1   Need for Cognition and Ability Self-Concepts as Predictors of Changes in School Grades

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Abstract

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Word count:

18   Need for Cognition and Ability Self-Concepts as Predictors of Changes in School Grades

19   Over the past decades, a large body of research has examined variables predicting

20   performance in school. Comprehensive meta-analytic findings demonstrated intelligence to

21   be the strongest predictor for academic achievement (e.g., Deary, Strand, Smith, &

22   Fernandes, 2007; Kriegbaum, Becker, & Spinath, 2018), but motivational variables have

23   consistently been found to have predictive value for school performance, too (e.g.,

24   Kriegbaum et al., 2018; Steinmayr, Weidinger, Schwinger, & Spinath, 2019). In this

25   context, motivational concepts like ability self-concept, hope for success and fear of failure,

26   interest and values are well known and equally established indicators (Wigfield & Cambria,

27   2010; e.g., Wigfield & Eccles, 2000) that are subsumed under the umbrella term of

28   achievement motivation (Steinmayr et al., 2019).

29   Over the last years, an additional predictor of academic performance came into the

30   focus of researchers in this field of research: Need for Cognition (NFC), the stable intrinsic

31   motivation of an individual to engage in and enjoy challenging intellectual activity

32   (Cacioppo, Petty, Feinstein, & Jarvis, 1996). According to the Investment Theory

33   (Ackerman & Heggestad, 1997), traits such as NFC determine how individuals invest their

34   cognitive resources and how they deal with cognitively challenging material. Studies could

35   show that NFC is related to academic performance in different stages of academic life (e.g.,

36   Ginet & Py, 2000; Grass, Strobel, & Strobel, 2017; Luong et al., 2017; Preckel, 2014; for a

37   meta-analytical review see von Stumm & Ackerman, 2013) as well as to behaviour

38   associated with success in learning. As examples, NFC was found to be related to ability

39   self-concept (e.g., Dickhäuser & Reinhard, 2010; Luong et al., 2017), to interest in school

40   (e.g., Preckel, 2014) or to deeper processing while learning (Evans, Kirby, & Fabrigar, 2003;

41   Luong et al., 2017).

Methods

⁴²

⁴³ We report how we determined our sample size, all data exclusions, all manipulations,

⁴⁴ and all measures in the study (cf. Simmons, Nelson, & Simonsohn, 2012). All data and

⁴⁵ materials for reproducing our analyses are permanently and openly accessible at . . . The

⁴⁶ study was not preregistered.

Participants

⁴⁷

⁴⁸ Sample size was determined by pragmatic considerations, i.e., to collect as many

⁴⁹ participants given existing time constraints and the longitudinal nature of the project. We

⁵⁰ eventually managed to recruit a sample of $N = 277$ participants (60% women) at the first

⁵¹ measurement occasion (T1) of which $N = 251$ participants (61% women) also took part at

⁵² the second measurement occasion (T2) that took place 53-59 weeks later. Age range was

⁵³ 14-19 years (median = 17 years) at T1 and 15-20 years (median = 18 years) at T2. With

⁵⁴ the sample size accomplished at T2, we were able to detect correlations of $r \geq .18$ at $\alpha =$

⁵⁵ .05 (two-sided) and $1\text{-}\beta = .80$. Yet, we tried to impute missing values to raise power (see

⁵⁶ below, *Statistical analyses*).

Material

⁵⁷

⁵⁸ We used the following self-report measures to assess the measures of interest for the

⁵⁹ present study.

⁶⁰ *School Grades* in general, i.e., Grade Point Average (GPA), and grades in German,

⁶¹ math, chemistry, and physics were assessed via self-report. In Germany, school grades

⁶² range from 1 (excellent) to 6 (insufficient). For better interpretability, we reversed this

⁶³ coding via $6 - grade$, so the values we used for statistical analyses ranged from 0

⁶⁴ (insufficient) to 5 (excellent).

65   *Need for Cognition* (NFC) was assessed with the 16-item short version of the German

66 NFC scale (Bless, Wänke, Bohner, Fellhauer, & Schwarz, 1994). Responses to each item

67 (e.g., "Thinking is not my idea of fun", recoded) were recorded on a four-point scale

68 ranging from -3 (completely disagree) to +3 (completely agree) and were summed to the

69 total NFC score. The scale has a comparably high internal consistency, Cronbach's $\alpha > .80$

70 (Bless et al., 1994; Fleischhauer et al., 2010), and retest reliability, $r_{tt} = .83$ across 8 to 18

71 weeks (Fleischhauer, Strobel, & Strobel, 2015).

72   *Hope for Successs* and *Fear of Failure* were assessed using the Achievement Motive

73 Scales (Gjesme & Nygard, 2006; German version: Göttert & Kuhl, 1980). For the present

74 study, we used a short form measuring each construct with seven items. All items were

75 answered on a four-point scale ranging from 1 (does not apply at all) to 4 (fully applies).

76 Example items for the two scales are "Difficult problems appeal to me" and "Matters that

77 are slightly difficult disconcert me". Both scales exhibit high internal consistencies,

78 Cronbach's $\alpha \geq .85$ (Steinmayr & Spinath, 2009).

79   The *Ability Self-Concept* in school in general and in the four subjects German, math,

80 physics, and chemistry were assessed with four items per domain using the Scales for the

81 Assessment of Academic Self-Concept (Schöne, Dickhäuser, Spinath, & Stiensmeier-Pelster,

82 2002) (example item: "I can do well in ... (school, math, German, physics, chemistry).").

83 Items were answered on a 5-point scale ranging from 1 () to 5 (). The scales' internal

84 consistency, Cronbach's $\alpha \geq .80$, and retest reliability, $r_{tt} \geq .59$ across six months, can be

85 considered as high.

86   *Interest* in school in general and in the above four subjects were measured using

87 Interest subscales of the Scales for the Assessment of Subjective Values in School

88 (Steinmayr & Spinath, 2010). Answers to three items per domain (example item: "How

89 much do you like ... (school, math, German, physics, chemistry).") were recorded on a

90 5-point scale ranging from 1 () to 5 (). The scales have high internal consistency,

91 Cronbach's $\alpha \geq .89$, and retest reliability, $r_{tt} = .72$ across six months (Steinmayr &

92 Spinath, 2010).

Procedure

94   . . .

Statistical analysis

96   We used *RStudio* [Version 2021.9.0.351; RStudio Team (2016)] with R (Version 4.1.1;

97 R Core Team, 2018) and the R-packages *lavaan* (Version 0.6.10; Rosseel, 2012), *psych*

98 (Version 2.1.9; Revelle, 2018), and *pwr* (Version 1.3.0; Champely, 2018). This manuscript

99 was created using RMarkdown with the packages *papaja* [Version 0.1.0.9997; Aust and

100 Barth (2018)], *knitr* [Version 1.37; Xie (2015)], and *shape* [Version 1.4.6; Soetaert (2021)].

101   First the variables were separated into four sets, each containing the T1 and T2

102 measurements of the variables Hope for Success (HfS), Fear of Failure (FoF), and Need for

103 Cognition (NFC) as well as either GPA, overall ability self-concept regarding school, and

104 general interest in school, or domain-specific grades, ability self-concept and interest in

105 German, math, physics, and chemistry. All measures were initially analyzed with regard to

106 descriptive statistics, reliability (retest-reliability r_{tt} as well as Cronbach's α), and possible

107 deviation from univariate and multivariate normality. Almost all relevant variables

108 deviated from univariate normality as determined using Shapiro-Wilks tests with a

109 threshold of $\alpha = .20$, all $p \leq .089$ except for NFC at T2, $p = .461$. Also, there was

110 deviation from multivariate normality as determined using Mardia tests, all p_{skew} and

111 $p_{kurtosis} < .001$. Therefore, we used more robust variants for the statistical tests to be

112 performed, i.e., Spearman rank correlations (r_s) for correlation analyses and Robust

113 Maximum Likelihood (MLR) for regression analyses and latent change score modeling.

114   Possible differences between the measurement occasions T1 and T2 were descriptively

assessed via boxplots, with overlapping notches—that can roughly be interpreted as 95%
confidence intervals of a given median—pointing to noteworthy differences. Otherwise
differences between time points were not considered further given the scope of the present
report. Correlation analyses were performed separately for the five sets of data (see Table 1
and Supplementary Tables S1 to S4). Where appropriate, evaluation of statistical
significance was based on 95% confidence intervals (CI) that did not include zero.
Evaluation of effect sizes of correlations was based on the empirically derived guidelines for
personality and social psychology research provided by Gignac and Szodorai (2016), i.e.,
correlations were regarded as small for $r < .20$, as medium for $.20 \leq r \leq .30$, and as large
for $r > .30$.

     To examine which variables measured at T1 would be significant predictors of school
grades at T2, we ran a five regression analyses with the GPA and the four subject-specific
grades as criterion and used the results of the first regression analysis (with the
domain-general Ability Self-Concept, Interest in School, Hope for Success and Fear of
failure, and NFC measured at T1 as predictors and GPA at T2 as criterion) to select the
variables for latent change score modeling. Significant predictors in this model were used
for all latent change score models even if for certain subjects, the predictors were not
significant in the respective regression models. Regression models were fitted via *lavaan*,
using MLR as estimation technique and the Full-Information Maximum Likelihood (FIML)
approach to impute missing values. Due to missing patterns, this resulted in an effective
sample size of $N = 271\text{-}276$. To asses whether a model that included NFC was superior to
a model that included established predictors of academic achievement, we (1) evaluated the
fit of the respective models based on the recommendations by Hu and Bentler (1999), with
values of CFI $\geq .95$, RMSEA $\leq .06$, and SRMR ≤ 0.08 indicating good model fit, and (2)
performed χ^2-difference tests between the former and the latter model (and all other
variables' loadings fixed to zero).

     In the final step, latent change score modeling was applied. In this approach (see

142 Kievit et al., 2018), one can examine (1) whether true change in a variable has occurred via

143 a latent change score that is modeled from the respective measurements of this variable at

144 different measurement occasions, here T1 and T2, (2) to what extent the change in a

145 variable is a function of the measurement of the *same* variable at T1 (self-feedback) and (3)

146 to what extent the change in this variable is a function of the measurement of *other*

147 variables in the model at T1 (cross-domain coupling). Thereby, cross-domain effects, i.e.,

148 whether the change in one domain (e.g., school grades) is a function of the baseline score of

149 another (e.g., NFC) and vice versa could be examined. In addition, correlated change in

150 the variables of interest can be examined, i.e., to what extent does the change in one

151 variable correlate with the change in another variable. Again, MLR estimation and

152 imputation of missing values via FIML was employed.

<h1 style="text-align:center">Results</h1>

153

Domain-general grades

154

155   Table 1 gives the descriptive statistics and intercorrelations of the variables of interest

156 in this analysis step, i.e., the T1 and T2 measurements of GPA, domain-general ability

157 self-concept, and general interest in school as well as the variables Hope for Success, Fear of

158 Failure, and NFC. As can be seen in the diagonal and the upper right of the correlation

159 table, all variables exhibited good internal consistency, Cronbach's $\alpha \geq .83$, and retest

160 reliability, $r_{tt} \geq .56$. Among the predictors at T1, GPA at T1 showed the strongest relation

161 to GPA at T2, $r_s = .75$, followed by the domain-general ability self-concept, $r_s = .53$, and

162 NFC at T1, $r_s = .46$, all $p < .001$. The other variables at T1 showed significant correlations

163 with GPA at T2 as well, $|r_s| \geq .20$, $p \leq .004$.

164   A multiple regression analysis involving all measures at T1 (see Table 2) showed that

165 apart from GPA at T1, $B = 0.61$, 95% CI [0.49, 0.73], $p < .001$, the only significant

166 predictors were the domain-general ability self-concept, $B = 0.12$, 95% CI [0.01, 0.22],

167 $p = .031$, and NFC, $B = 0.09$, 95% CI [0.01, 0.17], $p = .024$. Model fit was better for a

168 model that included GPA, the ability self-concept, and NFC at T1 (while all other

169 predictors were set to zero), $\chi^2(3) = 3.68$, p .299, CFI $= 1.00$, RMSEA $= .03$ with 90% CI

170 [0.00, 0.11], SRMR $= .01$, than a model that included GPA and the ability self-concept

171 only, $\chi^2(4) = 10.91$, p .028, CFI $= 0.96$, RMSEA $= .08$ with 90% CI [0.02, 0.14], SRMR $=$

172 .02, and a χ^2-difference test supported the superiority of the former compared to the latter

173 model, $\chi^2(1) = 6.34$, $p = .012$.

174   We therefore further examined a trivariate latent change score model involving school

175 grades, the ability self-concept, and NFC. Figure 1B gives the results of the latent change

176 score modeling with regard to the prediction of change and correlated change in overall

177 school grades, i.e., GPA. While the best predictor of change on GPA was GPA at T1 (i.e.,

178 self-feedback), $B = -0.37$, 95% CI [-0.48, -0.25], $p < .001$, $\beta = -.55$, there was also evidence

179 for cross-domain coupling, as the overall ability self-concept and NFC at T1 also

180 significantly predicted change in GPA, $B = 0.13$, 95% CI [0.02, 0.24], $p = .020$, $\beta = .19$,

181 and $B = 0.08$, 95% CI [0.02, 0.15], $p = .009$, $\beta = .19$, respectively. Correlated change was

182 observed for GPA and the ability self-concept, $B = 0.03$, 95% CI [0.01, 0.05], $p = .001$, $\beta =$

183 .22, and the ability self-concept and NFC, $B = 0.05$, 95% CI [0.02, 0.08], p.001, $\beta = .22$,

184 while the correlated changes in GPA and NFC did not reach significance, $B = 0.03$, 95% CI

185 [0.00, 0.05], $p = .053$, $\beta = .14$.

186 **Domain-specific grades**

187   For the four subjects examined, i.e., German, math, physics, and chemistry, similar

188 results were obtained with regard to correlation analyses (see Supplementary Tables Sx to

189 Sy). As regards multiple regression analyses (see Supplementary Table Sz), for all subjects,

190 grades at T2 were significant predictors of grades at T2, $p < .001$. The subject-specific

191 ability self concept at T1 was a significant predictor of grades at T2 in German only, $B =$

192 0.29, 95% CI [0.15, 0.43], $p < .001$. NFC at T1 was a significant predictor of T2 grades in

193 German, $B = 0.18$, 95% CI [0.05, 0.32], $p = .007$ and physics, $B = 0.22$, 95% CI [0.07,

194 0.37], $p = .004$.

195   As regards the latent change score models, there was evidence for significant

196 self-feedback for all subjects, all $p < .001$. With regard to the subject-specific ability

197 self-concept, cross-domain coupling with changes in grades was observed for German, $B =$

198 0.28, 95% CI [0.16, 0.40], $p < .001$, $\beta = .36$, and chemistry, $B = 0.09$, 95% CI [0.00, 0.18],

199 $p = .042$, $\beta = .14$. NFC at T1 showed cross-domain coupling with grades at T2 for

200 German, $B = 0.13$, 95% CI [0.04, 0.21], $p = .005$, $\beta = .17$, physics, $B = 0.23$, 95% CI [0.13,

201 0.33], $p < .001$, $\beta = .24$, and chemistry, $B = 0.10$, 95% CI [0.00, 0.20], $p = .047$, $\beta = .13$.

202 Correlated change between grades and the subject-specific ability self-concept was observed

203 for all subjects, while correlated change between grades and NFC was observed for

204 German, math, and physics only (see Fig. 1C-F).

Discussion

206   The present study was conducted in order to . . .

Subheading 1

208   Our result show that . . .

Subheading 2

210   . . .

Conclusion

212   Taken together, the present study provides evidence that . . .

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Table 1

Spearman correlations and descriptive statistics of the variables in the analyses on overall school grades

	GRD1	ASC1	INT1	HFS1	FOF1	NFC1	GRD2	ASC2	INT2	HFS2	FOF2	NFC2
GRD1	—	.58	.38	.34	-.24	.44	**.75**	.52	.34	.40	-.23	.49
ASC1		*.83*	.49	.37	-.27	.38	.50	**.60**	.32	.34	-.18	.26
INT1			*.88*	.32	-.09	.35	.44	.47	**.65**	.31	-.05	.26
HFS1				*.86*	-.30	.62	.32	.38	.26	**.57**	-.17	.50
FOF1					*.88*	-.42	-.17	-.28	-.14	-.29	**.59**	-.43
NFC1						*.89*	.46	.43	.25	.62	-.32	**.71**
GRD2							—	.53	.34	.41	-.18	.48
ASC2								*.84*	.53	.45	-.25	.46
INT2									*.88*	.31	-.05	.34
HFS2										*.87*	-.28	.66
FOF2											*.90*	-.39
NFC2												*.89*
Mean	3.30	3.55	3.25	2.92	1.86	4.46	3.46	3.62	3.41	2.72	1.71	4.69
SD	0.55	0.54	0.83	0.57	0.61	0.84	0.52	0.56	0.82	0.56	0.61	0.87
Min	2.00	1.75	1.00	1.14	1.00	2.19	2.10	2.25	1.00	1.00	1.00	2.50
Max	5.00	5.00	5.00	4.00	4.00	6.94	5.00	5.00	5.00	4.00	3.71	6.88
Skew	0.17	0.09	-0.27	-0.23	0.45	0.16	0.31	0.33	-0.21	-0.02	0.89	0.07
Kurtosis	-0.09	0.24	-0.37	-0.07	-0.34	0.14	-0.11	-0.14	-0.42	0.17	0.47	-0.45

Note. $N = 193\text{-}259$ due to missings; $p < .05$ for $|r_s| > .18$; coefficients in the diagonal are Cronbach's α, bold-faced coefficients give the 53-59 week retest reliability; GRD = Grade Point Average, ASC = Overall Ability Self-Concept, INT = Overall Interest in School, HFS = Hope for Success, FOF = Fear of Failure, NFC = Need for Cognition at measurement occasion 1, and 2, respectively

Table 2

Results of the multiple regression of school grades measured at T2 on predictors measured at T1

	B	SE	$CI.LB$	$CI.UB$	β	p
Intercept	0.488	0.231	0.034	0.941	.906	.035
GPA	0.606	0.061	0.485	0.726	.616	< .001
Ability Self-Concept	0.116	0.054	0.010	0.222	.117	.031
Interest	0.057	0.031	-0.005	0.118	.087	.072
Hope for Success	-0.028	0.050	-0.126	0.070	-.029	.578
Fear of Failure	0.013	0.039	-0.063	0.089	.015	.733
Need for Cognition	0.089	0.040	0.012	0.167	.140	.024

Note. $N = 276$; coefficients are unstandardized slopes B with their standard errors SE and 95% confidence intervals ($CI.LB$ = lower bound, $CI.UB$ = upper bound), β is the standardized slope and p the respective p-vcalues
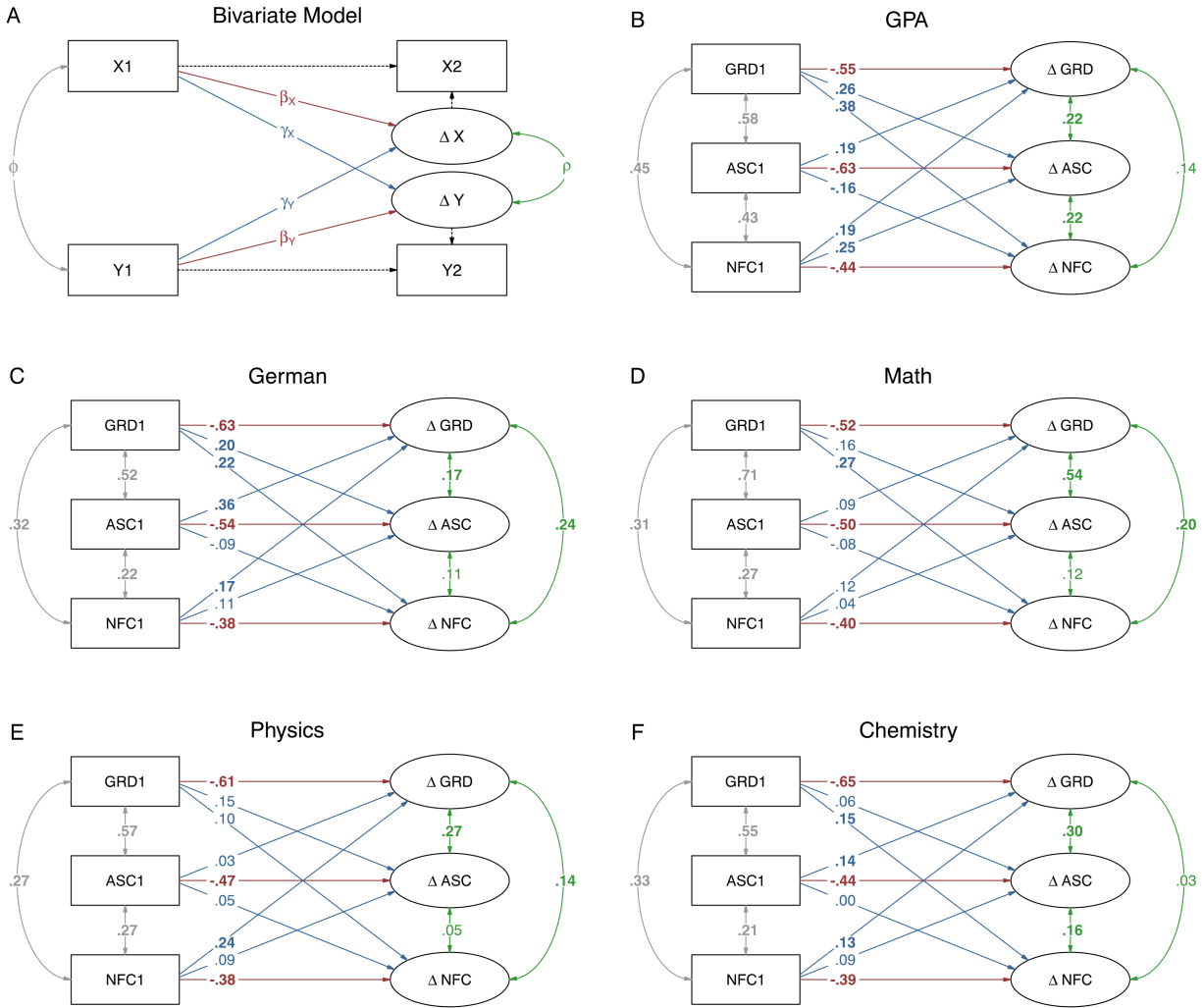
Figure 1. Latent change score models. (A) Example of a bivariate latent change score model (for details see text); legend to lines: dotted = loadings fixed to zero, red = self-feedback β, blue = cross-domain coupling γ, grey = correlation ϕ of predictors at T1, green = correlated change ρ; (B) Grade Point Average (GPA) and (C) to (F) subject-specific changes in grades at T2 (indicated by prefix Δ) as predicted by their respective T1 levels as well as by Need for Cognition (NFC) and (overall as well as subject specific) Ability Self-Concept (ASC) at T1; coefficients are standardized coefficients.