AMERICAN PSYCHOLOGICAL ASSOCIATION

Journal of Experimental Psychology: General

ISSN: 0096-3445

2021, Vol. 150, No. 5, 815–827
http://dx.doi.org/10.1037/xge0000980

Perceptions of the Malleability of Fluid and Crystallized Intelligence

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There is significant variation in lay people's beliefs about the nature of intelligence: Some believe that intelligence is relatively fixed and innate, whereas others view intelligence as more malleable and affected by experience. However, most studies in this domain do not explicitly define intelligence when probing about beliefs about intelligence and aptitude. Thus, variation in beliefs may reflect variation in how intelligence is defined. To address this issue, we conducted 3 studies examining individuals' beliefs about fluid versus crystallized intelligence. Study 1 used a modified version of Dweck's (1999) mindset questionnaire and found that people have more fixed views about fluid intelligence than either crystallized intelligence or intelligence in general. Study 2 used a switched-at-birth paradigm and found that individuals hold more essentialist beliefs about fluid intelligence than crystallized intelligence. Study 3 added a survey that probed participants' beliefs about mathematics achievement. It found that when reasoning about mathematics achievements, participants' attributions of ability and effort were differentially associated with their crystallized and fluid mindset beliefs. Specifically, mindsets of fluid intelligence were more associated with effort for professional-level mathematics achievements, whereas mindsets of crystallized intelligence were more associated with elementary-level mathematics achievements. Together, the present studies highlight the importance of considering the definition of intelligence when assessing related beliefs about malleability, inheritance, and achievement.

Keywords: mindset, essentialism, fluid intelligence, crystallized intelligence, effort–ability attribution

Supplemental materials: http://dx.doi.org/10.1037/xge0000980.supp

The idea that individuals have different mindsets about intelligence is a topic of much interest in science and the popular press. According to Dweck and colleagues (Dweck, 1999; Dweck, Chiu, & Hong, 1995; Dweck & Leggett, 1988), some individuals endorse an *entity* or *fixed* view in which intelligence is thought of as unchangeable, whereas others hold an *incremental* or *growth* view in which intelligence is thought of as more malleable and open to development by investing effort.

Despite the popularity of the notion of mindset, there is debate regarding the extent to which mindsets are consequential. Some studies find that individuals who endorse a growth mindset are more likely to embrace mastery learning goals, seek challenges, attribute failure and success to effort, remain persistent in the face of failure, maintain motivation, and even succeed academically (Blackwell, Trzesniewski, & Dweck, 2007; Claro, Paunesku, & Dweck, 2016; Dweck, 2008; Hong, Chiu, Dweck, Lin, & Wan, 1999; Yeager & Dweck, 2012). In this work, those who endorse a fixed mindset, in contrast, hold performance goals, are likely to avoid risk-taking behaviors, attribute success and failure to ability, and lack persistence. A recent large-scale study (Yeager et al., 2019) found small but significant positive effects (standardized mean effect size = .11) of a brief, 1-hr online mindset intervention on subsequent grade point average for low achieving students.

On the other hand, some studies find little to no effect of mindset on outcomes. Li and Bates (2019), for example, found that mindsets were not associated with IQ or grades and did not predict improvement in grades across an academic year. A recent meta-analysis (Sisk, Burgoyne, Sun, Butler, & Macnamara, 2018) found a very weak association between mindset and academic achievement (r = .10) and a small overall effect of mindset interventions on academic achievement (d = .08), with 86% of studies having no significant effect on achievement.

Here, we take a neutral stand on this controversial field and focus instead on the separate question of how people's reasoning about the malleability of intelligence and its inheritance are related to the definition of intelligence under consideration.

Classic studies of fixed and growth mindsets assessed mindset beliefs with the Implicit Theories of Intelligence Questionnaire (Dweck, 1999), which includes items such as "You can always

This article was published Online First October 1, 2020.

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Data are available in the Open Science Framework (https://osf.io/v7wfk/?view_only=dd247aece3844665874a0b52d1749b5e).

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substantially change how much intelligence you have," without any definition of *intelligence*. As such, it is currently unclear what people have in mind when they answer such surveys. One possibility is that different people consider different definitions of intelligence when rating their beliefs. This seems plausible when we examine the enormous body of research debating what constitutes intelligence (e.g., Humphreys, 1979; Legg & Hutter, 2007; Sternberg, 2000). For example, in one classical model of intelligence, Cattell (1987/1971) made a distinction between fluid and crystallized intelligence, whereas in another model, Sternberg (1985) regarded intelligence as having a triarchic structure, including analytic intelligence, creative intelligence, and practical intelligence. Given that even scientists historically have not fully agreed on the structure of intelligence, it is certainly not clear what participants might be thinking about when they respond to questions about intelligence.

What people consider when rating their beliefs about intelligence likely matters in meaningful ways. For example, if someone who reports a more fixed view is considering a different definition of intelligence than someone with a more growth view, then previous differences in fixed and growth views of intelligence might reflect differences in what it means to be intelligent, rather than different mindsets per se. Indeed, Sternberg, Conway, Ketron, and Bernstein (1981) presented participants with descriptions of behaviors of fictitious individuals and asked them to rate which descriptions were most characteristic of an ideal intelligent person. A factor analysis indicated that some individuals focused more on problem solving and abstract reasoning skills, others on verbal ability, and yet others on social competence. Given this issue, the present investigation has two aims: (1) to examine how defining intelligence in different ways is associated with people's views of intelligence (i.e., fixed/growth, inheritable/experience-based) and (2) to explore the consequences of different definitions of intelligence for people's reasoning about the relation between mindset and academic achievement.

This investigation has potentially broad implications. There is at least some evidence that beliefs about intelligence can influence a person's self-concept, school achievement, and occupational success (Dweck, 2006; Gunderson et al., 2013; Hill, Corbett, & St. Rose, 2010). In educational settings, mindsets of learning might influence educators' teaching strategies and their students' success (e.g., Brooks & Goldstein, 2008). As discussed in the preceding text, prior work shows that beliefs about intelligence are at least minimally associated with academic motivation, and are related to gender disparities in STEM fields (Leslie, Cimpian, Meyer, & Freeland, 2015; Meyer, Cimpian, & Leslie, 2015). Therefore, better characterizing people's beliefs about intelligence has potential implications across several domains. If mindset beliefs differ as a function of how intelligence is defined, this may also allow researchers to better understand potential noisiness in their data.

Here, we focus on how people reason about two specific definitions of intelligence: fluid intelligence and crystallized intelligence. Fluid intelligence refers to how an individual solves novel reasoning problems by identifying abstract patterns and relations and using inductive and deductive logic. In contrast, crystallized intelligence consists of an individual's knowledge and skills and their ability to apply them in different domains (Cattell, 1987). We chose these two definitions of intelligence because nonexperts have been found to incorporate fluid and/or crystallized skills in their personal understanding of the construct of intelligence (e.g., Nicholls, Patashnick, & Mettetal, 1986; Sternberg, Conway, Ketron, & Bernstein, 1981). Second, they are components of intelligence found in classical models (Cattell, 1963).

To our knowledge, there are only a few studies that address how individuals' conceptualizations of intelligence might be related to the extent to which they endorse fixed or growth mindsets (Furnham, 2014; Nicholls et al., 1986). In Nicholls et al.'s (1986) interview-based study, some adult participants (17 out of the 27 participants) reported that abstract skills are harder to improve than verbal skills. Specifically, they reported that verbal skills show what they have been taught, whereas abstract skills are not biased by the person's background and could not be improved through simple memorization. This finding supports our hypothesis that people may reason differently about different definitions of intelligence. However, this interview study did not explicitly quantify the extent to which views about malleability differed for abstract and verbal intelligence or consider the consequences of these potentially differing views. In another study, Furnham (2014) investigated people's mindsets of different versions of intelligence as defined by Gardner's (1983) multiple intelligence theory. The results showed that creative and musical intelligence were considered least likely to be deemed malleable, whereas verbal intelligence was thought of as the most easily altered (see also Gelman, Heyman, & Legare, 2007). However, in his study, these particular "intelligences" were framed more as specific skills or aptitudes, and not as generic conceptualizations of intelligence (see differences in beliefs about specific skills vs. domain-general competencies; Scott & Ghinea, 2014). More importantly, although skills resembling crystallized and fluid skills were included (verbal and logical intelligence), the analyses combined all skills into a single factor named *classical intelligence*.

The Present Studies

The present investigation is concerned with people's intuitive beliefs about the malleability (Study 1) and inheritance (Study 2) of fluid and crystallized intelligence. In Study 1, we assessed how mindset beliefs are related to definitions of intelligence under consideration: fluid versus crystallized. We predicted that lay individuals are likely to believe that crystallized intelligence is largely malleable whereas fluid intelligence is more fixed. We also predicted that participants would view general intelligence as a hybrid and thus that their ratings would lie in-between the two definitions of intelligence (Nicholls et al., 1986; Sternberg et al., 1981).

Study 2 addressed the extent to which conceptualizing intelligence in fluid or crystallized ways influences how participants endorse essentialist thinking about it. Essentialism is the view that certain characteristics are innate, stable, and biologically based (Gelman, 2004; Thomas & Sarnecka, 2015). Here, we tested the specific hypothesis that people are likely to view intelligence as not only less malleable, but also more inheritable when they reason about fluid, rather than crystallized, intelligence. Beliefs about malleability and inheritance are often linked (Heyman, 2008; Thomas & Sarnecka, 2015). For example, Heyman (2008) showed that labeling students with the best performance in class with terms like "math whiz" led children to adopt both a more essentialist and fixed view (i.e., these achievements are due to "innate ability" and, thus, "require less effort"). Further, Thomas and Sarnecka (2015) found a relation between holding a fixed mindset and holding essentialist beliefs about general intelligence. For example, they found that individuals who believe intelligence is fixed are also more likely to endorse an essentialist view that genetic but not environmental factors determine the development of the brain. However, this prior work has not examined people's beliefs when intelligence is clearly defined and, as such, it is unclear what definition of intelligence participants had in mind when answering their surveys.

In a preregistered third study (Study 3), our primary aim was to examine the consequences of providing these two definitions of intelligence in mindset measures for people's reasoning about academic achievement (i.e., mathematics achievement). Prior work suggests that beliefs about intelligence influence people's judgments of the amount of effort required to be successful at mathematics (Hong et al., 1999). Of interest to Study 3 is how people's beliefs about crystallized and fluid intelligence might be related to the amount of effort or ability people view as necessary for the various levels of academic achievements (e.g., less advanced mathematics vs. more advanced mathematics). Moreover, in Study 3, we investigated the validity of the mindset measures using crystallized and fluid intelligence definitions. We first tested the convergent validity of our mindset scale by examining its relation to a conceptually similar psychological essentialism measure. Next, we tested whether mindsets across the different definitions of intelligence were separable constructs via a confirmatory factor analysis.

Study 1

Study 1 examined how asking people to consider different definitions of intelligence might be related to their mindset beliefs. As discussed earlier, we expected growth mindset beliefs to be the highest for crystallized intelligence followed by intelligence in general and then finally by fluid intelligence. To test this, we included the original Implicit Theories of Intelligence Questionnaire (Dweck, 1999), an eight-item questionnaire with a six-point Likert response scale (1 = *strongly disagree*, 6 = *strongly agree*). In addition to the original Implicit Theories of Intelligence Questionnaire, which refers to intelligence in general, we created two variants that referred to participants' beliefs about fluid and crystallized intelligence. The items are identical to Dweck's (1999) well-validated measure, but for the specific intelligence items, the term *intelligence* was replaced with specific definitions of intelligence, that is, *fluid intelligence* or *crystallized intelligence*. One sample item is "You have a certain amount of fluid intelligence, and you can't really do much to change it."

We presented definitions of crystallized and fluid intelligence to participants before their respective mindset items. Our definitions were primarily constructed by considering lay persons' definitions of intelligence in prior research (Nicholls et al., 1986; Sternberg et al., 1981). Our definitions include examples of tasks used to assess intelligence, such as tests of geography and inductive reasoning (Cattell, 1987; Li, Baldassi, Johnson, & Weber, 2013; Undheim, 1981). Given our hypothesis that how intelligence is defined for participants might affect their responses, we were also careful to counterbalance the order in which definitions were presented, with half of participants seeing the general intelligence items before reading our two more specific definitions and half after.

Method

Participants. Participants were recruited from Amazon Mechanical Turk (MTurk); those who failed to select the correct choice on either of the two attention check items ($N = 18$) were removed from the analysis. The resulting sample size was 182. Participants' average age was 33 ($SD = 9.18$), 32.4% were female, 67% were males and .6% did not specify their gender. Based on participant self-report, the sample was 63.2% White, 27.5% Asian, 5.5% Black, and 3.8% other. 9.3% reported holding a high school diploma or lower, 33.0% reported having received some college education, 42.9% reported holding a bachelor's degree, and 14.8% reported holding a master's degree or higher. Participants who completed the questionnaire received $1.50. The study was approved as exempt by the institutional review board.

Procedure. Participants entered the questionnaire through the MTurk recruitment page. They read a brief description of the study and then proceeded to the main questionnaire. The questionnaire consisted of five main blocks: introduction to fluid intelligence and crystallized intelligence, Implicit Theories of Fluid Intelligence Questionnaire, Implicit Theories of Crystallized Intelligence Questionnaire, Implicit Theories of Intelligence Questionnaire, and demographic questions (including age, gender, race, educational level, and occupation).

In the introduction (see Figure 1), participants saw the following definitions of fluid and crystallized intelligence:

> Psychologists think about intelligence as having two distinct parts.
>
> Fluid intelligence is how efficiently and accurately you solve problems, use logic, and identify patterns. For example, you would use fluid intelligence to identify which number goes next in a series (1, 2, 4, 7, 11 . . .) or what figure belongs in the empty slot in the problem below . . .
>
> Crystallized intelligence includes your knowledge and skills such as vocabulary, common knowledge like knowledge of how to divide fractions, the names of the planets, or the location of different countries. (see the map below) . . .

To reduce the possible order effects, each participant randomly received a questionnaire with one of four different block orders: (1) introduction, fluid intelligence block, crystallized intelligence block, general intelligence belief block, demographics; (2) introduction, crystallized intelligence block, fluid intelligence block, general intelligence block, demographics; (3) general intelligence block, introduction, fluid intelligence block, crystallized intelligence block, demographics; or (4) general intelligence block, introduction, crystallized intelligence block, fluid intelligence block, demographics.

Results and Discussion

Descriptive statistics. The mean values of the three scales were calculated to represent mindsets of the three definitions of intelligence (with four reverse-coded items). A higher score indicates a more growth mindset. The mean values of the malleability of intelligence as a general construct, fluid intelligence, and crys-

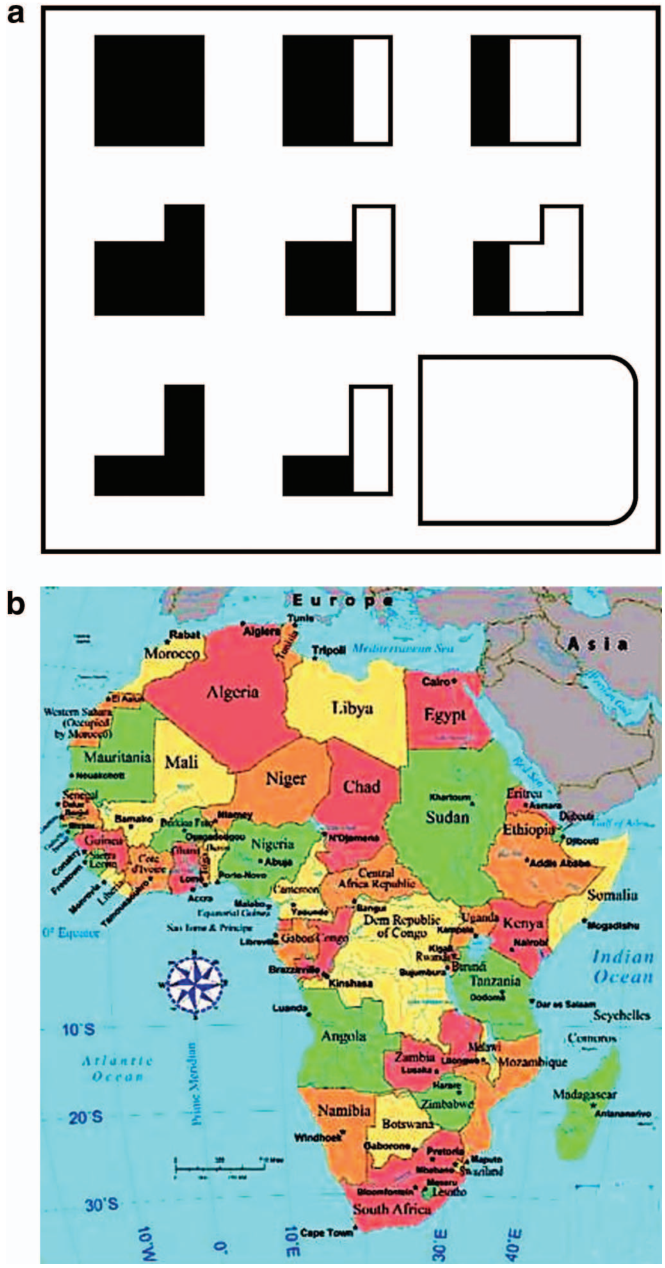

Figure 1. Panel a: Example of fluid intelligence. Panel b: Example of crystallized intelligence. See the online article for the color version of this figure.

tallized intelligence were respectively 3.94 (SD = 1.19), 3.63 (SD = 1.17), and 4.41 (SD = 1.12). Beliefs in the malleability of general intelligence highly correlated with beliefs about the malleability of both crystallized ($r = .62$, $p < .001$) and fluid intelligence ($r = .80$, $p < .001$), whereas beliefs about crystallized and fluid intelligence were moderately correlated ($r = .44$, $p < .001$). This pattern of correlations suggests that overall people who viewed intelligence as malleable did so across the board. Additionally, however, there was a significantly smaller correlation ($z = 3.53$, $p < .001$) between crystallized and the other two definitions of intelligence, suggesting that participants may view general intelligence as closer to fluid than crystallized intelligence.

Effect of the definitions of intelligence on mindsets. To assess the influence of the our definitions of intelligence on mindset, we conducted a 3 × 4 mixed analysis of variance (ANOVA) with definition of intelligence as a within-subject variable (i.e., fluid, crystallized, general), and questionnaire block order as a between-subjects variable (i.e., Orders 1 to 4). The main effect for definition of intelligence was significant, $F(2, 356) = 54.59$, $p < .001$, $\eta^2 = .23$. As predicted, block order did not have a significant main effect, $F(3, 178) = .35$, $p = .79$, $\eta^2 < .01$, nor did it significantly interact with definitions of intelligence, $F(6, 356) = 0.39$, $p = .88$, $\eta^2 < .01$. Because the three definitions of intelligence were significantly different, a post hoc analysis was con-

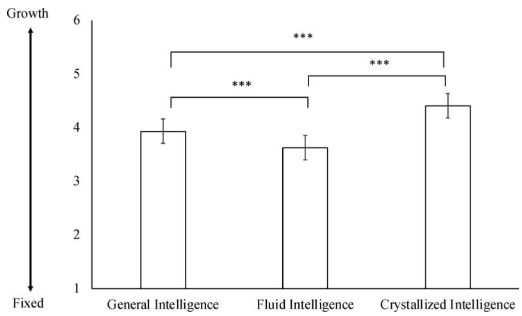

Figure 2. Means and pairwise comparisons of mindset of three definitions of intelligence. *** $p < .001$.

ducted (see Figure 2). We considered a p value significant at .017 after a Bonferroni correction (.05/3). The results showed that the three definitions of intelligence differed from one another, with the mean difference between general and fluid intelligence at .31 ($p < .001$, $d = .42$), between general and crystallized intelligence at $-.47$ ($p < .001$, $d = .47$), and between fluid and crystallized intelligence at $-.78$ ($p < .001$, $d = .64$). Participants' ratings did not differ by presentation order; but more importantly, they did differ depending on the definition of intelligence they were considering.

Midpoint analysis. On the six-point Likert scale, a response over 3.5 (i.e., midpoint) indicates a more growth mindset, whereas a response below 3.5 indicates a more fixed mindset. We conducted three t tests, comparing each of the three definitions of mindset against the midpoint value of 3.5. Scores for general and crystallized intelligence were significantly above the midpoint: $t_{\text{general intelligence}}(181) = 4.97$ ($p < .001$, $d = .37$) and $t_{\text{crystallized intelligence}}(181) = 10.98$ ($p < .001$, $d = .81$). Scores for fluid intelligence did not differ from the midpoint, $t_{\text{fluid intelligence}}(181) = 1.49$ ($p = .14$, $d = .11$). These results revealed that participants regarded intelligence as malleable when crystallized and general definitions were used; in contrast, intelligence was viewed on average as neither malleable nor stable when a fluid definition was used. Together, the findings suggest that the definition of intelligence is related to participants' mindset beliefs.

Study 2

Study 1 found that participants reasoning about mindset differed depending on whether they were considering general, crystallized, or fluid intelligence. Study 2 assessed how individuals' judgments of the inheritance of intelligence vary depending on its conceptualization. Prior work on essentialist views of intelligence has not examined whether providing specific definitions (i.e., for fluid and crystallized intelligence) influence people's thinking about it. As such, it is an open question, for example, whether intelligence might not only be viewed as less malleable, but also as innate or more inheritable when it is conceptualized in fluid ways (as opposed to crystallized ones).

This study might also be construed as a "conceptual replication" because of the association between fixed mindsets and essentialism (Thomas & Sarnecka, 2015). We used the switched-at-birth paradigm, which ascertains people's beliefs about the contributions of nature and nurture to the development of psychological traits (e.g., Gelman & Wellman, 1991; Heyman & Gelman, 2000; Hirschfeld, 1995; Taylor, Rhodes, & Gelman, 2009). Participants read a vignette about two babies who were born into two different families and then accidentally switched at birth. For each baby, the biological parents were distinctively different in some psychological characteristics from the adoptive parents (i.e., biological parents were high on the characteristic, adoptive parents were low on the characteristic, or vice versa). Then, participants were asked to predict whether the baby would grow up to be more like the adoptive parents or more like the birth parents on that characteristic. This paradigm is frequently used in developmental studies on individuals' essentialist beliefs and the measure is sensitive to variability in these beliefs (Gelman, 2004).

We predicted that participants would predict the child's fluid intelligence more on the basis of the biological parents, showing a more essentialist view when given the fluid definition of intelligence, and predict the child's crystallized intelligence more on the basis of the adoptive parents, showing a less essentialist view of when given the crystallized definition of intelligence.

Method

Participants. Participants were recruited from MTurk. Participants with non-U.S. IP addresses were excluded from data analysis ($N = 47$). The resulting sample size was 213. Participants' average age was 34.23 ($SD = 10.39$), 40.4% were female and 59.6% were male. Based on self-reported race, the sample was 79.3% White, 9.4% Asian, 7.5% Black, and 3.8% other. 17.4% reported holding a high school diploma or lower, 33.3% reported having received some college education, 35.2% reported holding a bachelor's degree, 14.1% reported holding a master's degree or higher. Participants who completed the questionnaire received $1.50 for participation.

Procedure. The questionnaire first provided definitions of fluid and crystallized intelligence, with examples (as in Study 1). Then, we presented a series of switched-at-birth scenarios. In each scenario, participants were told that a baby was born to biological parents with a certain level of intelligence (e.g., high crystallized intelligence), and that after they were born, they were adopted by a couple the opposite level of that intelligence (i.e., low crystallized intelligence). After each scenario, participants were asked to predict the baby's intelligence when they grew to be 10 years old, using a five-point Likert scale that ranged from 1 (*very low*) to 5 (*very high*). Ratings more similar to the biological parents indicated that participants viewed the target trait (e.g., fluid or crystallized intelligence) as more inheritable. In contrast, ratings more similar to the adoptive parents indicated that the participants viewed the trait as more influenced by life experiences or rearing practices.

Because there were two definitions of intelligence, there were four possible combinations (see Table 1 for parent-intelligence combinations). For example, crystallized (adopt high) described "Baby Z" as having adoptive parents with high crystallized intelligence but biological parents with low crystallized intelligence, whereas crystallized (bio high) described "Baby W" as having biological parents with high crystallized intelligence but adoptive parents with low crystallized intelligence. Participants were shown all four questions in a randomized order.

Table 1
Study 2: Parent Combinations of the Four Switched-at-Birth Items

Parent combination	Item
CI (adopt high)	Baby Z has adoptive parents with high CI but biological parents with low CI.
CI (bio high)	Baby W has biological parents with high CI but adoptive parents with low CI.
FI (adopt high)	Baby Y has adoptive parents with high FI but biological parents with low FI.
FI (bio high)	Baby V has biological parents with high FI but adoptive parents with low FI.

Note. Crucial differences between conditions are underlined. CI = crystallized intelligence; FI = fluid intelligence.

Results and Discussion

Effects of parents' intelligence on ratings of children's intelligence. We were interested in how different definitions of intelligence (fluid, crystallized) and biological–adoptive parent intelligence combinations would interact in participants' ratings about children's intelligence. A two-way repeated-measures ANOVA was conducted with definitions of intelligence and parent combination (see Table 1) as two within-subject factors (see Figure 3). The main effect of definition was not significant, $F(1, 212) = 0.22$, $p > .05$, $\eta^2 < .01$, but the main effect of parent combination was significant, $F(1, 212) = 4.02$, $p < .05$, $\eta^2 = .02$. Most importantly, the interaction was also significant, indicating that participants' ratings varied based on both the parent-combination and the definition at hand, $F(1, 212) = 60.48$, $p < .001$, $\eta^2 = .24$. Using a series of *t* tests, we then decomposed this interaction. We considered a *p* value significant at .0083 after a Bonferroni correction (.05/6).

Crystallized intelligence ratings. For crystallized intelligence, participants gave the child higher intelligence ratings for crystallized (adopt high), or when the adoptive parents were described as having high intelligence ($M = 3.55$, $SD = .88$), than for crystallized (bio high), or when the biological parents were described as having high intelligence ($M = 2.85$, $SD = .87$; $p < .001$, $d = .82$). One-sample *t* tests comparing participants' ratings with the midpoint of three, revealed a similar pattern of results. Participants' ratings of the child's intelligence were above the midpoint for crystallized (adopt high), or when the adoptive parents were described as having high crystallized intelligence ($p < .001$, $d = .63$), but below the midpoint for crystallized (adopt high), or when the biological parents were described as having high crystallized intelligence ($p = .01$, $d = -.17$). Overall, participants predicted that a child's crystallized intelligence would be more similar to that of the adoptive than the biological parents. This indicates that participants viewed crystallized intelligence as more based in experience.

Fluid intelligence ratings. For fluid intelligence, the reverse pattern of findings was found. Participants gave the child higher intelligence ratings for fluid (bio high), or when the biological parents were described as having high intelligence ($M = 3.39$, $SD = .89$), than for fluid (adoptive high), or when the adoptive parents were described as having high intelligence ($M = 3.03$, $SD = .91$, $p = .004$, $d = .39$). Again, one-sample *t* tests comparing participants' ratings with the midpoint of three, revealed a similar pattern of results. Participants' ratings of the child's fluid intelligence were above the midpoint for fluid (bio high), or when the biological parents were described as having high fluid intelligence ($p < .001$, $d = .44$), yet not significantly different from the midpoint for fluid (adoptive high), or when the adoptive parents were described as having high fluid intelligence ($p = .65$, $d = .03$). Thus, participants predicted that a child's fluid intelligence would be more similar to that of the biological than the adoptive parents. This indicates that participants viewed fluid intelligence as a relatively innate, inheritable characteristic.

Fluid versus crystallized ratings. We also directly compared participants' ratings between the two definitions of intelligence on matched parent pairs. First, we compared ratings of fluid and crystallized intelligence when the child's adoptive parents were described as having high intelligence (i.e., Fluid [adopt high] vs. crystallized [adopt high]). We found that participants rated children's crystallized intelligence as higher than their fluid intelligence ($p < .001$, $d = .50$). Next, we compared ratings of intelligence when the child's biological parents were described as having

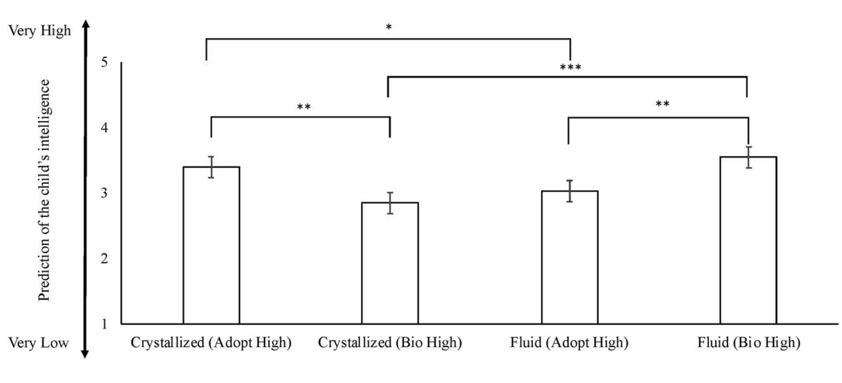

Figure 3. Means and pairwise comparisons of switched-at-birth items. * $p < .05$. ** $p < .01$. *** $p < .001$.

high intelligence (i.e., fluid [bio high] vs. crystallized [bio high]). In contrast to the result reported in the preceding text, we found that participants rated children's fluid intelligence as higher than their crystallized intelligence ($p < .001$, $d = .49$). In the online supplemental material, we also provide intercorrelations between participants' ratings of all items. These results suggest that participants held a more essentialist view when intelligence was defined in a fluid rather than in a crystallized way.

Study 3

In Studies 1 and 2, participants considered crystallized intelligence to be more malleable and less inheritable than fluid intelligence. The primary goal of Study 3 was to investigate the broader consequences of defining intelligence in mindset measures. To address this question, we considered one important potential consequence of intelligence mindsets: beliefs in the importance of effort versus ability in academic achievement.

We chose this effort–ability attribution measure because individuals who believe that intelligence is malleable are more likely to attribute poor performance to lack of effort (rather than lack of ability) when they face negative feedback (Hong et al., 1999). Some recent research has found that success in some fields, such as mathematics and economics, is considered more associated with "brilliance" or "raw intellectual talent" (i.e., fluid intelligence) than it is other fields (Leslie et al., 2015; Meyer et al., 2015). These studies focus on relatively high levels of achievement (e.g., successful faculty). In contrast, we are not aware of studies examining the relation of everyday levels of achievement (such as school performance) with crystallized or fluid intelligence. We predict that beliefs in less advanced level of mathematics achievements would be more related to participants' mindsets when intelligence is defined in a crystallized manner.

In addition, the current study provided an opportunity to test whether (1) the results of Studies 1 and 2 replicate and (2) the mindset measures using the more specific definitions of intelligence demonstrated good validity. These hypotheses were documented in the preregistration (see the online supplemental material).

Method

Participants. Participants ($N = 300$) were recruited from MTurk. Only participants in the United States (with U.S. IP addresses) were included. Participants who failed to pass the attention check items were excluded ($N = 26$). Thus, Study 3 had a final sample size of 274. Participants' average age was 40.52 ($SD = 11.11$), 46.7% were female, and 53.3% were male. Based on self-reported race, the sample was 78.5% White, 8% Asian, 9.5% Black, and 4% other. Of the participants, 12.4% reported holding a high school diploma or lower, 38% reported having received some college education, 38.3% reported holding a bachelor's degree, 11.3% reported holding a master's degree or higher. Participants who completed the questionnaire received $2 for participation.

Measures.

Effort-ability attribution. We asked four questions regarding the relative importance of effort versus ability on less and more advanced mathematics achievements. The less advanced achievements were "achieving an A in a middle-school level algebra course" and "learning multiplication tables, fraction, and percentage operations"; more advanced achievements were "becoming a mathematics professor" and "winning the Fields Medal" (equivalent to a Nobel Prize in Mathematics). Participants were asked to respond on a seven-point scale to what they attribute this achievement (1 = *pure ability*, 4 = [effort and ability are] *equally important*, and 7 = *pure effort*). There were two less advanced and two more advanced items.

Education as a right. As preregistered, we also included a brief survey about whether participants view education as a basic right (Savani, Rattan, & Dweck, 2017, Study 1). This measure was for exploratory purposes and therefore is discussed in the online supplemental material.

Procedure. Participants were asked to complete a Qualtrics questionnaire. The questionnaire consisted of five parts. The Parts 1 and 2 were the questions from Studies 1 and 2 where participants were given definitions and examples of fluid and crystallized intelligence and then asked to respond on the modified Implicit Theories of Intelligence Questionnaire and switched-at-birth questions. Part 3 asked participants their beliefs about the relative importance of effort and ability on specific mathematics achievements. Part 4 included the education as a right scale as well as the political orientation question. Part 5 collected demographic information including age, gender, race, educational level, and occupation. Questions within each scale were presented in a randomized order.

Data analysis. The preregistration documented the hypotheses and the data analysis plan corresponding to each hypothesis (see the online supplemental material). Our first goal was to test whether our initial findings were replicable. Therefore, we performed the same analyses that were conducted for Studies 1 and 2. Second, we tested the measure validity via (1) correlational analysis between mindset and psychological essentialism of intelligence and (2) confirmatory factor analysis of the three mindset scales to confirm the three-factor structure separating the three definitions of intelligence. Third, to compare beliefs about mathematics achievements across the mindset measures, a repeated-measures ANOVA was conducted. Overall, we predicted that people would assume that ability plays a greater role in more advanced mathematics achievement, and effort in less advanced ones. Next, we predicted that theories of fluid intelligence would be relevant to more advanced achievements, and that theories of crystallized intelligence would be relevant to less advanced ones. Statistical models were built to compare the coefficients of different theories of intelligence.

Results and Discussion

Table 2 provides a comparison of descriptive statistics for the Implicit Theories of Intelligence Questionnaire; the Switched-at-Birth subscales of Studies 1, 2, and 3; and the effort–ability attribution measure.

Did we replicate the results from Studies 1 and 2? As in Study 1, for the Implicit Theories of Intelligence Questionnaire, we conducted a repeated measures ANOVA with the definition of intelligence as a within-subject variable (fluid, crystallized, and general intelligence). The main effect for definition of intelligence was significant, $F(2, 546) = 171.91$, $p < .001$, $\eta^2 = .39$. We

Table 2

Studies 1, 2, and 3: Descriptive Statistics for the Implicit Theories of Intelligence Questionnaire (ITIQ), the Switched-at-Birth (SWAB) Subscales, and the Effort–Ability Attribution (EAA) Measure

		Study 1		Study 2		Study 3	
Survey	Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*
ITIQ	General intelligence	3.94	1.19			3.66	1.45
	CI	4.41	1.12			4.75	1.07
	FI	3.63	1.17			3.50	1.39
SWAB	CI (adopt high)			3.55	0.88	3.64	0.71
	CI (bio high)			2.85	0.87	2.67	0.83
	FI (adopt high)			3.03	0.91	3.04	0.93
	FI (bio high)			3.39	0.89	3.23	0.86
EAA	Less advanced math achievements					4.73	1.20
	More advanced math achievements					3.88	1.46

Note. For the ITIQ, higher scores indicate a more growth mindset. For the SWAB, higher scores indicate a higher estimation of the child's intelligence. CI = crystallized intelligence; FI = fluid intelligence.

considered a p value significant at .017 after a Bonferroni correction (.05/3). The results showed that crystallized intelligence differed from both fluid and general intelligence, but that fluid and general intelligence did not differ from one another. Specifically, the mean difference between general and fluid intelligence was .16 ($p > .05$, $d = .11$), between general and crystallized intelligence was -1.09 ($p < .001$, $d = .84$), and between fluid and crystallized intelligence was -1.25 ($p < .001$, $d = 1.01$). These results replicated the Study 1 result that participants viewed intelligence as more fixed (and less malleable) when intelligence was conceptualized in terms of fluid abilities as opposed to crystallized ones.

As in Study 2, for switched-at-birth questions, we conducted a two-way repeated-measures ANOVA with definition of intelligence and parent combination (see Table 1) as two repeated-measures factors. The main effect of definition of intelligence was again not significant, $F(1, 273) = 0.33$, $p > .05$, $\eta^2 < .01$, whereas that of parent combination was significant, $F(1, 273) = 36.23$, $p < .001$, $\eta^2 = .12$. The interaction analysis yielded comparable results to those of Study 2: $F(1, 273) = 98.75$, $p < .001$, $\eta^2 = .27$. Post hoc analysis (Bonferroni corrected at .0083) replicated three of the four significant comparisons. For crystallized intelligence, participants gave the child higher intelligence ratings for crystallized (adopt high), or when the adoptive parents were described as having high intelligence ($M = 3.64$, $SD = .71$), than for crystallized (bio high), or when the biological parents were described as having high intelligence ($M = 2.67$, $SD = .83$, $p < .001$, $d = 1.15$). For fluid intelligence, however, there was no statistical significance between ratings of the child when the adoptive parents were described as having high intelligence (fluid [adopt high] $M = 3.04$, $SD = .93$), and when the biological parents were described as having high intelligence (fluid [bio high] $M = 3.23$, $SD = .86$, $p = .04$, $d = .21$).

The results also held when we compared ratings of fluid and crystallized intelligence of matched parent pairs. When the child's adoptive parents were described as having high intelligence (i.e., crystallized [adopt high] and fluid [adoptive high]), participants rated the child's crystallized intelligence as higher than their fluid intelligence ($p < .001$, $d = .55$). When the child's biological parents were described as having high intelligence (i.e., crystallized [bio high] and fluid [bio high]), participants rated the child's fluid intelligence as higher than their crystallized intelligence ($p < .001$, $d = .51$). Taking together, the results revealed that participants were more essentialist when considering a fluid definition of intelligence than when considering a crystallized one.

Do the mindset scales with fluid and crystallized intelligence definitions demonstrate good psychometrics properties?

Reliability. Consistent with Study 1, the three Implicit Theories of Intelligence Questionnaires all demonstrated very high reliability. Specifically, for the general intelligence questionnaire, Cronbach's $\alpha = .98$; for the fluid intelligence questionnaire, $\alpha = .98$; and for the crystallized intelligence questionnaire, $\alpha = .96$.

Convergent validity. Intercorrelations of the Implicit Theories of Intelligence Questionnaires and Switched-at-Birth subscales were calculated (see Table 3). Across scales, crystallized and fluid intelligence showed moderate to high correlations (absolute r values ranging from .29 to .58), whereas across intelligence definitions, the correlations were either low or nonsignificant (absolute r values ranging from .00 to .15). These results demonstrated adequate convergent validity between mindset and psychological essentialism of intelligence within the same definition of intelligence.

Factor structure. Because the three mindset scales demonstrated moderate to high correlations (especially between mindsets

Table 3

Study 3: Intercorrelations Between the Implicit Theories of Intelligence Questionnaire (ITIQ) and the Switched-at-Birth (SWAB) Subscales

Measure	1	2	3	4	5
1. ITIQ-CI	—				
2. ITIQ-FI	.40**	—			
3. CI (adopt high)	.36**	.09	—		
4. CI (bio high)	−.29**	.00	−.41**	—	
5. FI (adopt high)	.09	.58**	.15*	.03	—
6. FI (bio high)	−.06	−.40**	−.04	.14*	−.51**

Note. CI = crystallized intelligence; FI = fluid intelligence.
* $p < .05$. ** $p < .01$.

of general and fluid intelligence), it is possible that these three scales are tapping into a singular underlying construct. As such, next we tested whether the three scales fit into a clear three-factor structure. Accordingly, we conducted a confirmatory factor analysis to see if the items loaded onto our predicted three latent factors. We also tested the possibilities of either a one-factor structure (i.e., all items loading into one factor) or a two-factor structure (e.g., fluid and general intelligence items loading onto one factor and crystallized intelligence items loading onto a second factor). A wide range of goodness of fit indices suggested that the three-factor model yielded a good fit, $\chi^2(249) = 1121.1$, comparative fit index = 0.92, Tucker–Lewis index = 0.91, root mean square error of approximation = 0.11, standardized root mean square residual = 0.03, Akaike information criterion = 13,316.34, Bayesian information criterion = 13,500.61. The two-factor and one-factor models both fit poorly with respect to their fit indices (see Table 4 for goodness of fit indices of all three models). Chi-square tests showed that the three-factor structure fit significantly better than either the two-factor, $\chi^2_{\text{diff}}(2) = 1693.9$, $p < .001$, or one-factor structures, $\chi^2_{\text{diff}}(3) = 3617.9$, $p < .001$ (see Table 5 for comparisons among the three models).

How are crystallized and fluid mindsets associated with attributions of effort across different levels of mathematics achievements? We hypothesized that participants would attribute relatively more effort (than ability) when reasoning about achievement at "less advanced" levels (e.g., middle school mathematics grade), but relatively more ability (than effort) when reasoning about achievement at "more advanced" levels (e.g., becoming a mathematics professor). To test this prediction, we conducted a one-way repeated-measures ANOVA among the four items of less and more advanced mathematics achievements. There was a significant main effect of achievement difficulty, $F(3, 1088) = 9.39$, $p < .001$, $\eta^2 = .03$. Post hoc analysis with a Bonferroni correction (corrected at .0083) showed significantly more attributions of effort for the two less advanced achievements—they were both rated significantly higher than the more advanced achievements (all $p < .001$).

We next ran two sets of multiple regression analyses. The first included mindsets of fluid and crystallized intelligence as predictors and the dependent variable of effort–ability attribution of less advanced mathematics achievements. The second included mindsets of fluid and crystallized intelligence as predictors and the dependent variable of effort–ability attribution of more advanced mathematics achievements. These analyses tested the role of crystallized and fluid intelligence in predicting participants of attributions.

As part of our regressions, we included dominance analyses (DA; Azen & Budescu, 2003; Budescu, 1993) to assess whether mindset beliefs, measured with crystallized or fluid definitions, were more strongly associated with certain mathematics achievements than the others. This approach considers the additional explained variance of a predictor with respect to all possible subset models to compare the relative importance of regression coefficients within a multiple regression model. It has been applied to various empirical studies to compare the regression coefficients (for applications, see Behson, 2005; Davenport, Bergman, Bergman, & Fearrington, 2014). According to Davenport et al. (2014), DA yields two indicators: first, an overall dominance weight, which is the amount of variance of each predictor; and second, the relative importance score, which is the ratio of variance explained by each predictor and sums to 100%.

Table 6 summarizes the results for the two levels of achievement. For less advanced mathematics achievement, malleability beliefs measured using crystallized intelligence definitions were positively associated with effort attributions ($B = .28$, 95% CI [.14, .43], $SE = .07$), $t(271) = 3.99$, $p < .001$, $R^2 = .07$, explaining 82.2% of the total explained variance among the two predictors. It was also the only significant predictor ($p < .001$) and dominated the influence of malleability beliefs about fluid intelligence. For more advanced mathematics achievement, malleability beliefs measuring using fluid intelligence were positively associated with effort attributions ($B = .44$, 95% CI [.31, .57], $SE = .06$), $t(271) = 6.91$, $p < .001$, $R^2 = .15$, accounting for 95.6% of total explained variance among the two predictors. It was also the only significant predictor ($p < .001$) and dominated the influence of malleability beliefs about crystallized intelligence. We also present regression results with three mindsets (including mindsets of general intelligence) as predictors in the supplement, which yielded similar results. Together, the results indicate that mindsets measured using fluid and crystallized intelligence definitions uniquely and differentially predicted effort-attribution in academic achievements of different levels. At both levels of achievement, a growth mindset was associated with attaching more important to effort than ability, but for different definitions of intelligence.

Next, we further examined this pattern of results using a series of ANOVAs that tested the fit of different regression models. For less advanced mathematical achievements, we found that a regression model only containing crystallized intelligence did not significantly differ from a regression model containing both fluid and crystallized intelligence, $F(1, 271) = .86$, $p = 36$. But, in contrast, a model containing only fluid intelligence did significantly differ from a model containing both fluid and crystallized intelligence,

Table 4
Goodness of Fit Indices for Confirmatory Factor Analysis Models of the Implicit Theories of Intelligence Questionnaire (ITIQ)

Model	χ^2	*df*	CFI	TLI	RMSEA	SRMR	AIC	BIC
Three-factor	1121.11**	249	.92	.91	.11	.03	13316.34	13500.61
Two-factor	2815.00**	251	.76	.74	.19	.07	15006.22	15183.26
One-factor	4739.02**	252	.58	.54	.26	.18	16928.24	17101.67

Note. The three-factor model loaded items of general, fluid, and crystallized intelligence onto the three factors as hypothesized; the two-factor model combined items of general and fluid intelligence onto one factor and crystallized intelligence as a second factor; the one-factor model assumed all items loading onto one factor. CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; AIC = Akaike information criterion; BIC = Bayesian information criterion.
** $p < .01$.

Table 5
Comparative Fit of Confirmatory Factor Analysis Models

Model comparison	$\Delta\chi^2$	Δdf	p	AIC difference	BIC difference
Three-factor[a] vs. two-factor	1693.9	2	<.001	1689.89	1682.66
Three-factor[a] vs. one-factor	3617.9	3	<.001	3611.91	3601.07

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion.
[a] Indicates the model with a better fit.

$F(1, 271) = 15.93$, $p < .001$. The same series of analyses was conducted for more advanced mathematical achievements, but the reverse pattern was found. Here, we found that a regression model only containing fluid intelligence did not significantly differ from a regression model containing both fluid and crystallized intelligence, $F(1, 271) = 1.09$, $p = .30$. But, in contrast, a model containing crystallized intelligence did significantly differ from a model containing both fluid and crystallized intelligence, $F(1, 271) = 47.75$, $p < .001$.

Together, these findings suggest that, for effort attribution of less advanced mathematics achievements, mindsets of fluid intelligence do not add unique contributions beyond mindsets of crystallized intelligence, but in contrast, for effort attribution of more advanced mathematics achievements, mindsets of crystallized intelligence do not add unique contributions beyond mindsets of fluid intelligence. This pattern provides additional evidence that crystallized intelligence mindsets are a vital component of understanding beliefs about less advanced mathematical achievements, and in contrast that fluid intelligence mindsets are a vital component of understanding beliefs about more advanced mathematical achievements.

General Discussion

The present research examines an understudied issue regarding lay mindset beliefs about intelligence, namely: How do different definitions of intelligence influence the extent to which people display a fixed versus growth mindset? Further, do these mindsets have consequences for reasoning about academic achievement? Overall, we found that people embraced markedly different views of crystallized and fluid intelligence, and these views were differentially related to beliefs about mathematics achievements (i.e., less advanced vs. more advanced mathematics achievements).

Study 1 showed that when given specific definitions of intelligence, individuals reasoned about intelligence in different ways. Namely, people held different mindsets for crystallized versus fluid intelligence. Participants regarded crystallized intelligence as most malleable, followed by general intelligence, then followed by fluid intelligence. These findings demonstrate that it is important to consider variation in how individuals conceptualize intelligence when asking about mindsets. Future research can expand on whether individual differences in mindset beliefs are at least in part due to differences in conceptions of intelligence, by explicitly asking participants to define intelligence.

Study 2 showed that people's view about inheritance of intelligence is associated with how intelligence is defined. Participants believed that adoptive parents (i.e., experience) would have a greater influence on a child's crystallized intelligence, but that biological parents (i.e., biological inheritance) would have a greater influence on a child's fluid intelligence. As such, Study 2 served as an extension and conceptual replication of Study 1. These findings have implications for research on essentialist views of intelligence. First, here again, our study showed that participants held different essentialist views when intelligence was defined in different ways, thus extending beyond prior research, which exclusively focused on undifferentiated, general intelligence (Dar-Nimrod & Heine, 2011; Gelman et al., 2007; Jayaratne et al., 2009). Second, bridging mindset beliefs and essentialism provides further insights on the nature of mindsets. As Haslam, Bastian, Bain, & Kashima (2006) suggested, mindset beliefs directly tap into the immutability aspect of essentialism and covary with other aspects of essentialism such as inheritability. Our study demonstrated that fluid intelligence was viewed as not just more fixed, but also as more innate and determined at birth. Crystallized intelligence, in contrast, was viewed not only as more changeable, but also as more influenced by experience. It may be interesting for future work to examine how differences in beliefs about the perceived innateness of different definitions of intelligence

Table 6
Study 3: Regression and Dominance Analysis on Academic Contexts

Academic context	β	p	Dominance weight (Unique R^2)	Relative importance score (Percentage R^2)	Total R^2
Less advanced mathematics achievements					.08
Mindset of crystallized intelligence	.28	<.001	.07	82.2%	
Mindset of fluid intelligence	.05	.355	.01	17.7%	
More advanced mathematics achievements					.16
Mindset of crystallized intelligence	−.09	.297	.01	4.4%	
Mindset of fluid intelligence	.44	<.001	.15	95.6%	

Note. Dominance weight = the R^2 value explained by the predictor, summing to the total R^2; Relative importance score = the percentage of the R^2 value taken by the predictor.

might be linked to beliefs in other educational constructs, such as the attainability of related academic careers paths.

The preregistered Study 3 showed that crystallized and fluid mindsets have important and distinct consequences. First, results of Study 3 replicated our findings in Studies 1 and 2, that the beliefs individuals hold about the malleability of intelligence changed depending on the definition (i.e., in fluid or crystallized ways), with our mindset measures demonstrating strong psychometric properties. Second, and importantly, beliefs about the malleability of crystallized and fluid intelligence played vital roles in effort–ability attributions for different levels of mathematics achievement. In particular, participants' mindsets of crystallized but not fluid intelligence were related to the importance of effort in less advanced level mathematics. For example, individuals holding a growth mindset for crystallized intelligence were more likely to attribute earning an A in a middle school mathematics class to effort. In contrast, mindsets of fluid but not crystallized intelligence were related to the importance of effort for advanced level mathematics. For example, individuals holding a growth mindset in fluid intelligence were more likely to attribute obtaining a Fields Medal to effort.

There remains debate as to how well participants' beliefs about crystallized versus fluid intelligence map onto the scientific literature. On the one hand, in our data, lay beliefs about the malleability of crystallized and fluid intelligence were consistent with some intelligence research, that fluid abilities are more fixed and innate than many aspects of crystallized abilities (Cattell, 1963; Duncan, 2010; Nicholls et al., 1986; Rindermann, Flores-Mendoza, & Mansur-Alves, 2010). Historically, experts have viewed fluid intelligence as less influenced by life experience and more biologically based than crystallized intelligence. For example, when the concept of fluid intelligence was initially proposed, it was described as mostly relying on biological factors (Cattell, 1987/1971). On the other hand, the extent to which fluid intelligence can be increased through effort and is biologically based remains hotly debated (see Davies et al., 2011; Harrison et al., 2013; Katz, Shah, & Meyer, 2018; Melby-Lervåg & Hulme, 2013; Redick, 2019; Rindermann et al., 2010; Sternberg, 1999). Crystallized intelligence, because of its knowledge-based nature, has long been considered dependent mostly on experiential factors (e.g., education) and less biologically based (Cattell, 1987/1971). However, interestingly, some recent research finds that crystallized intelligence may actually be less influenced by experience than fluid intelligence (Loughnan et al., 2019).

These results have potential implications for stereotypical beliefs in education, such as those of women in STEM careers (for related work, see Leslie et al., 2015; Meyer et al., 2015). For example, as noted above, we found that people attached beliefs about crystallized intelligence to school-level mathematics, but beliefs about fluid intelligence to career-level mathematics. Given that women are often stereotyped as possessing a "lack of raw abilities" (Leslie et al., 2015), this might help to explain the leaky pipeline phenomenon that female students maintain comparable enrollments and achievements in STEM subjects at school early on, but only a small number of them actually pursue mathematics-related careers (Blickenstaff, 2005). It will be important for future work to directly explore how individual differences in conceptualization of math achievements might affect attitudes toward, and/or enrollment in, mathematics-related fields as people step into more advanced levels of schooling and/or careers.

Our results suggest that how people conceptualize intelligence relates to their beliefs about the malleability of intelligence, as well as the extent to which these beliefs link to beliefs about other outcomes. The present findings further suggest that individual differences in how people evaluate intelligence may be at least partly due to individual differences in how they define intelligence. Researchers have debated the relation between mindset and academic outcomes such as motivation and achievements (e.g., Li & Bates, 2019; Yeager et al., 2019). Our results might help account for some of the variable results in this research domain. This could be further explored by assessing how participants conceptualize intelligence, when examining relations between mindset and academic outcomes.

The present studies also have limitations. First, in Study 3, the associations between mindsets and the other variables were quite modest (R^2 all below .20), suggesting that mindsets may have only limited effects on people's reasoning about academic outcomes. However, it is also worth noting that these findings showed similar effect sizes as obtained in other mindset research (Moreau, Macnamara, & Hambrick, 2019; Sisk et al., 2018). Furthermore, although the total amount of variance explained was small, there were large differences between beliefs about the attainability of different levels of mathematics achievements and beliefs about fluid and crystallized intelligence (see Study 3, dominance analysis).

A second limitation of the present research is that we defined intelligence for participants, and thus did not explore the potential richness and variation in lay theories. Furthermore, our definitions of crystallized and fluid intelligence were simplifications based on lay descriptions of the scientific constructs. Crystallized intelligence includes both knowledge and facts and the ability to acquire and apply them; it would be valuable to see if our findings hold when these aspects of crystallized intelligence (e.g., acquisition) are more explicitly highlighted. Although we told participants that crystallized intelligence includes the knowledge and skills that people have, we do not know if they considered individual differences in acquisition in their judgments.

In sum, the present studies found that mindset beliefs differed for fluid versus crystallized intelligence and had differential predictions for other belief outcomes. Future steps could go beyond these preset definitions and explore how wider definitions might shed light on how individuals reason about intelligence malleability. It would also be meaningful to manipulate intelligence definitions in a richer way and see if/how this affects individuals' mindsets. We look forward to future research examining these questions.

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Received July 23, 2019
Revision received July 6, 2020
Accepted August 9, 2020 ■