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Measuring Growth Mindset

Validation of a Three-Item and a Single-Item Scale in Adolescents and Adults

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Abstract: A growth mindset is a belief that personal characteristics, specifically intellectual ability, are malleable and can be developed by investing time and effort. Numerous studies have investigated the associations between a growth mindset and academic achievement, and large intervention programs have been established to train adolescents to develop a stronger growth mindset. However, methodological research on the adequacy of the measures used to assess a growth mindset is scarce. In our study, we conducted one of the first comprehensive assessments of the psychometric properties of Dweck’s widely used three-item Growth Mindset Scale in two samples (adolescents aged 14–19 years and adults aged 20–64 years). We test the comparability (i.e., measurement invariance) of the scale across these age groups. Furthermore, using the same two samples, we identified and validated a single-item measure to assess growth mindset in settings with severe time constraints. Results reveal that both the three-item and the single-item scales have acceptable psychometric properties regarding reliability, comparability, and validity. However, the results did not support some of the central tenets of mindset theory, such as that a growth mindset is positively linked to goal regulation and achievement, calling for future research on the criterion validity of a growth mindset.

Keywords: growth mindset, single-item scale, German validation, adolescents and adults, Big Five



A growth mindset is a belief that personal characteristics, specifically intellectual ability, are malleable and can be cultivated. In the theory of growth mindset, Carol Dweck (1999, 2006) distinguished two mindsets: a growth mindset and a fixed mindset. Whereas people with a growth mindset believe that their ability and intelligence can be developed over time, those with a fixed mindset believe that they were born with a certain invariant amount of ability that cannot be increased through effort and experience over time. According to Dweck’s theory, these mindsets differentially affect achievement motivation: Students with a fixed mindset tend to avoid challenges and negative feedback and give up easily, whereas students with a growth mindset embrace challenges, persist in the face of setbacks, and learn from criticism (Dweck, 2016).

The growth mindset and its implications for academic achievement have received enormous attention from policy-makers, educators, and the media over the past two decades (e.g., Eisenberg, 2005; Paul, 2013; Smith, 2014). The White House (Obama Administration) even convened a special meeting in May 2013 entitled “Excellence in Education:

The Importance of Academic Mindsets,” and Boaler (2013) hailed the findings of mindset research as the basis of “the mindset revolution that is reshaping education.” Subsequently, funding for mindset research was sought as a “national education priority” (Rattan et al., 2015, p. 723), resulting in a vast body of – mostly applied – research testing the basic assumptions of Dweck’s theory. In addition, given the postulated association between a growth mindset and academic achievement, extensive interventions were funded to increase academic performance and reduce rates of school dropout among adolescents (Sisk et al., 2018; Yeager et al., 2019).

Several meta-analyses have summarized the findings of numerous studies on the antecedents and consequences of having a growth versus a fixed mindset. Their results indicate that a growth mindset is positively associated with various self-regulatory processes and negatively associated with psychological distress (Burnette et al., 2013; Burnette et al., 2020). This supports Dweck’s assumption that a growth mindset is related to achievement motivation. Regarding her second central assumption – namely, that a growth mindset is predictive of academic achievement – the evidence is less clear. Several comprehensive national/regional and international large-scale studies, for example, a study of mindset among students in California’s CORE school districts (Claro & Loeb, 2019) and the OECD’s Programme for International Student Assessment

(PISA; OECD, 2019), support the hypothesized link between growth mindset and academic achievement. In PISA, for example, students who reported a fixed mindset scored on average about one-fourth of a standard deviation (23–32 scale points) lower in all skills assessed.¹ However, in other studies (both small- and large-scale), the association between growth mindset and academic achievement was found to be zero, or even negative (e.g., Bahnik & Vranka, 2017). A recent meta-analysis by Sisk and colleagues (2018) summarized the findings of the existing 273 studies on growth mindset and found only a very weak positive association overall between growth mindset and academic achievement.

The effectiveness of growth mindset interventions is also debated. Based on their meta-analysis of 43 such interventions, Sisk et al. (2018) concluded that the overall effects of mindset interventions on academic achievement were weak (but see Yeager & Dweck, 2020, who criticized this conclusion, arguing that the effect size is acceptably large). However, some results of the studies reviewed in the meta-analysis indicated that students with low socioeconomic status or students who are academically at risk might benefit from such interventions.

Given the vast amount of attention that the growth mindset has received in both academic and applied circles and the vast body of research on the construct, one would expect that this line of research would be based on a set of well-validated scales for the assessment of growth mindset. This, however, is not the case. There are few, primarily two, established scales assessing growth mindset, namely a more comprehensive, six- to eight-item scale (Dweck, 1999), also sometimes referred to as the Implicit Theories of Intelligence Scale (ITIS; see, e.g., Troche & Kunz, 2020) or the Growth Mindset Scale (Midkiff et al., 2017) and its short-scale version, comprising three items, developed as part of Dweck's (Dweck et al., 1995) broader Implicit Theories Scale. Surprisingly, little research has been conducted on the psychometric properties of the scales (see Midkiff et al., 2017), especially regarding the short, three-item scale. With regard to the eight-item scale, the few studies conducted to date have yielded mixed results on the quality of the existing growth mindset scales. Levy and Dweck (1999) as well as Erdley and Dweck (1993) report only moderate internal consistencies (.62 and .71, respectively) and test-retest stabilities across a short 1-week interval (.70 and .64, respectively). In addition, two studies indicated that the eight items did not fit a unidimensional model (Midkiff et al., 2017; Troche & Kunz, 2020). For the three-item scale,

Dweck herself conducted a series of validation studies demonstrating its high internal consistency (.94–.98) and test-retest stability (.80 across a 2-week interval) as well as its unidimensionality (Dweck et al., 1995). In these studies, she could also show that the growth mindset measured by the three-item scale is largely independent of other constructs such as intelligence or optimism.

The current trend of assessing growth mindset in individual diagnostic settings and in large-scale surveys with extreme time constraints raises the need for a highly efficient, parsimonious, and valid assessment of this construct. Because of the lack of validation studies to guide item selection, current large-scale studies have adopted different subsets of the existing growth mindset items in an ad hoc manner, thus yielding different solutions for the different surveys. The latter may gravely hamper the comparability and replicability of the respective research findings. For example, whereas the CORE survey of 4th–7th-grade students in California selected four items from Dweck's eight-item scale (Claro & Loeb, 2019), PISA used a single-item measure by selecting one item from Dweck's three-item scale (OECD, 2021), and a nationwide survey of high school students in Chile used two items from Dweck's six-item scale (Claro et al., 2016). To our knowledge, no studies have psychometrically validated a short (e.g., three-item) or ultra-short (single-item) measure of growth mindset for use in settings where questionnaire space is severely restricted.

Unsurprisingly, given the scope of growth mindset, most studies on the construct focus on primary and secondary school settings and thus investigate children and adolescents. Also, the above-mentioned original growth mindset measures were developed and validated for these populations. However, the relevance of a growth mindset for adults is often stressed (see Han & Stieha, 2020, for a review of recent applications in human resource development). The few studies investigating growth mindset in adult samples (usually college students) have simply adopted the usual growth mindset items verbatim without methodologically testing their appropriateness for this age group (see, e.g., Midkiff et al., 2017; Thompson et al., 2013).

In sum, research on growth mindset does not currently rest on a solid psychometric footing. In addition to this general need for further scrutiny of the psychometric quality of commonly used growth-mindset measures, there is also a need for short and ultra-short measures of growth mindset for use in survey research – and a need for scales that can be validly applied to adult samples.

¹ Notably, the effect of growth mindset on cognitive skills was with differences in skills between students with high and low self-reported growth mindset between 12 and 17 points (i.e., a standardized effect size between .04 and .06) small in Germany compared to other countries participating in PISA.

The Present Study

The aim of the present study is twofold: First, given the lack of empirical validation studies, we aim to validate Dweck's widely used three-item Growth Mindset Scale and examine its psychometric properties in terms of descriptive statistics, reliability, factorial validity, and its nomological network. To this end, we have developed a new German-language version of the instrument. We will conduct validation in parallel for the typical target group of adolescents as well as for adults who are no longer in primary or secondary education, for which no validated instruments assessing growth mindset exist so far. Therefore, we focus our analyses on testing the applicability (including measurement invariance) of the scale in adolescent and adult populations. Therefore, we use adolescent and adult samples, both of which are heterogeneous regarding the target population.

Our validation strategy also includes assessing the nomological network for the growth mindset measure. However, given the lack of such psychometric validation studies on growth mindset, it is difficult to posit clear-cut hypotheses regarding the criterion validity of the scale. First, for adult populations – and especially for adults who are no longer in education – empirical findings are extremely scarce, and it is somewhat unclear what meaningful criterion variables might be. For adolescents, very few associations between growth mindset and external criteria are substantial and replicable. Although Dweck's mindset theory postulates a link between a growth mindset and academic achievement, this link was not replicated in several recent studies (e.g., Bahník & Vranka, 2017; see also meta-analyses by Sisk et al., 2018). Likewise, though Dweck found that students from lower socioeconomic status households were less likely to hold a growth mindset (Claro et al., 2016), socioeconomic differences in growth mindset are debated (see Destin et al., 2019; King & Trinidad, 2021). Similarly, a stronger fixed mindset was postulated for girls/women (see Dweck, 1999), which was also not replicated empirically (e.g., Spinath & Stiensmeier-Pelster, 2001). With regard to age and personal characteristics such as optimism, self-esteem, and intelligence, theoretical assumptions and empirical findings agree that these are largely unrelated to a growth mindset (e.g., Dweck, 1999; Dweck et al., 1995). Similarly, basic dimensions of personality in the Big Five, investigated only in one study so far (Zamarro et al., 2016), seem to be mostly independent of a growth mindset. Only for aspects of self-regulation, there is support for a positive – albeit small – association with a growth mindset (see meta-analysis by Burnette et al., 2020).

Thus, based on previous studies and theoretical assumptions, we expect the growth mindset measure to be mostly independent of other personal and sociodemographic vari-

ables. Also, with regard to academic achievement, the existing data is not clear enough to formulate directed hypotheses. Only with regard to self-regulation, we can assume a small positive association.

The second aim of our study is to identify and validate an ultra-short, single-item measure of growth mindset to be used in large-scale settings (either in adolescent or adult populations) in which even the three-item scale may be too lengthy. By doing so, we hope to support large-scale studies using a highly time-effective but validated alternative to the three-item Growth Mindset Scale.

In sum, with the present paper, we attempt to increase the comparability of future studies by providing extensive information on the psychometric properties of two very short, viable options for assessing a growth mindset.

Method

Samples

We used data from a large multi-thematic, four-wave survey in which several measurement instruments were validated. The survey comprised a total of four assessment waves and two samples residing in Germany, one targeting adolescents aged 14–19 years (Sample A), the other targeting adults aged 20–64 years (Sample B). The adolescent sample had a quota for gender, whereas the adult sample had quotas for age, gender, and educational attainment, according to the German Microcensus 2011. The survey was conducted by the online survey provider respondi AG. Respondents received a small monetary remuneration for participation.

For our analyses of growth mindset, we used data from those adolescents and adults who participated in the second survey wave (fielded between February 2 and February 21, 2021; $n = 365$ adults; $n = 362$ adolescents), in which we first assessed growth mindset. A retest of the growth mindset followed approximately 4 months later in the fourth and final survey wave (fielded between May 21 and June 6, 2021; $n = 263$ adults; $n = 171$ adolescents). Some additional measures that we used to assess the nomological network of growth mindset were also taken from the first (January 21 to February 1, 2021; $n = 365$ adults and $n = 362$ adolescents) and third (March 8 to March 30, 2021; $n = 300$ adults and $n = 256$ adolescents) survey waves. The median spacing between the two assessments was 109 days.

For an independent assessment of the psychometric properties of our proposed single-item measure, we (a) analyzed the German data of PISA 2018 (OECD, 2020; here Sample C), in which the same item was assessed based on $N = 4,235$ 15-year-olds and assessed the single item in

Table 1. Sociodemographic descriptives of Samples A, B, and D

	N	Female (%)	Age			Education		
			M	SD	Range	Low (%)	Intermediate (%)	High (%)
Sample A (Adolescents)	360	66	17.27	1.57	14–19	8	22	70
Sample B (Adults)	368	47	43.88	12.93	20–64	25	34	41
Retest Sample A	155	68	17.32	1.53	14–19	5	22	73
Retest Sample B	264	47	44.28	12.46	20–64	21	45	34
Sample D	794	49	42.74	13.64	18–65	24	35	31

Note. "Education" refers to the school track attended (adolescents) or the highest educational qualification obtained (adults).

a separate online sample (Sample D) of $N = 794$ adults (fielded between February 17 and February 26, 2022). Sample D had the same quotas for gender, age, and education and was collected via the same provider as the initial adult sample. Table 1 shows the sociodemographic profiles of samples A, B, and D. The raw data of these samples is available from the OSF project website at <https://osf.io/etx7j> (Lechner, Rammstedt, et al., 2022).

Instruments

Growth Mindset

In Samples A and B, we measured growth mindset using a newly developed German-language adaptation of Dweck's three-item measure (Dweck et al., 1995), which is the most widely used growth mindset short scale in applied research to date (e.g., Blackwell et al., 2007; Romero et al., 2014; Yeager et al., 2019). All three items are formulated as fixed mindset statements. They are answered on a 6-point rating scale ranging from 1 = *fully agree* to 6 = *fully disagree*, such that higher values imply a growth mindset. In Samples C and D, only one single item of the three items was assessed; Sample C (PISA), however, used a 4-point response scale.

We translated the three items using the TRAPD approach (Harkness et al., 2010). Two experts in personality assessment – both native speakers of German with a very good command of English – translated the items from English to German. Two independent experts in cross-cultural research and personality assessment then reviewed these translations and suggested improvements as necessary. At a reconciliation meeting in which all the aforementioned experts participated, we resolved any remaining disagreements through discussion and agreed on the final translation. The original English-language source version and the final translations of the instruction, items, and response-scale labels are provided in Table A1 in the Appendix. Note that for all questions in the questionnaire (including growth mindset and the following criterion variables), there was a questionnaire split such that adolescents were addressed by the informal you (German "Du"), whereas adults were addressed with the formal you (German "Sie").

Correlational Variables

Based on previous research and theoretical assumptions, we selected a set of correlates to validate the three-item Growth Mindset Scale as well as the single-item measure derived from it and explore the nomological network of the construct. These were mainly assessed in our Samples A and B, some of them also in Sample D. First, to explore whether there are differences in growth mindset across different subsegments of the population, we investigated associations between growth mindset and sociodemographic characteristics. The latter included gender, age, education (clustered according to the highest degree into low), intermediate and high. Low refers to a lower secondary level providing a basic general education; intermediate also refers to a lower secondary level that provides a more extensive general education and an opportunity to continue to the upper secondary level; high refers to an upper secondary level (that leads to a higher education entrance qualification), parental education (only in Sample A), employment status (only in Samples B and D; coded as unemployed (1) vs. (self-)employed (2)), and income (only in Samples B and D; assessed by 17 categories ranging from < 300€ to $\geq 10,000$ €/month).

Second, to establish the nomological network of growth mindset in relation to other established individual-difference constructs, we investigated associations between growth mindset and other key personality constructs, namely, the Big Five (measured using the BFI-2-S; Soto & John, 2017; German adaptation Rammstedt et al., 2020), self-regulation skills, and goal regulation (all only in Samples A and B). The measures of the latter two constructs were taken from the German-language version of the Behavioral, Emotional, and Social Skills Inventory (BESSI-G; Lechner, Knopf, et al., 2022).

Third, to test the (concurrent) criterion validity, we tested associations between growth mindset and indicators of achievement and ability, namely, self-reported final overall grade and grades in various subjects (math, German, English, history, and biology) in Sample A; and crystallized intelligence (gc) as well as fluid intelligence (gf) in Samples A and B.

We assessed crystallized intelligence (gc) with the short version of the Berliner Test zur Erfassung fluider und

kristalliner Intelligenz (BEFKI GC-K; Schipolowski et al., 2013). BEFKI contains 12 items that cover basic knowledge from humanities, natural and social sciences. The reliability of the 12-item BEFKI sum score in our sample was $\alpha = .68$. In the present study, the BEFKI-GC-K was here – in contrast to its validation study – assessed in self-completion mode, thus possibly allowing room for cheating. Our results, however, yield no support for such cheating tendencies as they are highly comparable to the original validation study by Schipolowski et al. (2013; $M = 7.19$, $SD = 2.39$ in the present adult sample compared to $M = 7.04$, $SD = 2.66$).

To assess fluid intelligence (gf), we used 12 items from the International Cognitive Assessment Resource (ICAR; Condon & Revelle, 2014), assessing Verbal Reasoning (VR), Letter and Number Series (LN), and Matrix Reasoning (MR). The reliability of the 12-item sum score of ICAR in our sample was $\alpha = .73$.

Documentation of the criteria variables used can be found in the respective codebooks on the OSF project website at <https://osf.io/etx7j> (Lechner, Rammstedt, et al., 2022).

Data Analysis

We analyzed the quality of our German-language adaptation of the three-item Growth Mindset Scale in terms of its descriptives, reliability, nomological network, and factorial validity. To investigate the factorial (structural) validity of the three items, we estimated a unidimensional confirmatory factor analysis (CFA) model via the R package lavaan using a robust maximum likelihood estimator (MLR) in Samples A and B. Because a single-factor model with three indicators is just-identified ($df = 0$) and would not allow for model fit assessment via fit indices, we tested an essentially tau-equivalent model (i.e., a model in which all items have identical factor loadings). The essentially tau-equivalent model is also more parsimonious. We assessed model fit via Hu and Bentler's (1999) commonly used heuristics for fit indices (i.e., $CFI \geq .950$, $RMSEA \leq .060$, and $SRMR \leq .080$).

To test the applicability and comparability of the three-item Growth Mindset Scale for adolescent and adult populations, we investigated exact measurement invariance using multiple-group CFA based on the assumption of an essentially tau-equivalent model. We tested three levels of invariance²: metric invariance (same factor loadings), scalar invariance (same factor loadings and item intercepts), and strict invariance (additionally, same residual variances). To evaluate invariance across samples, we compared the fit of these models using the differences in the goodness

of fit (ΔGOF), $\Delta\chi^2$, and the sample-size adjusted Bayesian Information Criterion (aBIC) (see Chen, 2007; Putnick & Bornstein, 2016; Rutkowski & Svetina, 2014). Regarding ΔGOF , we followed the simulation-based guidelines proposed by Chen (2007), which stipulate that differences of $\Delta CFI \geq .010$, $\Delta RMSEA \geq .015$, $\Delta SRMR \geq .010$ suggest intercept non-invariance when comparing scalar to metric invariance. Regarding aBIC, lower values indicate a better balance between model fit and complexity (or parsimony).

Results

As outlined above, our study aimed to validate the German-language adaptation of Dweck's three-item Growth Mindset Scale and investigate its applicability to adolescent and adult samples. Second, we aimed to identify and validate an ultra-short, single-item measure for assessing growth mindset in research settings with severe time constraints.

Validation of the Three-Item Growth Mindset Scale

Based on adolescent and adult data from Samples A and B, we investigated the quality of our German-language adaptation of the three-item Growth Mindset Scale in terms of its descriptives, reliability, and factorial validity. We also investigated its associations with sociodemographic variables, personality traits, and indicators of achievement and abilities. To investigate the applicability of the scale to adolescent and adult populations, we conducted all analyses separately for adolescents and adults, compared the results, and formally tested the measurement invariance of the scale across the two samples.

Descriptive Statistics and Reliability

The upper part of Table 2 shows the means, standard deviations, and skewness of the three-item scale, as well as its reliability coefficients in terms of Cronbach's α and test-retest stability over a roughly 4-month (i.e., 109 days in the median) period. Detailed results on the item level are provided on the OSF project website (<https://osf.io/etx7j>; Lechner, Rammstedt, et al., 2022). Means, standard deviations, and skewness were highly comparable across the adolescent and adult samples (Samples A and B). Indicators of reliability were also similar for both samples. Internal consistency coefficients were high in both populations, with

² Note that testing configural measurement invariance is neither possible nor necessary when using an essentially tau-equivalent factor model.

Table 2. Descriptives and reliability of the three-item and the single-item growth mindset scale, separately for adolescents and adults

	<i>M</i>	<i>SD</i>	Skewness	Kurtosis	Reliability	
					α	r_{tt}
Three-item scale						
Adolescents (Sample A)	3.89	1.01	-.19	-.14	.83	.67
Adults (Sample B)	3.73	1.21	-.06	-.53	.91	.45
Single-item scale						
Adolescents (Sample A)	3.96	1.19	-.28	-.30	-	.54
Adults (Sample B)	3.86	1.29	-.13	-.62	-	.43
Adults (Sample D)	4.05	1.35	-.29	-.56	-	-

Note. The score of the three-item scale was computed by taking the mean across all three items. r_{tt} retest-stability over a 4-month period.

Table 3. Model fits of the three-item Growth Mindset Scale for (a) factorial structure (separately for adolescents and adults) and (b) measurement invariance across adolescents and adults

	Factorial validity (fit of essentially tau-equivalent single-factor CFA)		Measurement invariance (across the adolescent and adult sample)		
	Adolescents (Sample A)	Adults (Sample B)	Metric	Scalar	Strict
χ^2	7.83	6.39	14.21	25.23	30.13
<i>df</i>	2	2	4	6	9
<i>p</i>	.020	.041	.007	< .001	< .001
rCFI	.985	.994	.991	.983	.972
aBIC	3,000.600	2,950.023	5,976.612	5,981.152	5,989.873
RMSEA [90% CI]	.090 [.032; .158]	.078 [.017; .146]	.084 [.041; .131]	.094 [.059; .132]	.080 [.055; .107]
SRMR	.061	.044	.043	.048	.051

Note. The measurement model was an essentially tau-equivalent single-factor model in which the factor loadings of all three indicators were constrained to equality. rCFI = robust comparative fit index; aBIC = sample-size adjusted Bayesian criterion; RMSEA = root-mean-square error of approximation; CI = confidence interval; SRMR = standardized root-mean-square residual.

$\alpha = .83$ in the adolescent sample and $\alpha = .90$ in the adult sample. Test-retest stability, r_{tt} , over a 4-month period was somewhat lower than the internal consistencies, with $r_{tt} = .67$ in the adolescent sample and $r_{tt} = .45$ in the adult sample. Note that r_{tt} reflects not only unreliability (i.e., classical measurement error) but also true changes and state fluctuations in a construct, rendering it a conservative estimate of scale reliability.

Factorial Validity

As shown in Table 3, an essentially tau-equivalent single-factor CFA model showed a good fit in both the adolescent (Sample A) and the adult sample (Sample B; e.g., CFI $\geq .985$, RMSEA $\leq .094$). All standardized factor loadings were high ($\lambda > .75$). The German-language version of Item 3 had comparatively the lowest standardized loading on the common factor in both samples (.75 in Sample A and .83 in Sample B), whereas the German-language version of Item 2 loaded highest on average (.81 in Sample A and .92 in Sample B).

Measurement Invariance

As seen from the right-hand side of Table 3, results suggest that the three-item Growth Mindset Scale is largely

measurement invariant across adolescents and adults, even on the strict level. Thus, researchers can make valid comparisons with the mean of the three-item Growth Mindset Scale's manifest scores and perform meaningful regression analyses across the two age groups.

Associations With External Criteria

To investigate the nomological network of the three-item Growth Mindset Scale, we correlated the measure with different sociodemographic, psychological, and achievement indicators, which have been investigated in earlier validation studies. Based on previous findings, we assume – as outlined in the introduction – mostly zero associations. Only with regard to self- and goal regulation, do meta-analytic findings suggest small positive correlations.

The left-hand side of Table 4 shows – separately for adolescents and adults – the correlations between the three-item Growth Mindset Scale and sociodemographic variables (age, gender, own and parental education, employment status, income), central personality characteristics (the Big Five, self-regulation, goal regulation) and aspects of achievement and ability (school grades, crystallized intelligence, and fluid intelligence). The overall picture indicates two things: First, and in line with our assumption,

Table 4. Correlations of the three-item and single-item Growth Mindset Scales with external criteria (separately for adolescents and adults)

	Three-item scale		Single-item scale			
	Adolescents		Adolescents		Adults	
	Sample A	Sample B	Sample A	Sample C; PISA2018	Sample B	Sample D
Sociodemographic variables						
Age	.07	-.01	.09		-.01	.02
Gender	.03	.06	.07	.03	.05	.14
Education (own)	-.11	-.08	-.11		-.05	-.05
Education (maternal)	-.12		-.14	-.01		
Education (paternal)	-.10		-.11	-.01		
Employment status		-.05			-.05	-.01
Income		-.06			-.05	-.06
Personality characteristics						
Extraversion	.09	-.01	.11		-.01	
Agreeableness	.02	.07	-.01		.05	
Conscientiousness	.12	.04	.10		.04	
Neuroticism	-.06	-.05	-.05		-.02	
Openness	.05	.11	.03		.09	
Self-regulation	.07	.07	.04		.04	
Goal-regulation	.04	.06	.05		.04	
Achievement and ability						
Final overall grade	-.06		.00			
Math grade	-.14**		-.10			
German grade	-.04		-.02			
English grade	-.03		-.07			
History grade	-.10		-.05			
Biology grade	-.03		.00			
Crystallized intelligence	-.06	-.12*	-.02	.03	-.07	
Fluid intelligence	-.14**	-.09	-.16		-.03	
Average abs. corr. (all indicators)	.07	.06	.07		.04	
Average abs. corr. (common indicators)	.06	.06	.06		.04	

Note. Average abs. corr. refers to the average of the absolute correlations in a sample. For gender, grades, and employment, higher scores reflect being female, having better grades, and being (self-)employed. In PISA2018, the aggregated scores in the three competence domains reading, math, and science were taken as a proxy for crystallized intelligence. * $p < .05$; ** $p < .01$.

a growth mindset showed mostly zero associations with the investigated sociodemographic variables and personality characteristics (with an average association of $|.07|$ in the adolescent sample and $|.06|$ in the adult sample). Second and more importantly for the current research question, results were highly comparable across adolescents and adults (column vector correlation after applying the Fisher's z transformation to the individual correlations: $r = .73$).

Looking at the associations with sociodemographic variables, we found support for the previous finding that, on average, males and females do not differ in terms of a growth mindset. There were no big age differences, either. Further, we found no effects of own or parental education, indicating that socioeconomic background and educational attainment are unrelated to a growth mindset.

The present results whereby growth mindset also had negligible associations with the Big Five dimensions in both

the adolescent and the adult samples are, for the most part, consistent with the findings of Zamarro et al. (2016).

According to the literature, a growth mindset should be positively related to self- and goal regulation. In the present study, we found no statistically significant relations to either construct, even though the direction of all associations was positive as assumed.

The only statistically significant – albeit also small-sized – associations appeared with achievement and ability items, all of which were counter to mindset theory, indicating that more of a fixed mindset was associated with higher math grades, fluid intelligence, and crystallized intelligence.

Interim Summary

In sum, the results of our study indicate that the three-item Growth Mindset Scale conforms to an essentially tau-equivalent (i.e., equal-weights) single-factor CFA model and shows

measurement invariance across adolescents and adults. Further, the three items proved to be highly internally consistent, indicating room for a further reduction of scale length. Finally, we could replicate the finding that a growth mindset is largely independent of sociodemographic variables and personality traits. For the other investigated constructs, only marginal associations were found in most cases, which in some of these cases contradicts basic assumptions of Dweck's mindset theory, especially the claim that a growth mindset is related to higher achievement.

Selection and Validation of a Single-Item Measure for Growth Mindset

Having established the psychometric properties of the German-language version of the three-item Growth Mindset Scale, we next aimed to identify and validate the item best suited to serve as an ultra-short, single-item measure of growth mindset in adolescents and adults. This measure should allow the assessment of a growth mindset in research settings with extreme time constraints. We investigated the quality of the three items in terms of different criteria and selected the best-fitting item. These criteria were, on the one hand, the above-described empirical quality indicators (item descriptives, retest reliability, factor loadings, correlation with external constructs) and, on the other hand, how verbally intuitive and easy to understand the item was. As an additional criterion, we considered whether each item had already been used in existing large-scale studies. The psychometric properties were highly similar for the three items, with slightly higher loadings on the common growth mindset factor as well as correlations with the full scale in the case of Item 2. The correlations with the external criteria varied slightly for the three items. Contrary to Dweck's hypothesis, Item 1 and Item 3 showed a negative association between growth mindset and achievement, but this was not true for Item 2.

Also, with regard to wording, we deemed Item 2 to be the most straightforward and least double-barreled of the three items. Finally, of the large-scale studies that have investigated growth mindset to date, all have used at least Item 2. In PISA 2018, this item was used as a single-item measure (OECD, 2019). In the CORE survey, Item 2 was used in combination with three other items from a longer growth mindset scale (Claro & Loeb, 2019), and in a nationwide survey of high school students in Chile, Item 2 was used together with Item 3 (Claro et al., 2016)

Therefore, we selected Item 2 ("Your intelligence is something about you that you can't change very much.") as the psychometrically most sound and the most widely used single-item indicator of a growth mindset.

In what follows, we will briefly describe the psychometric performance of the single-item. This was assessed on the one hand based on our Samples A and B, in which all three items were assessed. On the other hand, to assess this item's psychometric quality when fielded as a single-item measure (i.e., without the other two items of the three-item scale), we (a) analyzed the German PISA data (Sample C), thus a comprehensive and representative sample of 15-year-olds in which this item was assessed, and (b) additionally assessed this single item separately in a sample of adults (Sample D).

Descriptive Statistics and Reliability

The lower part of Table 2 shows – separately for Samples A, B, and D – the means, standard deviations, skewness, and test-retest stability over a 4-month period of the single-item measure of a growth mindset (The corresponding results for PISA are not comparable as PISA used a 4-point response scale). The means, standard deviations, and skewness of the single-item measure were comparable to those of the full scale. With regard to its test-retest stability, for the adult sample (Sample B), the single item performed about as well as the full scale (.43 and .45, respectively), while for the adolescents (Sample A), stability was markedly lower (.52 and .67, respectively).

Associations With the Full Scale

One crucial question when reducing the number of items on a scale is how much information is lost as a result. In the present case, the correlations of the selected item with the full scale were $r = .73$ in the adolescent sample and $r = .86$ in the adult sample. Therefore, by reducing the number of items to one-third, it is important to note that in variance terms, especially in the adolescent sample, nearly half of the variance (47%) is lost, while the same reduction of items only reduced the variance by a fourth (26%) in the adult sample.

Associations With External Criteria

The associations of the single growth-mindset item with the diverse external correlates can be found on the right-hand side of Table 4. In general, in all four samples, only small and statistically non-significant associations with the criteria emerged. These associations are – with regard to their size and direction highly comparable to those of the full scale, with only marginal differences in the average absolute correlation ($\Delta r < .01$ and $\Delta r = .02$ in Samples A and B, respectively). In addition, column-vector correlations comparing the pattern of criterion correlations for the full scale against the single-item measure indicate very high comparability – namely, $r = .92$ in the adolescent sample and $r = .97$ in the adult sample. Further, results are also highly comparable for samples assessing all three growth mindset items and those assessing the single item only.

Discussion

Given the broad attention paid to the construct of a growth mindset, methodological investigations on the adequacy of the measurement instruments used to assess it are still surprisingly scarce. This especially holds for Dweck's three-item Growth Mindset Scale (Dweck et al., 1995), despite this scale being one of the most frequently used growth mindset measures. The present study, therefore, aimed to investigate the validity of this three-item Growth Mindset Scale. Specifically, we examined the psychometric properties of a newly developed German-language adaptation of that scale in terms of reliability, structural validity, and external validity. Moreover, and even more importantly, we provide the first evidence about the applicability of the three-item Growth Mindset Scale to adult populations and its measurement invariance across age groups (adolescents and adults). As more and more large-scale studies include growth mindset in their assessments, and no validated ultra-short measure exists for such settings, the second goal of the present study was to identify and validate a single-item measure for the assessment of growth mindset in research contexts with extreme time constraints.

Our findings show that the three-item Growth Mindset Scale is sufficiently reliable and that an essentially tau-equivalent model shows a good fit for the scale. Moreover, the scale achieved high levels of comparability across an adolescent and an adult sample: scale means, reliability coefficients, factor loadings, and correlations with external criteria were highly similar across the two populations. Last, and most importantly, the formal test of multi-group confirmatory factor analysis across samples confirmed the measurement invariance of Dweck's three-item scale across adolescents and adults. The level of invariance achieved (scalar invariance) indicates that researchers can validly compare correlations and means across these age groups based on observed scale scores.

Its brevity notwithstanding, the three-item scale was highly internally consistent in adolescent and adult samples. By contrast, test-retest stability coefficients over a 4-month period were only moderate, especially among adults. For adolescents, the found coefficients are somewhat lower than those reported by Dweck herself for the three-item scale (based on an only 2-week intervals), but mostly in line with previous research based on the 8-item growth mindset scale and only 1-week intervals (see Erdley & Dweck, 1993; Levy & Dweck, 1999). The slightly lower stability in the adult sample might reflect that intelligence and the desire to increase it is less salient in populations no longer in primary and secondary education. The three items formed a clear common factor, thus underlining the factorial validity of the scale.

Investigating the construct validity of the scale based on the nomological network of a growth mindset is difficult because, for most external criteria, the associations are debated. However, our results support previous evidence insofar as we found that growth mindset was largely unrelated to the sociodemographic variables gender and age, as well as to personal characteristics such as intelligence and personality. Crucially, our findings did not support Dweck's – recently disputed (see e.g., King & Trinidad, 2021; Macnamara & Rupani, 2017; Sisk et al., 2018) – assumption of a positive link between growth mindset and academic achievement. If anything, and in line with previous studies (e.g., Yan et al., 2014), our results suggest a slight tendency toward an inverse association between the two variables. Thus, more research on the sensitivity of growth mindset measures for group differences and especially their predictive validity for achievement is needed.

Based on an in-depth analysis of Dweck's three-item scale, we propose a single-item measure to assess growth mindset in research contexts with extreme time constraints. We showed – based on our adolescent and adult samples as well as on an independent adult sample and a re-analysis of the PISA data, both assessing the single item only – that the indicators for the selected item were highly comparable to those of the full-scale.

The present paper empirically complements the existing research on growth mindset by (a) providing methodological evidence that one of the most frequently used growth mindset measures – the three-item Growth Mindset Scale – is equally applicable to adolescent and adult populations and (b) proposing a single-item scale that allows large-scale studies to use an ultra-short but validated measure of a growth mindset. It should be noted, however, that the present study is limited insofar as we tested the measurement invariance and the performance of the growth mindset measures only in adolescent and adult samples in Germany. The extent to which the invariant usability of the three-item scale also holds for other languages and cultures still needs to be investigated. Moreover, the measurement invariance of the three-item scale across national languages for cross-national comparisons has yet to be established. However, our proposed single-item measure of growth mindset has already been widely and internationally tested in the context of PISA 2018 (OECD, 2019, 2021), thus proving its adequacy for an assessment of growth mindset in contexts with severe time constraints.

Another limitation of the current research – and growth mindset scales in general – can be seen in the vocabulary used in the item phrasing. Nearly all items refer to “intelligence” without defining this construct. Recent research has shown that participants (at least university students) interpret this term differently and that their interpretations

affect how they respond to the items, which limits the measure's response process validity (Limeri et al., 2020).

Although the three-item and single-item growth mindset scales under study here are already widely used in applied research, we submit that future research should aim to validate further and improve measures of a growth mindset. For example, we see some room for improvement with regard to external validity. Through such continuous development and validation efforts, research on the growth mindset can be put on the solid psychometric footing required for valid and replicable research findings (Flake et al., 2017).

In sum, the present study provides evidence that the (German version of the) existing three-item Growth Mindset Scale, which to date has been applied mainly to adolescent populations, is equally applicable to adult populations. Further, we present a validated single-item measure of growth mindset that allows an assessment whose psychometric quality is comparable to that of the full three-item scale and that can thus be used in research settings with extreme time constraints.

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Open Science

We report how we determined our sample size, all data exclusions (if any), all data inclusion/exclusion criteria, whether inclusion/exclusion criteria were established prior to data analysis, all measures in the study, and all analyses including all tested models. If we use inferential tests, we report exact *p* values, effect sizes, and 95% confidence or credible intervals.

Open Data: The information needed to reproduce all of the reported results are openly accessible (<https://osf.io/etx7j>; Lechner, Rammstedt, et al., 2022).

Open Materials: I confirm that there is sufficient information for an independent researcher to reproduce all of the reported methodology (<https://osf.io/etx7j>; Lechner, Rammstedt, et al., 2022).


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Appendix

Table A1. Three-item Growth Mindset Scale: Original English-language version and German-language adaptation

	Original wording	German translation
Instruction	How much do you agree with the following statements?	Wie sehr stimmen Sie folgenden Aussagen zu?
Item 1	You have a certain amount of intelligence, and you can't really do much to change it.	Sie haben ein bestimmtes Maß an Intelligenz und können nicht wirklich viel daran ändern.
Item 2	Your intelligence is something about you that you can't change very much.	Ihre Intelligenz ist eine Eigenschaft, die Sie nicht groß verändern können.
Item 3	You can learn new things, but you can't really change your basic intelligence.	Sie können neue Dinge lernen, aber Ihre grundsätzliche Intelligenz können Sie nicht wirklich verändern.
Response scale		
1	Strongly disagree	Stimme gar nicht zu
2	Disagree	Stimme nicht zu
3	Mostly disagree	Stimme eher nicht zu
4	Mostly agree	Stimme eher zu
5	Agree	Stimme zu
6	Strongly agree	Stimme voll und ganz zu

Note. To compute a growth mindset score, values of all items are to be inversed and were inversed for all analyses of the present paper.