

# The factorial structure and construct validity of a German translation of Dweck's Implicit Theories of Intelligence Scale under consideration of the wording effect

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Stefan J. Troche<sup>1</sup> & Alexandra Kunz<sup>1</sup>

<sup>1</sup> Institute of Psychology, University of Bern, Bern, Switzerland

**Abstract:**

Dweck's Implicit Theories of Intelligence Scale (ITIS) assesses laypersons' belief that their own intelligence is a fixed (entity theory) or a malleable trait (incremental theory). The ITIS implies a unidimensional construct but studies using confirmatory factor analyses identified entity and incremental theories as two distinct constructs. Negative wording of half the ITIS items might artificially cause this finding. In two studies, the factorial structure of a German translation of the ITIS was examined in 292 and 195 participants, respectively. Despite high internal consistency (Cronbach's  $\alpha > .90$ ), a one-factor measurement model did not describe the data well. A two-factor model described the data better, but a wording-effect model provided the best data description indicating a unidimensional construct with a biasing method effect due to negatively worded items. Implicit theories of intelligence were related to goal choice orientation, general self-esteem and lack of confidence in test situations but unrelated to the Big Five personality traits and aspects of procrastination. Thus, considering the wording effect in the ITIS substantially improved data description and interpretation but did not challenge previous results on the nomological network of implicit theories of intelligence.

**Keywords:**

implicit theories of intelligence, wording effect, confirmatory factor analysis

## Introduction

Implicit theories of intelligence refer to laypersons' or experts' conceptions of intelligence as resided in their minds and, in contrast to experts' explicit theories, not based on scientifically tested data (Sternberg, Conway, Ketrone, & Bernstein, 1981). Some researchers investigated the implicitly assumed structure of intelligence (Lim, Plucker, & Im, 2002; Sternberg et al., 1981). Other research emphasized individual differences in laypersons' belief of whether their intelligence is a fixed trait or a malleable characteristic (Dweck, 1999; Martin, Bostwick, Collie, & Tarbetsky, 2017). Accordingly, Dweck and Leggett (1988) differentiated between individuals who hold an entity theory and believe in intelligence as a fixed trait and individuals who hold an incremental theory and view intelligence as being developable by learning and experience. In the present paper, the term "implicit theories of intelligence" refers to this differentiation between the belief in an entity or an incremental theory of intelligence.

Most research on implicit theories of intelligence is concerned with their influence on achievement motivation and, more specifically, on goal and task choice (Dweck, 1999; Martin et al., 2017). When being able to choose between different tasks, individuals holding an entity theory prefer tasks, with which they can demonstrate their ability and avoid the risk to fail. Thus, they have performance goals rather than learning goals, because a possible failure would indicate that their ability is insufficient. Individuals holding an incremental theory, on the contrary, are less concerned with failure as long as they can increase their ability and learn something new by the task (Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2013; Dinger, Dickhäus-

er, Spinath, & Steinmayr, 2013; Haimovitz, Wormington, & Henderlong Corpus, 2011; Robins & Pals, 2002).

The finding that individuals holding an entity theory are concerned with failure is consistent with their report of more procrastination behavior and less positive school feelings compared to individuals holding an incremental theory (Mouratidis, Michou, & Vassiou, 2017; Rickert, Meras, & Witkow, 2014). It could be expected, therefore, that implicit theories of intelligence are related to self-esteem. Studies on this assumption, however, obtained mixed results. Dweck et al. (1995) found no significant relationship between implicit theories of intelligence and self-esteem. Other studies reported a positive relationship between the belief in an incremental (vs. entity) theory and self-esteem (Diseth, Meland, & Bredablik, 2014; Robins & Pals, 2002).

Of particular interest for the present study are differences in the assessment of implicit theories of intelligence. Dweck (1999) introduced the Implicit Theories of Intelligence Scale (ITIS) as an eight-item questionnaire to assess implicit theories of intelligence with four items on the entity theory (e.g., "Your intelligence is something about you that you can't change very much.") and four items on the incremental theory (e.g., "You can even change your basic intelligence level considerably."). The items are answered on a six-point Likert scale from 1 (strongly agree) to 6 (strongly disagree). Thus, after reversing the items on the entity theory, high sum scores indicate a strong belief in an entity theory and low sum scores in an incremental theory. It should be noted that such a sum score implies the assumption of a unidimensional construct with individuals holding an entity theory at one pole of the dimension, individuals holding an

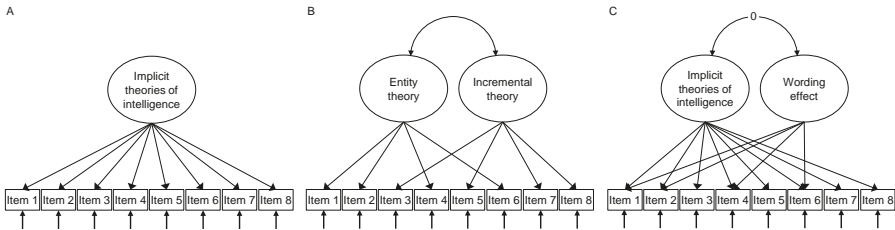
incremental theory at the other pole, and many individuals scoring in between. The assumption of unidimensionality is supported by the high internal consistency with Cronbach's  $\alpha \approx .90$  (e.g. Rickert et al., 2014). Some researchers, however, build separate scores for the entity and incremental items (Bråten & Stømsø, 2005; Diseth et al., 2014; Martin, 2015; Wang & Ng, 2012). Thus, this procedure suggests that entity and incremental views on intelligence are distinct (albeit correlated) constructs. Although it seems as if the assumption of two distinct constructs describes empirical data better than the assumption of unidimensionality (Diseth et al., 2014), it is difficult to explain how an individual can hold concurrently an entity theory and an incremental theory. Martin et al. (2017) recommended choosing one or two ITIS scores in accordance with the research need of the respective study.

Alternatively, the question of the dimensionality of the ITIS might be answered by an empirical investigation of its factorial structure. Such an investigation and systematic comparison of the two conceptualizations of the ITIS is still pending. Furthermore, it might be complicated by the fact that the four items on an incremental theory are positively worded while the four items on an entity theory are negatively worded. The negative wording of some items is recommended in order to reduce the impact of the acquiescence bias. The negative wording, however, can lead to common variance of these items beyond the variance they share due to the actual construct intended to be measured. This can result in the empirical finding that negatively and positively worded items load on different factors (DiStefano & Motl, 2006; Molina, Rodrigo, Losilla, & Vives, 2014). Consequently, a unidimensional structure is prone to become blurred

and to be mistaken for a two-dimensional structure due to differently worded items (Molina et al., 2014). In the framework of confirmatory factor analyses, the presence of a wording effect can be investigated by bifactor models (Schweizer & Troche, 2016). In these models, one latent variable is extracted from all items of a scale while an additional latent variable describes the common variance of the negatively worded items. Such controlling for the wording effect facilitates the detection of unidimensionality of the construct underlying a scale composed of positively and negatively worded items. Neglecting the wording effect, on the contrary, might easily lead to the wrong conclusion of two distinguishable factors.

Thus, the major aim of the present study was to investigate the factorial structure of a German translation of Dweck's (1999) ITIS. More specifically, in two studies, the one-factor model with the assumption of unidimensionality was systematically compared to a) the two-factor model with the assumption of holding entity and incremental theories being two distinct (albeit related) constructs and b) a bifactor wording-effect model. The three competing models are depicted in **Figure 1** with the one-factor model in panel A, the two-factor model in panel B and the wording-effect model in panel C. For the purpose of this investigation, the items of the ITIS were translated into German and the resulting scale was examined with regard to its psychometric properties and factorial structure. Furthermore, relationships between implicit theories of intelligence and constructs previously reported to be (or not to be) associated with implicit theories of intelligence were investigated to probe whether they can be confirmed with the best fitting measurement model of the German translation of the ITIS.

**Figure 1** Three measurement models on the factorial structure underlying the ITIS items.  
 A) The one-factor model with the assumption of unidimensionality.  
 B) The two-factor model with the assumption of entity and incremental theories as two distinct constructs.  
 C) The wording-effect model with the assumption of unidimensionality and a bias due to the wording-effect.



## Study 1

The first study investigated the reliability and factorial structure of the translated version of the ITIS as well as its relationship to goal choice, procrastination and the Big Five personality traits. As recommended by Borsa, Damásio, and Bandeira (2012), two native German speakers translated the original eight items and answer options of Dweck's (1999) ITIS into German (see also International Test Commission, 2017). Both translators were fluent in English and the translations were done independently from each other. The resulting versions were discussed between the two translators regarding differences and a synthesis was obtained. This synthesis was re-translated into English by two independent native English speakers. Deviations between the re-translated versions and the original English version were discussed and the German wording was adapted when necessary.

With regard to the construct validity, we expected that individuals with an entity theory (vs. incremental theory) would have a tendency to prefer performance goals rather than learning goals (Burnette et al., 2013; Dinger et al., 2013; Haimovitz et al., 2011; Robins & Pals, 2002) and would report more procrastination-related behavior (Mouratidis et al., 2017; Rickert et al., 2014). Furthermore, global personality variables such as the Big Five were expected to be independent of implicit theories of intelligence as previously reported by Spinath, Spinath, Riemann, and Angleitner (2003). Thus, these personality variables should provide evidence for discriminant validity of the ITIS.

## Method

### Participants

A total of 295 participants (150 women) took part in Study 1. Their age ranged from 18 to 33 years ( $M \pm SD = 23.3 \pm 3.1$  years). Due to incomplete responses, the ITIS data of three participants could not be analyzed, so that the final sample size was 292. Six participants reported a university degree, 232 participants (mainly students of different disciplines) hold the university entrance qualification as the highest education, 23 the vocational baccalaureate diploma, and 33 the secondary school or vocational extension certificate.

### Implicit Theories of Intelligence

Like the original version, the German version of the ITIS consists of eight items. Four items point to an incremental theory of intelligence and four items to an entity theory. The four items on an incremental theory were positively worded (e.g., "You can even change your basic intelligence level considerably.") while the four items on an entity theory were negatively worded (e.g., "Your intelligence is something about you that you can't change very much."). All items were answered on a Likert scale ranging from 1 (strongly agree) to 6 (strongly disagree). For data analyses, responses on the four items pointing to an entity theory were recoded so that higher scores indicated a stronger tendency to an entity rather than an incremental theory of intelligence. Afterwards, all item scores were re-scaled from 0 to 5.

### Goal choice

Dweck's (1999) goal choice questionnaire consists of four items. The first three items are statements on whether participants

prefer "learning something new" or "good performance" when challenged by a task (e.g., "It's much more important for me to learn things in my classes than it is to get the best grades."). Participants choose one out of six answer options with 1 (strongly agree) to 6 (strongly disagree). Higher scores on the first two items indicate a preference of learning while a higher score on the third item indicates a preference of performance. Responses to the first and second item were reversed. Thus, higher scores on the first three goal choice items indicate a preference of good grades or good performance over challenges or learning. In a fourth question, participants completed the sentence "If I had to choose between getting a good grade and being challenged in class, I would choose...". The answer options were "good grade" (coded as 2) and "being challenged" (coded as 1).

### Personality

The Big Five Inventory (BFI; Lang, Lüdtke, & Asendorpf, 2001) was used to assess neuroticism (7 items), extraversion (8 items), openness to experience (10 items), conscientiousness (9 items), and agreeableness (8 items) as broad dimensions of personality. Participants indicate their agreement with the statements on a five-point Likert scale ranging from "very good" to "not at all". Lang et al. (2001) reported internal consistencies of  $\alpha = .62$  to  $.77$  for neuroticism,  $\alpha = .76$  to  $.84$  for extraversion,  $\alpha = .82$  to  $.86$  for openness to experience,  $\alpha = .65$  to  $.68$  for conscientiousness, and  $\alpha = .49$  to  $.61$  for agreeableness.

### Procrastination

The General Procrastination Questionnaire (GPQ; Höcker, Engberding, & Rist, 2013) differentiates between "procrastination" as the

tendency to postpone personally important tasks (seven items), "task aversiveness" as the strength of unpleasant feelings associated with the tasks (six items), and "preference of alternatives" as the willingness to prefer less important tasks (five items). Each item consists of a statement (e.g., "I postpone important tasks until the very last moment.") and participants indicate their agreement on a seven-point Likert scale ranging from "never" to "always". In the present data, the internal consistencies were  $\alpha = .93$  (procrastination),  $\alpha = .89$  (task aversiveness), and  $\alpha = .84$  (preference of alternatives).

### Statistical analyses

The main focus was on the factorial structure of the eight ITIS items. Using confirmatory factor analysis (CFA), the unidimensionality of the ITIS was investigated by means of the congeneric model, in which all items had factor loadings on one latent variable. Individuals with high scores on this latent variable had a strong belief in an entity theory while individuals with low scores held an incremental theory of intelligence. This model was compared with a two-factor model, in which the four entity-theory items loaded on a first latent variable and the four incremental-theory items loaded on a second latent variable. The two latent variables in the two-factor model were allowed to correlate. Finally, the wording-effect model also comprised two latent variables. The first latent variable was derived from all eight items as in the one-factor model. The four items on an entity theory, which were negatively worded, additionally loaded on the second latent variable. The correlation between the two latent variables was set to zero.

The analyses were conducted with Mplus 8.0 (Muthén & Muthén, 2017). Satorra-Bentler robust maximum likelihood estimation method was used (Satorra & Bentler, 1994) because it is robust against violations of the assumption of normally distributed sample data (e.g., Finney & DiStefano, 2006). Model fit was evaluated by means of the fit indices. A model fit was assumed to be good when the  $\chi^2$  value was not more than twice the degrees of freedom and to be acceptable when less than three times the degrees of freedom (Kline, 2011). Furthermore, model fit was evaluated as acceptable when the Comparative Fit Index (CFI) was larger than .950, the Root Mean Square Error of Approximation (RMSEA) was smaller than .080, and the Standardized Root Mean Square Residual (SRMR) was smaller than .080 (Browne & Cudeck, 1993; Hu & Bentler, 1999). Models were compared to each other by means of differences in the Akaike Information Criterion (AIC) and the CFI.

Results

### Results

For the eight items of the ITIS, mean values, standard deviations, and part-whole corrected item-total correlations are presented in Table 1. The high internal consistency of the ITIS with Cronbach's  $\alpha = .92$  was comparable to the internal consistency of the English version, for which Rickert et al. (2014) reported an internal consistency of  $\alpha = .90$ . Furthermore, the item-total correlations indicated that all eight items had a similar association with the total scale.

To investigate the factorial structure of the eight items, confirmatory factor analyses were computed on the three competing models presented in Figure 1. Fit indices for the three models are given in Table 2. The one-factor model did not reproduce the data well. The two-factor model with the assumption of two correlated latent variables,

**Table 1** Mean (M), Standard Deviation (SD), and Part-Whole Corrected Item-Total Correlations ( $r_{it}$ ) of the Eight Items of the Implicit Theories of Intelligence Scale (ITIS) in Study 1 (N = 292) and Study 2 (N = 195).

	M		SD		$r_{it}$	
	Study 1	Study 2	Study 1	Study 2	Study 1	Study 2
Item 1	2.68	2.73	1.27	1.08	.67	.77
Item 2	2.66	2.70	1.22	1.09	.80	.75
Item 3	2.46	2.57	1.28	1.20	.78	.78
Item 4	2.38	2.42	1.24	1.18	.70	.76
Item 5	2.84	2.87	1.28	1.15	.72	.70
Item 6	3.01	3.15	1.24	1.20	.76	.75
Item 7	2.88	2.98	1.23	1.16	.75	.72
Item 8	3.08	3.15	1.29	1.15	.74	.74

**Table 2** Fit Indices for the One-Factor, the Two-Factor, and the Wording-Effect Measurement Models of the ITIS in Study 1 (N = 292) and in Study 2 (N = 195).

	Model	$\chi^2$	df	$p$	$\chi^2/df$	CFI	RMSEA	SRMR	AIC
Study 1	One-factor model	146.34	20	<.001	7.32	.897	.147	.059	6329.16
	Two-factor model	56.33	19	<.001	2.96	.970	.082	.039	6198.95
	Wording-effect model	35.80	16	<.01	2.24	.984	.065	.026	6176.02
Study 2	One-factor model	100.68	20	<.001	5.03	.900	.144	.052	3971.93
	Two-factor model	63.64	19	<.001	3.35	.945	.110	.044	3924.45
	Wording-effect model	38.89	16	<.01	2.43	.972	.086	.031	3896.60

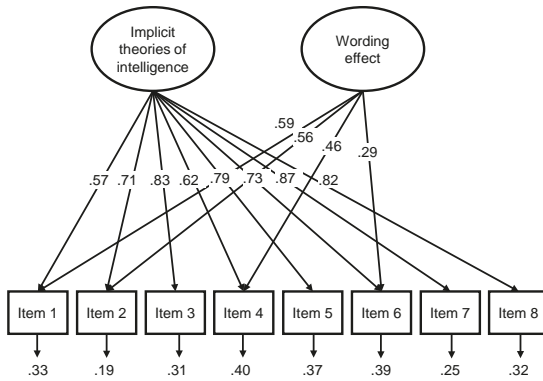
Note:  $\chi^2$  = Satorra-Bentler corrected  $\chi^2$

CFI = comparative fit index

RMSEA = root mean square error of approximation

SRMR = standardized root mean square residual

AIC = Akaike information criterion



**Figure 2**

Measurement model for the Implicit Theories of Intelligence Scale under consideration of the wording effect in 292 participants of Study 1. All factor loadings are statistically significant ( $p < .001$ ).

underlying the incremental-theory items and the entity-theory items, described the data better than the one-factor model according to AIC and CFI. The correlation between the two latent variables was high,  $r = .807$ ,  $p < .001$ .

For the bifactor wording-effect model, all items had factor loadings on the first latent variable, reflecting implicit theories of intelligence with higher factor scores referring to a higher agreement with an entity theory. The second latent variable was derived from the negatively worded items (entity-theory items) and the correlation between the two latent variables was fixed to zero. This bifactor model, which is depicted in Figure 2, described the data substantially better than the other two models as indicated by the higher CFI and the lower AIC (see Table 2). Although the  $\chi^2$  statistic yielded significance, it did not excel three times the degrees of freedom and indicated therefore an acceptable model fit (Kline, 2011). Also CFI and SRMR suggested a good model/data fit, while RMSEA indicated an acceptable fit (Hu & Bentler, 1999).

In order to examine the relation between implicit theories of intelligence as measured with ITIS and goal choice, a latent

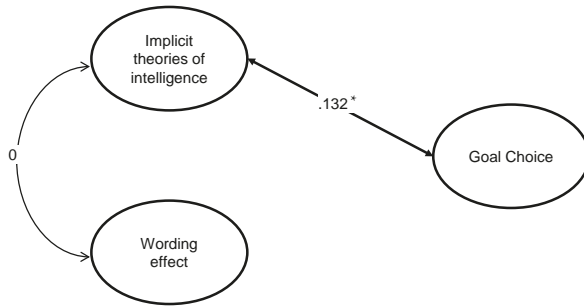
variable was derived from goal choice items with higher scores indicating a tendency to prefer “good performance” over “learning something new”. One participant did not respond to all the goal choice questions, so that the analysis of the relation between goal choice and implicit theories of intelligence was based on data of 291 participants. A positive correlation was expected between the extent to which an entity theory (vs. incremental theory) of intelligence was held and the extent to which “good performance” was preferred over “learning something new”. Hence, the correlation was tested by a one-tailed test of significance. The latent variable representing goal choice was added to the wording-effect measurement model of the ITIS. The resulting model described the data well,  $\chi^2(48) = 69.905$ ,  $p = .022$ , RMSEA = .039, CFI = .963. In this model, however, goal choice was only marginally related to implicit theories of intelligence,  $r = .092$ ,  $p = .093$ . However, when the link between the wording effect and goal choice was set to zero, the correlation between goal choice and implicit theories of intelligence became significant,  $r = .132$ ,  $p = .033$ . According to CFI and RMSEA, this model did not describe the data significant-



**Figure 3**

The relationship between goal choice and implicit theories of intelligence as represented by the wording-effect model (N = 291). Presented is an illustration of the core of the model.

\*  $p < .05$



ly worse than the unrestricted model,  $\chi^2(49) = 73.601, p = .013, RMSEA = .042, CFI = .958$ . The model is depicted in Figure 3.

Neuroticism, extraversion, openness to experience, conscientiousness, and agreeableness have been reported to be unrelated to implicit theories of intelligence (Spinath et al., 2003). Thus, we did not expect significant relationships and aimed to confirm discriminant validity for the German translation of the ITIS with regard to the five broad personality traits. The five traits were added as manifest variables to the bifactor measurement model of the ITIS and correlations between these personality variables were set free for estimation. The fit of the resulting model was good,  $\chi^2(46) = 72.21, p < .01, RMSEA = .044, CFI = .974, SRMR = .027, AIC = 15127.48$ . None of the personality variables was significantly correlated with implicit theories of intelligence, neuroticism:  $r = .021$ , extraversion:  $r = .016$ , openness to experience:  $r = .056$ , conscientiousness:  $r = -.021$ , agreeableness:  $r = .023$ , all  $ps > .382$ . A stronger wording effect, however, was associated with lower openness to experience,  $r = -.141, p = .041$ , but not with the other four traits, neuroticism:  $r = .004$ , extraversion:  $r = -.099$ , conscientiousness:  $r = -.041$ , agreeableness:  $r = -.079$ , all  $ps > .127$ . It should be

noted, that implicit theories of intelligence were still unrelated to the five personality traits when the correlations between the wording effect and the five traits were fixed to zero.

Two participants did not complete the procrastination questionnaire, so that the following analyses were based on 290 participants. The three subscales of the procrastination scale (procrastination, task aversiveness, and task alternatives) were added as manifest variables to the measurement model of implicit theories of intelligence, and correlations with implicit theories of intelligence and the wording effect were computed. The model described the data well,  $\chi^2(34) = 56.34, p < .01, RMSEA = .048, CFI = .986, SRMR = .028$ . In contrast to our expectations, implicit theories of intelligence were not significantly correlated with procrastination,  $r = .019$ , task aversiveness,  $r = .023$ , and task alternatives,  $r = .044$ , all  $ps > .484$ . Also the wording effect was unrelated to procrastination,  $r = -.058$ , task aversiveness,  $r = .009$ , and task alternatives,  $r = -.026$ , all  $ps > .373$ . Even when the correlational relationship between the wording effect and procrastination behavior was suppressed, implicit theories of intelligence were unrelated to procrastination behavior.

## Discussion

The German translation of the ITIS has a high degree of internal consistency, which might, at first sight, support the assumption of homogeneity. The one-factor model, however, did not describe the data sufficiently well. Although the two-factor model with the assumption that holding an entity theory and holding an incremental theory are distinct constructs led to a better model fit, the best data description resulted from the wording-effect model. In this model, individual differences in the belief in intelligence being fixed or malleable was represented by one latent variable while, concurrently, the additional variance in the scale by the negative wording of the entity-theory items was controlled for by a second latent variable.

With regard to construct validity, the well-known correlation between implicit theories of intelligence and goal choice preferences was observed with the present German translation of the ITIS. Preferring tasks, in which learning something new was more important than looking smart, was associated with a stronger belief in the malleability of intelligence. Although the correlation was small, it was similarly strong as the meta-analytic correlation of  $r = .15$  between the belief in an entity (vs. incremental) theory and performance-oriented goals reported by Burnette et al. (2013). Dweck (1999) suggested a stronger relationship when participants were confronted with an actual choice between a difficult task providing the possibility to learn something new and an easy task where good performance was more likely. In the setting of the present study, it was obvious that no such task would be presented so that effects of choosing the social desirable response alternatives might have artificially lowered the relationship.

It should be noted, however, that the expected association between implicit theories of intelligence and goal choice was observed only when the relation between the wording effect and goal choice was actively suppressed. Since two of the goal choice items were negatively worded, a wording effect might also have affected the goal choice questionnaire and, consequently, the relationship between ITIS and goal choice scores. Unfortunately, two negatively worded items in the goal choice questionnaire are not enough to extract a latent variable representing the wording effect and to test this assumption empirically. In future studies, however, all four goal choice items should be worded in the same direction to avoid such a confounding and hardly controllable wording effect.

Consistent with previous findings (Spinath et al., 2003), the Big Five as broad and basic personality traits were unrelated to implicit theories of intelligence. In addition, procrastination was not related to implicit theories of intelligence. This result was surprising, as Rickert et al. (2014) reported such a relationship. A tentative explanation might be seen in the fact that Rickert et al. (2014) assessed procrastination and implicit theories of intelligence in a sample of children in a school-related setting. Maybe, the young adults in the present sample have reported their procrastination behavior in more general terms, i.e. not only with regard to their achievement-related behavior. In this case, however, the relationship between procrastination and implicit theories of intelligence, which explicitly refer to abilities, might be lowered or even disappear.

## Study 2

The second study was conducted to confirm the findings from the first study regarding reliability and factorial structure of the German translation of the ITIS. As the wording-effect model was not reported previously to provide the best data description of the ITIS items, a confirmation of this result seemed to be mandatory.

In addition, the second study examined the previously reported association between self-esteem and implicit theories of intelligence (Diseth et al., 2014; Dweck et al., 1995; Robins & Pals, 2002). For this purpose, Rosenberg's Self-Esteem Scale (SES; von Collani & Herzberg, 2003a) and the subscale "lack of confidence" from the Test Anxiety Inventory (TAI; Hodapp, Rohrman & Ringeisen, 2011) were used to measure self-esteem. While the SES is a measure of general self-esteem, the subscale "lack of confidence" from the TAI assesses self-esteem in test situations. Implicit theories of intelligence refer to an individual's belief in the malleability of the own abilities. Therefore, implicit theories of intelligence might be more strongly related to self-esteem in a performance-related context (i.e. lack of confidence in test situations) than to general self-esteem, which might be additionally determined by experiences unrelated to performance and/or abilities (Rentzsch & Schröder-Abé, 2018).

For Rosenberg's SES, previous studies reported a wording effect due to five positively and five negatively worded items (e.g. Horan, DiStefano, & Motl, 2003; Wu, 2008). Thus, the consideration of the wording effect in both SES and ITIS might reveal more information about the nature of the wording effect, but also about the relationship between "purified" measures of self-esteem

and implicit theories of intelligence controlled for wording effects.

## Method

### Participants

Fifty-seven male and 138 female participants took part in the second study. Their mean age was 23.0 years ( $SD = 3.6$  years), ranging from 18 to 48 years. All participants were university students from different disciplines.

### Implicit Theories of Intelligence

The ITIS was presented and analyzed as in Study 1.

### Rosenberg's Self-Esteem Scale

The German adaptation of Rosenberg's SES (von Collani & Herzberg, 2003a) consists of 10 statements (e.g., "I take a positive attitude toward myself."). Participants indicate their agreement on a 4-point Likert scale from "not correct at all" to "fully correct". The internal consistency of the SES is high with Cronbach's  $\alpha \approx .85$  (von Collani & Herzberg, 2003a). Five items were negatively worded and, consequently, recoded for data analysis so that higher scores indicated more self-esteem.

### Test Anxiety Inventory

The TAI by Hodapp et al. (2011) differentiates between four components of test anxiety: worry, emotionality, cognitive interference, and lack of confidence. Each subscale consists of five statements about feelings and thoughts in test situations (e.g. "I rely on my achievement."). Participants respond to the statements on a 4-point Likert scale from 1 (almost never) to 4 (almost ever). The internal consistency of the four subscales was  $\alpha = .79$  for cognitive interference,  $\alpha =$

.81 for worry,  $\alpha = .85$  for lack of confidence, and  $\alpha = .86$  for emotionality. The items of the subscale lack of confidence were positively worded so that this subscale actually indicates *confidence* in test situation. As recommended by the manual, these items were recoded prior to further analyses so that higher scores on all TAI items indicated higher test anxiety.

## Results

Descriptive statistics of the eight ITIS items and their part-whole corrected item-total correlations are reported in Table 1. All corrected item-total correlations exceeded  $r_{it} = .70$  and Cronbach's Alpha was  $\alpha = .93$ .

As can be taken from the fit indices in Table 2, the confirmatory factor analyses on the ITIS items corroborated the outcome of Study 1. The wording-effect model with the assumption of a wording effect besides a general latent variable representing implicit theories of intelligence led to a better data description compared to the one-factor and the two-factor model. Although the superiority of the wording-effect model over the other two models was evident from the AIC and CFI comparisons, it described the data less well than in Study 1. However, only the RMSEA was not acceptable while all other fit indices suggested an acceptable model fit.

Analogously, the structure of the ten SES items was investigated. A one-factor model assumed one general factor of self-esteem underlying all ten items of the SES. The two-factor model proceeded from the assumption that the five positively worded items could be assigned to a factor "self-acceptance" and the five negatively worded items to a factor "self-deprecation" (von Collani & Herzberg, 2003b). The two factors were allowed to correlate with each other.

Additionally, the wording-effect model assumed a general factor of self-esteem and an independent wording effect derived from the negatively worded items.

The one-factor model did not describe the data well,  $\chi^2(35) = 150.277, p < .001$ , RMSEA = .130, CFI = .805, SRMR = .085, AIC = 3638.917. The two-factor model described the data better than the one-factor model,  $\chi^2(34) = 95.629, p < .001$ , RMSEA = .096, CFI = .896, SRMR = .076, AIC = 3571.336. The correlation between "self-acceptance" and "self-deprecation" was high,  $r = .708, p < .001$ . According to AIC and CFI, the wording-effect model had the best model fit,  $\chi^2(30) = 55.055, p = .004$ , RMSEA = .065, CFI = .958, SRMR = .052, AIC = 3523.289.

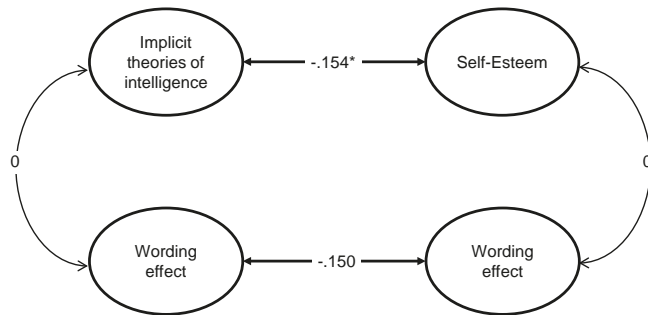
Combining the wording-effect models derived from the ITIS and the SES led to the model presented in Figure 4. Proceeding from the assumption that a stronger belief in an entity (vs. incremental) theory of intelligence was related to lower self-esteem, we expected a negative correlation and conducted one-tailed tests. The correlation between the wording effect in the ITIS and self-esteem as well as the correlation between the wording effect in the SES and implicit theories of intelligence was set to zero, because these correlations were not statistically significant when freely estimated ( $r = -.005, p = .961$  and  $r = .052, p = .542$ , respectively). The model fit was acceptable,  $\chi^2(124) = 184.127, p < .001$ , RMSEA = .050, CFI = .962, SRMR = .054, AIC = 7417.918. The correlation between implicit theories of intelligence and self-esteem was statistically significant,  $r = -.154, p = .035$ , while the correlation between the wording effects in the ITIS and in the SES just failed to reach statistical significance,  $r = -.15, p = .050$ .

Finally, the associations between implicit theories of intelligence and aspects of test

**Figure 4**

The relationship between self-esteem as measured by Rosenberg's Self-Esteem Scale and implicit theories of intelligence when for both measures a wording effect was considered (N = 195). Presented is an illustration of the core of the model.

\*  $p < .05$



anxiety were investigated. For this purpose, the four aspects of text anxiety were added to the wording-effect model of the ITIS as manifest variables. Correlations between the four aspects of test anxiety were allowed. The model fit was good,  $\chi^2(40) = 78.338$ ,  $p < .001$ , RMSEA = .070, CFI = .964, SRMR = .035, AIC = 7885.874. The latent variable representing implicit theories of intelligence correlated significantly with lack of confidence,  $r = .163$ ,  $p = .041$ , but not with worry,  $r = .052$ , emotionality,  $r = .084$ , and cognitive interference,  $r = -.050$ , all  $ps > .475$ . The wording effect was positively related to cognitive interference,  $r = .152$ ,  $p = .041$ , but not to lack of confidence,  $r = -.090$ , worry,  $r = .049$  and emotionality,  $r = .084$ , all  $ps > .248$ . The correlations between implicit theories of intelligence and the four aspects of test anxiety only marginally changed when the correlations between the wording effect and the four aspects of test anxiety were set to zero.

## Discussion

The results on the structure of the ITIS in this second study confirmed the results of Study 1. ITIS was a unidimensional measure of implicit theories of intelligence, when the influence of negative wording of half the items was controlled for. The wording-effect model provided a better data description than the one-factor model and the two-factor model.

A stronger belief in the malleability of the own abilities was associated with more general self-esteem. The relation between implicit theories of intelligence and general self-esteem, however, was weak and only significant when one-tailed statistical tests were conducted. This weakness of the correlation might contribute to the inconsistent results of previous studies on the relation between general self-esteem and implicit theories of intelligence (Diseth et al., 2014; Dweck et al., 1995; Robins & Pals, 2002).

Lack of confidence as a more performance-related measure of self-esteem from the TAI, was also related to implicit theo-

ries of intelligence with a stronger belief in an entity rather than incremental theory of intelligence being associated with more lack of confidence in test situations. Of particular interest, however, was the finding that implicit theories of intelligence were not more closely associated with performance-related lack of confidence than with general self-esteem. Even though the relationships between general self-esteem / lack of confidence and implicit theories of intelligence were weak it might be that the effect would be larger when individuals with especially high test anxiety or a strong lack of confidence would be investigated. Thus, it might be worth to consider implicit theories of intelligence in the counseling of students with high test anxiety, who suffer from a lack of confidence in their abilities.

## General Discussion

The main goal of the present study was to investigate the factorial structure and the nomological network of the German version of the ITIS. Results of two independent studies indicated that a wording-effect model described the data better compared to a one-factor or a two-factor model. Although the wording-effect model implies two independent factors, only one refers to implicit theories of intelligence, while the other one captures the common variance of items due to their negative wording. Therefore, the present results support the assumption that implicit theories of intelligence are best represented by one dimension with the belief in an entity theory at the one pole of the dimension and the belief in an incremental theory at the other pole. Ignoring the wording effect would lead to problems of data interpretation since the

theoretically plausible assumption of unidimensionality described the data worse than the theoretically implausible assumption that a person can concurrently hold an incremental and an entity theory of intelligence. This dilemma was solved when the wording effect was taken into account since the theoretically plausible assumption of unidimensionality could be combined with an appropriate data description. Therefore, the representation of ITIS data by means of a bifactor wording-effect model might be of particular interest for future studies using the ITIS and confirmatory factor analysis or structural equation modeling.

The well-known relationship between implicit theories and goal choice (Burnette et al., 2013; Dinger et al., 2013; Dweck, 1999; Haimovitz et al., 2011) as well as the less consistent relationship between implicit theories of intelligence and self-esteem (Diseth et al., 2014; Robins & Pals, 2002) could be observed for the German translation of the ITIS and under consideration of the wording effect. Furthermore, as in the previous report by Spinath et al. (2003) implicit theories of intelligence were unrelated to the Big Five personality traits. The only unexpected finding was the lack of a substantial association between implicit theories of intelligence and procrastination behavior. (To note, even with the one- or two-factor measurement models, this association was not significant.) In sum, these results indicate that the German translation of the ITIS has a similar construct validity as the original version by Dweck (1999). Furthermore, our finding of a wording-effect systematically affecting the ITIS scores does not severely challenge previous findings on the nomological network of the ITIS.

The presence of a wording-effect in scales composed of a similar number of posi-

tively and negatively worded items is not unusual and was previously reported for measures of self-esteem (DiStefano & Motl, 2006), optimism (Schweizer & Rauch, 2008), mindfulness (Höfling, Moosbrugger, Schermelleh-Engel, & Heidenreich, 2011), life orientation (Scheier, Carver, & Bridges, 1994) or general health (Molina et al., 2014). Due to significant correlations between wording effects from different scales, DiStefano and Motl (2006) suggested that the wording effect reflects a response style. In the present study, the wording effects in the ITIS and in Rosenberg's SES, however, were only marginally correlated. This finding supports the assumption that the wording effect is a bias associated with the specific questionnaire rather than an indication of a response style. For example, with the ITIS but not with Rosenberg's SES, a higher agreement with each item is indicated by choosing a lower score on the Likert scale resulting in a kind of doubled negative wording. It might be promising for future research on the wording effect to control for such effects and to investigate the convergence of wording effects depending on systematic variations of the response format. The present results indicated that scores on the subscale cognitive interference of the TAI were positively and scores on the openness scale of the BFI negatively related to the wording effect in the ITIS. This seems to indicate that individuals, who report more cognitive interference by irrelevant thoughts during a test and less openness to experience, have a stronger wording effect. However, given the lack of theory for these findings, the results should be replicated prior to interpretation.

In sum, the present study elucidated the factorial structure of the ITIS. Taking into account a wording effect, implicit theories of intelligence can be considered a uni-

dimensional construct with individuals holding an entity theory at the one pole of the dimension and individuals holding an incremental theory at the other pole. The German translation of the ITIS showed a similar internal consistency as the original English version and similar construct validity. Thus, the consideration of the wording effect improves data description, but is not a challenge of previous results regarding the construct validity of the ITIS.

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*Author Correspondence:*

*Stefan J. Troche*

*Institute of Psychology*

*University of Bern*

*Fabrikstrasse 8*

*CH-3012 Bern*

*Switzerland*

*stefan.troche@psy.unibe.ch*

*Phone: +41 (0) 31 631 31 24*