1 On the interplay of motivational characteristics and academic achievement: The role of

2 Need for Cognition

3 Abstract

4 While intelligence and motivational variables are well-established predictors of academic

5 achievement, Need for Cognition (NFC), the stable intrinsic motivation to engage in and

6 enjoy challenging intellectual activity, has not yet been considered comprehensively in this

7 field of research approaches, especially not longitudinally. By applying latent change score

8 modelling, we examined the incremental value of NFC, considering well-established

9 motivational constructs as well as prior achievement in the prediction of academic

10 achievement across different subjects in a longitudinal approach in a sample of secondary

11 school students (*N* = 271 and 255, respectively). Correlations of NFC with grades were

12 comparable to those of established predictors. NFC incrementally predicted academic

13 achievement over and above prior achievement as well as ability self-concept. Furthermore,

14 a mutual influence of NFC and academic achievement was found pointing to

15 skill-development as well as self-enhancement processes taken place in this interplay.

16 Consequently, we propose to include NFC in models for the comprehensive explanation of

17 academic achievement in school.

18 *Keywords:* Need for Cognition, Academic Achievement, Academic Self-Concept,

19 Latent Change Score Modeling, Longitudinal

20 Word count: 5797

21 On the interplay of motivational characteristics and academic achievement: The role of

22 Need for Cognition

23 In recent decades, a great deal of research has been conducted on the prediction of

24 academic achievement. While meta-analyses indicate that intelligence is the strongest

25 predictor for academic achievement (e.g., Deary, Strand, Smith, & Fernandes, 2007; Roth

26 et al., 2015; Zaboski, Kranzler, & Gage, 2018), motivational variables have consistently

27 been found to have incremental value for academic achievement (e.g., Kriegbaum, Becker,

28 & Spinath, 2018; Steinmayr, Weidinger, Schwinger, & Spinath, 2019). Concepts like ability

29 self-concept, hope for success and fear of failure, interest and values are well known and

30 equally established indicators (Wigfield & Cambria, 2010; e.g., Wigfield & Eccles, 2000)

31 that are subsumed under the umbrella term of achievement motivation (Steinmayr et al.,

32 2019).

33 Over the last years, an additional predictor of academic achievement came into the

34 focus of research in this field: the personality trait Need for Cognition (NFC), defined as

35 the stable intrinsic motivation of an individual to engage in and enjoy challenging

36 intellectual activity (Cacioppo, Petty, Feinstein, & Jarvis, 1996). Investment traits (von

37 Stumm & Ackerman, 2013) such as NFC determine how individuals invest their cognitive

38 resources and how they deal with cognitively challenging material. It has been shown that

39 NFC is related to academic achievement in different stages of academic life (e.g., Ginet &

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

41 meta-analytical review see von Stumm & Ackerman, 2013) and to behaviors associated with

42 success in learning. As examples, NFC was found to be related to ability self-concept (e.g.,

43 Dickhäuser & Reinhard, 2010; Luong et al., 2017), interest in school (e.g., Preckel, 2014) or

44 deeper processing while learning (Evans, Kirby, & Fabrigar, 2003; Luong et al., 2017).

45 The enjoyment of accomplishing something, the interest in task engagement, and the

46 intrinsic value of working on a task have been suggested to be relevant to learning and

47 academic achievement and have been integrated into models of achievement motivation

48 (e.g., Wigfield & Eccles, 2000; see also Wigfield & Cambria, 2010 for a review).

49 Surprisingly, the concept of a more general joy of thinking, that is NFC, has not yet been

50 investigated systematically together with established motivational indicators or was

51 integrated into models for the prediction of academic achievement, especially in school

52 contexts. In particular, longitudinal studies are missing that have a comprehensive look at

53 the interplay of all relevant variables.

54 Only last year, a large longitudinal study examined intelligence, the Big Five, a range

55 of different motivational measures together with NFC in order to determine their value in

56 predicting academic achievement in school (Lavrijsen, Vansteenkiste, Boncquet, &

57 Verschueren, 2021). Their results showed intelligence and NFC to be the strongest

58 predictors of academic performance. The ability self-concept was the best predictor within

59 the group of motivational variables. This underscores the importance to consider NFC

60 along with established predictors in gaining a comprehensive picture of the prediction of

61 academic achievement.

62 To follow-up on these findings and to provide new insights in the interplay of

63 academic achievement, NFC and motivational variables, we examined the incremental

64 value of NFC, considering well-established motivational constructs as well as prior

65 achievement in the prediction of academic achievement across different subjects in a

66 longitudinal approach in a sample of secondary school students.

# 67 Achievement Motivation and its relation to academic achievement

68 Achievement motivation is operationalized through various variables and can be seen

69 as an essential predictor of academic achievement (e.g., Hattie, 2009; Steinmayr & Spinath,

70 2009; Wigfield & Cambria, 2010). Well-established concepts such as ability self-concept,

71 hope for success and fear of failure, or variables such as interests and values can be found

72 under this term (Hulleman, Barron, Kosovich, & Lazowski, 2016; Steinmayr et al., 2019).

73 These constructs are part of prominent motivational theories (cf., Eccles & Wigfield, 2020;

74 Elliot & Church, 1997; Wigfield & Eccles, 2000), and they positively predict academic

75 achievement (e.g., Steinmayr & Spinath, 2009; Steinmayr, Weidinger, & Wigfield, 2018),

76 which is why they were included in this study as important motivational indicators. They

77 are briefly introduced below.

78 *Ability Self-concept.* Ability self-concept can be described as generalized or

79 subject-specific ability perceptions that students acquire based on competence experiences

80 in the course of their academic life (Möller & Köller, 2004). They thus reflect cognitive

81 representations of one’s level of ability (Marsh, 1990), which affects students’ academic

82 performance (e.g., Wigfield & Eccles, 2000). A meta-analysis found moderate correlations

83 with academic achievement (*r* = *.*34, Huang, 2011), whereas the association was lower

84 (*r .*20) when controlled for prior achievement (e.g., Marsh & Martin, 2011). Steinmayr et

85 al. (2019) demonstrated that among several motivational indicators, domain-specific ability

86 self-concept was the strongest predictor of academic achievement. Moreover, ability

87 self-concept and academic achievement influence each other and can thus mutually

88 reinforce or weaken each other (e.g., Guay, Marsh, & Boivin, 2003).

89 *Hope for Success/Fear of Failure.* Murray (1938) considered the Need for

90 Achievement as one of the basic human needs and as a relatively stable personality trait.

91 His concept was extended by McClelland, Atkinson, Clark, and Lowell (1953), who

92 differentiated the achievement motives hope for success (the belief of being able to succeed

93 accompanied by the experience of positive emotions) and fear of failure (worry about

94 failing in achievement situations and the experience of negative emotions). Such affective

95 tendencies in the context of achievement motivation are reflected, for instance, in the

96 choice of task difficulty, affinity for risk, and quality of task completion (Diseth &

97 Martinsen, 2003). Hope for success may facilitate knowledge acquisition, whereas fear of

98 failure may impede it (Diseth & Martinsen, 2003). A meta-analysis found achievement

99 motivation in the sense of hope for success weakly to moderately positively related to

100 academic achievement (*r* = *.*26, Robbins et al., 2004). For the association of fear of failure

101 and academic achievement, findings from individual studies suggest a relationship of

102 similar magnitude but in a different direction (e.g., *r* = *−.*26, Dickhäuser, Dinger, Janke,

103 Spinath, & Steinmayr, 2016).

104 *Task values - Interest.* Another important motivational indicator that was also

105 included in the influential model of Wigfield and Eccles (2000); see also Eccles and

106 Wigfield (2020), describes task values. Such task values focus on importance, perceived

107 utility, and interest in a task and costs associated with it, whereas the latter is often

108 omitted (cf. Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). Findings on relations

109 between task values and academic achievement point to reciprocal relationships between

110 them (Li, Huebner, & Tian, 2021). Furthermore, there is some evidence that the

111 interaction of task values and self-concept may be of special relevance for predicting

112 academic achievement, although the state of evidence on this is still mixed (Meyer,

113 Fleckenstein, & Köller, 2019). Specifically on the domain of interest, a number of papers

114 are available on the relationship with academic achievement in school, with correlations

115 being in a low to moderate range (for an overview, see Steinmayr et al., 2019). A

116 meta-analysis on the relationship between interest and achievement found moderate

117 positive correlations between these two variables (Schiefele, Krapp, & Winteler, 1992).

# 118 Need for Cognition and academic achievement

119 NFC describes the stable intrinsic motivation of an individual to engage in and enjoy

120 challenging intellectual activity (Cacioppo et al., 1996). While individuals with lower NFC

121 scores tend to rely more on other people, cognitive heuristics or social comparisons in

122 decision making, individuals with higher NFC scores show a tendency to seek, acquire and

123 reflect on information (Cacioppo et al., 1996). NFC, mirroring the typical cognitive

124 performance of a person, has been shown to be rather modestly related to intelligence and

125 its fluid (Fleischhauer et al., 2010) and crystallized (von Stumm & Ackerman, 2013)

126 components.

127 NFC correlates with academic achievement across different stages of school and

128 university: For example, Preckel (2014) reported a weak positive correlation primarily for

129 Math in secondary school. Ginet and Py (2000) found a mean correlation of *r* = *.*33

130 between NFC and academic achievement in school across all school years studied, with

131 lower correlations in earlier and higher correlations in later school years, a pattern that can

132 also be found in Luong et al. (2017). Colling, Wollschläger, Keller, Preckel, and Fischbach

133 (2022) also report differences in the strength of the correlations with academic achievement

134 in school, here depending on the type of school, with the associations between NFC and

135 academic achievement being strongest in the highest and weakest in the lowest school

136 track. As regards university, low to medium correlations were found for NFC and average

137 grades (see Richardson, Abraham, & Bond, 2012; von Stumm & Ackerman, 2013). A

138 similar picture emerges for the correlation of NFC and university entrance tests results

139 (Cacioppo & Petty, 1982; Olson, Camp, & Fuller, 1984; Tolentino, Curry, & Leak, 1990).

140 Concerning the interplay of intelligence and NFC in the context of academic

141 achievement, Strobel, Behnke, Grass, and Strobel (2019) found that reasoning ability and

142 NFC both significantly predicted higher grade point average (GPA). Interestingly, NFC

143 also moderated the relation between intelligence and GPA: at higher levels of NFC, the

144 relation of reasoning ability and GPA was diminished. Although this finding requires

145 independent replication, it could point to a potentially compensating effect of NFC.

# 146 NFC and motivational aspects of learning

147 The increased willingness to invest mental effort and attention in task and

148 information processing that is typical for individuals with higher NFC is also associated

149 with positive correlations to various traits, behaviours and indicators relevant to learning.

150 Evans et al. (2003) found associations of NFC with deeper processing while learning.

151 Dickhäuser and Reinhard (2010) reported strong associations of NFC with the general

152 ability self-concept and smaller correlations with subject-specific ability self-concepts.

153 Luong et al. (2017) not only reported moderate to high correlations of NFC with aspects of

154 the ability self-concept, but also with learning orientation, processing depth and the desire

155 to learn from mistakes. Preckel (2014) found medium correlations of NFC with learning

156 goals and interest in various school subjects (for the latter association, see also Keller et

157 al., 2019). Furthermore, Elias and Loomis (2002) found NFC and efficacy beliefs to be

158 moderately correlated. Their results suggested that the relationship between NFC and

159 GPA was mediated by efficacy beliefs, in a way that individuals with higher NFC had

160 higher efficacy beliefs which in turn had a positive effect on academic achievement. Diseth

161 and Martinsen (2003) examined another indicator of performance motivation: In a student

162 sample, they found a high positive correlation between NFC and hope for success and a

163 medium negative relationship between NFC and fear of failure. Bless, Wänke, Bohner,

164 Fellhauer, and Schwarz (1994) report comparable findings. In a large sample of 7th grade

165 students, Lavrijsen et al. (2021) found a strong positive correlation with achievement

166 motivation and no relation of NFC to fear of failure.

167 Several studies examined NFC along with other motivational variables and found

168 NFC to explain variance in academic achievement beyond established motivational

169 variables such as learning orientation or ability self-concept (Keller et al., 2019; Luong et

170 al., 2017). Meier, Vogl, and Preckel (2014) examined potential predictors of the attendance

171 of a gifted class. They found that NFC, compared to other motivational constructs like

172 academic interests and goal orientations, significantly predicted the attendance of a gifted

173 class even when controlling for cognitive ability and other factors like parental education

174 level or ability self-concept. Lavrijsen et al. (2021) examined the predictive value of

175 intelligence, personality (Big Five and NFC) and different motivational constructs for

176 academic achievement and found intelligence, NFC, and the ability self-concept to be the

177 strongest predictors of Math grades and performance in standardized Math tests.

178 **The present study**

179 Overall, NFC has been proven to be a very promising predictor of academic

180 achievement over and above other motivational constructs. Yet, so far the evidence on its

181 incremental predictive value is limited by the mainly cross-sectional nature of available

182 studies and by the fact that only a few school subjects were considered. Furthermore, up to

183 now, prior achievement was not integrated as performance predictor in studies examining

184 NFC. This is a limitation insofar as besides students’ cognitive abilities their prior

185 achievement is a relevant predictor of future academic achievement (e.g., Hailikari, Nevgi,

186 & Komulainen, 2007; Steinmayr et al., 2019).

187 With the present study, we aim at adding to the existing body of research by

188 examining NFC, motivational indicators (ability self-concept, hope for success and fear of

189 failure, interests, each of them general and subject-specific) and academic achievement

190 (assessed via GPA, and grades in German, Math, Physics, and Chemistry) at two points of

191 time. By considering GPA plus four subject grades we extend the existing literature on

192 predicting academic achievement in school not only in general and in the domains of math

193 and German (see Steinmayr & Spinath, 2009), but also on focusing on the further domains

194 Physics and Chemistry. By applying latent change score modelling, we will be able to

195 determine the influence of our different predictors on the change of academic achievement

196 in general and in different domains in school over time. At the same time, mutual influences

197 of changes in academic achievement, NFC and motivational constructs can be detected

198 (i.e., correlated change). We examine the following research questions and assumptions:

199 1. Is Need for Cognition able to predict changes in academic achievement over time?

200 Because of evidence of relations of NFC with academic achievement in cross-sectional

201 studies, we expect NFC to also be able to predict changes in academic achievement

202 over time.

203 2. What is the incremental value of Need for Cognition in the prediction of academic

204 achievement over and above different motivational constructs and prior achievement

205 in school? Based on previous findings, we assume that NFC will predict academic

206 achievement even when the influence of established motivational variables and prior

207 achievement is controlled for.

208 3. Are longitudinal changes in motivational variables, Need for Cognition and academic

209 achievement in school related? To our knowledge, there is no prior evidence on

210 correlated change of NFC and the other variables examined here. Therefore, we can

211 only speculate that NFC and academic achievement will mutually influence each

212 other as has been observed for the interplay between motivational variables and

213 academic achievement.

214 **Methods**

215 **Openness and transparency**

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

217 and all measures in the study (cf. Simmons, Nelson, & Simonsohn, 2012) and follow JARS

218 (APA Publications and Communications Board Working Group on Journal Article

219 Reporting Standards, 2008). Data were analyzed using R (version 4.1.1, R Core Team,

220 2018). All data and code for reproducing our analyses are permanently and openly

221 accessible at <https://osf.io/34yav/?view_only=3bf5e46b6a444bd8b69300041f838523>

222 (project blinded for review, and to ensure blind review, please do not follow the “View this

223 file on GitHub” link). This study was not preregistered.

224 **Participants**

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

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

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

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

229 the second measurement occasion (T2) that took place 53-59 weeks later. Students

230 attended eleventh grade at two academic-track schools in Baden-Wuerttemberg at T1. Age

231 range was 14-19 years (median = 17 years) at T1 and 15-20 years (median = 18 years) at

232 T2. With the sample size accomplished at T2, we were able to detect correlations of *r ≥*

233 .18 at *α* = .05 (two-sided) and 1-*β* = .80. Yet, we tried to impute missing values to raise

234 power (see below, *Statistical analyses*).

235 **Material**

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

237 present study.

238 *Academic achievement* We assessed school grades in general, i.e., Grade Point

239 Average (GPA), and grades in German, Math, Physics, and Chemistry via self-report. In

240 Germany, school grades range from 1 (excellent) to 6 (insufficient). For better

241 interpretability, we reversed this coding via 6 *− grade*, so the values we used for statistical

242 analyses ranged from 0 (insufficient) to 5 (excellent).

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

244 NFC scale (Bless et al., 1994). Responses to each item (e.g., “Thinking is not my idea of

245 fun”, recoded) were recorded on a four-point scale ranging from -3 (completely disagree) to

246 +3 (completely agree) and were summed to the total NFC score. The scale has a

247 comparably high internal consistency, Cronbach’s *α* > .80 (Bless et al., 1994; Fleischhauer

248 et al., 2010), and retest reliability, *rtt* = *.*83 across 8 to 18 weeks (Fleischhauer, Strobel, &

249 Strobel, 2015).

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

251 Scales (German version: Göttert & Kuhl, 1980). For the present study, we used a short

252 form measuring each construct with seven items. All items were answered on a four-point

253 scale ranging from 1 (does not apply at all) to 4 (fully applies). Example items for the two

254 scales are “Difficult problems appeal to me” and “Matters that are slightly difficult

255 disconcert me”. Both scales exhibit high internal consistencies, Cronbach’s *α ≥ .*85

256 (Steinmayr & Spinath, 2009).

257 The *Ability Self-Concept* in school in general and in the four subjects German, Math,

258 Physics, and Chemistry were assessed with four items per domain using the Scales for the

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

260 2002) (example item: “I can do well in . . . (school, Math, German, Physics, Chemistry).”).

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

262 consistency, Cronbach’s *α ≥ .*80, and retest reliability, *rtt ≥ .*59 across six months, can be

263 considered as high.

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

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

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

267 much do you like . . . (school, Math, German, Physics, Chemistry).”) were recorded on a

268 5-point scale ranging from 1 (. . . ) to 5 (. . . ). The scales have high internal consistency,

269 Cronbach’s *α ≥ .*89, and retest reliability, *rtt* = *.*72 across six months (Steinmayr &

270 Spinath, 2010).

271 **Procedure**

272 Testing took place during a regular school day between March 2008 and 2009. Tests

273 were administered at school during a regular class, which was scheduled for our study.

274 Parents of underaged students (age < 18) provided informed consent. As the school

275 actively supported the study participation rate was very high (96%). However, some

276 students could not participate at measurement point 1 or 2 due to illness or other reasons

277 (T1: *n* = 18; T2: *n* = 26). Students were separated into groups of about 20 and tested by

278 trained research assistants. The test sessions lasted approximately 45 minutes.

279 **Statistical analysis**

280 We used *RStudio* (Version 2021.9.0.351, RStudio Team, 2016) with R (Version 4.1.1;

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

282 (Version 0.6.1; Tierney, Cook, McBain, & Fay, 2021), *psych* (Version 2.1.9; Revelle, 2018),

283 and *pwr* (Version 1.3.0; Champely, 2018). This manuscript was created using R Markdown

284 with the packages *papaja* (Version 0.1.0.9997, Aust & Barth, 2018), *knitr* (Version 1.37, Xie,

285 2015), and *shape* (Version 1.4.6, Soetaert, 2018). Additionally, the packages *renv* (Version

286 0.14.0, Ushey, 2021) and *here* (Version 1.0.1, Müller, 2020) were employed to enhance the

287 reproducibility of the present project (see [https://github.com/alex-strobel/NFC-Grades).](https://github.com/alex-strobel/NFC-Grades)

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

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

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

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

292 German, Math, Physics, and Chemistry. All measures were initially analyzed with regard

293 to descriptive statistics, reliability (retest-reliability *rtt* as well as Cronbach’s *α*), and

294 possible deviation from univariate and multivariate normality. Almost all relevant variables

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

296 threshold of *α* = .20, all *p ≤* .089 except for NFC at T2, *p* = .461. Also, there was

297 deviation from multivariate normality as determined using Mardia tests, all *pskew* and

298 *pkurtosis* < .001. Therefore, we used robust variants for the statistical tests to be performed,

299 i.e., Spearman rank correlations (*rs*) for correlation analyses and Robust Maximum

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

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

302 assessed via boxplots but not considered further given the scope of the present report.

303 Correlation analyses were performed separately for the five sets of data (see Table 1 and

304 Supplementary Tables S1 to S4). Where appropriate, evaluation of statistical significance

305 was based on 95% confidence intervals (CI) that did not include zero. Evaluation of effect

306 sizes of correlations was based on the empirically derived guidelines for personality and

307 social psychology research provided by Gignac and Szodorai (2016), i.e., correlations were

308 regarded as small for *r < .*20, as medium for *.*20 *≤ r ≤ .*30, and as large for *r > .*30.

309 To examine which variables measured at T1 would be significant predictors of

310 academic achievement at T2, we ran five regression analyses with the GPA and the four

311 subject-specific grades as criterion. We then used the results of the first regression analysis

312 (with the domain-general Ability Self-Concept, Interest in School, Hope for Success and

313 Fear of failure, and NFC measured at T1 as predictors and GPA at T2 as criterion) to

314 select the variables for latent change score modeling. Significant predictors in this model

315 were used for all latent change score models even if, for certain subjects, the predictors

316 were not significant in the respective regression models. Regression models were fitted via

317 *lavaan*, using MLR as estimation technique and—because missing data were missing

318 completely at random (MCAR), all *p ≥* .169—the Full-Information Maximum Likelihood

319 (FIML) approach to impute missing values. Due to missing patterns, this resulted in an

320 effective sample size of *N* = 271-276. To assess whether a model that included NFC was

321 superior to a model that included established predictors of academic achievement, we (1)

322 evaluated the fit of the respective models based on the recommendations by Hu and

323 Bentler (1999), with values of CFI *≥* .95, RMSEA *≤* .06, and SRMR *≤* 0.08 indicating

324 good model fit, and (2) performed *χ*2-difference tests between the former and the latter

325 model (and all other variables’ loadings fixed to zero).

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

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

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

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

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

331 (3) to what extent the change in this variable is a function of the measurement of *other*

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

333 whether the change in one domain (e.g., academic achievement) is a function of the

334 baseline score of another (e.g., NFC) and vice versa can be examined. In addition,

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

336 change in one variable correlate with the change in another variable. Fig. 1A provides an

337 example of a bivariate latent change score model. For latent change score modeling, again

338 MLR estimation and imputation of missing values via FIML was employed.

339 **Results**

340 **Domain-general grades**

341 Table [1](#_bookmark0) gives the descriptive statistics and intercorrelations of the variables of interest

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

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

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

345 table, all variables exhibited good internal consistency, Cronbach’s *α ≥* .83, and retest

346 reliability, *rtt ≥* .56. Among the predictors at T1, GPA at T1 showed the strongest relation

347 to GPA at T2, *rs* = *.*75, followed by the domain-general ability self-concept, *rs* = *.*53, and

348 NFC at T1, *rs* = *.*46, all *p <* .001. The other variables at T1 showed significant correlations

349 with GPA at T2 as well, *|rs| ≥ .*20, *p ≤ .*004.

350 A multiple regression analysis involving all measures at T1 (see Table [2)](#_bookmark1) showed that

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

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

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

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

355 predictors were set to zero), *χ*2(3) = 3.68, *p* .299, CFI = 1.00, RMSEA = .03 with 90% CI

356 [0.00, 0.11], SRMR = .01, than a model that included GPA and the ability self-concept

357 only, *χ*2(4) = 10.91, *p* .028, CFI = 0.96, RMSEA = .08 with 90% CI [0.02, 0.14], SRMR =

358 .02. A *χ*2-difference test supported the superiority of the former compared to the latter

359 model, *χ*2(1) = 6.34, *p* = .012.

360 We therefore further examined a trivariate latent change score model involving

361 academic achievement, the ability self-concept, and NFC. Fig. 1B gives the results of the

362 latent change score modeling with regard to the prediction of change and correlated change

363 in overall academic achievement, i.e., GPA. While the best predictor of change on GPA was

364 GPA at T1 (i.e., self-feedback via prior achievement), *B* = -0.37, 95% CI [-0.48, -0.25],

365 *p < .*001, *β* = -.55, there was also evidence for cross-domain coupling, as the overall ability

366 self-concept and NFC at T1 also significantly predicted change in GPA, *B* = 0.13, 95% CI

367 [0.02, 0.24], *p* = *.*020, *β* = .19, and *B* = 0.08, 95% CI [0.02, 0.15], *p* = *.*009, *β* = .19,

368 respectively. Correlated change was observed for GPA and the ability self-concept, *B* =

369 0.03, 95% CI [0.01, 0.05], *p* = *.*001, *β* = .22, and the ability self-concept and NFC, *B* =

370 0.05, 95% CI [0.02, 0.08], *p.*001, *β* = .22, while the correlated changes in GPA and NFC did

371 not reach significance, *B* = 0.03, 95% CI [0.00, 0.05], *p* = *.*053, *β* = .14.

372 **Domain-specific grades**

373 For the four subjects examined, i.e., German, Math, Physics, and Chemistry, similar

374 results were obtained with regard to correlation analyses (see Supplementary Tables S1 to

375 S4). As regards multiple regression analyses (see Table [3),](#_bookmark2) for all subjects, grades at T1

376 were significant predictors of grades at T2, *p < .*001. The subject-specific ability

377 self-concept at T1 was a significant predictor of grades at T2 in German only, *B* = 0.29,

378 95% CI [0.15, 0.43], *p < .*001. NFC at T1 was a significant predictor of T2 grades in

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

380 0.37], *p* = *.*004. In both cases, models with NFC as predictor together with grades at T1

381 and ability self-concept were superior to models with grades at T1 and ability self-concept

382 only, German: *χ*2(1) = 9.31, *p* = .002, physics: *χ*2(1) = 13.49, *p* = < .001.

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

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

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

386 0.28, 95% CI [0.16, 0.40], *p < .*001, *β* = .36, and Chemistry, *B* = 0.09, 95% CI [0.00, 0.18],

387 *p* = *.*042, *β* = .14. NFC at T1 showed cross-domain coupling with grades at T2 for

388 German, *B* = 0.13, 95% CI [0.04, 0.21], *p* = *.*005, *β* = .17, Physics, *B* = 0.23, 95% CI [0.13,

389 0.33], *p < .*001, *β* = .24, and Chemistry, *B* = 0.10, 95% CI [0.00, 0.20], *p* = *.*047, *β* = .13.

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

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

392 German, Math, and Physics only (see Fig. 1C-F).

393 **Discussion**

394 The present study was conducted to provide new insights into the interplay of

395 academic achievement, motivational variables and NFC. In a sample of secondary school

396 students, we examined the incremental value of NFC, considering ability self-concept,

397 interest (general and domain-specific), hope for success and fear of failure as well as prior

398 achievement in the prediction of academic achievement (assessed via GPA and grades in

399 German, Math, Physics, and Chemistry. By applying latent change score modelling, we

400 determined the influence of these predictors on the change of academic achievement over

401 one year. At the same time, we examined mutual influences of change in these variables.

402 The main results are discussed below.

403 **Predictive value of NFC**

404 Concerning associations of all predictors examined and academic achievement, we

405 found typical correlation patterns: In line with former findings (Hailikari et al., 2007;

406 Steinmayr et al., 2019), prior achievement showed a strong relation to GPA at the second

407 time of assessment. Also mirroring previous findings (Steinmayr et al., 2019), among the

408 motivational variables, ability self-concept showed the highest correlations with academic

409 achievement, and this held for general as well as domain-specific ability self-concept.

410 Furthermore, comparable to associations reported by Ginet and Py (2000) or Luong et al.

411 (2017), moderate to strong associations were found for academic achievement and NFC

412 pointing to the relevance of this variable in the school context.

413 **Incremental value of NFC**

414 The importance of NFC becomes even more apparent when looking at the prediction

415 models: Multiple regression analyses showed NFC to incrementally predict academic

416 achievement as reflected in GPA, German and Physics grades over and above prior

417 achievement and the general or domain-specific ability self-concept. A more differentiated

418 picture is provided by the latent change score models. For GPA, German and Chemistry,

419 prior achievement positively predicted changes in grades, as did general, or domain specific

420 ability self-concept, respectively, and NFC. Concerning Physics, only NFC was found to

421 predict changes in grades for this subject alongside with prior achievement, while for Math

422 grades, prior achievement was the only relevant predictor. The findings are thus slightly

423 varying within the school subjects, with the results for Maths being particular different

424 from the others. It is noteworthy that the stability of the Maths grade is lower than that of

425 the other subjects included. There could be many possible reasons for this finding. For

426 example, there could have been a change of teachers or changes in the conditions in the

427 different subjects. However, we are not able to draw firm conclusions on the basis of the

428 available information: Since the examination of individual subjects was not the core of the

429 study and we investigated a convenience sample, no further information about the teaching

430 (e.g., via diary entries) was collected. This should be addressed in further studies. Apart

431 from this limitation, with regard to all grades examined and comparable to the results of

432 Lavrijsen et al. (2021), NFC proved to be a valuable predictor that should be considered

433 alongside established motivational variables in order to gain a comprehensive picture of the

434 factors that influence grades.

435 **Interplay of all predictors**

436 By applying latent change score modelling, we were also able to gain insights into the

437 interplay of prior achievement, ability self-concept, and NFC. For all three variables, their

438 level at the first measurement occasion predicted changes in their respective level at the

439 second time of assessment. Changes in NFC could also be predicted by prior achievement

440 (with the exception of Physics) while for changes in ability self-concept, prior achievement

441 was only predictive for GPA and German grades. Furthermore, concerning correlated

442 change, the amount of change in grades at the second measurement occasion correlated

443 with changes in ability self-concept for GPA and all subjects, that is, changes in grades

444 were accompanied by changes in ability self-concept and vice versa. This is a plausible

445 interplay as ability self-concept is subject to change through feedback and the experience of

446 success or failure (e.g., Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Spinath &

447 Spinath, 2005). The same association was observable for changes in grades and NFC in

448 German, Math and Physics. Thus, change in grades was accompanied by larger change in

449 the enjoyment of and motivation for thinking, particularly in these subjects. Changes in

450 ability self-concept and NFC, in turn, were correlated for GPA and Chemistry. Taken

451 together, this lends support to self-enhancement and skill-development processes for both,

452 ability self-concept and NFC. While such reciprocal relations of academic achievement and

453 the ability self-concept are well-confirmed (Marsh & Martin, 2011; Möller, Retelsdorf,

454 Köller, & Marsh, 2011; Möller, Zitzmann, Machts, Helm, & Wolff, 2020), to our knowledge,

455 this has not yet been demonstrated for NFC as well. Academic achievement and NFC

456 appear to mutually strengthen or weaken each other. Therefore, fostering NFC at school

457 can be an essential part of ensuring that children can develop their full intellectual

458 potential. The findings of Meier et al. (2014) support this assumption: for the attendance

459 of a gifted class, the level of NFC played a pivotal role even after controlling for cognitive

460 ability or ability self-concept.

# 461 Limitations and further directions

462 Some limitations of our study have to be noted. We assessed all data in a convenience

463 sample, and while it was large enough to have adequate power to detect small to medium

464 correlations, it was not representative for the German population of adolescents.

465 Furthermore, there were missing values in the data and we had to impute them in order to

466 increase power for our analyses. Yet, the FIML approach to treat missing values employed

467 here was shown to lead to adequate estimates for the standard error of regression estimates

468 (Larsen, 2011). Also, we did not have the opportunity to examine the predictive value of

469 intelligence together with the predictors in our study. Although we assessed prior

470 achievement as a relevant predictor also mirroring intellectual potential, further studies

471 should also assess intelligence in order to gain a more comprehensive picture of the

472 interplay of all variables of relevance. Furthermore, because of the trait-character of NFC,

473 hope for success and fear of failure, we did not assess these variables in a domain-specific

474 way. As research concerning NFC showed that there is also a domain-specific component

475 for this variable (Keller, Strobel, Martin, & Preckel, 2019) which is especially relevant in

476 Math, it could be worthwhile to incorporate domain-specific measures at least of NFC in

477 future research. This could also be helpful to further clarify the reasons for the observed

478 differences in results for the subjects examined here. As a last aspect, it would be

479 interesting to longitudinally investigate the potential of NFC together with established

480 motivational variables in school especially in *critical* stages of school life, for instance when

481 decisions about school tracks are made.

482 **Conclusion**

483 Taken together, using a longitudinal approach and including a large set of established

484 predictors of academic achievement, the present study shows that NFC is of incremental

485 value when aiming at a comprehensive picture on the prediction of academic achievement.

486 Associations of NFC with grades were comparable or even stronger than for

487 well-established motivational variables. In the prediction of grades over time, NFC could

488 largely consistently prove its predictive value over and above prior achievement.

489 Furthermore, a mutual influence of NFC and academic achievement could be demonstrated

490 with first evidence for skill-development as well as self-enhancement processes taken place

491 in this interplay. To sum up, we propose that NFC should be included in models aiming at

492 comprehensively explaining academic achievement in school. In addition, we consider

493 fostering the general joy of thinking and conquering cognitively challenging tasks a

494 worthwhile endeavor to help children to unfold their intellectual potential.

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Table 1

*Spearman correlations and descriptive statistics of the variables in the analyses on Grade Point Average*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 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* = 193-259 due to missings; *p < .*05 for *|rs|* > .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 academic achievement 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 |

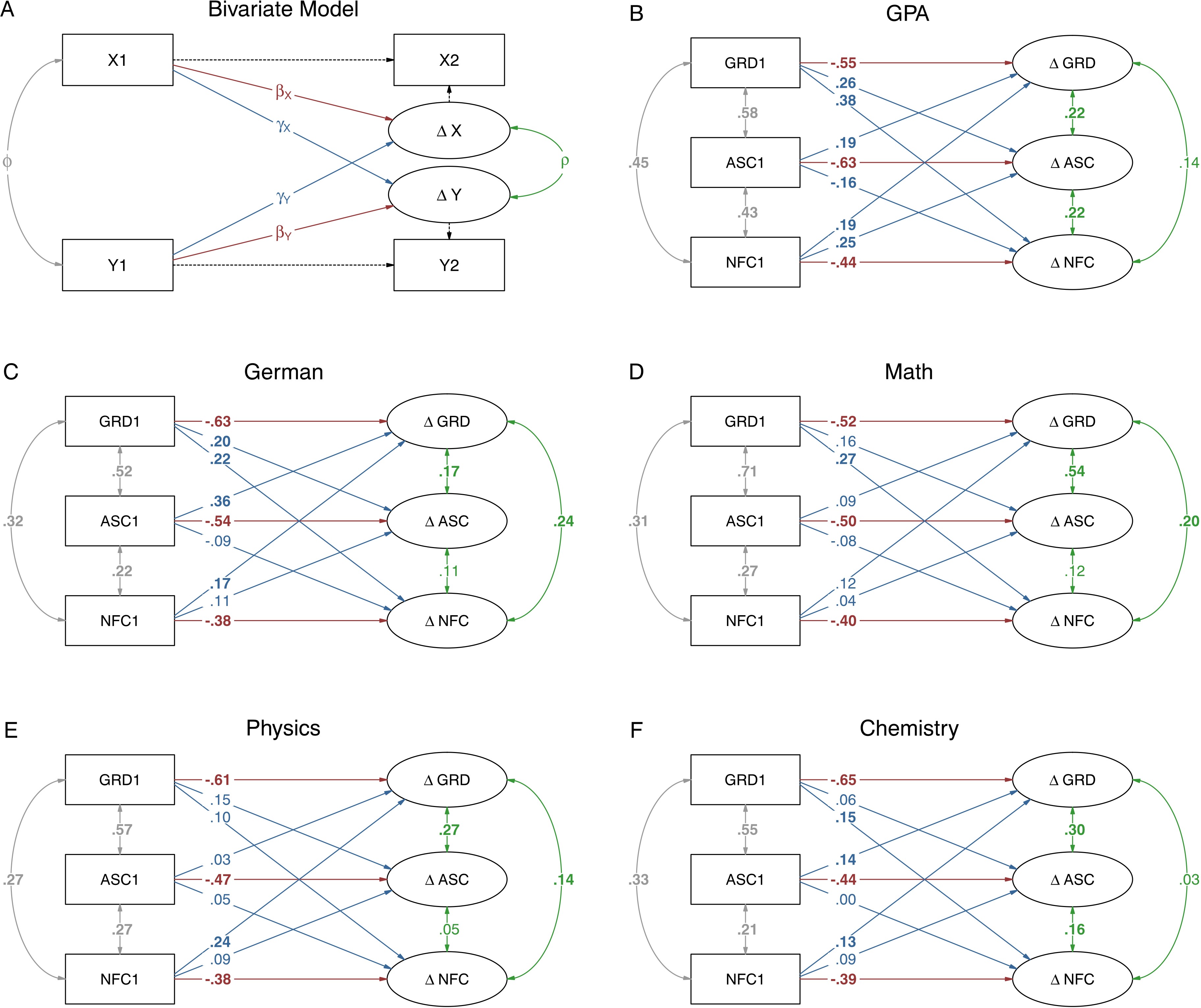
*Note. N* = 276; coefficients are unstandardized slopes *B* with their standard errors *SE* and 95% confidence intervals (*CI.LB* = lower bound, *CI.UB* = upper bound), *β* is the standardized slope and *p* the respective *p*-vcalues

Table 3

*Multiple regressions of subject grades at T2 on predictors at T1*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *B* | | *SE* | *CI.LB* | *CI.UB* | *β* | *p* |
| German Intercept | 0.374 | 0.300 | -0.214 | 0.962 | .465 | .213 |
| Grade German | 0.506 | 0.063 | 0.382 | 0.629 | .499 | < .001 |
| Ability Self-Concept German | 0.289 | 0.072 | 0.147 | 0.430 | .294 | < .001 |
| Interest in German | -0.022 | 0.052 | -0.124 | 0.079 | -.027 | .668 |
| Hope for Success | -0.129 | 0.089 | -0.303 | 0.045 | -.091 | .145 |
| Fear of Failure | -0.044 | 0.061 | -0.165 | 0.076 | -.033 | .470 |
| Need for Cognition | 0.183 | 0.068 | 0.050 | 0.316 | .192 | .007 |
| Math  Intercept | 1.498 | 0.517 | 0.484 | 2.512 | 1.368 | .004 |
| Grade Math | 0.493 | 0.089 | 0.318 | 0.667 | .461 | < .001 |
| Ability Self-Concept Math | 0.057 | 0.122 | -0.182 | 0.295 | .052 | .643 |
| Interest in Math | 0.041 | 0.084 | -0.124 | 0.207 | .043 | .625 |
| Hope for Success | -0.083 | 0.140 | -0.357 | 0.191 | -.043 | .552 |
| Fear of Failure | -0.184 | 0.111 | -0.401 | 0.033 | -.102 | .097 |
| Need for Cognition Physics  Intercept | 0.091  -0.234 | 0.107  0.381 | -0.118  -0.979 | 0.300  0.512 | .070  -.252 | .392  .539 |
| Grade Physics | 0.533 | 0.064 | 0.407 | 0.658 | .590 | < .001 |
| Ability Self-Concept Physics | 0.062 | 0.096 | -0.126 | 0.249 | .066 | .521 |
| Interest in Physics | -0.035 | 0.068 | -0.169 | 0.099 | -.044 | .610 |
| Hope for Success | 0.116 | 0.109 | -0.098 | 0.330 | .071 | .288 |
| Fear of Failure | 0.117 | 0.092 | -0.063 | 0.298 | .076 | .204 |
| Need for Cognition | 0.217 | 0.076 | 0.068 | 0.366 | .197 | .004 |
| Chemistry  Intercept | 0.583 | 0.348 | -0.098 | 1.265 | .703 | .093 |
| Grade Chemistry | 0.554 | 0.054 | 0.448 | 0.661 | .633 | < .001 |
| Ability Self-Concept Chemistry | 0.088 | 0.069 | -0.048 | 0.223 | .112 | .205 |
| Interest in Chemistry | -0.011 | 0.056 | -0.120 | 0.098 | -.016 | .839 |
| Hope for Success | -0.006 | 0.089 | -0.180 | 0.168 | -.004 | .943 |
| Fear of Failure | 0.051 | 0.082 | -0.111 | 0.213 | .037 | .536 |
| Need for Cognition | 0.122 | 0.062 | -0.001 | 0.244 | .124 | .051 |

*Note. N* = 271-275; 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 ∆) 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.