



Growth mindset and academic achievement in Chinese adolescents: A moderated mediation model of reasoning ability and self-affirmation

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Abstract

Although growth mindset (i.e., the belief that intelligence can be developed) has been shown to play an important role in academic achievement, little is known about the underlying mediating and/or moderating mechanisms in adolescents. The current study investigated (a) the mediating role of reasoning ability in the relationship between growth mindset and academic achievement, and (b) the moderating role of self-affirmation in the direct and indirect relationships between growth mindset and academic achievement. Participants were 1828 Chinese adolescents (age, $M = 16.88$; 59.4% male). Participants filled out questionnaires regarding growth mindset, academic achievement, reasoning ability, and self-affirmation. After controlling for age, sex, annual family income, *hukou* (household registered), and parent's educational level, we found that growth mindset was significantly positively associated with academic achievement. Mediation analysis revealed that reasoning ability partially mediated this relationship. Growth mindset (incremental theories of intelligence) significantly predicted academic achievement in adolescents with high self-affirmation, but not in those with low self-affirmation. Moderated mediation analysis further indicated that the direct and indirect relationships between growth mindset and academic achievement were moderated by self-affirmation. The indirect effect of growth mindset on academic achievement via reasoning ability was stronger for adolescents with high self-affirmation than in those with low self-affirmation.

Keywords Growth mindset · Self-affirmation · Academic achievement · Reasoning ability · Adolescents

Introduction

Academic achievement can be influenced by structural factors, such as socioeconomic background, and psychological factors, such as students' beliefs about their abilities (Claro

et al. 2016). According to the Mindset theory, there are two kinds of beliefs about the nature of students' own intelligence (Dweck 2008). First is growth mindset (incremental theories of intelligence), which is the belief that intellectual abilities can be improved through students' own efforts (Yeager et al. 2016). Students with a growth mindset tend to be more resilient in the face of challenges, and opt for difficult tasks that they can learn from rather than tasks for which success is guaranteed (Spitzer and Aronson 2015). The other is fixed mindsets (entity theories of intelligence), whereby students with a fixed mindset believe that intellectual abilities are fixed and that levels of ability cannot be changed (Yeager et al. 2016). Students with a fixed mindset tend to have worse long-term outcomes because they believe that performing poorly or struggling with difficult material is a sign that they are not intelligent enough to handle the task at hand (Spitzer and Aronson 2015). The growth mindset promotes resilience, and individuals with growth mindset are more likely to focus on the effort and they interpret setbacks and challenges as effective ways to improve their ability, intelligence, and experience (Dweck 2008; Yeager and Dweck 2012).

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Growth Mindset and Academic Achievement

Growth mindset has been found to predict a higher academic achievement than fixed mindset (Grant and Dweck 2003; Blackwell et al. 2007; Dweck 2008). Students with growth mindset were found to care more about learning goals, therefore, they displayed better task performance. (Mueller and Dweck 1998). Indeed, Claro et al. (2016) showed that growth mindset is a strong predictor of achievement and exhibits a positive relationship with achievement across all socioeconomic strata in the Chile. Aronson et al. (2002) found that growth mindset can counteract the negative effects of stereotypes. Specifically, growth mindset can eliminate the threat of stereotypes that African Americans are not smart and women are not good at math and science, and improve standardized test scores for women and African Americans. Besides, Students with growth mindset have greater confidence in their future academic performance, which leads to higher expectations, all this in turn improve their academic performance (Plaks and Stecher 2007). Meanwhile, growth mindset interventions have been associated with a decreased dropout risk of high school students from core academics courses and an increase in satisfactory performance in core courses (Paunesku et al. 2015). However, previous studies have primarily focused on the direct relationship between growth mindset and academic achievement. The mediating mechanism/s (i.e., how growth mindset relates to academic achievement) and moderating mechanism/s (i.e., under what conditions the link is most potent) have received only little attention.

Reasoning Ability as a Mediator

Mindset has an important impact on not only students' academic achievement, but also the development of their cognitive abilities (Dweck 2008). For example, growth mindset has been reported to predict higher math and science achievement compared to fixed mindset (Grant and Dweck 2003; Blackwell et al. 2007; Dweck 2008). Similarly, Adhitya and Prabawanto (2018) found a significant negative correlation between fixed thinking and students' mathematical reasoning. That said, many studies have shown that reasoning ability can predict academic achievement (Karbach et al. 2013), and the improvement of growth mindset increases brain connectivity and promotes academic achievement. For example, one electroencephalography study showed that school-aged children with growth mindset training performed with higher accuracy after mistakes had been made (i.e., post-error accuracy) (Schroder et al. 2017). Furthermore, Harper (2014) demonstrated that students that have received growth mindset intervention can make brain connections to alter their academic achievement. Growth mindset relates to brain processes, and brain processes relate to reasoning ability (Ng 2018).

Likewise, cognition undoubtedly affects students' academic achievement. Therefore, reasoning ability may play an intermediary role between growth mentality and academic achievement.

In present study, the Reasoning Ability Test, which was developed by the National Project Team for the Investigation of Psychological Development Characteristics of Chinese Children and Adolescents (Dao et al. 2015), consists of analogical reasoning and inductive reasoning subsets. The analogical reasoning is a composite test which consists the digital analogical reasoning and graphic analogical reasoning tasks, while the inductive reasoning only measured by the graphic sequence inference task. The Cronbach's alpha coefficient of each subtest and overall test are 0.74–0.94.

Self-Affirmation as a Moderator

Better academic achievement in students with growth mindset could be explained by stronger academic motivations, effort beliefs, and psychological resilience (Yeager and Dweck 2012). For instance, students show greater motivation to learn when they believe that they have the potential to develop their abilities (Yeager et al. 2016). Growth mindsets have been found to predict greater achievement and effort than fixed mindsets from early childhood through to college-aged students (Blackwell et al. 2007). Schroder et al. (2017) demonstrated the combined role of growth mindset and neural mechanisms of attention allocation in bouncing back after failure in young children. Self-affirmation is an act that maintain one's global conceptions of self-adequacy. Self-affirmations can involve many everyday activities. Even activities that seem like distractions can also function as self-affirmations (Steele 1988). Individuals maintain their self-integrity by affirming the self through action or thought (Harris et al. 2017). Self-affirmation resolves the "tension between self-protection and self-improvement", allowing people to accept the reality of the threat and, consequently, to address the threat assertively and adaptively (Sherman and Hartson 2011), in this sense, self-affirmation may have implications for health. Indeed, individuals who tend to be self-affirming do increase their acceptance of relevant health-risk information (Harris and Epton 2009). Stronger academic motivations, effort beliefs, and psychological resilience can promote self-affirmation and the positive knock-on effects of this (Cohen and Sherman 2014). Furthermore, social psychological self-affirmation research shows that value affirmations (i.e., promote self-affirmation) often boost adaptive functioning (Howell 2017), and affirmation of personal adequacy (i.e., promote self-affirmation) can not only strengthen resilience to adverse events (Cohen and Sherman 2014) but improve the performance of executive functioning, which have been shown to have a significant impact on the outcomes of actions (Harris et al. 2017). Therefore, self-affirmation may be the effect of growth

mindset in terms of reasoning ability and academic achievement.

The Present Study

The present study investigated (a) whether reasoning ability mediates the relationship between growth mindset and academic achievement, and (b) whether the direct and the indirect relationships between growth mindset and academic achievement mediated by reasoning ability are moderated by self-affirmation. We developed a moderated mediation model (see Fig. 1), which can address both mediation and moderation mechanisms underlying the relation between growth mindset and academic achievement. The following hypotheses were proposed: (1) reasoning ability mediates the relationship between growth mindset and academic achievement, and (2) self-affirmation moderates the direct and indirect relationships between growth mindset and academic achievement via reasoning ability. Specifically, we hypothesized that the direct and indirect relationships between growth mindset and academic achievement would be stronger in Chinese adolescents with higher levels of self-affirmation.

Methods

Participants and Procedure

The survey was conducted between March and June 2017. Participants were 1828 adolescents enrolled at two secondary vocational schools in Anhui, China. Anhui is a province of China in which social and economic development is relatively poor. In China, most students who enter secondary vocational schools have a poor academic performance and come from families with a low socioeconomic status (Yi et al. 2013). Participants were students of classes that had been randomly selected within each department. Data collection was conducted in a computer room of the collaborative school via an online questionnaire, which was overseen by the research group, etc. The annual family income and parents' education level were reported by participants' parents or guardians. Written consent was obtained from each participant after a full

explanation of the study procedure had been provided. Informed consent was also obtained from parents/guardians of participants younger than 18 years old. The study was reviewed and approved by the Institutional Review Board of Human Research Ethics Committee for Non-Clinical Faculties at Beijing Normal University.

All participants (age of all participants: $M = 16.88$, $SD = 0.80$ years; age range = 13.5 to 18.5 years; male: $n = 1085$, 59.4%; female: $n = 743$, 40.6%), 69.1% were agricultural *hukou* ($n = 1264$) and 30.9% were non-agricultural *hukou* ($n = 564$). Participants fathers' and mothers' years of education ranged from 0 to 18 years (fathers: $M = 8.80$, $SD = 3.79$; mothers: $M = 8.03$, $SD = 3.93$). Annual family income ranged from 1 to 9 (see the background questionnaire for details; $M = 3.97$, $SD = 2.39$).

Instruments

Background Questionnaire

The background questionnaire is a self-reported inventory of sex, date of birth, *hukou* (household registered in an agricultural or non-agricultural area), annual family income (scored on a 9-point scale as follows: 1 = ¥ 3000, 2 = ¥ 3001–6000, 3 = ¥ 6001–10,000, 4 = ¥ 10,001–30,000, 5 = ¥ 30,001–50,000, 6 = ¥ 50,001–100,000, 7 = ¥ 100,001–150,000, 8 = 150,001–200,000, 9 = more than ¥ 200,001), and father's and mother's level of education (number of years).

Reasoning Ability Test

Reasoning ability was measured using the NCSC (National Children's Study of China; Dong and Lin 2011). The reasoning ability test (i.e., this has been stated to be the NCSC) consists of two subtests that measure analogical reasoning ability (e.g. Figure 2) and inductive reasoning ability (e.g. Figure 3). The stimuli used in this test are either digital or graphic. The analogical reasoning ability subtest consists of a digital analogical reasoning task and a graphical analogical reasoning task, and the inductive reasoning ability subtest consists of a graphical sequence inference task. The reliability of these reasoning ability tests is reportedly good, with a subtest and overall Cronbach's alpha coefficient of 0.74–0.94, a

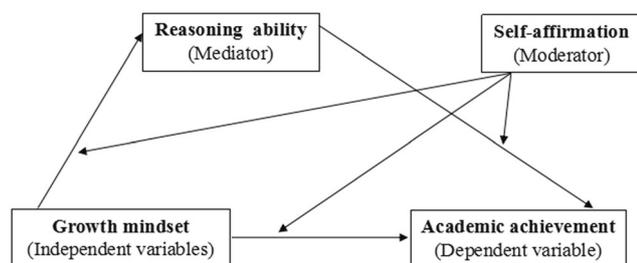


Fig. 1 The proposed moderated mediation model

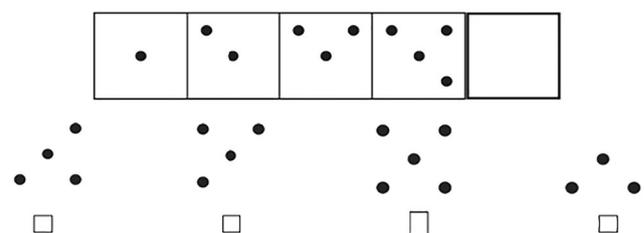


Fig. 2 Analogical reasoning test

15, 14, 13, 12, ?

Fig. 3 Inductive reasoning test

test reliability of 0.53–0.90 at a 1 month interval, and a Wechsler test (Revised Edition 4) reliability of 0.61–0.72 (Dong and Lin 2011) (Figs. 2 and 3).

Academic Achievement Test

Academic achievement was measured using the NCSC (Dong and Lin 2011). In the present study, academic achievement was measured using the language test compiled by the NCSC; this uses factual and literary text to examine students' discourse consistent contextual coherence and understanding of key information, types information, and overall information. In a national sample in China, the academic achievement by the NCSC has a good reliability and validity, and the Cronbach's alpha coefficient of each section is between 0.72 and 0.94 (Dong and Lin 2011).

Growth Mindset Scale

Growth mindset was measured using the Dweck's mindset scale, which was developed by Dweck (2008). The Dweck's mindset scale is a 20-item questionnaire that determines the respondent's mindset (growth mindset or fixed mindset) using a 4-point rating scale scored as follows: 3 = Strongly Agree; 2 = Agree; 1 = Disagree; 0 = Strongly Disagree. Growth mindset items (2, 3, 5, 6, 9, 10, 15, 13, 18, and 19) and fixed mindset items (1, 4, 7, 8, 11, 12, 14, 16, 17, and 20) were separated during data analysis. When calculating the total growth mindset score, the items score of the fixed mindset is calculated in reverse, and then calculate the sum of all item (Including growth mindset items and reverse fixed mindset items) scores (Mora 2015). In the present study, the growth mindset scale had a Cronbach's alpha coefficient of 0.80.

Self-Affirmation Scale

Self-affirmation was measured using Rosenberg's (1985) self-esteem scale. The self-esteem scale comprises a self-affirmation (five items, e.g., "On the whole, I was satisfied with myself") and self-denial (four items, e.g., "I often feel that I am useless") subscale. In the present study, we only used the self-affirmation subscale. We used the Chinese version of the self-esteem scale, which was developed by the NCSC (Dong and Lin 2011). The Chinese version of the self-affirmation scale includes five items that are scored from 1 to 4, with higher score indicating greater levels of self-affirmation. In a nationwide survey of 23,971 subjects, Cronbach's alpha coefficient of the self-affirmation scale was 0.82 (Dong and Lin 2011). In the present study, the self-affirmation scale had a Cronbach's alpha coefficient of 0.92.

Statistical Analyses

All statistical analyses were conducted using MPLUS 7 (Los Angeles, CA). We first tested the correlations between growth mindset, self-affirmation, reasoning ability, academic achievement, and background variables (i.e., sex, age, *hukou*, annual family income, and father's and mother's educational level) using Pearson's correlations. Second, we followed MacKinnon's four-step procedure to test the mediating effect of reasoning ability on the relationship between growth mindset and academic achievement (MacKinnon 2008). This procedure requires a significant correlation between a) growth mindset and academic achievement; (b) growth mindset and reasoning ability; and (c) reasoning ability and academic achievement while controlling for growth mindset; as well as (d) a significant coefficient for the indirect path between growth mindset and academic achievement via reasoning ability. Then, the mediating effect of reasoning ability in the relationship between growth mindset and academic achievement was tested using the Bootstrap estimation procedure in MPLUS (a bootstrap sample of 1000 was specified). Third, we explored whether the mediation process was moderated by self-affirmation using Hayes's PROCESS macro (Model 59) (Hayes 2013). Simple slope analyses were used to explore the interaction effect. $P < 0.05$ was considered significant.

Results

Descriptive Statistics and Correlations between Variables

The descriptive statistics for background variables (i.e., sex, age, *hukou*, annual family income, and father and mother's educational level), growth mindset, self-affirmation, reasoning ability, academic achievement, and correlations between these variables are shown in Table 1. Academic achievement was significantly positively correlated with growth mindset ($r = 0.15, p < 0.01$) and reasoning ability ($r = 0.37, p < 0.01$). These correlations remained significant when controlling for background variables ($r = 0.14, p < 0.01$; $r = 0.33, p < 0.01$, respectively). Growth mindset was significantly positively correlated with reasoning ability ($r = 0.24, p < 0.01$) and this correlation remained significant when controlling for background variables ($r = 0.24, p < 0.01$). Self-affirmation was non-significantly correlated with academic achievement ($r = 0.02, p = 0.472$), was significantly positively correlated with growth mindset ($r = 0.09, p < 0.05$), and was significantly negatively correlated with reasoning ability ($r = -0.08, p < 0.05$). Background variables had either weak or non-significant correlations with growth mindset, self-affirmation, reasoning ability, and academic achievement.

Table 1 Descriptive statistics and correlations among variables

	M	SD	1.Gender	2	3	4	5	6	7	8	9
2.Age	16.88	0.80	-0.04	–							
3.Hukou	0.69	0.46	-0.10**	-0.02	–						
4.Annual family income	3.97	2.39	-0.03	-0.02	-0.21**	–					
5.Father’s educational level	8.80	3.79	0.11**	0.01	-0.36**	0.36**	–				
6.Mother’s educational level	8.03	3.93	0.09**	-0.01	-0.32**	0.34**	0.69**	–			
7.Growth mindset	31.87	3.98	-0.01	0.06*	0.04	-0.02	-0.11**	-0.13**	–		
8.Self-affirmation	14.85	3.42	-0.02	0.00	-0.11**	0.14**	0.11**	0.16**	0.09**	–	
9.Reasoning ability	90.39	12.69	-0.03	-0.03	0.05*	0.07**	-0.14**	-0.12**	0.24**	-0.08**	–
10.Academic achievement	108.98	50.21	0.01	-0.06*	-0.01	0.09**	-0.02	-0.02	0.15**	0.02	0.37**

Gender and hukou was dummy coded such that 1 = female or agricultural and 0 = male or non-agricultural

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

The Mediation Effect of Reasoning Ability

We hypothesized that reasoning ability would mediate the relationship between growth mindset and academic achievement. To examine this hypothesis, we followed MacKinnon’s (2008) four-step procedure to test the mediation effect. We included background variables (sex, age, hukou, annual family income, and father’s and mother’s educational level) as covariates in all analyses. Multiple regression analysis indicated that, in the first step, growth mindset was significantly associated with academic achievement ($\beta = 0.157$, $t = 6.24$, $p < 0.001$, see Model 1 of Table 2). In the second step, growth mindset was significantly associated with reasoning ability ($\beta = 0.240$, $t = 9.84$, $p < 0.001$, see Model 2 of Table 2). In the third step, when we controlled for growth mindset, reasoning ability was significantly associated with academic achievement ($\beta = 0.376$, $t = 15.44$, $p < 0.001$, see Model 3 of Table 2). Finally, the Bootstrap method indicated that there

was an indirect effect of growth mindset on academic achievement via reasoning ability ($ab = 0.09$, $SE = 0.02$, 95% CI = 0.06, 0.13). The mediation effect accounted for 57.32% of the total effect. Overall, the four criteria for establishing a mediation effect were fully satisfied, thus supporting hypothesis 1.

The Moderated Mediation Effect of Growth Mindset on Academic Achievement

We hypothesized that self-affirmation would moderate the direct and indirect relationships between growth mindset and academic achievement via reasoning ability. According to Hayes (2013) and Edwards and Lambert (2007), moderated mediation is established if either or both or total of three patterns existed (direct effect and/or first stage and/or second stage moderation): (a) direct effect, i.e., the path between growth mindset and academic achievement was moderated

Table 2 Testing the mediation effect of growth mindset on academic achievement

Predictors	Model 1 (Academic achievement)			Model 2 (Reasoning ability)			Model 3 (Academic achievement)		
	B	SE B	β	B	SE B	β	B	SE B	β
Gender (female = 1, male = 0)	3.973	2.589	0.039	0.331	0.631	0.013	3.467	2.411	0.034
Age	-4.302	1.579	-0.068**	-0.706	0.385	-0.045	-3.248	1.472	-0.051*
Hukou (agricultural = 1, non-agricultural = 0)	-2.216	2.953	-0.020	-0.347	0.719	-0.013	-1.691	2.751	-0.015
Annual family income	2.046	0.576	0.096***	0.657	0.140	0.123***	1.066	0.540	0.050*
Father’s educational level	-0.260	0.480	-0.019	-0.497	0.117	-0.146***	0.480	0.449	0.035
Mother’s educational level	-0.525	0.463	-0.039	-0.084	0.113	-0.025	-0.403	0.431	-0.030
Growth mindset	2.013	0.323	0.157***	0.774	0.079	0.240***	0.855	0.310	0.067**
Reasoning ability							1.498	0.097	0.376***
R ²	0.039			0.092			0.167		
F	9.09***			22.56***			38.98***		

Each column is a regression model that predicts the criterion at the top of the column

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

by self-affirmation (Model 1 of Table 3); (b) first stage moderation, i.e., the path between growth mindset and reasoning ability was moderated by self-affirmation (Model 2 of Table 3); and/or (c) second stage moderation, i.e., the path between reasoning ability and academic achievement was moderated by self-affirmation (Model 3 of Table 3). In each model, we controlled for background variables.

In Model 1, there was a significant main effect of growth mindset on academic achievement ($\beta = 0.153$, $t = 6.06$, $p < 0.001$), and this effect was moderated by self-affirmation ($\beta = 0.093$, $t = 3.53$, $p < 0.001$). To further investigate the nature of this moderation, a simple slope analysis was performed separately for self-affirmation at $+1$ *SD* (high and low levels) from the mean (Fig. 4). These analyses revealed that, in those with a self-affirmation score of 1 *SD* above the average, there was a significant positive relationship between growth mindset and academic achievement (simple slope = 2.588, $t = 6.83$, $p < 0.001$), indicating that higher levels of growth mindset were associated with higher levels of academic achievement. However, for those with a self-affirmation score of 1 *SD* below the average, the effect of growth mindset on academic achievement was not significant (simple slope = 0.653, $t = 1.35$, $p = 0.178$).

Model 2 indicated that the effect of growth mindset on reasoning ability was significant ($\beta = 0.247$, $t = 10.10$, $p < 0.001$), and that this effect was moderated by self-affirmation ($\beta = 0.075$, $t = 2.95$, $p < 0.01$). We plotted predicted reasoning ability against growth mindset for low and high levels of self-affirmation (1 *SD* below the mean and 1 *SD* above the mean, respectively) (Fig. 5). Simple slope tests indicated that, in high self-affirmation individuals, higher levels

of growth mindset were associated with higher levels of reasoning ability (simple slope = 0.939, $t = 10.06$, $p < 0.001$). In low self-affirmation individuals, the effect of growth mindset on reasoning ability was still significant but was much weaker (simple slope = 0.555, $t = 4.65$, $p < 0.001$). Finally, there was a significant main effect of reasoning ability on academic achievement ($\beta = 0.067$, $t = 2.69$, $p < 0.01$), and this effect was not moderated by self-affirmation ($\beta = -0.014$, $t = -0.53$, $p = 0.596$).

The Bootstrap method results further indicated that the indirect effect of growth mindset on academic achievement via reasoning ability was moderated by self-affirmation. For high self-affirmation individuals, the indirect effect of growth mindset on academic achievement via reasoning ability was significant ($ab = 0.15$, $SE = 0.04$, 95% CI = 0.07, 0.24). This indirect effect was non-significant for low self-affirmation individuals ($ab = 0.07$, $SE = 0.03$, 95% CI = 0.00–0.12). Given that self-affirmation only moderated the direct effect and first stage of the mediation process, the current study considered this a “direct effect and first stage moderation model” (Edwards and Lambert 2007), which is one form of the moderated mediation model. Thus, hypothesis 2 was partially supported.

Discussion

The current study formulated a moderated mediation model to test whether growth mindset would be indirectly related to academic achievement via reasoning ability, and whether the direct and indirect relationships between growth mindset and

Table 3 Testing the moderated mediation effect of growth mindset on academic achievement

Predictors	Model 1 (Academic achievement)			Model 2 (Reasoning ability)			Model 3 (Academic achievement)		
	B	SE B	β	B	SE B	β	B	SE B	β
Gender (female = 1, male = 0)	4.081	2.582	0.040	0.262	0.626	0.010	3.645	2.410	0.036
Age	-4.331	1.574	-0.069**	-0.723	0.382	-0.046	-3.263	1.470	-0.052*
Hukou (agricultural = 1, non-agricultural = 0)	-2.273	2.948	-0.021	-0.505	0.715	-0.018	-1.472	2.752	-0.013
Annual family income	2.014	0.576	0.094***	0.694	0.140	0.130***	0.987	0.542	0.046
Father's educational level	-0.259	0.478	-0.019	-0.505	0.116	-0.148***	0.486	0.449	0.036
Mother's educational level	-0.489	0.464	-0.037	-0.033	0.113	-0.010	-0.445	0.433	-0.033
Growth mindset	1.961	0.324	0.153***	0.794	0.079	0.247***	0.810	0.317	0.063*
Self-affirmation	0.322	0.398	0.022	-0.272	0.097	-0.073**	0.652	0.397	0.044
Growth mindset \times Self-affirmation	0.338	0.096	0.093***	0.069	0.023	0.075**	1.476	0.101	0.370***
Reasoning ability							0.245	0.091	0.067**
Reasoning ability \times Self-affirmation							-0.016	0.031	-0.014
R ²	0.048			0.107			0.172		
F	8.52***			20.58***			29.23***		

Each column is a regression model that predicts the criterion at the top of the column

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

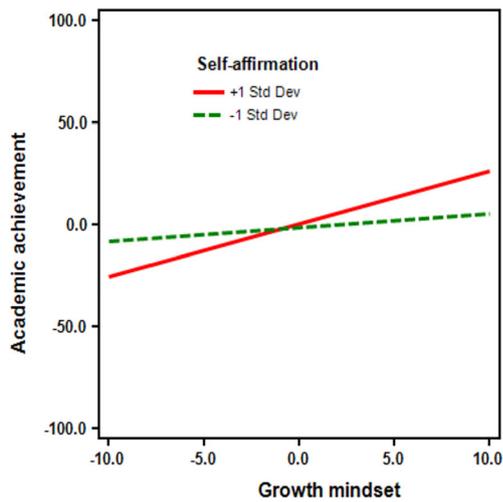


Fig. 4 Plots of slopes for the interaction between growth mindset and self-affirmation (± 1 Std Dev) on academic achievement, using background variables as control variables

academic achievement were moderated by self-affirmation. Our findings indicated that the positive effect of growth mindset on academic achievement was partially explained by a higher reasoning ability. Furthermore, the positive effect of growth mindset on academic achievement was moderated by self-affirmation, such that the path from growth mindset to academic achievement was enhanced in the context of higher self-affirmation. Similarly, the indirect relationship between growth mindset and reasoning ability was moderated by self-affirmation in the first stage of the mediation process, such that the path from growth mindset to reasoning ability was enhanced in the context of higher self-affirmation. The following sections discuss each of the hypotheses in light of this moderated mediation model of growth mindset and academic achievement.

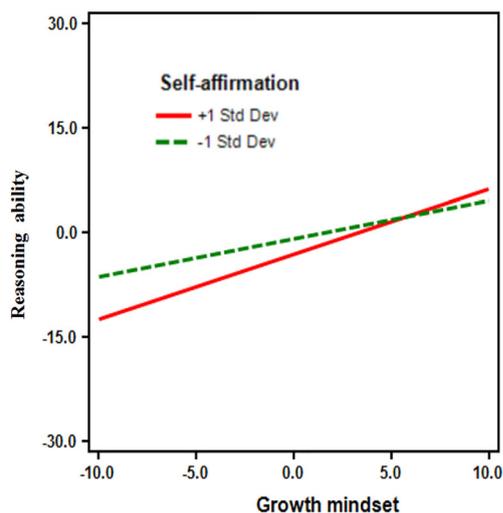


Fig. 5 Plots of slopes for the interaction between growth mindset and self-affirmation (± 1 Std Dev) on reasoning ability, using background variables as control variables

The Mediating Role of Reasoning Ability

Previous research has shown that non-cognitive factors (e.g., academic motivations, effort beliefs, and psychological resilience) crucially mediate the relationship between growth mindset and academic achievement (Yeager and Dweck 2012; Yeager et al. 2016; Blackwell et al. 2007; Schroder et al. 2017); however, the mediating role of cognitive factors has not been investigated. The current study is the first to document the mediating effect of reasoning ability in the link between growth mindset and academic achievement.

We found that the positive effect of growth mindset on academic achievement, which indirectly supports some evidence in the field of cognitive neuroscience. For instance, Myers et al. (2016) reported that growth mindset was related to ventral and dorsal striatal connectivity with both the dorsal anterior cingulate cortex and dorsolateral prefrontal cortex, which are critical areas involved in error monitoring and behavioral adaptation. Hence, students with growth mindset are efficient in error monitoring and receptive to corrective feedback, and are more likely to use behavioral adaptation in learning environments (Ng 2018).

Each of the separate links in the mediation model between growth mindset and academic achievement is noteworthy. For the first stage of the mediation process (i.e., the effect of growth mindset on reasoning ability), our results support the premise that growth mindset can facilitate reasoning ability. This is similar to findings that growth mindset intervention can increase brain connectivity (Harper 2014), and that growth mindset may lead to the malleability of intelligence and other self-attributes (Dweck 2012; Ng 2018). For the second stage of the mediation process (i.e., the effect of reasoning ability on academic achievement), we found that reasoning ability was positively associated with academic achievement. This is consistent with findings that general reasoning ability can significantly predict academic achievement (Karch et al. 2013).

The Moderating Role of Self-Affirmation

The second goal of the current study was to explore the moderating effect of self-affirmation on the direct and indirect associations between growth mindset and academic achievement via reasoning ability. Our results indicated that self-affirmation moderated the direct association between growth mindset and academic achievement. This result is similar to those of previous studies. An individual’s view of themselves as having efficacy, agency, and integrity is a key driver of achievement motivation (Brady et al. 2016). Motivation, learning, and performance decrease when an individual’s sense of adaptive adequacy is not secure. Self-affirmation reasserts integrity of the self, and can improve an individual’s sense of

adaptive adequacy (Cohen and Sherman 2014). Mindset according to Dweck (2008) is the belief that intellectual abilities can be improved through an individual's own efforts. A high level of self-affirmation is more conducive to an individual's belief that their intellectual abilities can be changed. Thus, reasoning ability not only plays an intermediary role between growth mentality and academic achievement, but is also involved in the relationship between self-affirmation and academic achievement. In addition, self-affirmation belongs to the self-system, which is closely related to personality (Cohen and Sherman 2014). Personality moderates the relationship between growth mindset and academic achievement. For instance, Beaujean et al. (2011) found that reasoning ability and personality independently predicted reading achievement, but also that their interaction predicted math achievement. Meanwhile, the current study found that the indirect relationship between growth mindset and academic achievement via reasoning ability was also moderated by self-affirmation. However, self-affirmation only moderated the first stage of the mediation process (i.e., the relationship between growth mindset and reasoning ability). This result can be explained by previous findings that students with a growth mindset welcome challenges and attribute failure to a lack of effort rather than a lack of intellectual ability, and thus maintain self-affirmation (Murphy and Thomas 2008). Hall et al. (2014) have also suggested that self-affirmation can improve cognitive performance and decision making.

Limitations and Future Directions

There are some limitations of the current study. First, we did not collect information about academic achievement, after one or more years. Therefore, we should be cautious about inferring a causal relationship between growth mentality and academic achievement. Follow-up studies could supplement the present data by distributing follow-up surveys, or could conduct intervention studies on growth mindset. Second, in present study cognitive ability was based on reasoning ability; however, attention, memory, and other cognitive abilities also influence academic achievement (Ng 2018). Future tests of cognitive ability should include attention, memory and other more general cognitive abilities. Finally, we did not examine differences between subgroups (e.g., adolescents with low socioeconomic status vs. adolescents with high socioeconomic status; agricultural *hukou* adolescents vs. non-agricultural *hukou* adolescents). In mainland China, *hukou* is an important symbol of identity. Agricultural *hukou* often indicates a low family socioeconomic status and academic achievements (Lu and Zhou 2012; Xu and Xie 2015). Socioeconomic status is linked to academic

achievement (Chung et al. 2017), and growth mindset interventions have been found to be more effective in adolescents with low social and economic status in terms of improvements in academic achievement (Claro et al. 2016; Yeager et al. 2016). Future studies could therefore compare such subgroups, the results of which will be of great value for a more in-depth analysis of mediating and moderating mechanisms.

To summarize, by incorporating self-affirmation as a moderator into the model, the present study detected effects that would otherwise have been overlooked. The results indicated that growth mindset predicted academic achievement in adolescents with high self-affirmation, but not in those with low self-affirmation. The present study also indicated that the indirect effect of growth mindset on academic achievement via reasoning ability was stronger for adolescents with high self-affirmation than for those with low self-affirmation. Therefore, future work could focus on fostering self-affirmation to counter the adverse effect of growth mindset on academic achievement. The moderated mediation model in the present study is conceptually more nuanced and provides greater predictive power than the mediation model or moderation model alone.

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Compliance with Ethical Standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Written consent was obtained from each participant after a full explanation of the study procedure.

Conflict of Interest The authors declare that there are no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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