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SHORT PROJECT REPORTS

Fixed is not the opposite of growth: Item keying matters for measuring mindsets

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Abstract

Research on growth mindset, the belief that one's cognitive abilities are malleable and can be developed through dedication and practice, has received considerable media attention and influenced educational policy and practice. However, mindset theory and measurement have also drawn criticism. In the present paper, we add a cautionary note pertaining to the conceptualization and measurement of growth mindset. Through a critical reanalysis of a large-scale representative study of adolescents from the US ($N = 15{,}362$), we show that a growth (i.e., forward-keyed) and a fixed (i.e., reverse keyed) mindset item from a widely used scale are only moderately correlated ($r = -.31$). Further, we demonstrate that the two items are very differently related with a range of educationally relevant criteria such as learning engagement and self-efficacy, and sociodemographic characteristics such as sex. This leads us to conclude that the growth and fixed mindset items are not mutually interchangeable (apart from keying) indicators of a unidimensional construct that has fixed and growth mindset at its opposing poles. Which items researchers choose to measure mindset (fixed, growth, or a blend thereof) may therefore have a significant impact on the findings they obtain. Our insights highlight the need for greater attention to the conceptual foundations and measurement of mindset in future studies.

Keywords Growth mindset · Fixed mindset · Item keying · Validity · Acquiescence · Dimensionality

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1 Introduction

Growth mindset, first conceptualized by Carol Dweck (1999), refers to an individual's belief that one's intelligence and abilities are malleable and can be developed through dedication and practice. In her theory, Dweck (e.g., 2006) originally distinguished between two types of mindsets: Growth mindset and fixed mindset. In her account, people with a *growth* mindset believe that their cognitive abilities (e.g., fluid intelligence) can be developed over time, whereas those with a *fixed* mindset believe that they were born with an invariant amount of such abilities which cannot be substantially increased through effort and learning. Theoretically, these mindsets should differ in their effects on students' motivation: A growth mindset should promote motivation to learn and foster resistance to setbacks. In contrast, a fixed mindset should detract from individual's motivation to learn and make them question the utility of learning. Ultimately, better educational outcomes should be expected among those with the former mindset compared to those with the latter (e.g., Dweck, 2015, 2016).

Growth mindset already exerts a substantial influence on educational policy around the world. Several educational reforms by practical interventions have been guided by insights from growth mindset research (e.g., Sisk et al., 2018; Yeager et al., 2019). The construct has continuously received attention across different media platforms (e.g., Eisenberg, 2005; Paul, 2013; Smith, 2014). Political and policy attention has also increased over the years (see e.g., Boaler, 2013; and a meeting by the White House in 2013 on "The importance of academic mindsets").

In Dweck's (1999) original *Implicit Theories of Intelligence Scale* (ITIS), both mindsets are equally represented with four items, while the underlying assumption is that individuals can either hold a growth mindset (i.e., incremental theory), such as "You can always greatly change how intelligent you are," or fixed mindset (entity theory), such as "Your intelligence is something about you that you can't change very much." Based on this assumption that growth mindset is a unidimensional, bipolar construct with growth and fixed mindset at the opposing poles, the items measuring growth mindset can be seen as generally forward-keyed and as reverse-keyed items of fixed mindset. Accordingly, responses to these items are commonly averaged into one joint score after inverting items from one of the two mindsets (Scherer & Campos, 2022). Based on the unidimensionality assumption, many studies only use one of the two mindset framings. Studies also often change the orientation of the rating scale so that low values signal agreement and high values refer to disagreement (e.g., Claro et al., 2016; Rammstedt et al., 2022; Yeager et al., 2019). Most large-scale studies use a three-item (e.g., Rammstedt et al., 2022), two-item (e.g., Claro et al., 2016), or single-item scale (e.g., OECD, 2019, 2021) that measures only one of the two mindsets.

Contrary to the dominant view originally offered by Dweck (1999), however, growth and fixed mindset might not be opposing poles of a unidimensional construct. Instead, recent meta-analytic confirmatory factor analyses (Scherer & Campos, 2022) strongly suggest that fixed and growth mindset—at least as measured

with Dweck's (1999) 8 items or a 6-item subset thereof—may in fact measure two separate dimensions that are only moderately correlated ($\rho = 0.63$–0.65). In other words, items pertaining to growth mindset and fixed mindset may not only be forward-keyed and reverse-keyed items of the same construct; they might even represent separate constructs or at least separate dimensions of the same construct. It is important to note that lower-than-expected intercorrelations of growth and fixed mindset might also originate (at least partly) from acquiesence, that is, respondents' tendency to agree with items regardless of these items' content and keying (e.g., Lechner et al., 2019). For both these reasons, we consider the question of item keying—or more generally whether growth, fixed, or both mindset items are used—to be central to advancing mindset theory and assessment.

One central development further necessitates attention to the keying of growth mindset. First, the evidence on growth mindset's positive (intervention) effects (e.g., Claro et al., 2016; Destin et al., 2019; Sisk et al., 2018) and its association with academic achievements (Burnette et al., 2023; Macnamara & Burgoyne, 2023) is decidedly mixed. Meta-analytic between-study heterogeneity of effect sizes is high (Scherer & Campos, 2022), and studies also highlight the construct's cultural dependence for predicting positive outcomes (Lou & Li, 2022). We submit that some of the observed variation in associations between mindset and criteria (e.g., student motivation) or effects of mindset interventions on student outcomes might simply arise from the specific items used to assess mindset, more specifically, whether these items represent fixed mindset, growth mindset, or a blend of both. Further, Limeri et al. (2020) demonstrated that the growth mindset construct lacks process validity. The authors showed that students differed in their perception of intelligence as acquired accumulated knowledge vs. existing cognitive capability. The students' interpretation was further malleable to cues that were prominent in the context in which the interpretation was made (e.g., social cues like observing peers or recent experiences with academic performance).

To illustrate this problem, recently, King and Trinidad (2021) presented another piece of evidence for the allegedly far-reaching positive effects of a growth mindset on key educational outcomes. Their findings were based on a large-scale nationally representative sample of US adolescents (i.e., tenth-graders) from the Educational Longitudinal Study, which is also the age group most prominently focused on in growth mindset research. The data set included two items of opposite keying measuring growth mindset (i.e., "Most people can learn to be good at math.") and fixed mindset (i.e., "You have to be born with the ability to be good at math."), respectively. King and Trinidad (2021) chose only the former of these two items, namely the forward-keyed one measuring growth mindset, as the basis for all their analyses. They did not report results for the second, reverse-keyed item containing a fixed-mindset statement, even though this keying is more frequently used in recent research (see e.g., Claro et al., 2016; OECD, 2020; Rammstedt et al., 2022).[1]

In the present paper, we re-analyze the dataset used by King and Trinidad (2021) and show how drastically correlational results with educational outcomes can vary

[1] Claro et al. (2016), in their Supplementary Material, explained this to be due to reducing response biases.

between fixed and growth mindset items and their average score. The study's basis provides an excellent case in point to demonstrate the relevance of item keying in the measurement of growth mindset. Our main argument is this: Research on growth mindset cannot claim to sufficiently understand its core construct as long as differently-keyed items allegedly measure the same construct but show substantially different empirical associations with key outcomes (e.g., student motivation). Our analytical exploration is twofold. First, we inspect the association between the two mindset items included in the same data set. As they were designed to be direct opposites (in keying) of each other, one targeting growth mindset and the other targeting fixed mindset, one should expect (1) a high negative correlation between the items and (2) associations with external criteria that are similar to each other but with different signs (i.e., positive vs. negative associations). We therefore compare the associations with relevant educational and sociodemographic variables obtained when using the growth mindset item (the one that King & Trinidad, 2021, used) to these same associations obtained when using the fixed mindset item instead. Additionally, we compare these two items' associations with the associations of the average score of both items (e.g., Dweck, 1999). The present study adds to recent findings presented by Scherer and Campos (2022) cautioning that the unidimensionality premise of the implicit theories is in need of revision.

2 Method

2.1 Participants

We reanalyzed data collected in the Education Longitudinal Study of 2002 (United States Department of Education, 2005). The dataset included a nationally representative sample of 15,362 tenth-grade students (49.77% female) drawn from 751 schools in the US. The data set can be retrieved openly on the website of the Consortium for Political and Social Research (ICPSR): https://www.icpsr.umich.edu/web/ICPSR/studies/4275/versions/V1. For further details, we refer to the descriptions of King and Trinidad (2021).

2.2 Measures

2.2.1 Growth and fixed mindset

The central variables in our analyses were two items measuring respondents' mindset regarding their mathematical skills. The first item was forward-keyed, such that higher agreement implies a growth mindset (i.e., "Most people can learn to be good at math."). This is the item on which King and Trinidad (2021) based their analyses. The second item was reverse-keyed, such that higher agreement implies a fixed mindset (i.e., "You have to be born with the ability to be good at math."). Both items were rated on a 4-point Likert scale ranging from *1—strongly disagree*, to *4—strongly agree*, such that higher numerical values imply stronger agreement. As a

consequence of the orientation of the response scale, lower numerical values for the growth mindset item and higher numerical values for the fixed mindset item indicated less of a growth mindset, whereas higher values for the growth mindset item and lower values for the fixed mindset item indicated more of a growth mindset. For the subsequent analyses, and as outlined in the Results section, we reverse-coded the fixed mindset item so that lower numerical values reflect disagreement and higher values reflect agreement with a growth mindset in order to increase interpretability of the presented correlations.

2.2.2 External criteria

To ensure full comparability, we used as external criteria the same correlates as King and Trinidad (2021), namely, self-efficacy, student-rated engagement, teacher-rated engagement, household income of the student's family, parental education, gender, and ethnicity. These educational outcomes and sociodemographic and -economic characteristics have also been the focus of several previous papers on growth mindset (e.g., Burnette et al., 2020; Lou & Li, 2022; Rammstedt et al., 2022; Rhew et al., 2018; Wang & Amemiya, 2019; Zeng et al., 2016).

Self-efficacy. Self-efficacy was assessed via five separate items with a specific reference to mathematics. That is, respondents were asked to indicate the frequency of them experiencing being effective at mathematics (e.g., "I'm certain I can understand the most difficult material presented in math texts." and "I'm confident I can understand the most complex material presented by my math teacher."). Participants indicated their responses on a 4-point Likert scale that ranged from *1—almost never*, to *4—almost always*.

Student-rated engagement. Respondents were also asked about their self-rated engagement with the subject of mathematics via two items (i.e., "Because doing mathematics is fun, I wouldn't want to give it up." and "When I do mathematics, I sometimes get totally absorbed."). They rated their self-engagement on a 4-point Likert scale, ranging from *1—strongly disagree*, to *4—strongly agree*.

Teacher-rated engagement. Teacher-rated student engagement with mathematical subjects was also rated on two items which referred to the engagement of the student that teachers had observed in their own classes (i.e., "How often does this student complete homework assignments for your class?" and "How often is this student attentive in your class?"). Respondents used a 5-point Likert scale that ranged from *1—never*, to *5—all the time*.

Household Income. Income was assessed as a student's indicated family income in dollars ($), representing a continuous variable.

Parental education. Parental education was measured by two independent items assessing maternal (i.e., "Mother's highest level of education?") and paternal education (i.e., "Father's highest level of education?"), respectively. Respondents were able to indicate eight different levels of attained education, ranging from the lowest level as *1—Did not finish high school*, to the highest as *8—Completed PhD, MD, other advanced degree*.

Gender. Participants indicated their gender as either *1—Female* or *2—Male*, as a binary variable.

Ethnicity. Ethnicity was indicated on an item with seven levels, including, *1—Amer. Indian/Alaska Native, non-Hispanic*, *2—Asian, Hawaii/Pac. Islander, non-Hispanic*, *3—Black or African American, non-Hispanic*, *4—Hispanic, no race specified*, *5—Hispanic, race specified*, *6—More than one race, non-Hispanic*, and *7—White, non-Hispanic*. Following the strategy employed by King and Trinidad (2021), we binarized the ethnicity variable so that 0 indicated that a student primarily identified as Black, Hispanic, Asian, or Native American, and 1 indicated identifying as White. As a reviewer pointed out, this dichotomization of the ethnicity variable is overly simplistic because it ignores the possibility of cross-ethnic identification (e.g., identifying as Hispanic and White). However, we adopted this practice with the central goal of providing correlational analyses that are directly comparable to King and Trinidad's (2021) results.

3 Results

We aimed to inspect differences between two mindset items with opposite keying on two levels, namely, by their (1) direct association with each other and (2) discrepancies in correlations with theoretically related constructs (e.g., student motivation). First, we inspected the association between both mindset items. The growth and fixed mindset items correlated at $r = -0.31$, $p < 0.001$. Even considering measurement error, which attenuates the correlation, this association is unexpectedly low for two items that were designed to measure opposing poles (i.e., fixed vs. growth) of the same construct, representing beliefs about intelligence that should be mutually exclusive. This counterintuitively low correlation suggests that respondents did not necessarily perceive the items as mutually exclusive, contradictory, or polar opposites of each other. This is consistent with the results of the recent meta-analysis by Scherer and Campos's (2022).

Second, we examined several associations between the mindset items and the aforementioned constructs. Table 1 shows the complete construct correlation matrix for both mindset items and their scale score (i.e., the average across the two items after reverse-coding the fixed mindset item) separately. Following the consensus of mindset measurement in the literature, we reverse-coded the fixed mindset item (i.e., "You have to be born with the ability to be good at math."), such that higher numerical values reflected a growth mindset. Accordingly, we named this item FM(-), whereas we abbreviated the growth mindset item used by King and Trinidad (2021) as GM. With this coding, both items should have similar correlations with outcomes with the same sign. Table 1 shows the complete construct correlation matrix for both mindset items and their scale score (i.e., the average across the two items after reverse-coding the fixed mindset item) separately. For both mindset items, we found the same characteristic negative correlations of growth mindset with the socioeconomic variables of income and parental education found recently by Rammstedt et al. (2022) and in PISA 2018 (OECD, 2021).

For both mindset items, we found the same characteristic negative correlations of growth mindset with the socioeconomic variables of income and parental education

Table 1 Construct correlations for both GM items and their averaged score

Variables		"Most people can learn to be good at math." **GM**	"You have to be born with the ability to be good at math." **FM(-)**	**Scale score**
Sex	*N*	11,598	11,677	11,598
	Pearson's *r*	**−0.084**	**0.027**	−0.031
	CI (95%)	[−0.102; −0.065]	[0.009; 0.046]	[−0.049; −0.013]
	p-value	< 0.001	0.003	< 0.001
Ethnicity	*N*	11,598	11,677	11,598
	Pearson's *r*	−0.151	−0.080	−0.143
	CI (95%)	[−0.169; −0.133]	[−0.098; −0.062]	[−0.161; −0.125]
	p-value	< 0.001	< 0.001	< 0.001
Income	*N*	11,598	11,677	11,598
	Pearson's *r*	−0.073	−0.066	−0.089
	CI (95%)	[−0.091; −0.055]	[−0.084; −0.048]	[−0.107; −0.071]
	p-value	< 0.001	< 0.001	< 0.001
Maternal education	*N*	10,236	10,284	10,236
	Pearson's *r*	−0.055	−0.057	−0.069
	CI (95%)	[−0.074; −0.035]	[−0.076; −0.038]	[−0.088; −0.050]
	p-value	< 0.001	< 0.001	< 0.001
Paternal education	*N*	9597	9635	9597
	Pearson's *r*	−0.028	−0.057	−0.054
	CI (95%)	[−0.048; −0.008]	[−0.076; −0.037]	[−0.074; −0.035]
	p-value	0.007	< 0.001	< 0.001
I'm certain I can understand the most difficult material presented in math texts. (SE1)	*N*	11,263	11,238	11,263
	Pearson's *r*	**0.228**	**0.055**	0.166

Table 1 (continued)

Variables		"Most people can learn to be good at math." **GM**	"You have to be born with the ability to be good at math." **FM(-)**	**Scale score**
	CI (95%)	[0.211; 0.246]	[0.036; 0.073]	[0.148; 0.184]
	p-value	<0.001	<0.001	<0.001
I'm confident that I can do an excellent job on my math tests. (SE2)	*N*	11,320	11,289	11,320
	Pearson's *r*	**0.235**	**0.093**	0.195
	CI (95%)	[0.218; 0.253]	[0.075; 0.112]	[0.178; 0.213]
	p-value	<0.001	<0.001	<0.001
I'm confident I can understand the most complex material presented by my math teacher. (SE3)	*N*	10,899	10,885	10,899
	Pearson's *r*	**0.246**	**0.079**	0.190
	CI (95%)	[0.228; 0.263]	[0.060; 0.097]	[0.172; 0.208]
	p-value	<0.001	<0.001	<0.001
I'm confident I can do an excellent job on my math assignments. (SE4)	*N*	10,678	10,665	10,678
	Pearson's *r*	**0.246**	**0.085**	0.196
	CI (95%)	[0.229; 0.264]	[0.066; 0.103]	[0.177; 0.214]
	p-value	<0.001	<0.001	<0.001
I'm certain I can master the skills being taught in my math. (SE5)	*N*	10,605	10,581	10,605
	Pearson's *r*	**0.251**	**0.084**	0.197
	CI (95%)	[0.233; 0.268]	[0.065; 0.103]	[0.179; 0.216]
	p-value	<0.001	<0.001	<0.001
Self-efficacy (total score)	*N*	11,380	11,367	11,380
	Pearson's *r*	0.269	0.089	0.212
	CI (95%)	[0.252.; 286]	[0.071; 0.108]	[0.194; 0.229]
	p-value	<0.001	<0.001	<0.001

Table 1 (continued)

Variables		"Most people can learn to be good at math." **GM**	"You have to be born with the ability to be good at math." **FM(-)**	**Scale score**
When I do mathematics, I sometimes get totally absorbed. (StE1)	*N*	11,481	11,456	11,481
	Pearson's *r*	**0.236**	**0.013**	0.143
	CI (95%)	[0.218; 0.253]	[−0.005; 0.032]	[0.126; 0.161]
	p-value	< 0.001	0.151	< 0.001
Because doing mathematics is fun, I wouldn't want to give it up. (StE2)	*N*	11,481	11,451	11,481
	Pearson's *r*	**0.275**	**0.027**	0.174
	CI (95%)	[0.258; 0.292]	[0.009; 0.045]	[0.156; 0.192]
	p-value	< 0.001	0.004	< 0.001
Sudent engagement (total score)	*N*	11,549	11,525	11,549
	Pearson's *r*	0.295	0.024	0.184
	CI (95%)	[0.278; 0.311]	[0.005; 0.042]	[0.166; 0.201]
	p-value	< 0.001	< 0.001	< 0.001
How often does this student complete homework assignments for your class? (TE1)	*N*	9607	9658	9607
	Pearson's *r*	0.034	0.024	0.033
	CI (95%)	[0.014; 0.054]	[0.004; 0.044]	[0.013; 0.053]
	p-value	< 0.001	0.020	< 0.001
How often is this student attentive in your class? (TE2)	*N*	9595	9649	9595
	Pearson's *r*	0.034	0.024	0.035
	CI (95%)	[0.014; 0.054]	[0.005; 0.044]	[0.015; 0.055]
	p-value	< 0.001	0.016	< 0.001
Teacher evaluation (total score)	*N*	9744	9797	9744
	Pearson's *r*	0.037	0.024	0.036

Table 1 (continued)

Variables		"Most people can learn to be good at math." **GM**	"You have to be born with the ability to be good at math." **FM(-)**	**Scale score**
	CI (95%)	[0.017; 0.056]	[0.005; 0.044]	[0.016; 0.056]
	p-value	<0.001	<0.001	<0.001
Average absolute correlation		0.102	0.018	0.067

GM: "Most people can learn to be good at math."; FM(-) (reverse-coded): "You have to be born with the ability to be good at math."; SE: Self-efficacy; StE: Student engagement; TE: Teacher-rated engagement. Substantial correlational differences (i.e., $r_{diff.} > 0.10$) between both items are in bold. Associations of mindset with sex and ethnicity were calculated with a biserial correlation analysis to account for the variables' dichotomy

found recently by Rammstedt et al. (2022) and in PISA 2018 (OECD, 2021). Notably, however, a selected number of relevant constructs differed substantially in their correlations with the two different mindset items, respectively. Especially striking in this regard are two aspects. First, the association between growth mindset and sex was positive for GM as reported by King and Trinidad (2021) but negative (and even stronger) for the FM(-) item. That is, while the growth mindset as measured by GM was higher for female adolescents, the growth mindset allegedly assessed through the inverted FM(-) was higher for male respondents, although both correlations were small. Second, the associations of growth mindset with student engagement and self-efficacy—which comprised central outcomes to King and Trinidad's (2021) analyses—were substantially smaller for FM(-) than for GM ($\Delta r = 0.183$), with one association (i.e., with StE1) not even statistically significant despite the large sample size. We did not find a notable difference between the two growth mindset items in their correlations with teacher-rated student engagement. This result may indicate that the substantial difference between the two growth mindset items in their associations may, at least partially, be explained by response biases that exclusively influence self-reported evaluations but not informant reports (see e.g., Vazire, 2010; but also see, Vazire & Mehl, 2008).

4 Discussion

In the present paper, we highlighted how crucial item keying is to the measurement of growth mindset. In the large-scale data we re-analysed, two oppositely keyed mindset items correlated only moderately ($r = -0.31$) with each other. Even considering attenuation through measurement error, this correlation is arguably lower than one would expect for items that are meant to be polar opposites on the same construct continuum. Moreover, the two items were differentially related to several central outcomes of growth mindset research. Importantly, the criterion correlations of the fixed mindset item were by no means just mirroring the correlations of the growth mindset item reported by King and Trinidad (2021). Together, these findings suggest that the two items are not mutually interchangeable (apart from keying). Instead, as suggested by Scherer and Campos (2022), there is reason to assume that they capture partly distinct dimensions. Importantly, the analyses of the compared two mindset items were done with the same large-scale data set on the same respondents, meaning that the differential correlations with the external criteria were not due to different samples or test power.

Our findings demonstrate that using growth (forward-keyed) or fixed (reverse-keyed) mindset items can substantially alter the associations with external correlates and criteria. Therefore, deciding which item keying should be used for measurement is not trivial. Crucially, one also cannot deduce from strong(er) associations of an item with selected educational outcomes alone that this item has higher construct validity compared to a lower-correlated item. Assuming so runs the risk of a theoretical fallacy by a-posteriori defining the concept (i.e., growth mindset) and its adjunct theory of effects by relations to other practically relevant variables (e.g., student motivation). Accordingly, finding lower criterion correlations when using a

reverse-keyed item, as was the case in the present analyses of fixed mindset, should not mislead one to disregard this item as an inferior measure. Rather, the divergence in correlational results between the reverse-keyed mindset items may indicate a larger issue with the theory underlying the respective construct: Growth mindset and fixed mindset items may represent conceptually distinct constructs (i.e., growth mindset corresponding to malleability and fixed mindset corresponding to heritability) that may coexist rather than oppose each other.

The low item intercorrelation and the divergent associations that GM and FM(-) have with many external criteria suggest that one item cannot be uncritically substituted for the other (accompanied by reverse coding). Given the correlational divergences, the average score of the two GM-items may be more informative than either of the individual items, as this scale score is (1) implicitly corrected for acquiescence and (2) theoretically more reliable than any individual item. However, these benefits only accrue under the assumption that both items actually measure the same unidimensional construct—which, as we have argued on the basis of these results and in line with Scherer and Campos (2022), is questionable. Given the questionable unidimensionality of the growth mindset measure, we recommend maximum analytical transparency when reporting results regarding growth mindset. This is outlined in more detail in the following conclusion.

4.1 Acquiescence, bidimensionality, or suboptimal wording?

An only weak to moderate correlation ($r = -0.31$) between two items that are framed as opposites (i.e., "Most people can learn to be good at math." vs. "You have to be born with the ability to be good at math.") is alarming.[2] There are several explanations for why two items that were designed to measure opposing and mutually exclusive beliefs about the nature of mathematical ability do not correlate more strongly.

One explanation for the low correlation, which we want to entertain here, is acquiescent responding, describing the tendency of respondents to agree with questionnaire items regardless of their content and keying. Given the prevalence of acquiescent responding in surveys around the world (Lechner et al., 2019), it seems likely that acquiescence is at least partly responsible for the lower-than-expected negative association between the two items in the present sample as well. In addition to shifting the item means toward higher agreement, acquiescence introduces a bias into the correlations. Specifically, it artificially increases positive correlations while decreasing negative correlations (Lechner et al., 2019). In the present case, higher agreement on both the fixed and growth mindset items due to an acquiescent response tendency would shift the otherwise expected negative correlation toward less negative values. However, in the absence of a longer, balanced-keyed inventory, it is difficult to detect, quantify, and correct for acquiescent responding in this sample. In general, research on acquiescence effects for measuring mindset is scarce, which is particularly problematic given that the orientation of rating scales

[2] Notably, the fixed mindset item was worded inconveniently as the phrase "to be born with" leaves open its addressee (i.e.,: "Born in order to do what?").

varies across studies, sometimes deviating from the original orientation proposed by Dweck (i.e., rating scales where low values refer to agreement and high values to disagreement; e.g., Claro et al., 2016; Rammstedt et al., 2022). The need for further research on the role of acquiescence in the growth mindset assessment is urgent.

A more fundamental explanation has been presented recently (Glerum et al., 2020; Li & Bates, 2020; Lou et al., 2021): A low correlation between reverse-keyed items might point to a construct's bidimensionality. In their meta-analysis, Scherer and Campos (2022) showed that a two-factor model of growth mindset is empirically more plausible than assuming construct unidimensionality, namely, growth and fixed mindset being mere polar opposites.

Similar to the dimensionality issue, consider the following problem: Due to their wording, the existing mindset items, going back to Dweck (2006), include beliefs about learnability as a hallmark of a growth mindset (e.g., "Most people can learn to be good at math.") and beliefs about heritability as a hallmark of a fixed mindset (e.g., "You have to be born with the ability to be good at math."). However, malleability and heritability are not mutually exclusive, neither objectively so nor subjectively perceived by individuals. Rather, an individual competence can well be both highly heritable and highly malleable at the same time. The fact that individuals—correctly so—do not perceive heritability and malleability as contradictory may be one of the reasons why the correlation between fixed and growth items is often lower than one would hope for a unidimensional, bipolar construct. Following this explanation, correcting the concept of mindset might mean reconceptualizing the opposite of growth mindset as measuring non-malleability, and the opposite of fixed mindset as measuring non-heritability.

In order to put future mindset measures on a more solid conceptual and psychometric footing, we encourage growth mindset researchers to engage with the above explanations and to make a renewed effort to refine what growth and a fixed mindset really constitute, and whether they can be conceptualized as polar opposites.

4.2 Future directions

Future analyses should test all three explanations. For example, Scherer and Campos's (2022) model could be extended to include a method factor, thus testing the relationship between fixed and growth mindset while controlling for acquiescent responding. If acquiescence plays a critical role in the low correlation between growth and fixed mindset, then controlling for acquiescence should substantially increase this correlation. A resulting reduced or largely unchanged association between the two content factors would thus be an even stronger indication of the mindset's bidimensionality. If the correlation increases after controlling for acquiescence, this would necessitate a detailed discussion of what this means for the novel bidimensionality claim. In this case, researchers would need to reach a consensus on the correlational threshold at which two constructs are considered unidimensional and opposite poles of a continuum from a fixed to a growth mindset.

The present sample was large and diverse, and consisted only of adolescents, namely, tenth graders in the United States. The mindset measure referred to

mathematical ability, rather than general intelligence (as in the original mindset scales). This is consistent with existing research on growth mindset, which is concerned with educational outcomes in adolescents (e.g., Claro et al., 2016; King & Trinidad, 2021; Lou & Li, 2022; Yeager et al., 2019), and a substantial amount of these studies have a specific focus on mathematics and related abilities (e.g., King & Trinidad, 2021; Yeager et al., 2019). Nevertheless, future work should extend our analyses to growth mindset measured across different domains and for different abilities, ideally with samples that span other age groups and national cultures.

5 Conclusion

Growth mindset is a psychological construct that is widely researched and informs policy and educational reform. However, its theory and measurement have been criticized for some time. In the present paper, we add to one line of criticism that revolves around the conceptualization of mindset and the measures currently used to assess it. In a large sample of adolescents, we showed that the forward-keyed growth mindset item and its reverse-keyed fixed mindset counterpart (1) were only moderately negatively correlated with each other and (2) had substantially different associations with external criteria prominent in the literature, sometimes leading to different interpretations. This result is at odds with the notion that growth and fixed mindset items stemming from Dweck's *Implicit Theories of Intelligence Scale* (1999) measure opposite poles of a unidimensional construct. There are three possible explanations for these findings. Participants' acquiescent response biases could reduce the negative correlation between growth and fixed mindset items. Alternatively, growth and fixed mindset may be two separate dimensions, rather than opposite poles of the same continuum (see e.g., Glerum et al., 2020; Li & Bates, 2020; Lou et al., 2021; Scherer & Campos, 2022). Finally, the wording of the items might lead respondents to believe that growth mindset refers to learnability, whereas fixed mindset refers to heritability, two concepts that are independent of each other.

Our results underscore the importance of rethinking the existing assessment of mindsets by more carefully considering item keying (growth vs. fixed), construct dimensionality (unidimensional vs. bidimensional), and item wording. For now, we suggest that scientists use average scores of balanced numbers of oppositely keyed items, including both mindset frames, as well as also to report the results for both the fixed and growth mindset scales separately. While focusing on the balanced scale score is consistent the original mindset theory (Dweck, 1999), reporting the results for fixed and growth mindset items separatelyis consistent with our findings as well as the recent findings by Scherer and Campos (2022), suggesting that the two mindsets may represent different dimensions. Until the debate about the dimensionality of mindset is resolved and a consensus is reached, we advocate for full transparency regarding mindset associations with relevant outcomes and sociodemographics.

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Declarations

Competing interest The authors declare no competing interests.

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