Does mindset affect children's ability, school achievement, or response to challenge? Three failures to replicate.

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Abstract

Mindset theory states that children's ability and school grades depend heavily on whether they believe basic ability is malleable and that praise for intelligence dramatically lowers cognitive performance. Here we test these predictions in 3 studies totalling 624 individually-tested 10-12-year-olds. Praise for intelligence failed to harm cognitive performance and children's mindsets had no relationship to their IQ or school grades. Finally, believing ability to be malleable was not linked to improvement of grades across the year. We find no support for the idea that fixed beliefs about basic ability are harmful, or that implicit theories of intelligence play any significant role in development of cognitive ability, response to challenge, or educational attainment.

Introduction

Mindset theories of cognitive ability and educational attainment suggest that beliefs about whether basic ability is fixed or greatly changeable exert powerful causal influences on intelligence, educational attainment, and recovery from set-backs (Blackwell, Trzesniewski, & Dweck, 2007; Dweck & Molden, 2000; Gunderson et al., 2013; Paunesku et al., 2015). While widely adopted in education (Yettick, Lloyd, Harwin, Riemer, & Swanson, 2016), to our knowledge, these claims have not been subject to independent replication. Here, we report three large (total n = 624) studies testing the prediction that "*Praise for intelligence can undermine children's motivation and performance*" (Mueller & Dweck, 1998, p. 33) and (in studies 2 & 3) that children's own fixed- or growth-mindset relates to their cognitive ability and school grades (Blackwell et al., 2007; Dweck, 2006).

An entity (or "fixed", "limited", or "performance") mindset is the belief that basic ability cannot be significantly altered. By contrast an incremental (aka "growth", "non-limited", or "learning") mindset entails a belief that even basic ability can be changed substantially (Henderson & Dweck, 1990). These beliefs are posited to cause widely divergent learning paths, accounting for large observed differences in cognitive ability (Mueller & Dweck, 1998) and school attainment (Blackwell et al., 2007).

Endogenous mindset is readily and rapidly measured, for instance using 8 or fewer items such item as "*You can change even your basic intelligence level considerably*" (Dweck, 1999). Well-documented laboratory manipulations have been created: contrasting praise for hard work versus for being smart (Mueller & Dweck, 1998). Two papers using these tools proved particularly influential. The first reported "*Implicit theories of intelligence predict achievement*"

(Blackwell et al., 2007, p. 246), finding that, controlling for entry scores, mindset predicted final mathematics grades (β =0.17, t(372) = 3.40, p < .001). Mindset was unrelated to baseline grades.

A second influential paper reported a laboratory manipulation, praising children either for hard work or for ability (Mueller & Dweck, 1998). In this report, following challenging negative feedback, children in the growth and fixed conditions differed in cognitive performance by ~1.3 SD (~ 20 points in IQ terms). Much more modest results have emerged from larger studies of longer-lasting interventions. For instance, Paunesku et al. (2015) found that a mindset intervention failed to significantly raise grades, and found only a marginally significant impact after excluding students performing adequately and merging the mindset intervention with a "sense-of-purpose" intervention. Unlike Blackwell et al. (2007), these authors found a significant (small) association of growth mindset with pre-study GPA (β = 0.06, CI95= [0.03, 0.09], t(1561) = 3.47, p < .001).

The size of the reported associations makes testing the theory with high power relatively easy. However, despite these findings being reported over a decade ago and being cited over 2,000 times each, to our knowledge no independent replications have been published. We therefore conducted three studies testing whether mindset impacts cognitive ability and school grades in the predicted fashion. We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the studies.

Study 1 tested replicability of the reported effect of praise-for-ability and praise-for-effort on cognitive ability scores after a challenging set-back. Studies 2 and 3 added an active-control condition, and tested if children's mindset predict their grades, ability, and response to negative feedback. Our resources allowed us to test 1 complete class of children (n~200) per study, and to conduct these three studies. These gave us ~85% power to detect d=.3 size effects in each study, which we deemed the lower limit compatible with the theoretical mechanisms proposed by mindset which imply a tight dependence of performance and of grades on implicit theories.

Study 1

We first wished to replicate the large difference in ability scores induced by a brief praise intervention, shown in each of five small to moderately-sized studies (Ns = 128, 51, 88, 51, 46, 48) reported by Mueller and Dweck (1998). In their study 1, children completed three sets of 10 Standard Progressive Matrices (SPM: Raven, Raven, & Court, 2000) problems. On the first (easy) set, children were told they got at least 80% correct and received either praise for hard work, being smart, or control praise. This was followed by a challenging set on which they were told they did "*a lot worse*", getting no more than 50% correct. On a subsequent post-challenge block of relatively easy items, children in the growth and fixed conditions differed by ~1.3 SD. The intervention was reported to affect children of all ability levels.

In study one, we closely replicated Mueller and Dweck (1998). To maximise power for the critical difference in performance between children praised for intelligence versus hard work, we omitted the uninformative control condition, allocating all subjects to the treatments.

Method

Participants. A total of 190 children participated (all children in grade: 89 Male (mean age 10.56 years, SD = 0.51) and 101 Female (mean age 10.41 years, SD = 0.50). All subjects were recruited from one of the largest primary schools in Harbin (capital city of Heilongjiang Province, China). Schools are public and draw from a catchment area 21% below the Chinese national average income (average income 48,881 Yuan: National Bureau of Statistics of the People's

Republic of China, 2017), equating to USD 7,133 or ~$14,000 purchasing-power equivalent. Compensation for participation consisted of a reward of sweets at the end of the study.

Materials. Individual IQ was assessed by using items from sets B, C, and E of the SPM (Raven et al., 2000). Following Mueller and Dweck (1998), the praise IQ test consisted of the first 10 items from set B (easy). The challenging test consisted of the first 10 puzzles from set E (challenging). The post-challenge measure consisted of the first 10-items (moderate) from set C.

Learning and motivation were assessed using the learning and motivation questionnaire (Mueller & Dweck, 1998). Preference for learning or performance goals was assessed by an item asking participant's which of four options they would prefer: A: "*problems that aren't too hard, so I don't get many wrong*", B: "*problems that are pretty easy, so I'll do well*", C: "*problems that I'm pretty good at, so I can show that I'm smart*" and D: "*problems that I'll learn a lot from, even if I won't look so smart*" (Mueller & Dweck, 1998), with D scored as a learning goal, and responses A, B, or C as performance goal preference. Task-persistence, task-enjoyment, and self-rated performance were assessed via a 4-item measure described in Mueller and Dweck (1998). Items were "*How much would you like to take these problems back home to work on*?", "*How much did you like working on the first/second set of problems*?", "*How much fun were the problems*?" and "*How well did you do on the problems overall*?". Participants responded on a scale from 1 (not at all) to 6 (very much).

Attributional style for performance after negative feedback was assessed as in Mueller and Dweck (1998). Four slotted disks of colored paper were pinned together so they could rotate, exposing various amounts of each disk viewed from the front. The disks each had printed on them one of four attributions: "*I didn't work hard enough.*", "*I'm not good enough at the problems*", "*I'm not smart enough.*", or "*I didn't have enough time*.", corresponding to attributions of lack of effort, lack of skill, lack of intelligence, and lack of time respectively. Participants were asked to rotate the disks to show how much each factor accounted for their failure. In addition, subjects were asked to weight the importance of ability and effort when solving the puzzles using a circle with marks from 1-36 around its circumference which they connected to divide the circle into two parts ("smart" and "effort"), and coloring-in the smart proportion. Whenever items were translated from English text into Chinese, the experimenter made an initial translation, which was then back translated by 5 bilingual (Chinese and English) speakers, checked and edited where necessary to ensure an accurate translation.

Procedure

After informed consent was gained from the headmaster, teachers, parents, and participants themselves, participants were asked to fill in their demographic information form including name, gender, date of birth, and class. Participants were tested individually in a private room near his or her classroom. Testing began with a welcome, and an introduction to the testing procedures. Subjects were then given an example item from the Raven puzzles, and shown how to solve this puzzle, before beginning the experimental tasks. Participants were assigned to a mindset intervention condition in a sequential ABAB order (95 in each condition).

Children then completed the first test, answering as many items as they could in 4 minutes. The experimenter (YL) removed the items and scored them. All children received the same positive feedback "*Wow, you did very well on these problems. You got 7/8/9 right, That's a really high score*!". Subjects who correctly solved fewer than 5 items were told they got 7 items correct. Subjects solving 6–9 items correct were told they had got 8 items correct. Subjects who got all 10-items correct were told they got 9 items correct. Subjects randomized to the praise-for-intelligence condition were then told "*You must be smart at these problems!*" while children in the praise-for-effort condition were told "*You must have worked hard at these problems*!". Children then completed the learning goals questionnaire.

The challenge test was then given. After 4-minutes, the test was scored, and no matter what their performance, subjects were told "*Your performance was poor on that: You got less than half the puzzles correct*". Subjects were then asked to complete the task persistence and task enjoyment, overall self-rated performance quality, and failure attribution questionnaires, and the smart vs hard working attribution for their task performance. Finally, participants were asked to work on the post-challenge puzzles, again with a 4-minute time limit.

All participants were debriefed, and were told that the hard ability test on which they had received poor scores contained problems that were appropriate for older and higher-grade students. Therefore, in fact, students in their grade who solved even a single puzzle should be proud as they were especially hard working to have attempted and succeeded at these.

Results

All analyses were completed using R (R Core Team, 2016) and umx (Bates, 2014; Bates, Neale, & Maes, 2017). Standardized effect sizes are reported throughout. All data and analysis code are open-access and raw data and R analysis scripts used in all three studies are available in supplementary data at https://osf.io/uethh These files also produce descriptive data on the measures. Scores on the easiest test were highly skewed (median performance was 100%, skew = -2.41, kurtosis = 7.66). For this reason, scores on the more difficult second test were used to control for initial ability.

The hypothesis that participants praised for effort would achieve higher post-challenge scores compared to those in those praised for ability was tested in a regression model with post-challenge scores as the dependent variable, mindset condition as the independent variable and initial ability, sex, and age entered as covariates.

Contrary to prediction, mindset-condition was not significant by conventional standards ($\beta = -0.24$ [-0.48, 0.02], $t = -1.87$, $p = 0.064$: see Figure 1). By contrast, initial Raven scores were highly significant predictors of scores on Raven 3 ($\beta = 0.48$ [0.35, 0.61], $t = 7.44$, $p < 0.001$). No effect was found of sex or age and removing these covariates did not meaningfully alter results. While Mueller and Dweck (1998) found no interaction effect (i.e., the intervention was equally effective for all children) we also examined the interaction of condition with initial ability as recently this has been reported as a prediction from mindset theory (Paunesku et al., 2015). This interaction was not significant ($\beta = 0.01$ [-0.25, 0.27], $t = 0.07$, $p = 0.943$). Finally, in case initial ability acted as a suppressor, we repeated the analysis with initial ability removed. This, however, further reduced the significance of the effect of condition ($\beta = -0.24$ [-0.53, 0.05], $t = -1.64$, $p = 0.102$).

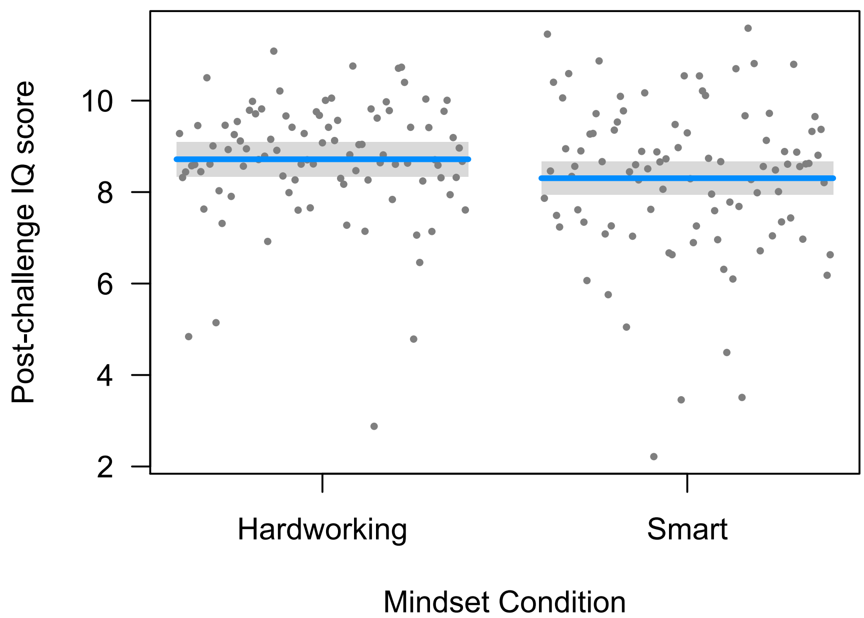

Figure 1 Study 1 post-feedback Raven scores in praise-for-intelligence and praise-for-effort conditions.

Our primary interest was the post-challenge hypothesis. However, we also examined the hypotheses that praise-for-effort would increase enjoyment solving the puzzles, persistence, and self-rated performance compared to praise for intelligence. This was done via regressions, with responses on these questions as the dependent variables, and mindset condition as the independent variable. Sex and age were entered as covariates. The predicted effects were not supported by the results. Condition was not associated with expression of a learning goal (β = -0.07 [-0.36, 0.22], t = -0.49, p = 0.626), wishing to take the problems home (β = 0.25 [-0.03, 0.54], t = 1.75, p = 0.082), finding working on the problems enjoyable (β = -0.08 [-0.37, 0.2], t = -0.58, p = 0.565), or fun (β = 0.10 [-0.18, 0.39], t = 0.72, p = 0.474). Neither was there any effect of condition on perceived performance (smart higher than work: $\beta = 0.10$ [-0.18, 0.39], $t = 0.72$, $p = 0.474$).

Discussion

Contrary to expectation, the mindset intervention had only a marginal effect on the response to challenging feedback, although this was in the predicted direction. This result encouraged us to undertake a second replication, modified to enhance the chance of success and to shed additional light on mindset.

Study 2

Three modifications were made which did not alter the direct replication design, but improved power and reduced the ambiguity of testing. First, to avoid ceiling effects, the puzzles were made slightly more difficult and the number of items available in the easier tests was increased from 10 to 12 items. We hypothesised that a more challenging third test set would maximise the opportunity for any mindset effect on response to challenge to be seen. To enable this, a set of harder items matched to those of set 2 were added to the post-negative feedback phase.

Second, to test whether mindset impacts high-stakes school grades, ability, or response to challenge, we included the standard mindset questionnaire (Dweck, 1999) and measured student grades for the semester before and after they were tested. Even if mindset affects only those children who are struggling (Paunesku et al., 2015), the lower range of GPA scores should become increasingly enriched with fixed-mindset children over the course of education. Thus, mindset is predicted to show both main-effect and interactive associations with students' grades and grade-trajectories across a school year. Because mindset is predicted to raise cognitive ability (Dweck, 2006), we also tested the prediction that students' mindsets are associated with their cognitive ability.

Third, we wished to test specificity of the praise intervention. Both trait personality and motivation theory predict that hard work causes good outcomes (Locke & Latham, 2002; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). What is specific to mindset theory is the prediction that believing basic ability is malleable increases basic ability and grades. The standard intervention, however, confounds hard work with beliefs about intelligence. To distinguish these, we created a novel active-control condition based on the mindset questionnaire item "*You can learn new things, but you can't really change your basic intelligence*". Participants in this new condition were told "*Even though we cannot change our basic ability, you work hard at hard problems and that's how we get hard things done*". This condition thus conformed to the limited mindset (we can learn but can't change basic ability), while instructing the child that effort is required to do hard things.

Method

Participants

In total, 222 pupils were recruited from a second primary school in the same city as Study 1 drew upon: 116 male (mean age 11.07, SD = 0.49) and 106 female subjects (mean age 11, SD = 0.45). Compensation for participation consisted of sweets at the end of the study.

Materials

Mindset was assessed using the 8-item Theories of Intelligence scale (Dweck, 1999). The 8-item Theory of Talent scale was also administered but is not analysed here. Example items include "*You have a certain amount of intelligence, and you can't really do much to change it*." Possible responses range from 1 (Strongly Agree) to 6 (Strongly Disagree) with high scores coded to indicate a growth mindset.

The puzzles were drawn from the original and parallel-form versions of the SPM (Raven et al., 2000), presented in a counterbalanced order. Test one included 12 (rather than 10) items from set C (rather than set B). The second (challenge test) consisted of the first 10-items from set E. Equivalent easier and more difficult tests were used in the post-feedback test. Learning and motivation measures were given as in Study 1.

Procedure

The procedure was identical to that used in study 1, with children again tested individually in a private room near their classroom. Seventy-four subjects were allocated to each condition at sequential-random. Participants in the praise-for-intelligence-and-effort condition were told "*Even though we cannot change our basic ability, you work hard at hard problems and that's how we get hard things done*". At the end of experimental session, all participants were debriefed as in study 1.

Results

Consistent with the strong inter-correlation among grades, a 1-factor CFA of the grades in each testing wave fit well (CFI = 1; TLI = 1; RMSEA = 0) with loadings of 0.80, 0.79, and 0.86 and 0.69, 0.86, and 0.90 for Math, Chinese, and English in semesters 1 and 2 respectively. To generate a GPA score for each semester, we computed factor scores based on this 1-factor model for each child and each semester.

Does mindset predict grades?

Regression modelling was used to test whether school grades were positively associated with mindset, controlling for age, sex and scores on the challenge test (Ravens E).

Mindset was unrelated to GPA in either semester 1 or 2 (β = -0.01 [-0.14, 0.11], t = -0.22, p = 0.829; β = 0.03 [-0.12, 0.18], t = 0.35, p = 0.723 respectively). By contrast, ability was a highly significant predictor of GPA in both semesters (Semester 1 β = 0.34 [0.22, 0.47], t = 5.38, $p < 0.001$; semester 2 β = 0.25 [0.1, 0.4], t = 3.22, p = 0.002). Because cognitive ability is itself predicted to be impacted strongly by mindset (Dweck, 2006), potentially masking a mindset effect on GPA, we removed this control variable from the model. Mindset remained a non-significant predictor of initial or final GPA (β = 0.03 [-0.11, 0.16], t = 0.39, p = 0.700 and β = 0.05 [-0.11, 0.2], t = 0.61, p = 0.540 respectively. Models of change in each subject on their own (instead of averaged as GPA), also yielded only null effects of mindset on attainment (p values .692 for English, .812 for Chinese, and .855 for mathematics).

Does mindset predict baseline reasoning ability?

Mindset is predicted to be the major mechanism by which differences in ability and grades are created (Dweck, 2006). It is therefore critical that students' mindsets are associated with their cognitive ability. While the presence of an association would be ambiguous (higher ability might cause a feeling that growth is possible), a null or negative correlation can falsify the theory. This hypothesis was tested in regressions, controlling for age and sex. Children's mindsets were not significant predictors of ability as measured by either the easier (β = 0.12 [-0.02, 0.25], t = 1.73, p = 0.085) or more difficult (β = 0.12 [-0.01, 0.25], t = 1.75, p = 0.082) baseline tests.

Does mindset enhance learning across time, at least at below-average attainment?

We next tested the prediction (Paunesku et al., 2015) that attainment growth (second-half of year GPA, controlling for initial GPA) would be associated with mindset, either as a main effect, or as an interaction, with only children gaining lower scores in semester 1 showing any benefit of mindset (i.e., a significant GPA1 × mindset interaction). This was tested in a regression predicting GPA2 from mindset and GPA1 × mindset (controlling for age and sex). Neither hypothesis was supported: There was no significant effect of mindset on GPA change across the year ($\beta = 0.03$ [-0.06, 0.12], $t = 0.65$, $p = 0.514$). In addition, there was no special impact of mindset at low levels of initial GPA (gpa1 × mindset interaction $\beta = -0.07$ [-0.20, 0.06], $t = -1.09$, $p = 0.276$). GPA2 was, however, strongly linked to GPA1 ($\beta = 0.9$ [0.80, 0.99], $t = 18.74$, $p < 0.001$).

We next examined the possibility that mindset may have a highly-specific effect, interacting on a course-by-course basis with low semester-1 grades such that while, in most students, mindset would be unrelated to grades, for the lowest-performing students in each subject, growth-mindset would trigger the predicted effort and hard-work response which would improve grades in that subject by the end of the semester. The predicted interaction was not supported. In all cases these subject × mindset interaction effects were non-significant ($\beta = 0.01$ [-0.08, 0.1], $t = 0.27$, $p = 0.790$); $\beta = 0.02$ [-0.09, 0.14], $t = 0.43$, $p = 0.671$; $\beta = 0.06$ [-0.06, 0.19], $t = 1.01$, $p = 0.315$ for Chinese, English, and mathematics, respectively).

Does mindset enhance post-challenge reasoning ability?

We next tested if fixed mindset treatment impacted negatively on post-feedback performance using regression, testing if scores on the third set of ability puzzles were predicted by praise intervention, controlling for age, sex, and baseline ability scores.

On the easier post-challenge ability measure (comparable to that used in Mueller & Dweck, 1998), there was no effect of condition (F(2, 215) = .475, p = 0.623). The more powerful focussed comparison of limited vs. non-limited condition was also near zero (β = 0.06 [-0.21, 0.32], t = 0.41, p = 0.682). In line with these null results, children's own mindsets did not affect their response to challenge (β = 0.07 [-0.04, 0.18], t = 1.22, p = 0.223).

On the more challenging puzzles, where mindset is predicted to most strongly reveal its effect, there was, again, no effect of mindset intervention (F(2, 215) = 0.23, p-value = 0.796). The focussed limited vs non-limited contrast was similarly non-significant (β = 0.06 [-0.16, 0.28], t = 0.56, p = 0.578: See Figure 2 left panel).

Contrary to the prediction of mindset theory, response to this challenging material was related to mindset in the *reverse* direction to the growth-mindset prediction (β = –0.10 [–0.19, -0.01], t = -2.26, p = 0.025). This may be a false positive, but the direction of response suggests growth mindset harms response to negative challenge (See Figure 2 right panel).

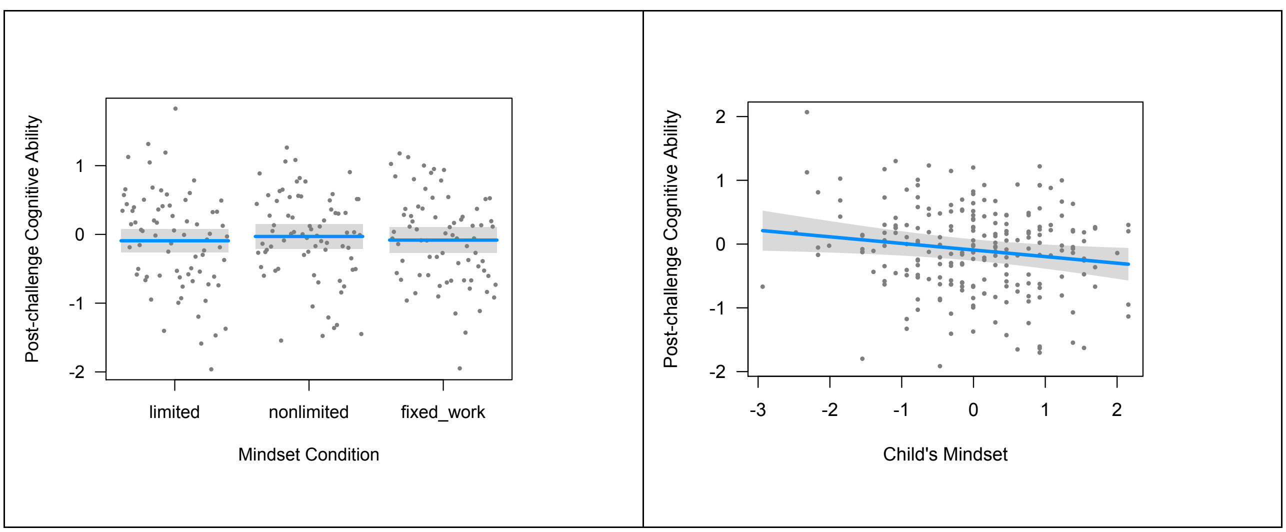

Figure 2: Growth-mindset intervention is unrelated to performance (left panel) while children's own growth-mindsets *harmed* post-challenge performance (right panel). Data from Study 2 challenging item-set.

Discussion

Contrary to Mueller and Dweck (1998), we found no effect of mindset manipulation on response to challenge. Moreover, children's own growth mindset showed a small but significant damaging effect on response to challenge (see Figure 2). Turning to grades, we found no association of children's own mindsets to their grades, or to improvement in grades over the year. Whereas Paunesku et al. (2015) observed no main effect of a mindset intervention on grade change but did report an effect among lower achievers, we found no support for this interaction of mindset with initial grade on final grade.

The finding that even children's own mindsets showed no effects on IQ, grades, or performance is clearly confounding and incompatible with mindset theory. We took this outcome seriously, and wished to run a final study, exactly replicating study 2, in an independent sample to gather more evidence regarding whether mindsets might be epiphenomena unrelated to key outcomes of ability, grades, or improvement in grades in children, or if they performed as predicted by mindset theory.

Study 3

Study 3 was executed identically to Study 2, testing the same hypotheses.

Method

Subjects

Subjects. In total, 212 children participated. One male subject was removed from the analyses. This student had consistent exceptionally low grades scoring, for example, 9.2 SDs below the class average for Chinese. Their mindset was 3.75, close to class average. Of the 211 remaining participants, 120 were male (mean age 10.78 years, SD = 0.58) and 91 were female (mean age 10.6, SD = 0.46).

Procedure

Numbers in the limited, non-limited, and working despite limits condition were 70, 71, and 70 respectively. All procedures were identical to those of study 2.

Results

Does mindset predict grades?

As before, we tested whether student's mindsets predicted their school grades using regression models including controlling for age, sex, and ability scores. As in study 2, mindset was unrelated to GPA in either the first semester ($\beta = 0.03$ [-0.09, 0.16], $t = 0.52$, $p = 0.606$) or the second semester ($\beta = 0.05$ [-0.07, 0.18], $t = 0.86$, $p = 0.391$). In addition, these models tested the hypothesis that growth mindset would translate IQ into greater GPA outcomes, but this ability × mindset interaction was non-significant for GPA in semester 1 ($\beta = -0.08$ [-0.21, 0.06], $t = -1.12$, $p = 0.266$) and 2 ($\beta = -0.01$ [-0.14, 0.12], $t = -0.13$, $p = 0.898$).

Ability was again a strong predictor of GPA in both semesters (e.g., $\beta = 0.32$ [0.19, 0.45], $t = 4.97$, $p < 0.001$ in semester 1). Therefore, as in study 2, we examined the effect of mindset with ability removed from the model to unmask any suppression effect: Mindset still failed to predict either initial or final GPA: β = 0.04 [-0.09, 0.18], t = 0.65, p = 0.516; β = 0.08 [-0.06, 0.21], t = 1.13, p = 0.262 respectively. In models substituting single school subjects for GPA, mindset was unrelated to attainment (p-values 0.748, 0.607, and 0.630 for English, Chinese, and mathematics respectively).

Does mindset predict baseline reasoning ability?

We next tested the hypothesised effect of mindset on IQ development in regression models with ability as a DV (either the easy or more difficult test) and mindset as a predictor, controlling for age and sex. Replicating the null effect in study 2, children's own mindsets were unrelated to scores on either the difficult (β = 0.06 [-0.08, 0.2], t = 0.88, p = 0.381) or easier (β = 0.11 [-0.03, 0.25], t = 1.61, p = 0.110) cognitive tests.

Does mindset predict learning across time, at least following low academic achievement?

As in study 2, we tested whether second-semester GPA was associated with children's mindsets, using a regression predicting GPA2, with mindset and GPA1 × mindset as predictors, controlling for age and sex. Again, neither hypothesis was supported. There was no main effect of mindset on GPA change across the year (β = 0.04 [-0.03, 0.12], t = 1.21, p = 0.228) and no initial GPA × mindset interaction (β = -0.05 [-0.13, 0.03], t = -1.2, p = 0.230). Course-by-course tests for initial-grade × mindset effects on final grades also were not supported for any subject: β = 0.03 [-0.06, 0.13], t = 0.69, p = 0.489; β = 0.03 [-0.05, 0.1], t = 0.68, p = 0.500; β = 0.06 [-0.03, 0.15], t = 1.25, p = 0.212 for Chinese, mathematics, and English respectively.

Thus, no support was found for the claim that beliefs about whether ability is fixed or greatly malleable affect school outcomes, nor for the claim that mindset affects learning, either as a main effect or in children in who initially score poorly.

Does a mindset intervention enhance post-challenge reasoning ability?

We next turned to the experimental intervention. As before, we tested the prediction that a growth-mindset intervention would improve post-feedback performance, relative to performance after a fixed-mindset intervention (and relative to our condition which emphasised ability is fixed but recognised children for working on the puzzles). Again, for each level of difficulty this was done using regression models to predict scores on the final ability tests as DVs with mindset condition, children's own mindset, pre-test ability, and the interaction of mindset and baseline ability as predictors, controlling for age and sex.

Does mindset or praise alter response to negative feedback on easier puzzles?

We first tested differences in solving the easier puzzle set following negative feedback. As in study 2, there was no effect of children's own mindset on their response to the challenge ($\beta = 0.01$ [-0.09, 0.12], $t = 0.28$, $p = 0.777$). There was, however a significant effect of mindset condition ($F(2, 204) = 4.161$, $p = 0.017$). Relative to the limited condition, scores in the non-limited condition were improved ($\beta = 0.26$ [0.01, 0.51], $t = 2.03$, $p = 0.044$).

This result would seem compatible with mindset theory, were it not that performance in our active-control condition, which told children that basic ability cannot be changed (while still reinforcing that doing the puzzles requires work) did not have the predicted harmful effect (predicted from its invocation of fixed mindset), but rather yielded an approximately 35% larger *positive* effect ($\beta = 0.36$ [0.1, 0.61], $t = 2.8$, $p = 0.006$) (see Figure 3).

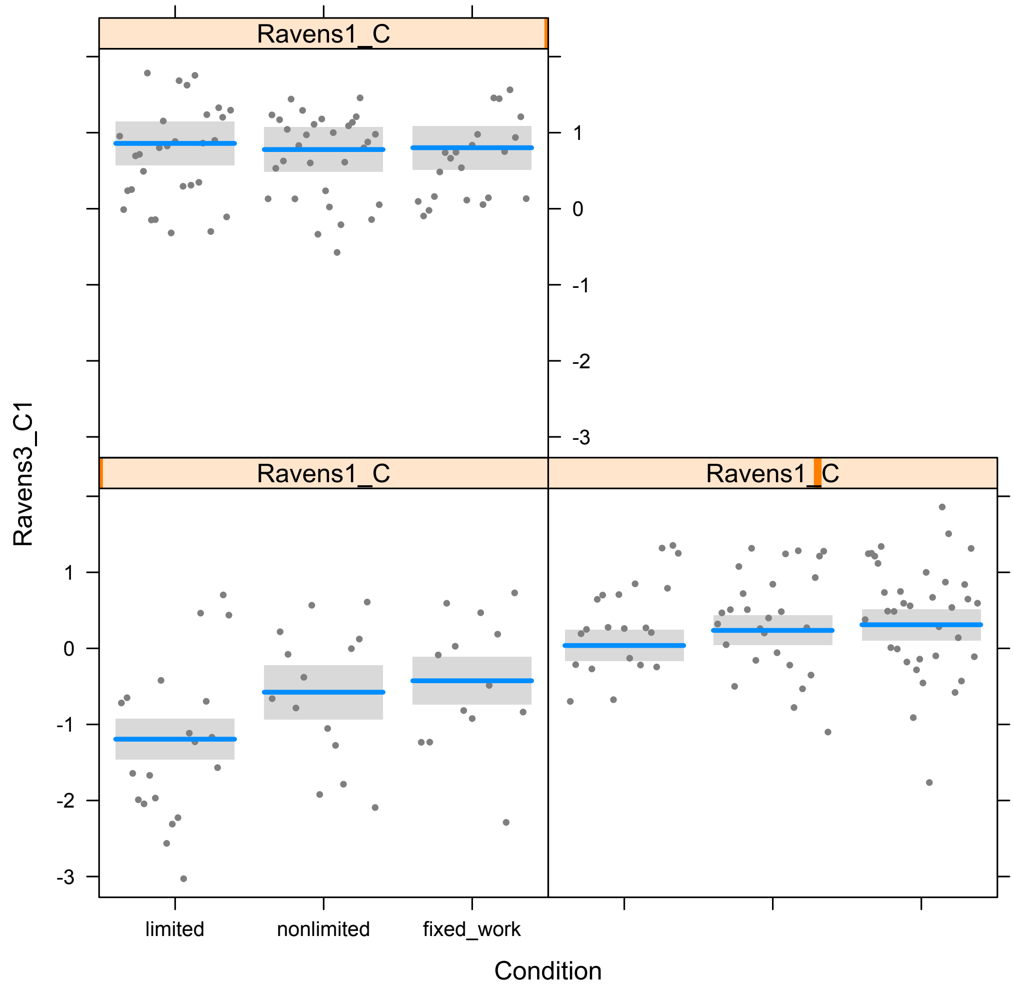

Figure 3: Interaction plot from Study 3 breaking out scores on the (easy) post-challenge Raven score across the three mindset conditions × pre-test Raven score. Panels show results for, at bottom left, the children with the lowest scores on the initial ability test, bottom right shows children with average ability scores, and the upper panel shows the results for the most able children.

Does mindset affect response to negative feedback on challenging material?

We next tested if mindset affected performance on the harder material to which negative feedback had been directed. As in study 2, the mindset intervention had no effect on performance on this more challenging material ($F(2, 202) = 0.306$, $p = 0.737$). The focussed contrast for this prediction (performance of the fixed versus growth praise groups) showed no effect ($\beta = 0.06$ [-0.16, 0.27], $t = 0.51$, $p = 0.612$). Moreover, as in study 2, there was no effect of children's own mindsets on post-challenge performance ($\beta = 0.01$ [-0.08, 0.10], $t = 0.16$, $p = 0.870$). Finally, we tested if the growth mindset intervention was effective but only in children with lower initial scores. The relevant initial-ability × condition, interaction, however, was non-significant ($F(2, 202) = 0.187$, $p = 0.830$) as was the focal "ability × non-limited condition" contrast (β (relative to the limited condition) = 0.03 [-0.17, 0.24], $t = 0.32$, $p = 0.749$). As no effect of mindset on outcomes was found, we did not analyse the attitude measures predicted to mediate these effects.

Discussion

Study 3 yielded results consistent with the previous two studies. We found no evidence for growth mindset promoting higher grades, nor was there evidence that children's mindset was related to grades: Even in the lowest-performing children, their own growth-mindset failed to trigger the predicted improvements.

General Discussion

Mindset was predicted to be a major influence determining not only student learning, but also ability and response to negative feedback. Mindsets and mindset-intervention effects on both grades and ability, however, were null, or even reversed from the theorised direction. In study 2, we found one nominally significant effect of mindset on grades, but in the opposite direction to that predicted. Other effects, bar one, were non-significant. This single significant effect of the mindset intervention in study 3 on just the easier material, however, was found even more strongly for our active-control condition, contrary to prediction. This contradicts the idea that beliefs about ability being fixed are harmful. At best, it supports a role for effort predictable from trait personality and motivation theory.

Limitations?

How do we account for our lack of results? Differing ethnicity is unlikely to account for the difference as previous reports have used Chinese subjects (Hong, Chiu, Dweck, & Sacks, 1997) and effects are unrelated to ethnicity (Mueller & Dweck, 1998). Poverty was recently predicted to boost, not suppress effects of mindset (Claro, Paunesku, & Dweck, 2016). Instead, we suggest these null findings across three substantial studies support the null: that mindsets are unrelated to attainment.

Future directions

Given the purpose of mindset interventions in school is to enhance student attainment and reduce group attainment gaps (Paunesku et al., 2015), replicability is critical. Other outcomes attributed to mindset (influences on willpower (Job, Walton, Bernecker, & Dweck, 2013), world peace, personal relationships, business and sporting success (Dweck, 2006)) also require replication. Future work on praise should remove the confound of implicit theory with reinforcing hard work. Finally, given widespread and costly policy and real-world educational implications, we encourage an emptying of the file drawer to account for non-reported null studies.

For the majority of teachers who report believing mindset matters, 80% of whom say they have been unable to make effective changes in their own classes (Yettick et al., 2016), the present results may provide a simple answer to this apparent disparity. Teaching activities known to be effective (Brown, Roediger, & McDaniel, 2014) are likely to be more fruitful than mindset interventions.

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