cross-lagged analyses revealed that growth mindset significantly negatively predicted academic anxiety, aligning with existing literature [29,67]. According to mindset theory, a growth mindset facilitates adaptive coping strategies and enhances self-regulatory capacity, enabling students to reframe academic challenges as opportunities for development rather than personal threats [14], thereby mitigating anxiety [25]. Students with a growth mindset also tend to explain academic results more positively—they think outcomes depend on things they can control, like effort, instead of fixed ability [16], which reduces fear of failure. Meta-analytic evidence further confirms that growth mindset interventions effectively reduce student anxiety [31].

Notably, the growth mindset at T2 did not significantly predict academic anxiety at T3. This may be explained by the timing of T3 data collection, which coincided with final examinations—a period of heightened academic pressure. According to control-value theory [40], when stress from the environment is too strong, situational factors may temporarily weaken the influence of personal traits on emotions. Even students with a growth mindset may feel more anxious during important exams, which could explain why the long-term relationship was not significant during this specific period. Empirical evidence supports this interpretation. One study found that test anxiety was higher in high-stakes testing situations than in low-stakes classroom assessments [68]. Similarly, research on academic self-concept and interest—both linked to growth mindset—showed that their protective effects against anxiety were weaker during exam periods [69]. More recently, a systematic review confirmed that high-stakes testing contexts attenuate the buffering effects of adaptive beliefs [41]. Thus, even students with a high level of growth-mindedness may experience more exam anxiety, overriding typical benefits. This result may underscore the context-dependent expression of protective factors.

Nevertheless, the growth mindset continued to exert a sustained indirect protective effect on academic anxiety through its promotion of students' sense of control. This finding suggests that in school practice, besides building a growth mindset, we should also help students keep a sense of control when facing high pressure. This would be more effective in preventing and reducing academic anxiety.

5.2 The Relations between Growth Mindset and Sense of Control

Our findings reveal that while a growth mindset positively predicted subsequent sense of control, sense of control did not demonstrate a reciprocal predictive effect on growth mindset. Although this pattern contradicts Hypothesis 2, it aligns with the classic findings of Robins and Pals [70], suggesting an asymmetrical causal relationship between these psychological constructs.

The predictive effect of growth mindset on sense of control can be understood through the self-efficacy theory. When students believe abilities can be developed, they are more likely to perceive challenges as obstacles that could be overcome through effort, consequently engaging in more strategic and proactive behaviors [36]. This adaptive coping pattern reinforces the "effort-outcome" contingency belief, enabling students to gradually develop a stronger sense of control through successful experiences. Longitudinal

evidence supported this mechanism, with Wang et al. [71] demonstrating that an enhanced growth mindset during middle school predicts an increased sense of control in high school. Experimental research further indicated that students randomly assigned to growth mindset interventions subsequently reported a significantly higher sense of control compared to control groups [25].

The absence of a reverse predictive effect may be explained by the fundamental nature of these constructs. Sense of control, as an evaluation of one's current capacity to navigate environmental demands, is more susceptible to transient situational influences. In contrast, growth mindset represents a relatively stable belief system about the malleability of ability, the development of which requires deeper cognitive restructuring [14]. Accordingly, simply possessing a sense of control may not be sufficient to produce meaningful changes in students' underlying beliefs about ability. According to self-efficacy theory [8], mastery experiences enhance perceived control but remain task-specific, reflecting evaluation of current capability rather than beliefs about the malleability of intelligence. Growth mindset, by contrast, entails a fundamental cognitive shift regarding the nature of ability itself—one that is unlikely to emerge from control experiences alone. Furthermore, the implicit theories framework posits that mindset change typically requires direct intervention targeting meta-theories, not merely performance expectations [14]. Empirically, although numerous studies have demonstrated that growth mindset predicts subsequent increases in sense of control [32,72], no evidence to date has supported the reverse pathway. These findings suggest that educational efforts should prioritize cultivating a growth mindset directly, rather than assuming that an enhanced sense of control alone will eventually reshape students' core beliefs about ability.

5.3 The Relations between Sense of Control and Academic Anxiety

The results demonstrated a reciprocal negative relationship between sense of control and academic anxiety, aligning with established research [73]. According to control-value theory [40], when students believe they can manage their learning process, they are more likely to perceive academic challenges as manageable tasks rather than threats, thereby reducing anxiety levels. Empirical studies show that students with a strong sense of control exhibit lower test anxiety [44] and are more adept at employing proactive coping strategies [43]. Intervention studies further indicated that enhancing the sense of control effectively reduces academic anxiety symptoms [45]. Simultaneously, academic anxiety can weaken individuals' sense of control. According to attentional control theory, anxiety consumes limited cognitive resources and interferes with self-regulation during learning [6], leading students to attribute failures more readily to stable ability deficits [47], thereby reinforcing feelings of helplessness.

Notably, the bidirectional predictive relationship between sense of control and academic anxiety was not significant at T1 and T2. This may be because the academic pressure was relatively low in the early stage of the study, and the interaction between the two had not been fully activated. As time progressed, particularly as important exams approached, academic pressure increased significantly, making the dynamic interplay between sense of control and anxiety more pronounced and resulting in a clear mutual predictive pattern in later stages. This finding highlights the important role of stress levels in academic environments in moderating the relationship between sense of control and anxiety.

5.4 The Longitudinal Mediating Role of Sense of Control

The finding of a partial mediation suggested that the protective effect of a growth mindset against academic anxiety operates partly through fostering a greater sense of control over one's learning, aligning with previous research [18,25]. According to cognitive appraisal theory, students with a growth mindset tend to initially appraise academic challenges as opportunities for development rather than personal threats.

This positive cognitive pattern motivates more proactive engagement in learning management, where sustained effort and practice enhance their sense of control over the learning process [35].

During secondary appraisal, this enhanced sense of control subsequently moderates emotional responses. When students feel they can influence academic outcomes, they are much less likely to see academic stress as a threat [72]. As a key psychological resource, a sense of control both buffers physiological arousal in stressful situations [74] and facilitates the adoption of adaptive coping strategies [8]. Although speculative, this mechanism may resonate with culturally embedded beliefs in Chinese societies—such as the traditional saying that "diligence can compensate for lack of talent"—which conceptually align with the core tenets of growth mindset interventions [75].

Empirical evidence from multiple perspectives supported this mediating mechanism. Hagger and Chatzisarantis [76] verified the pathway whereby growth mindset indirectly alleviates academic anxiety through enhanced sense of control, while Burnette et al.'s [31] meta-analysis further identified sense of control as a core component connecting growth mindset to anxiety reduction. Collectively, these findings demonstrated that cultivating students' growth mindset helps strengthen their sense of control, thereby establishing a psychological protective mechanism against academic stress.

Regarding methodological considerations, although the traditional cross-lagged panel model (CLPM) can confound between- and within-person variance [77], its use in this study was appropriate for several reasons. First, our primary aim was to examine longitudinal linkages at the group level across early adolescence, for which CLPM provides valid estimates of developmental relationships [78]. Second, the hypothesized process was expected to reflect both individual differences and within-person change over time—a combined effect that CLPM captures and that remains relevant for informing group-level interventions. Third, our three-wave design aligned well with CLPM's utility for tracking systematic developmental trends [79]. Therefore, the present analysis offers a foundational map of how these constructs unfold over time, thereby guiding more nuanced future investigations.

5.5 Theoretical and Practical Implications

The observed cross-lagged effect ($\beta = 0.12$) is considered medium-to-large for longitudinal research [80]. The indirect effect ($\beta = -0.019$), while modest, still carries practical meaning—particularly because small effects can accumulate over time in educational settings [81]. Moreover, when implemented at scale, these individual-level gains can translate into meaningful population-level benefits [82]. These findings have several implications for theory and practice.

Theoretically, this study offers three contributions to the literature. First, by integrating cognitive appraisal theory with control-value theory, it illustrates how growth mindset relates to academic anxiety through sense of control. Specifically, growth mindset may shape students' beliefs about ability, encouraging them to view academic challenges as opportunities. Second, the three-wave design provides a more rigorous test of temporal ordering than cross-sectional studies, clarifying the directional sequence among these constructs. Third, the findings reveal that growth mindset predicts subsequent sense of control, but the reverse pathway is not significant. This observation adds nuance to theoretical understandings by suggesting that sense of control may function primarily as an outcome of growth mindset rather than a reciprocal influence. Collectively, these contributions offer a longitudinal clarification of how these constructs unfold over time.

Practically, the research results indicated a promising direction for intervention, given the links between growth mindset, sense of control, and academic anxiety. Educational practitioners could simultaneously cultivate a growth mindset to establish beliefs about malleable ability and enhance a sense of control through

self-regulated learning training. School mental health educators could plan a structured curriculum that systematically fosters a growth mindset while building adaptive control beliefs. This cognitive-behavioral intervention approach may not only ease anxiety in the short term but also build long-term psychological resilience, providing schools with a practical plan for mental health education.

5.6 Limitations and Future Directions

Several limitations should be considered. First, the reliance on self-report measures may introduce social desirability effects. Future studies would benefit from incorporating multi-method assessments, such as teacher reports or neurophysiological measures. Second, although the cross-lagged panel model (CLPM) remains widely used, it can conflate between- and within-person variance. Therefore, random-intercept CLPM (RI-CLPM) may better isolate within-person processes and provide a more precise test of dynamic mediation over time. Third, although our three-wave design indicated that growth mindset and sense of control synergistically predicted lower anxiety, it is important to note that this design was observational and did not constitute experimental manipulation. Consequently, future experimental interventions targeting both constructs could help establish causal evidence for this synergistic effect. Fourth, all key variables were assessed using self-report measures, which may have introduced shared method variance and inflated observed associations. Future studies would therefore benefit from incorporating multi-method assessments, such as teacher reports or behavioral tasks. Fifth, the present findings were derived from a convenience sample drawn from two local schools, which limits their generalizability to other regions, school types, or socioeconomic backgrounds. Accordingly, future research should employ probability sampling across more diverse educational settings. Finally, although Harman's test suggested no severe common method bias, the six-month measurement intervals may still have introduced such a risk. Future studies should therefore employ longer time lags to further mitigate this concern.

6 Conclusions

The current study adopted a longitudinal mediation model to test the crucial role of sense of control in the relationship between growth mindset and academic anxiety. The findings demonstrated that a growth mindset not only directly predicted reduced academic anxiety but also exerted an indirect protective effect by enhancing students' sense of control. This partial mediating pathway indicated that cultivating a growth mindset may help strengthen students' sense of control when confronting academic challenges, thereby effectively alleviating anxiety. These results may help advance our understanding of how cognitive factors relate to emotional adaptation and provide both theoretical foundations and practical implications for developing student anxiety interventions centered on fostering a growth mindset and enhancing a sense of control. However, several limitations should be noted, including the use of self-report measures, convenience sampling, and the observational design, which preclude causal inferences. Future research should employ experimental designs, more diverse samples, and longer time intervals to further validate and extend these findings.

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