Child Development, 2026, 200–218
https://doi.org/10.1093/chidev/aacaf016
Published: January 7, 2026
Empirical Article

Perceptions of academic ups and downs in relation to effort and ability: A cross-cultural comparison of Chinese and Canadian children

Yuhan Wang,[1] Lena Khadra[2] and Xin Sun[3,*]

[1]Department of Psychology, University of Wisconsin Madison, Madison, WI, United States
[2]Department of Psychology, University of British Columbia, Vancouver, BC, Canada
[3]Department of Language Science and Technology, The Hong Kong Polytechnic University, Kowloon, Hong Kong, China
*Corresponding author: Department of Language Science and Technology, The Hong Kong Polytechnic University, Room 721, Hung Hom Bay Campus, Kowloon, Hong Kong, China. Email: xinsun@polyu.edu.hk

Abstract

This study examines individuals' lay theories of academic performance as a dynamic process, rather than a one-time outcome. Chinese and Canadian children (Study 1, $N = 225$, ages 6–14) and adults (Study 2, $N = 332$) were probed on their views of changes in academic performance in relation to changes in effort and intellectual ability. Results showed that all samples primarily associated fluctuations in performance with changes in effort, followed by intellectual ability, but not attributes like prettiness. Canadian children believed that both ability and effort change in parallel with performance, yet Chinese children, especially older ones, viewed the two as relatively independent attributes. These results reveal the diverse belief mechanisms that individuals of different cultures use to understand school performance.

Keywords academic performance, changes, intellectual ability, effort, cross-culture

Lay summary

When students score higher than before, do they have "become smarter," "worked harder," both, or neither? This study examined how Chinese and Canadian children and adults reason about performance changes in relation to effort and ability changes. Participants were presented with student characters whose grades either improved or declined and were asked whether performance fluctuations reflected changes in effort and ability. Overall, participants attributed changes in performance to changes in effort and ability, with a stronger emphasis on effort. However, Canadian participants viewed both effort and ability as changing alongside performance, whereas Chinese participants, especially the older groups, tended to associate performance changes with effort but not ability changes. These findings reveal how culture shapes beliefs about core constructs of motivation.

Children grow up endorsing the belief that academic performance builds upon effort and intellectual ability, and such intuitive theory influences their motivation to learn and matters to school success (Muradoglu & Cimpian, 2020; Dweck & Yeager, 2019). Yet, in real life, academic performance is never *one stable, broad outcome*, rather, it is dynamic and often fluctuates—sometimes children make progress, while at other times their grades may not improve, even decline, compared to last time. How do children and adults reason about changes in academic performance, particularly in relation to changes in effort and ability? Further, cultural messages shape one's beliefs about how effort and ability play a role in achievement—for example, effort is often more valued in Chinese individuals from earlier ages, whereas beliefs about intellectual ability are more predictive of American students' school outcomes (Sun et al., 2021). As such, how do these cultural variations yield specific perspectives on changes in academic performance?

Mapping out individuals' beliefs about changes in academic performance is important for several reasons. First, due to the changing nature of one's academic performance, how children reason about such dynamic processes may reflect their learning behaviors in real-world school contexts. Indeed, it was found that children show more persistence in problem-solving tasks when they have made improvements over time (Leonard et al., 2023; Zhang et al., 2025), and they will also plan their learning behavior based on predictions about learning progress (Poli et al., 2025).

Handling Editor: Eva Chen
Editor: Shauna Cooper
Received: November 5, 2024. **Revised:** August 25, 2025. **Accepted:** October 16, 2025

Thus, an essential motivator for children to learn is likely how they interpret their progress in the past. A more nuanced understanding of children's beliefs about academic fluctuations thus adds to the ecological validity in assessing motivation-relevant constructs and yields implications on motivating children to engage in learning activities by carefully cultivating these beliefs. Second, how one sees changes in performances in relation to changes in effort and intellectual ability is closely related to other important motivational beliefs, such as a growth mindset, and thus an examination of these beliefs adds to theories of learning and motivation. The idea of a growth mindset is the belief that one's intelligence is malleable and can be developed through effort. Students with a growth mindset will put in more effort to increase their intelligence and improve their achievements (Dweck, 1999). Therefore, with a growth mindset, one would interpret academic progress as showing increased intellectual ability and effort. Understanding these beliefs thus contributes to the literature and implicates educational practices as these motivational mechanisms play an essential role in one's cognitive and socio-emotional development (Blackwell et al., 2007; Dweck & Yeager, 2019). Third, recent studies suggest cross-cultural differences in individuals' intuitive theories of learning and academic performance, and these beliefs have differential implications for school outcomes (Lou & Li, 2023; Sun et al., 2021). Understanding the complexity of these lay beliefs helps unveil the diversity in how individuals in non-WEIRD cultures are motivated in similar or different ways. Further, taking a developmental perspective to look into these beliefs also reveals sources of cultural impacts on and variations in how children grow up thinking about learning and achievement.

Performance as a function of ability and effort

Developmental works have shown that children understand the sources of academic performance as a function of effort and ability, and effort is seen as more important than ability. One classic study from Nicholls (1978) mapped out the developmental trajectory of children's thinking. Five-year-old children see performance as an outcome of pure effort and they use effort to explain all differences in performance. In contrast, older children develop more adult-like theories that performance depends on both effort and ability and more effort is needed to receive the same outcome if one lacks the ability (see also Amemiya & Wang, 2018; Hau & Salili, 1996; Nisbett et al., 2012). Recent work has shown that young children already incorporate both effort and ability to explain performance. When presented with two equally well-performing characters, 4- to 9-year-olds viewed the character who exerted intermittent effort as more skilled than the one who consistently put in effort. They also predicted that the character showing intermittent effort would outperform the other if they both exerted the same level of effort (Muradoglu & Cimpian, 2020). These findings suggest that young children viewed "performance = effort + ability." To break the equation down, "performance" here refers to observable academic outcomes—such as test results or grades—which are concrete and context-dependent indicators of achievement. *Effort* refers to how much one "spends time, pays attention, avoids distractions on the task being performed" (as in Muradoglu & Cimpian, 2020). One can largely control how much effort they invest in certain tasks. On the other hand, *ability* is a relatively stable disposition, yet it is also malleable over broader temporal scales. In other words, one's ability remains at a certain level and they cannot instantly improve their ability. Yet, at the same time, one can improve their ability over months or years. Therefore, ability is neither entirely fixed nor constantly fluctuating, but shows both stability and potential for growth. We note that although our equation is largely similar to Muradoglu and Cimpian (2020), they used a slightly different version, namely, "performance = effort + skill" and argued that "skill" can also be termed as "ability" or "competency." Here, we do not see "ability" as interchangeable with "skill." The term "skill" represents specific strategies or information acquired through practice—concrete tools that are developed through experience. Here and after, we will use "performance = effort + ability" to refer to children's intuitive theories of performance.

Many other recent works also supported the idea that children hold a view of "performance = effort + ability." For example, 4- to 5-year-old children believe one is smarter and more competent if they complete more tasks and do them faster (Jara-Ettinger et al., 2015 ; Leonard et al., 2019). Effort is often seen as more important than natural ability for school achievements (Stevenson et al., 1990b; Sun et al., 2021 ; Yang et al., 2024). For example, by age 7, children in both the United States and China prefer "strivers" (i.e., those who put in a lot of effort) to "naturals" (i.e., those who figure out things quickly). Children also think they themselves are more similar to the character described as a "striver" than a "natural" (Yang et al., 2024). Stevenson et al. (1990b) found that both Americans and East Asians rated effort as the top one and ability as the top two important factors to school success, despite cultural differences in that Americans compared to East Asians see ability as relatively more important.

Children's perceptions of performance change over time

Past research has produced extensive work on how children and adults view academic performance as an overall construct. However, in daily school life, a student's performance is never one fixed score: A student needs to take multiple quizzes/tests across their educational experience, even during a semester, and they see how their performance changes over time. How do children make sense of these changes? A few recent studies looked at a related question, specifically, how performance changes influence children's motivation to persist. Poli et al. (2025) showed that 4-year-old children would choose activities that maximize their learning progress in a touchscreen game. Leonard et al. (2023) asked children to help put an egg back into a nest in a tree and manipulated the first four tryouts into either an increasing or a constant condition. In the increasing condition, the egg fell off the platform with a decreased distance (i.e., showing improvements across trials). In the constant condition, across trials, the egg fell off the platform at a constant distance. They found that 4- to 6-year-old children in the increasing condition were more likely to try again. Building on this work, Zhang et al. (2025) created a motor learning task and asked children to predict their performance for each trial. They found that by age 7, children understand their learning performance will improve over time. Together, these studies demonstrate that from an early age, children are sensitive that one's performance follows a dynamically changing pattern and use this information as a motivator to persist. This work informs further investigations into how children reason about the processes underlying performance progress and regress in academic contexts. What does it mean for children to exhibit different performance fluctuations over time? In the present study, we focus on children's theories about how changes in performance relate to changes in effort and ability. We acknowledge that our aim is to investigate children's conceptual reasoning about the process of performance change, rather than to directly examine the motivational or behavioral consequences of academic progress or regress.

While children and adults generally endorse a "performance = effort + ability" theory, this does not mean they also attach changes in performance with changes in effort and ability. Performance improvements may be explained as a result of increased effort but no change in ability, or both increased effort and increased ability, or no change in either, etc. The idea of a growth mindset is closely tied to how one thinks of changes in performance—if a student makes progress, a growth mindset endorser should believe that they increased their intelligence and invested more effort. In contrast, for a fixed mindset endorser, progress may not necessarily translate into improvement in intellectual ability. Mindset research has shown that holding a growth mindset motivates children to develop their intelligence by putting in more effort, leading to positive socio-emotional and academic outcomes (Blackwell et al., 2007; Dweck & Yeager, 2019; Yeager et al., 2019). Yet, mindset studies have been primarily focused on adolescents and college students, and very few studies have directly probed mindset beliefs in younger children (Dweck, 2017). Heyman and Dweck (1998) probed stability beliefs about intelligence in 7-to-8-year-olds with child-friendly scenarios. The scenarios equated intelligence with academic performance. In the scenarios, a student peer either performed better or worse in spelling and science tests than other students in class and participants were asked if they thought the student would still perform better or worse 2 years later. Around 25% of children believed the student would continue doing better if they do well now, and 20% of children believed the student would continue doing worse if they do not do well now. This evidence suggests that there are individual differences in children's beliefs about the malleability of intelligence as indicated by possible fluctuations in test performance across time (see the *Discussion* section on another recent paper with similar results by Muradoglu et al., 2024). A further question is what are the sources of academic performance across time. A focus on beliefs about performance change tackles this question, and this focus itself is psychologically meaningful in its own right. Rather than equating performance with ability, probing beliefs about performance change delineate one from the other. To put it simply, there can be individual differences that some may believe that one's ability changes with performance, some may not. An inquiry into beliefs about performance change thus adds contributions to the heterogeneity of lay people's conceptualizations of core motivational constructs central to mindset beliefs.

Cross-cultural and developmental considerations

A cross-cultural perspective is particularly invaluable in the current investigation. Stevenson's seminal works showed that children, parents, and teachers in Western and East Asian cultures hold different beliefs about ability, effort, and performance: While both cultures value effort and ability, Westerners put more emphasis on ability and East Asians more on effort (Stevenson et al., 1990a, 1990b, 1993a, 1993b). Among elementary school students, American children were more likely to agree that tests reflect natural talent than Chinese and Japanese children; in contrast, Chinese and Japanese children believed that best-performing students work harder than other students (Stevenson et al., 1990b). Researchers thus argue that such strong effort-oriented value in East Asians leads to a more growth mindset compared to Westerners (Heine et al., 2001; Hess et al., 1987). Yet, recent empirical evidence showed the opposite (Asbury et al., 2016; Jose & Bellamy, 2012; Kim et al., 2017; Sun et al., 2021). For example, using data from large-scale representative adolescent samples from the Programme of International Student Assessment (PISA) and college student samples, Sun et al. (2021) found that Chinese students held more fixed mindsets compared to their U.S. counterparts and their mindset beliefs are not positively associated with mathematics performance. As Ng and Wei (2020) puts it, Chinese parents have the same expectations of children's performance "regardless of whether their children are gifted." Therefore, entering school, Chinese children likely gradually grasp the idea that performance improvement mostly, if not solely, relies on more effort, and increased performance does not necessarily improve intellectual ability. In contrast, in the North American context, at least in the past few decades, the idea of a growth mindset is well-known and endorsed; children may be more likely to associate changes in performance with changes in both effort and ability, as a growth mindset emphasizes the potential to improve intellectual ability through more effort. In other words, North American children may be more likely to equate performance with ability, while Chinese children may not. We thus hypothesize that compared to Chinese children, North American children are more likely to associate changes in performance with changes in ability, and this difference may be more pronounced among older children who have greater exposure to their respective cultures.

Theories of ability and effort in the face of performance regress

A student never only scores higher. They also experience declines. However, research often focused on beliefs about improvements such as growth in ability and largely neglected performance declines over time (Berg & Sternberg, 1992; Kim et al., 2024). A few recent adult studies looked at individuals' theories about performance declines. Lou et al. (2017) and Kim et al. (2024) found that incremental beliefs about intelligence (i.e., "Your intelligence can always be substantially increased") and decremental beliefs (i.e., "Even your basic intelligence level can be reduced considerably") were relatively independent constructs in that they were only correlated with a small-to-moderate size and factor analysis loaded them into different factors. They further found meaningful associations between decremental beliefs and motivational outcomes such as effort beliefs about ability loss, measured by scenarios of performance regress in both studies (e.g., "Jessie took a test last year and got an average score. After that, Jessie didn't put as much effort into studying. What score do you expect Jessie would get in the same test one year later?") and prevention-focused goal orientations (e.g., “With this goal, I want to maintain something”) in addition to incremental beliefs. To our knowledge, no developmental studies have looked at children’s theories about performance decline and the current study looks to address this question.

The present studies

In the present studies, we investigate how children (6- to 14-year-olds) and adults in China and Canada reason about how performance increase and decline are related to changes in effort and ability. We chose the age range to be 6–14 for several reasons. First, since an important goal of the current study is to map the developmental trajectory of children’s theories of performance changes across key educational stages, we included children of early elementary, late elementary, and early adolescent ages. We start from age 6 because prior works have shown that 6-year-olds begin to associate ability with social categories and interpret performance as a function of effort and ability (Bian, Leslie, & Cimpian, 2017; Muradoglu & Cimpian, 2020; Shu et al., 2022). At the other end of the age spectrum, we selected age 14 to bridge the gap in the literature, which has focused on high schoolers to college students (e.g., Blackwell et al., 2007; Porter et al., 2022; Sun et al., 2021; Wang & Ng, 2012; Yeager et al., 2019). Second, our inclusion of a relatively wide age range is not a rare practice, as some prior studies in this field have included a broad age range. For example, the well-cited seminal work by Nicholls (1978) also had the purpose to map a developmental trajectory of children’s effort and ability beliefs, and it included 5–13-year-olds (see also Folmer et al., 2008, with 5–15-year-olds; Kurtz-Costes et al., 2005, with k to eighth graders; Usher et al., 2019, with elementary to middle schoolers).

In Study 1, we set up a child-friendly scenario in which child participants are presented with three student characters who either make progress, regress, or maintain their performance across two tests taken at the beginning and end of an academic year. We asked children whether these changes in performance indicate changes in effort and ability (i.e., “smarter,” “less smart,” “worked harder,” “worked less hard”) or whether the characters’ effort and ability stay the same. As a control, we also included two irrelevant attributes (prettiness and niceness). In study 2, we used the same scenarios to test two groups of college adults in China and Canada. We preregister our hypotheses, methods, and analyses on As.Predicted.

One important study design is that we contextualized performance in a common school academic setting involving a core subject area. We did this for several reasons. First, prior research—including findings from PISA and other large-scale assessments—shows that children’s performance is highly correlated across core subject areas (e.g., math, reading), and that beliefs about ability are similarly associated with outcomes across these areas (Sjøberg & Jenkins, 2022; Ünal et al., 2023). Moreover, research also found that people’s beliefs about student potential, given their learning styles, tend to cluster across core school areas (e.g., math, language studies) (Sun et al., 2023). Thus, we believe our scenario strikes an appropriate level of generality for examining children’s reasoning about academic performance. At the same time, we acknowledge that we probed children’s beliefs about performance changes under some uncertainty. As indicated in the preregistration, our main hypotheses are as follows:

1. Children and adults both believe that changes in performance are more related to changes in effort, then ability, but not prettiness or niceness.
2. With age, participants are less likely to believe that changes in performance are related to changes in ability.
3. With age, Chinese participants are less likely to believe that changes in performance are related to changes in ability, whereas Canadian participants are relatively more likely to attach changes in performance with changes in ability.
4. In adults, theories about changes in performance in relation to changes in ability are associated with growth mindset ratings.

Study 1

Method

Participants

Our final sample included 113 6- to 14-year-olds (6.01–14.30, $M = 9.26$, $SD = 2.34$; 57 girls, 55 boys, and 1 nonbinary) from Canada and 112 6- to 14-year-olds (6.01–14.60, $M = 9.49$, $SD = 2.08$; 61 girls and 51 boys) from China. We conducted Monte Carlo power analyses using the simr package in R (Green & MacLeod, 2016), which is specifically designed for generalized linear mixed effects models, including those with binary outcomes and categorical predictors. We reported these power analysis results alongside each model. Participants were recruited from either Beijing (China) or Vancouver (Canada)—both large urban centers that serve as economic and cultural hubs in their respective countries. The Canadian data collection was fully preregistered on AsPredicted in April 2023, prior to any data collection. In contrast, the Chinese data were collected earlier (November 2021 to May 2022) and were not preregistered. In our preregistration, the Chinese data were already collected but the core analysis would not be possible without the Canadian data. All children were from urban areas within these cities. In both samples, of all participants whose parents filled out education background information, more than half of the participants have parents with college education or higher, and this ratio is comparable across the two cultures (i.e., Canada: 64.62% and Chinese: 60.71%). In the Canadian sample, 41.96% did not have parent education information. Seventy-seven Canadian participants were recruited through a lab database run by the Early Development Research Group at the University of British Columbia and 37 through the local science museum. Canadian children were born and raised in Canada. Twenty-one additional Canadian children were removed because both parents are first-generation immigrants from East Asia and the current study hoped to remove influences from East Asian heritage cultures. One additional Canadian child was tested but excluded from data analyses due to failed comprehension checks (see below). All Canadian participants spoke English as their native language. Chinese participants were recruited through online social media platforms during COVID-19. While Chinese participants completed the task remotely due to COVID-related school disruptions, procedures were standardized across sites, and recent work has indicated that the findings from online and in-person studies were similar (Chuey et al., 2024). All Chinese participants were born and raised in China and spoke Chinese as their native language. Six Chinese participants were excluded due to failed comprehension checks. Chinese participant data were collected between November 2021 and May 2022. Canadian participant data was collected between May 2023 and August 2024. The study was approved by the local ethics board at the University of British Columbia and Beijing Normal University. The study procedure and data analyses were preregistered on As.Predicted: https://aspredicted.org/v6th-sdhp.pdf. The preregistration, study materials and data are available at OSF: https://osf.io/7n29j/?view_only=c7aa08188bc9457d9dcf0a6c353a5cac

Procedure

Warm-up task

Before the study began, children were introduced to a game and told that their job was to guess and tell whether things were more, less or stayed the same. Children were shown three signs, "+," "−," "O," respectively, and were told the signs represented "more," "less," or "stayed the same." Children then completed two warm-up scenarios. For example, in one scenario, participants were presented with a girl standing in front of an audio speaker. Children were asked if the girl would hear *more*, *less*, or *the same amount* of sound if she moved *closer*, *further*, or *remained* where she was at the beginning from the speaker. They were also asked to determine whether the girl would become *more shy, less shy,* or *stay the same level of shyness* if she moved closer, further, or remained where she was at the beginning.

We presented the warm-up scenarios for several purposes. First, they ensure children understand the meanings of the three signs and understand what it means by "more," "less," and "stay the same." Second, the questions about shyness were to make sure children would not exhibit the halo effect that the perception of a single positive attribute disproportionately influences the overall judgment of an individual's other, unrelated attributes (Nisbett & Wilson, 1977). Instead, an attribute does not necessarily change (i.e., shyness) because of other random changes (i.e., moving closer to the speaker). Children pass the comprehension checks if their accuracy on these questions is above 50%.

Main task

See Figure 1 for an example of the setup of the story. To transition to the main task, we first showed children a picture of a classroom and told them, "Look, here is a class! Look at all the kids in the class. They all took two tests during the school year, one at the beginning and one at the end of the school year. I am going to tell you about some of these kids and how they did." In our study, the test was framed as taking place at the beginning and end of a school year, and presented as a general school-based assessment used to evaluate student performance. We chose a "one academic year" time frame to provide a developmentally appropriate and ecologically valid context for reasoning about academic progress and regress. In both cultural contexts, a year is a familiar temporal unit in both children's personal and school life, and academic performance is commonly evaluated through beginning- and end-of-year assessments. This design allows children to draw on their personal school experiences.

We next presented participants with three student characters, one at a time, and the three characters form three study scenarios that depict academic progress, regress, as well as a control maintenance scenario (Figure 1; Supplementary Material). In the progress scenario, the student did not perform well in the first test (i.e., got most of the questions on an exam incorrectly) and performed well in the second test (i.e., got most of the questions on an exam correctly). In the regress scenario, the student performed well in the first test and did not perform well in the second test. In the maintenance scenario (see Supplementary Material), the student performed well on both tests. Manipulation check questions were asked to test whether children understood how story characters behave across tests (i.e., "Can you tell me how she did on the first test?" "She did really well on this test. She got a lot of questions right and one question wrong on this test."). The order of these three student characters was counterbalanced across participants. Apart from ability and effort, we included prettiness and niceness as controls to ensure children do not exhibit the Halo effect. After introducing each student character, the experimenter probed children's beliefs about changes in intellectual ability and effort in relation to the performance changes in the scenarios. For example, after introducing a student character, children were asked "Think of how she did on the first test and how she did on the second test, do you think she became *smarter*, *less smart* or *stayed the same*?" Our main task did not include a warm-up task to manipulate children's understanding of "smart" with a specific definition of smartness (i.e., Bian et al., 2017), and we believe that without a fixed definition better fulfill the goal of our study. In particular, our study aims to probe children's spontaneous beliefs about ability and effort changes in relation to performance changes. Therefore, allowing for a flexible interpretation of what it means to "be smart" provides insight into children's intuitive theories of intellectual ability as they are spontaneously held. In the meantime, as we did not explicitly offer definitions for effort and ability, we acknowledge that there could be conceptual overlap between these two terms, especially at early ages. For example, seminal research on this topic has shown that 5- to 6-year-olds often conflate ability with effort, and interpret being "smart" as trying hard or working diligently (e.g., Nicholls, 1978).

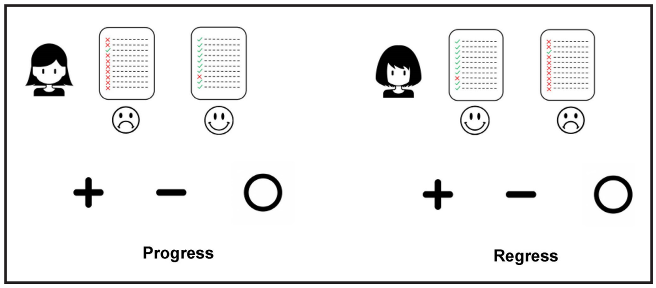

Figure 1 Examples of story setups in the progress and regress scenario (left: progress scenario, right: regress scenario).

The order of these four questions was counterbalanced in that the ability and effort items were either in the first or fourth trial, and the prettiness and niceness items were in the second or third trial (in our analysis, the coding if following: 1 = smart, 2 = effort, 3 = pretty, 4 = nice). Similar to questions in the warm-up task, children were asked to use the "+," "−," and "O" signs to indicate their choices. After each question, children were also asked to provide their justifications (i.e., "why do you think so?").

Lastly, we asked an exploratory question. In this question, children were shown two students side by side: the character who made progress and the character who declined in their performance. They were asked which student they thought was smarter and which worked harder. Children were again asked to provide justifications for their answers. This question was exploratory and not preregistered; we therefore put the results in the Supplementary Material.

Coding the open-ended justifications

Participants' justifications for their responses to the ability and effort questions were coded into separate categories:

- Repeated narrative: restating that the character did better on the test, worse on the test, or did not improve their performance; restating how many questions the character got correct or wrong (e.g., "Because she got a lot of questions wrong on the first test, and got a lot of right on the second test.").
- Situational factors: referring to anything to do with the situation that could have impacted the characters' test results (e.g., "Tests get harder through the year and she got way more correct.").
- Trait-based dispositional factors: referring to a change in the traits/personality of the character (e.g., "She became proud after the first test, so performed worse on the second test.").
- Action-based dispositional factors: referring to a change in the character's actions (e.g., "After a year of learning she will learn new things and how to do them differently. So on the first day she took the test she might not have known how to do all the stuff she did at the end of the year.").
- Stating that effort and/or ability is irrelevant to performance changes (e.g., "Smartness has nothing to do with grades.").

The main coding categories—situational factors, trait-based dispositional factors, and action-based dispositional factors—were determined prior to reviewing the children's responses. These categories were based on prior research in two key areas: (a) studies on children's intuitive theories of academic motivation and performance, which show that children often use traits (i.e., trait-based dispositional factor) or effort (i.e., action-based dispositional factor) to explain academic success and failure (Folmer et al., 2008; Muenks & Miele, 2017; Muradoglu & Cimpian, 2020; Zhao & Yang, 2023) and (b) the classic attribution theory (Weiner, 1985), which emphasizes ability, effort, and situational factors (e.g., luck or test difficulty) as common explanations for achievement outcomes. These categories captured the vast majority of children's responses. The only category identified after reviewing the data were several consistent responses in which children explicitly stated that smartness has nothing to do with effort. We added this coding category to capture the message that intellectual ability is fixed despite progress in performance.

The coding categories were not mutually exclusive; thus, one response may be coded into more than one category or not belong to any categories. The first author and a research assistant (Chinese-native) who was blind to the study design independently coded all the explanations in Chinese samples, and two English-native research assistants (one of them was blind to the study design) independently coded all the explanations in Canadian samples. The consistency percentage was 98.60% in Chinese samples and 92.61% in Canadian samples. Authors of the paper discussed and resolved inconsistencies.

Analytical approach

Data was analyzed using R lme4 package (Bates et al., 2015). As preregistered, we focused on the two response options that conceptually reflect our research question and removed the implausible responses that did not logically fit the scenario (e.g., in the progress scenario, "less smart" and "worked less hard" are implausible responses). Specifically, in the progress scenario, we excluded responses "less smart" and "worked less hard," and coded the remaining responses as 1 = "smarter" or "worked harder," and 0 = "stayed the same." In the regress scenario, we excluded "smarter" and "worked harder," and coded responses as 1 = "less smart" or "worked less hard," and 0 = "stayed the same." We acknowledge that despite that our research question was to tackle children's perceptions of performance changes, our task scenarios provided two meaningful responses and therefore the variables in the models were categorical. Given that this study employed a within-participant design, each child responded to 12 total trials: 4 progress trials, 4 regress trials, and 4 maintenance trials. However, given that our preregistered research question and hypotheses focused on performance changes (progress and regress), we excluded the four maintenance trials from the main analyses and put the maintenance scenario results in the Supplementary Material.

The preregistered hypothesis 1 aims to test whether participants associate changes in performance with changes in effort and ability, rather than the control attributes (i.e., prettiness and niceness). To test hypothesis 1, we conduct a binomial mixed effects model using all four levels of attributes and scenarios to predict participants' responses in each sample with a random intercept for participants. As preregistered, we drop control attributes in the next sets of analyses if participants see effort and ability, but not prettiness and niceness, parallel changes in academic performance (i.e., the attribute main effect was significant).

The preregistered Hypotheses 3–5 aim to test the role of culture, age, and attribute on children's responses for each scenario. Therefore, for each scenario narrative, we perform a binomial mixed effects model predicting children's responses as a function of culture (i.e., Chinese, Canadian), attribute (i.e., smartness, effort), and age (continuous) with a random intercept for participants. Simple effect tests are conducted if there are significant interaction terms. Based on likelihood ratio tests, we found that adding random effects significantly improved most of our model fits, so we adopted the mixed effects approach for all our models, and information about these likelihood test results could be found in the Supplementary Material.

Results

See Figure 2 for participants' responses split by age group (6–8, 8–11, and 11–14) and task-relevant attribute (ability vs. effort) in each scenario (progress vs. regress), and see Figure 3 for participants' responses split by age group and control attribute (prettiness vs. niceness) in each scenario (progress vs. regress). These figures were provided to facilitate visual comparisons by groups and items. See Table 1 for exact frequencies and percentages of responses split by age group and attribute in each scenario. This table highlights developmental and cross-cultural contrasts in a more interpretable way. The table includes the exact counts and statistics for each group, allowing for more precise numerical details.

Our statistical analysis modeled "age" as a continuous variable in years. For Figures 2 and 3, we divided age into three categories only in the figures for visualization and to help interpret the patterns across developmental stages. Despite this, the three age categories were not arbitrarily selected, but informed by prior research.

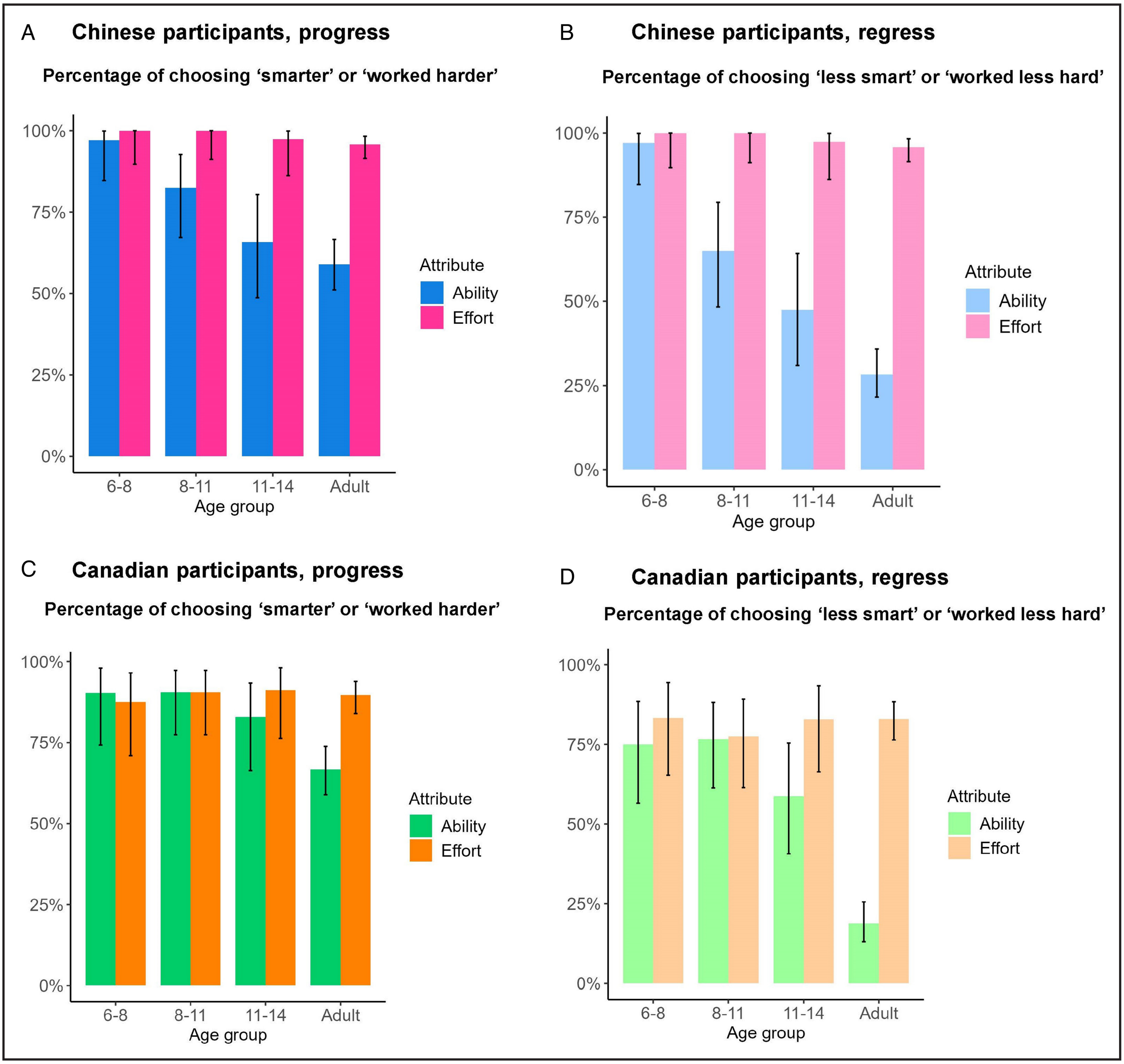

Figure 2 Percentage of participants split by age group (6–8, 8–11, 11–14, and adults) and question type (ability vs. effort) among Chinese and Canadian participants. (A) The percentage of participants selecting "smarter" or "worked harder" in the progress scenario among Chinese participants. (B) The percentage of participants selecting "less smart" or "worked less hard" in the regress scenario among Chinese participants. (C) The percentage of participants selecting "smarter" or "worked harder" in the progress scenario among Canadian participants. (D) The percentage of participants selecting "less smart" or "worked less hard" in the regress scenario among Canadian participants.

Specifically, these groups correspond to distinct stages in children's academic and cognitive development: early elementary school (6–8), late elementary school (8–11), and middle school (11–14). Prior work has shown that children's beliefs about ability, effort, and performance begin to differentiate during these stages (Folmer et al., 2008; Kurtz-Costes et al., 2005; Yang et al., 2024). For instance, 6–8-year-old children often view effort as the primary driver of success, 8–11-year-old children understand that both ability and effort contribute to academic performance in different ways, and middle school children think ability may limit the effectiveness of effort and begin to compare themselves to peers in more complex ways (Nicholls, 1978). These age groups also reflect meaningful differences in school structure and curriculum demands, particularly across the two cultural contexts. Therefore, we used them in the figures to facilitate the interpretation of developmental trends.

Do Canadian children associate changes in academic performance with changes in effort and intellectual ability?

Following our preregistered analysis plan, we first fit a binomial mixed effects model predicting children's responses as a function of attribute (ability, effort, prettiness, and niceness) and scenario

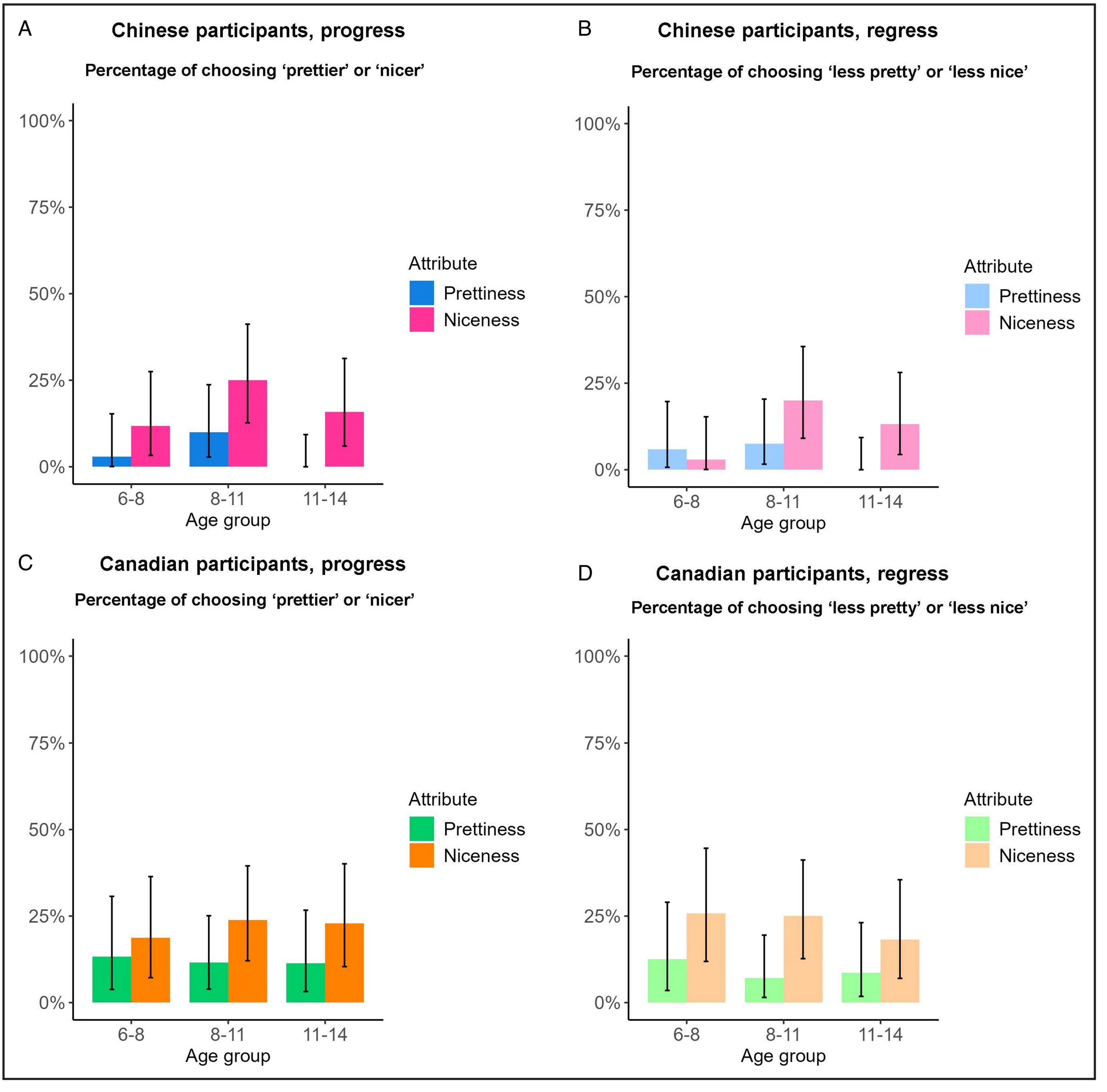

Figure 3 Percentage of participants split by age group (6–8, 8–11, and 11–14) and question type (prettiness vs. niceness) among Chinese and Canadian participants. (A) The percentage of participants selecting "prettier" or "nicer" in the progress scenario among Chinese participants. (B) The percentage of participants selecting "less pretty" or "less nice" in the regress scenario among Chinese participants. (C) The percentage of participants selecting "prettier" or "nicer" in the progress scenario among Canadian participants. (D) The percentage of participants selecting "less pretty" or "less nice" in the regress scenario among Canadian participants.

(progress and regress), as well as their interactions with a random intercept for participants. We found a significant main effect of attribute ($B = -2.26$, $SE = .32$, 95% confidence interval [CI] [−2.89, −1.63], $p < .001$; odds ratio [OR] = 0.10). A post hoc power analysis using simr package determined that the sample was adequately powered to detect this effect, 92% power with a 95% Cl (80.77%, 97.78%). As expected, these results suggest that the Canadian sample associated changes in academic performance with changes in effort ($M\ [SD]_{\%} = 85.45\%\ [0.35]$) and ability ($M\ [\mathrm{SD}]_{\%} = 79.26\%\ [0.41]$), but not prettiness ($M\ [SD]_{\%} = 10.60\%\ [0.31]$) nor niceness ($M\ [SD]_{\%} = 22.54\%\ [0.42]$). We thus dropped the two control attributes, prettiness and niceness, and focused on effort and ability beliefs in the following analyses as preregistered (see preregistration Analysis 1). We performed a binomial mixed effects model predicting children's responses as a function of attribute (smart, hard-working) and scenario (progress, regress), and it revealed a significant main effect of scenario ($B = -1.56$, $SE = .44$, 95% CI [−2.43, −0.69], $p < .001$; OR = 0.21). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 100% power with a 95% Cl (92.89%, 100%). Overall,

Table 1 Percentages (and frequencies) of children's responses split by attribute (ability, effort), scenario (progress, regress), culture (Canada, China), and age group (6–8, 8–11, 11–14, adults).

	Ability		Effort	
	Progress	Regress	Progress	Regress
Canada				
Study 1				
6–8	90.32% (28)	75.00% (24)	87.5% (28)	83.33% (25)
8–11	90.48% (38)	76.74% (33)	90.48% (38)	77.50% (31)
11–14	82.86% (29)	58.82% (20)	91.18% (31)	82.86% (29)
Total	87.96% (95)	70.64% (77)	89.81% (97)	80.95% (85)
Study 2				
Adults	66.67% (110)	18.79% (31)	89.70% (148)	83.03% (137)
China				
Study 1				
6–8	97.06% (33)	97.06% (33)	100% (34)	100% (34)
8–11	82.50% (33)	65.00% (26)	100% (40)	100% (40)
11–14	65.79% (25)	47.37% (18)	97.37% (37)	97.37% (37)
Total	81.25% (91)	68.75% (77)	99.11% (111)	99.11% (111)
Study 2				
Adults	59.04% (98)	28.31% (47)	95.78% (159)	95.78% (159)

Note. For responses in the progress scenario, numbers represent the percentages (frequencies) of children choosing "smarter" or "worked harder." For responses in the regress scenario, numbers represent the percentages (frequencies) of children choosing "less smart" or "worked less hard."

Canadian children were more likely to associate changes in effort and ability with academic progress than with academic regress. In other words, making progress reflects more hard work and a smarter mind, while a performance decline does not translate to a reduced amount of effort and a less smart mind. No main or interaction effects of attribute ($ps > .295$) were found. This suggests Canadian children equally associated changes in effort and ability with changes in academic performance.

Do Chinese children associate changes in academic performance with changes in effort and intellectual ability?

We then analyzed Chinese children's responses. The overall model with the control attributes yielded a significant main effect of attribute ($B = -1.78$, $SE = .31$, 95% CI [−2.39, −1.18], $p < .001$; OR = 0.17). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 100% power with a 95% Cl (92.89%, 100%). As expected, these results suggest that the Chinese sample associated changes in academic performance with changes in effort (M $[SD]_{\%} = 99.11\%$ [0.09]) and ability (M $[SD]_{\%} = 75.00\%$ [0.43]), but not prettiness (M $[SD]_{\%} = 4.46\%$ [0.21]) nor niceness (M $[SD]_{\%} = 15.18\%$ [0.36]). We then dropped the prettiness and niceness measures as preregistered. We then fit a binomial mixed effects model predicting children's responses as a function of attribute (ability, effort) and scenario (progress, regress), as well as their interactions with a random intercept for participants. Our final model yielded a significant main effect of scenario ($B = -6.54$, $SE = 1.65$, 95% CI [−9.76, −3.31], $p = .029$; OR < 0.01), suggesting that Chinese children, similar to Canadians, were also more likely to associate changes in effort and ability with academic progress than with academic regress. A post hoc power analysis determined that the sample was adequately powered to detect this effect, 98% power with a 95% Cl (89.35%, 99.95%). We also found a significant main effect of attribute, $B = 11.35$, $SE = 3.17$, 95% CI [5.14, 17.57], $p < .001$; OR = 84,965.45 (to address the potential instability associated with the large OR, we reestimated the model using Firth correction bias-reduced logistic regression without random effects, $B = 3.40$, $SE = 0.66$, 95% CI [2.11, 4.68], $p < .001$; OR = 29.96). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 100% power with a 95% Cl (92.89%, 100%). This suggests that Chinese children believe that changes in performance are more tied to changes in effort, rather than ability.

There was also a significant interaction between scenario and attribute ($B = 6.54$, $SE = 2.99$, 95% CI [.67, 12.40], $p = .029$; OR = 690.07). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 82% power with a 95% Cl (68.56%, 91.42%). We then ran binomial mixed effects models predicting Chinese children's responses as a function of scenario for each attribute (i.e., ability and effort). Chinese children were more likely to associate changes in ability with academic progress than regress ($B = -6.61$, $SE = 1.70$, 95% CI [−9.94, −3.28], $p < .001$; OR < 0.01); however, changes in effort were seen as equivalently associated with both academic progress and regress ($B < 0.01$, $SE = 1.42$, 95% CI [−2.78, 2.78], $p = .99$; OR = 1.00).

Across cultures, how do children grow up associate changes in performance with changes in effort and ability?

Our next analysis focused on the effect of culture, attribute, age and their interactions on children's responses. As preregistered (see preregistration Analysis 3), we ran binomial mixed effects models predicting responses as a function of culture, attribute, age, and their interactions with a random intercept for participants in each scenario (progress and regress). The models did not converge, so we dropped the three-way interaction because this is not an effect of interest in our preregistration (see preregistration Hypotheses 3–5). In the progress scenario, our final model revealed a significant interaction effect between culture and attribute ($B=-4.70$, $SE=1.42$, 95% CI [−7.49, −1.91], $p<.001$; OR = 0.01). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 84% power with a 95% Cl (70.89%, 92.83%). We next looked at the interaction between culture (i.e., Chinese and Canadian) and attribute (i.e., effort and ability). Specifically, for each culture, we ran a binomial mixed effects model predicting participants' responses as a function of attribute. For Chinese children, they were more likely to tie academic progress with increased effort than increased smartness ($B=2.86$, $SE=0.86$, 95% CI [1.17, 4.55], $p<.001$; OR = 17.46). In other words, Chinese children believe that academic progress is more associated with "working harder" than "smarter." However, Canadian children did not show significant differences in their beliefs about changes in effort and ability concerning increased performance ($B=.52$, $SE=.74$, 95% CI [−.92, 1.96], $p=.479$; OR = 1.68). This suggested that Canadian children believe that academic progress is associated with "working harder" and "smarter" to a similar extent. No main effects of culture, attribute, or age were found ($ps>.134$).

In the regress scenario, our final model revealed a significant main effect of attribute, $B=7.75$, $SE=3.69$, 95% CI [.52, 14.99], $p=.035$; OR = 2,321.57 (to address the potential instability associated with the large OR, we reestimated the model using Firth correction bias-reduced logistic regression without random effects, $B=1.38$, $SE=0.27$, 95% CI [0.85, 1.91], $p<.001$; OR = 3.97), suggesting that children believed that a decline in grades is more associated with decreased effort than smartness. A post hoc power analysis determined that the sample was adequately powered to detect this effect, 86% power with a 95% Cl (73.26%, 94.18%). There was also a significant main effect of age ($B=-1.87$, $SE=.72$, 95% CI [−3.27, −.46], $p=.009$; OR = 0.15), suggesting that older children were more likely to view both effort and ability as stable (i.e., "stay the same") in face of academic regress. A post hoc power analysis determined that the sample was adequately powered to detect this effect, 78% power with a 95% Cl (64.04%, 88.47%). We also found significant interaction effects between culture and attribute ($B=-4.43$, $SE=1.62$, 95% CI [−7.61, −1.26], $p=.006$; OR = 0.01), as well as between culture and age ($B=.72$, $SE=.33$, 95% CI [.08, 1.37], $p=.027$; OR = 2.05). Post hoc power analyses determined that the sample was adequately powered to detect these effects, 88% power with a 95% Cl (75.69%, 95.47%) and 84% power with a 95% Cl (70.89%, 92.83%). We further looked at the interaction between culture and attribute. Specifically, for each culture, we ran a binomial mixed effects model predicting participants' responses as a function of attribute. Despite the fact that both groups were more likely to associate academic regress with decrease in effort than decrease in ability, Chinese children endorsed this belief to a greater extent (Chinese children: $B=4.06$, $SE=1.06$, 95% CI [1.97, 6.14], $p<.001$, OR = 57.97); Canadian children: $B=.89$, $SE=.43$, 95% CI [.05, 1.73], $p=.039$, OR = 2.44). Then we looked at the interaction between culture and age. For Chinese children, compared to younger children, older children were more likely to view effort and ability as stable attributes (i.e., "stay the same") despite declines in grades ($B=-.44$, $SE=.11$, 95% CI [−.65, −.22], $p<.001$, OR = 0.64). However, no age effect was found in the Canadian sample ($B=-.08$, $SE=.11$, 95% CI [−.28, .13], $p=.469$, OR = 0.93).

Children's open-ended justifications

We then looked at participants' open-ended justifications for the ability and effort questions. We note that analyses on the open-ended justifications are preregistered as exploratory. See Tables 2 and 3 for frequencies and percentages of justifications in each category by scenario (progress and regress) and attribute (ability and effort).

We found that compared with Canadian children, Chinese children provided answers with more repeated narratives (averaged across four questions, in Chinese participants: 79% and in Canadian participants: 56%). Chinese children were more likely to restate descriptions for these characters as an explanation to their judgments. This was more common when Chinese children reasoned about effort than ability (ability: 68% and effort: 90%). Compared with Chinese participants, Canadian participants mention more situational factors (across four questions, in Chinese participants: 1%; in Canadian participants: 12%), and this is especially the case when they explain academic regress (in the progress scenario: 8%; in the regress scenario: 17%). Chinese participants mentioned more trait-based factors than Canadian participants (across four questions, in Chinese participants: 5% and in Canadian participants: 1%), and this is more prominent in ability than effort questions (ability: 7% and effort: 3%). On the other hand, Canadian children offered more action-based dispositional factors across two tests than Chinese participants (in Chinese participants: 11% and in Canadian participants: 29%). Overall, Canadian children explained their choices to the effort and ability questions similarly in each scenario, but differed between progress and regress scenarios. In contrast, Chinese children explained their choices to the effort and ability questions quite differently across scenarios and viewed the progress and regress scenarios similarly for each attribute (effort or ability).

We then looked at how children's explanations correspond to their judgments about whether ability or effort changed or stayed the same (see Tables 4 and 5 for a breakdown of participants' ability and effort responses by the type of open-ended explanations in Chinese and Canadian participants). For each type of explanation, we conducted a χ^2 test to examine whether each type corresponds to children's responses to the task scenarios. We note that, across all scenarios, the majority of responses were categorized

Table 2 Frequencies (and percentages) of each category of Chinese participants' open-ended justifications split by scenario (progress, regress) and measure (ability, effort).

	Progress		Regress	
	Ability	Effort	Ability	Effort
Repeated	79 (70.5%)	101 (90.2%)	73 (65.2%)	100 (89.3%)
Situational	1 (0.9%)	2 (1.8%)	2 (1.8%)	1 (0.9%)
Trait	6 (5.4%)	2 (1.8%)	9 (8.0%)	5 (4.5%)
Action	25 (22.3%)	2 (1.8%)	16 (14.3%)	6 (5.4%)
Irrelevant	6 (5.4%)	0 (0.0%)	8 (7.1%)	0 (0.0%)

as "repeated," the other types of responses were less frequent, and thus results should be interpreted with caution.

Overall, children's open-ended explanations were not particularly tied to certain responses to the task scenarios, except for the ability questions when children (a) provided "irrelevant" explanations and (b) were asked in the regress scenario. First, when children explicitly stated that intelligence is independent of performance (i.e., the irrelevant category), they were more likely to say the character's ability "stayed the same" despite performance changes (Chinese children: $\chi^2(1) = 16.95$, $p < .001$ in the progress scenario; $\chi^2(1) = 12.50$, $p < .001$ in the regress scenario; Canadian children: $\chi^2(1) = 11.87$, $p < .001$ in the progress scenario, no significance found in the regress scenario). This suggests that children who explicitly differentiate between intelligence and academic performance are less likely to infer changes in ability based on fluctuating performances. We note that only a handful of responses (<10 for each question) were categorized as "irrelevant," especially in the Canadian sample.

Table 3 Frequencies (and percentages) of each category of Canadian participants' open-ended justifications split by scenario (progress, regress) and measure (ability, effort).

	Progress		Regress	
	Ability	Effort	Ability	Effort
Repeated	65 (57.5%)	65 (57.5%)	57 (50.4%)	66 (58.4%)
Situational	9 (8.0%)	8 (7.1%)	21 (18.6%)	18 (15.9%)
Trait	0 (0.0%)	1 (0.9%)	4 (3.5%)	1 (0.9%)
Action	33 (29.2%)	39 (34.5%)	24 (21.2%)	33 (29.2%)
Irrelevant	3 (2.7%)	1 (0.9%)	4 (3.5%)	1 (0.9%)

Second, we observed some cross-cultural effects in children's explanations in the ability question of the regress scenario. Across the two samples, when children repeated the scenario, they were more likely to say the character became "less smart" (Chinese children: $\chi^2(1) = 7.72$, $p = .005$; Canadian children: $\chi^2(1) = 5.16$, $p = .023$). Some cross-cultural differences also emerged. Action-related dispositional factors were associated with the view that ability "stayed the same" in Chinese children ($\chi^2(1) = 7$, $p = .008$). In contrast, situational explanations were more associated with the view that ability "stayed the same" in Canadian children ($\chi^2(1) = 5.16$, $p = .023$). This may reflect culturally specific ways of viewing ability in the context of academic regression: Canadian children may focus more on external factors, whereas Chinese children may focus more on internal actions and behaviors that influence performance.

Study 2

Study 1 findings align with our preregistered hypothesis that Chinese children, especially in the older cohort, were more likely to view performance changes as reflecting changes in effort rather than ability, whereas Canadian children see performance changes as equally influenced by changes in effort and ability. Taking a developmental perspective, Study 2 aims to test young adults from Chinese and Canadian universities with the same scenarios, along with a growth mindset measure. As preregistered, we hypothesize that there are significant correlations between beliefs about changes in ability in the progress scenario and growth mindset beliefs in the adult samples. We also hypothesized that Chinese participants are more likely to see changes in performance as related to changes in effort than ability, whereas Canadian participants are more likely to attach changes in performance to changes in ability.

Table 4 Frequencies (and percentages) of Chinese children's ability and effort responses by the type of explanations.

		All	Repeated	Situational	Trait	Action	Irrelevant
Progress	"Smarter"	91 (81.25%)	72 (91.14%)	1 (100%)	5 (83.33%)	16 (64.0%)	0 (0)
	"Stayed the same"	21 (18.75%)	7 (8.86%)	0 (0)	1 (16.67%)	9 (36.0%)	6 (100%)
	χ^2		2.87	0.01	0.01	2.62	16.95
	p-value		.090	1	1	.106	<.001
	"Worked harder"	111 (99.11%)	100 (99.01%)	1 (50.0%)	2 (100%)	2 (100%)	0 (NA)
	"Stayed the same"	1 (0.90%)	1 (0.99%)	1 (50.0%)	0 (0)	0 (0)	0 (NA)
	χ^2		0.01	6.38	0.01	0.01	0.01
	p-value		1	.012	1	1	1
Regress	"Less smart"	77 (68.75%)	64 (87.67%)	1 (50.0%)	5 (55.56%)	5 (31.25%)	0 (0)
	"Stayed the same"	35 (31.25%)	9 (12.33%)	1 (50.0%)	4 (44.44%)	11 (68.75%)	8 (100%)
	χ^2		7.72	0.01	0.20	7.00	12.50
	p-value		.005	1	.657	.008	<.001
	"Worked less hard"	111 (99.11%)	99 (99.0%)	1 (100%)	5 (100%)	6 (100%)	0 (0)
	"Stayed the same"	1 (0.90%)	1 (1.0%)	0 (0)	0 (0)	0 (0)	0 (0)
	χ^2		0.01	0.01	0.01	0.01	0.01
	p-value		1	1	1	1	1

Note. NA = not available.

Table 5 Frequencies (and percentages) of Canadian children's ability and effort responses by the type of explanations.

		All	Repeated	Situational	Trait	Action	Irrelevant
Progress	"Smarter"	95 (87.96%)	59 (90.77%)	9 (100%)	0 (0)	31 (93.94%)	0 (0)
	"Stayed the same"	13 (12.04%)	6 (9.23%)	0 (0)	0 (0)	2 (6.06%)	3 (100%)
	χ^2		0.10	0.30	0.01	0.43	11.87
	p-value		.748	.581	1	.514	<.001
	Worked harder	97 (89.81%)	61 (93.85%)	5 (62.5%)	0 (0)	33 (84.62%)	0 (0)
	Stayed the same	11 (10.19%)	4 (6.15%)	3 (37.5%)	1 (100%)	6 (15.38%)	1 (100%)
	χ^2		0.40	2.98	1.57	0.33	1.57
	p-value		.526	.084	.211	.563	.211
Regress	"Less smart"	77 (70.64%)	50 (87.72%)	2 (9.52%)	4 (100%)	18 (75.0%)	1 (25.0%)
	"Stayed the same"	32 (29.36%)	7 (12.28%)	19 (90.48%)	0 (0)	6 (25.0%)	3 (75.0%)
	χ^2		5.16	25.09	0.51	0.03	1.93
	p-value		.023	< .001	.475	.859	.165
	"Worked less hard"	85 (80.95%)	60 (90.91%)	11 (61.11%)	1 (100%)	24 (72.73%)	0 (0)
	"Stayed the same"	20 (19.05%)	6 (9.10%)	7 (38.89%)	0 (0)	9 (27.27%)	1 (100%)
	χ^2		2.39	2.47	0.01	0.59	0.58
	p-value		.122	.116	1	.443	.447

Methods

Participants

Participants were college students recruited from a university on the west coast of Canada and a university in northern China. Both were among the most selective public universities in the country. The final sample included 166 Canadian participants (18–40, $M=20.67$, $SD=3.06$; 120 females, 40 males, and 6 nonbinary) and 166 Chinese participants (18–26, $M=21.28$, $SD=1.29$; 83 females and 83 males) from China. The Canadian sample was recruited from the university's human subject pool, and the Chinese sample was recruited via online social media platforms. The study is approved by the local ethics board in each university.

Procedure

Adult participants completed the study via a Qualtrics survey. Adults first provided their spontaneous definition of intelligence. The definition question was added simply because our previous studies have included it, and we thought it could help understand how they intuitively conceptualize this term. This was exploratory, and thus we did not preregister any hypothesis. At the same time, we do not believe this question influenced how participants responded to the following task scenarios. Then they were presented with the three student characters and scenarios, identical to Study 1. Then they were asked about their beliefs about changes in effort and ability from one of the following choices: "She became smarter and her effort remains the same"; "She worked harder and her smartness remains the same"; "She became smarter and worked harder"; and "Both her smartness and effort remain the same." There were no control attributes for adult participants. The order of three characters and four questions was counterbalanced as in the child scenarios.

Adult participants next completed the Implicit Theories of Intelligence Questionnaire (Dweck, 1999) probing their mindset beliefs. This measure has eight items, for example, "You have a certain amount of intelligence, and you can't really do much to change it." Participants answer each item on a 7-point Likert scale (1—Strongly disagree, 7—Strongly agree). Table 6 shows a summary of findings across Studies 1 and 2.

Results

Correlations between intuitive theories of performance change and intelligence mindset

First, we looked at participants' answers on growth mindset measures (Canadian adults: $M=4.13$, $SD=1.07$; Chinese adults: $M=3.60$, $SD=1.15$). Canadian participants were more growth-minded than Chinese participants ($t(330)=4.40$, 95% CI [.30, .77], $p<.001$). Given that the idea of a growth mindset taps into how much people support the idea that one's intellectual ability can be developed, we then calculated the correlations between people's views on ability in the progress scenario and their growth mindsets. There were significant correlations in both Canadian and Chinese samples (Canadian adults: $r=.46$, $p<.001$; Chinese adults: $r=.38$, $p<.001$).

Do Canadian adults associate changes in academic performance with changes in effort and intellectual ability?

For Canadian adults, we fit a binomial mixed effects model predicting their responses as a function of attribute (ability and effort) and scenario (progress and regress), and their interactions with a random intercept for participants. Our final model revealed a main effect of scenario ($B=-2.91$, $SE=.36$, 95% CI [−3.62, −2.21], $p<.001$; OR = 0.05) that Canadian adults were more likely to associate changes in effort and ability with academic progress than regress. A post hoc power analysis determined that the sample was adequately powered to detect this effect, 90% power with a 95% CI (78.19%, 96.67%). We also found a main effect of attribute ($B=1.84$, $SE=.35$, 95% CI [1.15, 2.53], $p<.001$; OR = 6.30). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 86% power with a 95% CI (73.26%,

Table 6 Summary of key findings by preregistered hypotheses across studies 1 and 2.

Preregistered hypothesis	Study	Hypo met?	Results
H1: Participants believe that changes in performance are more related to changes in effort, then ability, but not prettiness or niceness	S1	√	• In both scenarios, Canadian and Chinese participants associated changes in academic performance with changes in effort and ability, but not prettiness or niceness.
H2: With age, participants are less likely to believe that changes in performance are related to changes in ability	S1	Progress: X Regress: √	• In the progress scenario, no effects with age were found. • In the regress scenario, older children were more likely to view ability as stable ("stayed the same") with performance decrease.
H3: With age, Chinese participants are less likely to believe that changes in performance are related to changes in ability, whereas Canadian participants are relatively more likely to attach changes in performance with changes in ability	S1	Chinese: √ Canadian: X	• For the Chinese sample, older children were more likely to view effort and ability as stable. • No age effect was found in the Canadian sample.
H4: In adults, theories about changes in performance in relation to changes in ability are associated with growth mindset ratings	S2	√	• Canadian adults held a more growth mindset than Chinese adults. • There were significant correlations views on changes in ability in the progress scenario and growth mindsets in both samples.

94.18%). Overall, Canadian adults were also more likely to attach changes in effort, rather than ability, with changes in performance. There was also a significant interaction between scenario and attribute ($B=2.23$, $SE=.50$, 95% CI [1.26, 3.20], $p<.001$; $OR=9.30$). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 98% power with a 95% Cl (89.35%, 99.95%).

We further analyzed the interaction between scenario and attribute. When evaluating changes in ability, Canadian adults were more likely to associate changes in ability with academic progress than regress ($B=-17.99$, $SE=1.52$, 95% CI [−20.96, −15.02], $p<.001$; $OR<0.01$). In other words, to Canadian adults, performance increase means one gets "smarter," while performance decline does not necessarily mean one gets "less smart." When reasoning about effort, Canadian adults were also more likely to believe that academic progress is associated with "working harder," while they were less likely to believe that academic regress is associated with "working less hard" ($B=-1.53$, $SE=.64$, 95% CI [−2.78, −.29], $p=.016$; $OR=0.22$).

Do Chinese adults associate changes in academic performance with changes in effort and intellectual ability?

We then analyzed Chinese adults' responses by fitting a binomial mixed effects model predicting children's responses as a function of attribute (ability and effort) and scenario (progress and regress), as well as their interactions with a random intercept for participants. Our final model revealed a main effect of scenario ($B=-1.91$, $SE=.33$, 95% CI [−2.56, −1.26], $p<.001$; $OR=0.15$) that Chinese adults were more likely to associate changes in ability and effort with academic progress than regress. A post hoc power analysis determined that the sample was adequately powered to detect this effect, 100% power with a 95% Cl (92.89%, 100%). Additionally, there was also a significant effect of attribute ($B=3.50$, $SE=.51$, 95% CI [2.50, 4.49], $p<.001$; $OR=33.12$) that Chinese adults believed effort was more likely to change than ability. A post hoc power analysis determined that the sample was adequately powered to detect this effect, 100% power with a 95% Cl (92.89%, 100%). These main effects were also qualified by a significant interaction between scenario and attribute ($B=1.91$, $SE=.66$, 95% CI [.62, 3.21], $p=.004$; $OR=6.75$). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 74% power with a 95% Cl (59.66%, 85.37%).

We further analyzed the interaction between scenario and attribute. When evaluating changes in ability, Chinese adults were more likely to associate changes in ability with academic progress than regress ($B=-2.01$, $SE=.38$, 95% CI [−2.75, −1.26], $p<.001$; $OR=0.13$). However, when reasoning about effort, there were no significant differences between the two scenarios ($B=0.01$, $SE=.98$, 95% CI [−1.91, 1.91], $p=.99$; $OR=1.00$), in other words, Chinese adults believed that academic progress means that one "worked harder," and to a similar extent, they also believed that academic regress means that one "worked less hard."

Across cultures, how do adults associate changes in performance with changes in effort and intellectual ability?

Our next analysis looked at the effect of culture, attribute, and their interactions in adults' responses. We ran binomial mixed effects models predicting responses as a function of culture, attribute, and their interactions with a random intercept for participants in each scenario. In the progress scenario, results revealed significant main effects of attribute ($B=2.95$, $SE=.45$, 95% CI [2.07, 3.83], $p<.001$; $OR=19.11$) that participants tend to associate changes in performance with changes in effort than changes in ability, as well as interaction effect between culture and attribute ($B=-1.36$, $SE=.53$, 95% CI [−2.40, −.31], $p=.011$; $OR=0.26$). Post hoc power analyses determined that the sample was adequately powered to detect these effects, 86% power with a 95% Cl (73.26%, 94.18%) and 78% power with a 95% Cl (64.04%, 88.47%). Despite the overall stronger tie between changes in effort than ability with performance, the interaction suggested that this view is significantly more endorsed in Chinese adults ($B = 2.96$, $SE = .49$, 95% CI [2.01, 3.91], $p < .001$; OR = 19.30) compared to Canadian adults ($B = 1.59$, $SE = .34$, 95% CI [.92, 2.25], $p < .001$; OR = 4.90).

In the regress scenario, our final model revealed significant main effects of attribute ($B = 4.82$, $SE = .70$, 95% CI [3.45, 6.19], $p < .001$; OR = 123.97). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 92% power with a 95% Cl (80.77%, 97.78%). Overall, adults were more likely to attach changes in effort, rather than ability, with performance declines. There was also a significant main effect of culture ($B = -0.65$, $SE = .33$, 95% CI [−1.28, −0.01], $p = .048$; OR = 0.52). A post hoc power analysis determined that the sample was adequately powered to detect this effect, 74% power with a 95% Cl (59.66%, 85.37%). Specifically, Canadian adults, compared to Chinese adults, were more likely to view the two attributes "stayed the same" in the regress scenario, while Chinese adults were more likely to say the two attributes decreased as performance declines. The interaction between culture and attribute was not significant ($p = .075$).

Discussion

The current study took a developmental perspective and probed intuitive theories of changes in academic performance in relation to changes and effort and intellectual ability in Chinese and Canadian children and adults. Across samples, children (6–14 years, Study 1) and adults (Study 2) associated changes in academic performance primarily with changes in effort, followed by changes in ability, but not other attributes (prettiness or niceness). Moreover, changes in ability were seen as more linked to academic progress than academic regress. Several interesting cross-cultural and developmental differences arise. In the child samples, Chinese children associated changes in academic performance primarily with variations in effort, while Canadian children viewed performance changes as equally influenced by changes in both effort and ability. With age, Chinese children were more likely to believe that intellectual ability remained constant even when grades changed, particularly when grades declined, while no significant age-related pattern was observed among Canadian children. Chinese adults also primarily attached grade improvements with increased effort while Canadian adults linked improvements with both increased effort and ability. Yet, when a student performed less well than before, adults in both cultures believed it was primarily due to a decrease in effort. We next break down to discuss each piece of the results and their implications.

Intuitive theories of performance change across development

Overall, children and adults in both cultures associated changes in academic performance primarily with changes in effort, and then ability, but not attributes like prettiness or niceness. Thus, by age 6, children show a mature understanding of the relationships among effort, ability, and performance by not only endorsing the theory of "performance = effort + ability" (shown in many prior works, e.g., Muradoglu & Cimpian, 2020), but also overall believing that these two attributes develop as performance improves (although there are individual differences that some participants only attach effort change with performance change). Importantly, our results further suggest that intuitive theories of performance *change* include a set of complex beliefs. They build upon but differ from and expand on intuitive theories of performance, especially when important contextual factors are considered. These factors include (a) developmental stages, (b) when performance changes are viewed in positive and negative directions, and (c) cross-cultural differences. We discuss the first two points below and the cultural perspective in the next sections.

Across development, ability may not be seen as changing with performance changes, despite that ability is always considered an important source of performance (shown in many works, e.g., Muradoglu & Cimpian, 2020). In particular, our results show that many older children and adults believe that one's ability remains the same despite performance changes, while younger children generally associate changes in performance with changes in ability. This is interestingly the opposite of what was found in the prior literature on theories of performance that older children and adults often attach stronger importance to ability in performance compared to younger children (Nicholls, 1978). In other words, prior work found that children grow up attaching performance more to ability, yet we found that children grow up detaching changes in performance from changes in ability. Our results suggest that how individuals think of the sources of *performance change* differs from their theories of performance and intuitive theories of performance change may play a unique role in children's motivation to learn.

Performance changes can be realized in both positive and negative directions, and thus, each direction can be seen as associated with changes in ability and effort differently. Indeed, our data showed an asymmetry when participants were prompted to reason about declines in performance. To be specific, participants attached performance declines to effort but not to ability declines. This is likely due to the fact that people's views on positive and negative changes in ability are conceptually distinct. In other words, people hold a more incremental view about the potential to improve, but not decrease ability. Some recent research suggests that beliefs about positive and negative changes in ability are relatively independent and people are more likely to endorse the idea of positive changes in ability than negative changes in ability. In these studies, factor analysis showed that people's ratings on positive statements and negative statements fell into different factors and were weakly correlated (Kim et al., 2024; Lou et al., 2017). Our work adds to this literature with developmental samples across cultures, showing that from elementary years, children show such an "asymmetric" notion when thinking about ability changes in relation to grade fluctuations. More generally, our study shows that children are active reasoners who take into account the dynamic nature of one's performance. Our study goes beyond the extensive previous work which primarily focused on children's evaluations on performance at one single point, and further implicates research on children's learning attitudes and behaviors in face of performance variations from the past.

Implications for the mindset of intelligence

Our work focuses on people's theories of performance change, and it contributes to theoretical discussions by bridging literature on intuitive theories of performance and the mindset of intelligence. People generally hold "performance = ability + effort."

When considering performance change, children and adults generally associate changes in performance with changes in effort, but not necessarily ability. Here, individual differences in beliefs about changes in ability are likely tied to two different mindsets. As aforementioned, tying improvements in ability with performance may reflect a growth mindset. A fixed mindset endorser likely believes that academic progress may not necessarily translate into improvement in ability. Indeed, our two adult samples show moderate correlations between mindsets and beliefs about ability change in relation to performance change ($r = .46$ and .38), suggesting at least some overlaps between the constructs. Tying the theories together, one would benefit the most from a growth mindset, as investing more effort not only directly improves performance but also indirectly improves performance through increasing ability. In other words, a growth mindset likely motivates an individual the most, as performance can be more amplified from increased effort as well as increased ability (which is driven by effort). Overall, our work informs mindset research by mapping out the nuances in how children and adults reason about the essential components of mindset beliefs: one's potential in growing their ability and effort in relation to the growth of their academic performance.

Although our task scenarios do not directly measure the mindset of intelligence, they have methodological implications for probing mindsets in young children. In particular, our work opens a discussion on how to appropriately probe these beliefs, especially given the heterogeneous measurements in the literature (Combette & Kelemen, 2025). Some prior studies put these beliefs into specific academic contexts (e.g., math) as these contexts are arguably seen as domains requiring high ability and are more accessible to children (Heyman & Dweck, 1998, as described in introduction). Muradoglu et al. (2024) expanded on Heyman and Dweck's (1998) scenario by asking how much one's ability is responsive to intervention. Children were introduced to a student who performed either well or not-so-well in one of the subjects from math, spelling, or drawing. Then they switched to another school and either got to or did not get to practice the subject. Children were further asked if they will still perform well or not-so-well in the subject. One holds a growth mindset if they believe the student will perform worse if they do not get to practice, and better if they get to practice. We note that these scenarios equated academic performance with intellectual ability, as potentials in making performance progress simply mean an increase in intelligence. These scenarios thus may not be ideal, as our results showed that one may believe that performance can be improved by increased effort with ability being constant. Some other research took a more direct approach by asking children if one can get "smarter" if they are "not very smart" (Kurtz-Costes et al., 2005). Kurtz-Costes et al. (2005) sampled American and German children (k to 8) and found both samples showed an overall growth mindset and American children were more incremental (90.5% vs. 77% picking "yes"). Yet, this approach lacks child-friendly contexts and therefore may not be as valid for younger cohorts. Our approach used child-friendly scenarios and assessed how children reason about ability changes in relation to performance changes, and our results indeed revealed individual differences in whether one believes that ability and performance may cochange. Together, while it remains an open question as to how to probe children's mindset beliefs about intelligence, our investigation implicates this question and highlights the need for further theoretical and practical discussion on mindset assessments in developmental populations.

Cross-cultural considerations

With samples from China and Canada, we also found cross-cultural differences in individuals' intuitive theories of changes in academic performance. Across samples, children primarily associated performance changes with effort, and relatively less with intellectual ability, and this pattern is more pronounced in the Chinese children. In other words, there was an interaction between culture and attributes that Chinese children associated performance changes more with changes in effort (99%) than ability (75%), especially in the older group (97% vs. 57%), while Canadian children tended to view changes in performance as reflecting both effort (81%) and ability (76%) more equally. These results align with decades of research showing a stronger effort-oriented learning attitude toward academic performance in East Asian compared to Western contexts (studies mostly came from North America, see Lou & Li, 2023; Stevenson et al., 1990a, 1990b, 1993a, 1993b). We note that such a strong effort-orientation may limit to school contexts, as research found that Chinese college students, compared to U.S. peers, believed that career-level achievements (winning a Fields medal) rely more on raw ability than effort (Sun et al., 2021). Expanding on the prior research, the current study found evidence that Chinese children, relative to Canadian peers, were more likely to hold the belief that grade improvement does not necessarily mean someone becomes "smarter." Our adult results were also consistent with previous research, which found that Chinese students, despite their higher academic achievements, are less likely than their Western counterparts to believe that intellectual ability can be developed (Asbury et al., 2016; Sun et al., 2021).

These cross-cultural differences may stem from how school performance holds different meanings for Chinese and Canadian children, leading them to view performance fluctuations differently. Research showed that, compared to Chinese and Japanese children, American children were more likely to agree that school exams test natural talent (Stevenson et al., 1990b). In contrast, East Asian children may come to school grasping the idea that achieving higher performance is more important regardless of whether one is brilliant, especially considering East Asian societies put high emphasis on educational attainment (Wang & Rao, 2022; Yu et al., 2018). And therefore, variations in school performance are mainly, if not solely, associated with whether a student puts in more effort. This account is especially convincing with the current findings that older Chinese children who have more school experiences were more likely to *detach* changes in academic performance with changes in intellectual ability, while changes in effort were almost 100% attached to performance changes across ages. Moreover, results from the open-ended explanations also demonstrated cross-cultural differences in what academic performance means to Chinese and Canadian children. Overall, children in both samples mostly only repeated the narrative (e.g., the child got smarter/worked harder because "they scored higher"). Yet, this is especially true in the Chinese sample on the effort questions (90% responses were narrative repetition, versus 68% in the smartness questions, and 58% in Canadian children's effort questions).

Responses to the open-ended questions also revealed that Canadian children viewed changes in both effort and ability go with changes in performance, while Chinese children mostly attached the former with performance changes and see ability as relatively more independent. To be specific, Canadian children explained their choices to the effort and ability questions similarly in each scenario (progress or regress). For both effort and ability questions, Canadian children were more likely to offer situational accounts in the regress than progress scenarios (effort: 16% vs. 7%; ability: 19% vs. 8%) and less action-based dispositional accounts (effort: 29% vs. 35%; ability: 21% vs. 29%). In contrast, Chinese children explained their choices to the effort and ability questions quite differently, and in fact, they viewed the progress and regress scenarios similarly for each attribute (effort or ability). In both progress and regress scenarios, they were more likely to offer dispositional accounts when explaining their choices to the effort in comparison to the ability question (progress: 28% vs. 4%; regress: 22% vs. 10%).

These cross-cultural findings again pose a cautious note on how to best probe children's mindset of intelligence, and what it means to hold a growth mindset for children across cultures. In the western literature, as school performance is seen as reflective of intellectual ability, performance is often used as a direct proxy of intelligence. For example, as reviewed, some works (Heyman & Dweck, 1998; Muradoglu et al., 2024) probed children's growth mindset by asking if a student can maintain their school performance. Here, the measure treats test performance as a direct indicator of ability and maintaining test performance indicates that ability is stable and does not change. However, for Chinese children, school performance is largely (if not only) the extent to which one is able to replicate what they have done in quizzes/practice tests in a final or official exam; therefore, performance maintenance/increase does not necessarily translate into the level of malleability of ability. This distinction also helps tackle the cross-cultural paradox that Chinese children are more effort-oriented and well-achieved at school, yet they hold a relatively fixed mindset (Sun et al., 2021). In Chinese children's theory, ability is weighted a lot smaller than effort toward performance, and more effort does not improve ability; thus, a belief in effort, but not a growth mindset of intelligence, is the primary source to motivate them to improve performance. In sum, culture-specific considerations should be taken to probe and study children's mindset of intelligence.

Limitations and future directions

Several future directions should be noted given limitations from the current study. First, we looked at how children make inferences in a third-person but not their own perspective, and future works may use a first-person perspective and examine potential differences. Past work has suggested that children start to think about reputational outcomes when evaluating others' actions in achievement contexts from age 6 (Good & Shaw, 2022). Future work could explore how children in different cultures make inferences about changes in ability and effort from their own changes in performance. Second, our study did not specify the protagonist's grade level in order to allow participants to interpret the scenario through the lens of their own lived experiences. We recognize that this likely led children to reason about the scenario based on their own grade-level context—what "doing better on a test" means to a 6-year-old (mastering basic reading or arithmetic) may differ from what it means to an 11-year-old (solving abstract problems). Future work could specify this information and look at how children think about performance changes across different grade levels. Third, since we found that performance changes were strongly linked to changes in effort across our samples, a further direction is how children's beliefs about different forms of effort inform their beliefs about and actual learning outcomes across time. For example, do children view effort as a general quantity (e.g., "working harder" always helps), or do they distinguish between types of effort (e.g., focused practice vs. passive review) when explaining performance changes? Not all effort is equally effective—for instance, Dunlosky et al. (2013) found that investing efforts in strategies like practice testing leads to better long-term retention compared to less effective techniques like rereading. This distinction is important, as it may influence not only how children interpret academic progress or regress, but also how they choose to engage with learning tasks in the future. Finally, a future direction worth investigation is the culture-specific influences in how children growing up think of performance/achievement at different levels, across different subjects, and across different temporal frames. Prior work has shown that cross-cultural differences in perceptions of academic performance do not generalize to other types of performance or achievement (see Sun et al., 2021). Investigating children's reasoning about performance changes under more specific contexts becomes a more interesting and important topic considering the literature in beliefs about brilliance and career-level achievement/success (Leslie et al., 2015; Muradoglu et al., 2024).

In summary, our results showed that at least by school-age, children are active reasoners about academic progress and regress as reflecting changes in effort and ability. Across samples, children and adults associated changes in academic performance primarily with changes in efforts, followed by ability. This association is stronger when reasoning about performance increase rather than decline. Cross-culturally, Canadian children tended to attach changes in both ability and effort with changes in performance, while Chinese children viewed ability and effort as relatively more independent attributes. In sum, these results shed light on the diverse belief mechanisms children of different cultures may use to think of learning.

Supplementary material

Supplementary material is available at *Child Development* online.

Data availability

Materials and data of Studies 1 and 2 are openly available on https://osf.io/7n29j/overview?view_only=6a93d06f31e94e3fa4973c83a1e0236b.

Author contributions

Yuhan Wang (Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Visualization, Writing—original draft, Writing—review and editing), Lena Khadra (Data curation, Writing—original draft), Xin Sun (Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing—original draft, Writing—review and editing)

Funding

This work was supported by the Banting Postdoctoral Fellowship awarded to X.S. and the Social Sciences and Humanities Research Council Insight Grant GR030897 to J.F.Werker.

Conflicts of interest

All authors have no conflicts of interest to declare.

Acknowledgments

We thank Dr. Janet Werker for providing lab resources for the Canadian data collection. We also thank Dr. Shaylene Nancekivell for her advice on the study design.

References

Amemiya, J., & Wang, M. T. (2018). Why effort praise can backfire in adolescence. *Child Development Perspectives*, **12**, 199–203. https://doi.org/10.1111/cdep.12284

Asbury, K., Klassen, R., Bowyer-Crane, C., Kyriacou, C., & Nash, P. (2016). National differences in mindset among students who plan to be teachers. *International Journal of School & Educational Psychology*, **4**, 158–164. https://doi.org/10.1080/21683603.2015.1075164

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, **67**, 1–48. https://doi.org/10.18637/jss.v067.i01

Berg, C. A., & Sternberg, R. J. (1992). Adults' conceptions of intelligence across the adult life span. *Psychology and Aging*, **7**, 221–231. https://doi.org/10.1037/0882-7974.7.2.221

Bian, L, Leslie, SJ, & Cimpian, A. (2017). Gender stereotypes about intellectual ability emerge early and influence children's interests. *Science*, **355**, 389–391. www.doi.org/10.1126/science.aah6524.

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development*, **78**, 246–263. https://doi.org/10.1111/j.1467-8624.2007.00995.x

Chuey, A., Boyce, V., Cao, A., & Frank, M. C. (2024). Conducting developmental research online vs. in-person: A meta-analysis. *Open Mind: Discoveries in Cognitive Science*, **8**, 795–808. https://doi.org/10.1162/opmi_a_00147

Combette, L. T., & Kelemen, D. (2025, May 12). *Paying attention to mindset measures: a necessary step to move beyond mindset controversies*. [Unpublished Manuscript]. OSF. https://doi.org/10.31219/osf.io/yr85t_v2

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques: Promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest*, **14**, 4–58. https://doi.org/10.1177/1529100612453266

Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality, and development*. Psychology Press.

Dweck, C. S. (2017). The journey to children's mindsets—and beyond. *Child Development Perspectives*, **11**, 139–144. https://doi.org/10.1111/cdep.12225

Dweck, C. S., & Yeager, D. S. (2019). Mindsets: A view from two eras. *Perspectives on Psychological Science*, **14**, 481–496. https://doi.org/10.1177/1745691618804166

Folmer, A. S., Cole, D. A., Sigal, A. B., Benbow, L. D., Satterwhite, L. F., Swygert, K. E., & Ciesla, J. A. (2008). Age-related changes in children's understanding of effort and ability: Implications for attribution theory and motivation. *Journal of Experimental Child Psychology*, **99**, 114–134. https://doi.org/10.1016/j.jecp.2007.09.003

Good, K., & Shaw, A. (2022). Being versus appearing smart: Children's developing intuitions about how reputational motives guide behavior. *Child Development*, **93**, 418–436. https://doi.org/10.1111/cdev.13711

Green, P., & MacLeod, C. J. (2016). SIMR: An R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution*, **7**, 493–498. https://doi.org/10.1111/2041-210X.12504

Hau, K.-T., & Salili, F. (1996). Prediction of academic performance among Chinese students: Effort can compensate for lack of ability. *Organizational Behavior and Human Decision Processes*, **65**, 83–94. https://doi.org/10.1006/obhd.1996.0008

Heine, S. J., Kitayama, S., Lehman, D. R., Takata, T., Ide, E., Leung, C., & Matsumoto, H. (2001). Divergent consequences of success and failure in Japan and North America: An investigation of self-improving motivations and malleable selves. *Journal of Personality and Social Psychology*, **81**, 599–615. https://doi.org/10.1037/0022-3514.81.4.599

Hess, R. D., Chang, C.-M., & McDevitt, T. M. (1987). Cultural variations in family beliefs about children's performance in mathematics: Comparisons among People's Republic of China, Chinese-American, and Caucasian-American families. *Journal of Educational Psychology*, **79**, 179–188. https://doi.org/10.1037/0022-0663.79.2.179

Heyman, G. D., & Dweck, C. S. (1998). Children's thinking about traits: Implications for judgments of the self and others. *Child Development*, **69**, 391–403. https://doi.org/10.1111/j.1467-8624.1998.tb06197.x

Jara-Ettinger, J., Tenenbaum, J. B., & Schulz, L. E. (2015). Not so innocent: Toddlers' inferences about costs and culpability. *Psychological Science*, **26**, 633–640. https://doi.org/10.1177/0956797615572806

Jose, P. E., & Bellamy, M. A. (2012). Relationships of parents' theories of intelligence with children's persistence/learned helplessness: A cross-cultural comparison. *Journal of Cross-Cultural Psychology*, **43**, 999–1018. https://doi.org/10.1177/0022022111421633

Kim, J., Hong, S., & Na, J. (2024). Belief in negative change in intelligence: Whether and (if so) how it can add to the implicit theories of intelligence. *Personality and Individual differences*, **228**, Article 112723. https://doi.org/10.1016/j.paid.2024.112723

Kim, J. J., Fung, J., Wu, Q., Fang, C., & Lau, A. S. (2017). Parenting variables associated with growth mindset: An examination of three Chinese-heritage samples. *Asian American Journal of Psychology*, **8**, 115–125. https://doi.org/10.1037/aap0000064

Kurtz-Costes, B., McCall, R. J., Kinlaw, C. R., Wiesen, C. A., & Joyner, M. H. (2005). What does it mean to be smart? The development of children's beliefs about intelligence in Germany and the United States. *Journal of Applied Developmental Psychology*, **26**, 217–233. https://doi.org/10.1016/j.appdev.2004.12.005

Leonard, J. A., Bennett-Pierre, G., & Gweon, H. (2019). Who is better? Preschoolers infer relative competence based on efficiency of process and quality of outcome. In A. K. Goel, C. M. Seifert, & C. Freksa (Eds.), *Proceedings of the 41st annual conference of the Cognitive Science Society* (pp. 639–645). Cognitive Science Society.

Leonard, J. A., Cordrey, S. R., Liu, H. Z., & Mackey, A. P. (2023). Young children calibrate effort based on the trajectory of their performance. *Developmental Psychology*, **59**, 609–619. https://doi.org/10.1037/dev0001467

Leslie, S.-J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science*, **347**, 262–265. https://doi.org/10.1126/science.1261375

Lou, N. M., & Li, L. M. W. (2023). Social mobility and motivational payoff: Achievement motivation is more important in students' performance and well-being in cultures with high versus low social mobility. *Journal of Cross-Cultural Psychology*, **54**, 827–848. https://doi.org/10.1177/00220221231195930

Lou, N. M., Masuda, T., & Li, L. M. W. (2017). Decremental mindsets and prevention-focused motivation: An extended framework of implicit theories of intelligence. *Learning and Individual Differences*, **59**, 96–106. https://doi.org/10.1016/j.lindif.2017.08.007

Muenks, K., & Miele, D. B. (2017). Students' thinking about effort and ability: The role of developmental, contextual, and individual difference factors. *Review of Educational Research*, **87**, 707–735. https://doi.org/10.3102/0034654316689328

Muradoglu, M., & Cimpian, A. (2020). Children's intuitive theories of academic performance. *Child Development*, **91**, e902–e918. https://doi.org/10.1111/cdev.13325

Muradoglu, M., Porter, T., Trzesniewski, K., & Cimpian, A. (2024). A growth mindset scale for young children (GM-C): Development and validation among children from the United States and South Africa. *PLoS One*, **19**, Article e0311205. https://doi.org/10.1371/journal.pone.0311205

Ng, F. F.-Y., & Wei, J. (2020). Delving into the minds of Chinese parents: What beliefs motivate their learning-related practices? *Child Development Perspectives*, **14**, 61–67. https://doi.org/10.1111/cdep.12358

Nicholls, J. G. (1978). The development of the concepts of effort and ability, perception of academic attainment, and the understanding that difficult tasks require more ability. *Child Development*, **49**, 800–814. https://doi.org/10.2307/1128250

Nisbett, R. E., Aronson, J., Blair, C., Dickens, W., Flynn, J., Halpern, D. F., & Turkheimer, E. (2012). Intelligence: New findings and theoretical developments. *The American Psychologist*, **67**, 130–159. https://doi.org/10.1037/a0026699

Nisbett, RE, & Wilson, TD. (1977). The halo effect: Evidence for unconscious alteration of judgments. *Journal of Personality and Social Psychology*, **35**, 250–256. https://doi.org/10.1037/0022-3514.35.4.250.

Poli, F., Meyer, M., Mars, R. B., & Hunnius, S. (2025). Exploration in 4-year-old children is guided by learning progress and novelty. *Child Development*, **96**, 192–202. https://doi.org/10.1111/cdev.14158

Porter, T., Catalán Molina, D., Cimpian, A., Roberts, S., Fredericks, A., Blackwell, L. S., & Trzesniewski, K. (2022). Growth-mindset intervention delivered by teachers boosts achievement in early adolescence. *Psychological Science*, **33**, 1086–1096. https://doi.org/10.1177/09567976211061109

Shu, Y., Hu, Q., Xu, F., & Bian, L. (2022). Gender stereotypes are racialized: A cross-cultural investigation of gender stereotypes about intellectual talents. *Developmental Psychology*, **58**, 1345–1359. https://doi.org/10.1037/dev0001356

Sjøberg, S., & Jenkins, E. (2022). PISA: A political project and a research agenda. *Studies in Science Education*, **58**, 1–14. https://doi.org/10.1080/03057267.2020.1824473

Stevenson, H. W., Chen, C., & Lee, S. (1993a). Mathematics achievement of Chinese, Japanese, and American children: Ten years later. *Science*, **259**, 53–58. https://doi.org/10.1126/science.8418494

Stevenson, H. W., Chen, C., & Lee, S. (1993b). Motivation and achievement of gifted children in East Asia and the United States. *Journal for the Education of the Gifted*, **16**, 223–250. https://doi.org/10.1177/016235329301600302

Stevenson, H. W., Lee, S., Chen, C., Lummis, M., Stigler, J., Fan, L., & Ge, F. (1990a). Mathematics achievement of children in China and the United States. *Child Development*, **61**, 1053–1066. https://doi.org/10.1111/j.1467-8624.1990.tb02841.x

Stevenson, H. W., Lee, S.-Y., Chen, C., Stigler, J. W., Hsu, C.-C., Kitamura, S., & Hatano, G. (1990b). Contexts of achievement: A study of American, Chinese, and Japanese children. *Monographs of the Society for Research in Child Development*, **55**, i. https://doi.org/10.2307/1166090

Sun, X., Nancekivell, S., Gelman, S. A., & Shah, P. (2021). Growth mindset and academic outcomes: A comparison of US and Chinese students. *NPJ Science of Learning*, **6**, Article 21. https://doi.org/10.1038/s41539-021-00100-z

Sun, X., Norton, O., & Nancekivell, S. E. (2023). Beware the myth: Learning styles affect parents', children's, and teachers' thinking about children's academic potential. *NPJ Science of Learning*, **8**, Article 46. https://doi.org/10.1038/s41539-023-00190-x

Ünal, Z. E., Greene, N. R., Lin, X., & Geary, D. C. (2023). What is the source of the correlation between Reading and mathematics achievement? Two meta-analytic studies. *Educational Psychology Review*, **35**, Article 4. https://doi.org/10.1007/s10648-023-09717-5

Usher, E. L., Li, C. R., Butz, A. R., & Rojas, J. P. (2019). Perseverant grit and self-efficacy: Are both essential for children's academic success?. *Journal of Educational Psychology*, **111**, 877–902. https://doi.org/10.1037/edu0000324

Wang, J., & Rao, N. (2022). What do Chinese students say about their academic motivational goals—reasons underlying academic strivings? *Asia Pacific Journal of Education*, **42**, 245–259. https://doi.org/10.1080/02188791.2020.1812513

Wang, Q., & Ng, F. F.-Y. (2012). Chinese students' implicit theories of intelligence and school performance: Implications for their approach to schoolwork. *Personality and Individual differences*, **52**, 930–935. https://doi.org/10.1016/j.paid.2012.01.024

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review*, **92**, 548–573. https://doi.org/10.1037/0033-295X.92.4.548

Yang, X., Zhao, X., Dunham, Y., & Bian, L. (2024). The development and predictors of a preference for strivers over naturals in the United States and China. *Child Development*, **95**, 593–608. https://doi.org/10.1111/cdev.14012

Yeager, D. S., Hanselman, P., Walton, G. M., Murray, J. S., Crosnoe, R., Muller, C., Tipton, E., Schneider, B., Hulleman, C. S., Hinojosa, C. P., Paunesku, D., Romero, C., Flint, K., Roberts, A., Trott, J., Iachan, R., Buontempo, J., Yang, S. M., Carvalho, C. M., … &

Dweck, C. S. (2019). A national experiment reveals where a growth mindset improves achievement. *Nature*, **573**, 364–369. https://doi.org/10.1038/s41586-019-1466-y

Yu, S., Chen, B., Levesque-Bristol, C., & Vansteenkiste, M. (2018). Chinese education examined via the lens of self-determination. *Educational Psychology Review*, **30**, 177–214. https://doi.org/10.1007/s10648-016-9395-x

Zhang, X., Carrillo, B. A., Christakis, A., & Leonard, J. A. (2025). Children predict improvement on novel skill learning tasks. *Child Development*, **96**, 1177–1188. https://doi.org/10.1111/cdev.14232

Zhao, X, & Yang, X. (2023). She succeeded despite lack of ability or resources: Children's consideration of constraint in beliefs and reasoning about academic achievement. *Developmental Psychology*, **59**, 594–608. https://doi.org/10.1037/dev0001465.