On the interplay of motivational characteristics and academic achievement: The role of Need for Cognition

Abstract

While intelligence and motivational variables are well-established predictors of academic achievement, Need for Cognition (NFC), the stable intrinsic motivation to engage in and enjoy challenging intellectual activity, has not yet been considered comprehensively in this field of research approaches, especially not longitudinally. By applying latent change score modelling, we examined the incremental value of NFC, considering well-established motivational constructs as well as prior achievement in the prediction of academic achievement across different subjects in a longitudinal approach in a sample of secondary school students ($N = 271$ and 255, respectively). Correlations of NFC with grades were comparable to those of established predictors. NFC incrementally predicted academic achievement over and above prior achievement as well as ability self-concept. Furthermore, a mutual influence of NFC and academic achievement was found pointing to skill-development as well as self-enhancement processes taken place in this interplay. Consequently, we propose to include NFC in models for the comprehensive explanation of academic achievement in school.

Keywords: Need for Cognition, Academic Achievement, Academic Self-Concept, Latent Change Score Modeling, Longitudinal

Word count: 5809

On the interplay of motivational characteristics and academic achievement: The role of Need for Cognition

In recent decades, a great deal of research has been conducted on the prediction of academic achievement. While meta-analyses indicate that intelligence is the strongest predictor for academic achievement (e.g., Deary, Strand, Smith, & Fernandes, 2007; Roth et al., 2015; Zaboski, Kranzler, & Gage, 2018), motivational variables have consistently been found to have incremental value for academic achievement (e.g., Kriegbaum, Becker, & Spinath, 2018; Steinmayr, Weidinger, Schwinger, & Spinath, 2019). Concepts like ability self-concept, hope for success and fear of failure, interest and values are well known and equally established indicators (Wigfield & Cambria, 2010; e.g., Wigfield & Eccles, 2000) that are subsumed under the umbrella term of achievement motivation (Steinmayr et al., 2019).

Over the last years, an additional predictor of academic achievement came into the focus of research in this field: the personality trait Need for Cognition (NFC), defined as the stable intrinsic motivation of an individual to engage in and enjoy challenging intellectual activity (Cacioppo, Petty, Feinstein, & Jarvis, 1996). Investment traits (von Stumm & Ackerman, 2013) such as NFC determine how individuals invest their cognitive resources and how they deal with cognitively challenging material. It has been shown that NFC is related to academic achievement in different stages of academic life (e.g., Ginet & Py, 2000; Grass, Strobel, & Strobel, 2017; Luong et al., 2017; Preckel, 2014; for a meta-analytical review see von Stumm & Ackerman, 2013) and to behaviors associated with success in learning. As examples, NFC was found to be related to ability self-concept (e.g., Dickhäuser & Reinhard, 2010; Luong et al., 2017), interest in school (e.g., Preckel, 2014) or deeper processing while learning (Evans, Kirby, & Fabrigar, 2003; Luong et al., 2017).

The enjoyment of accomplishing something, the interest in task engagement, and the intrinsic value of working on a task have been suggested to be relevant to learning and academic achievement and have been integrated into models of achievement motivation (e.g., Wigfield & Eccles, 2000; see also Wigfield & Cambria, 2010 for a review). Surprisingly, the concept of a more general joy of thinking, that is NFC, has not yet been investigated systematically together with established motivational indicators or was integrated into models for the prediction of academic achievement, especially in school contexts. In particular, longitudinal studies are missing that have a comprehensive look at the interplay of all relevant variables.

Only last year, a large longitudinal study examined intelligence, the Big Five, a range of different motivational measures together with NFC in order to determine their value in predicting academic achievement in school (Lavrijsen, Vansteenkiste, Boncquet, & Verschueren, 2021). Their results showed intelligence and NFC to be the strongest predictors of academic performance. The ability self-concept was the best predictor within the group of motivational variables. This underscores the importance to consider NFC along with established predictors in gaining a comprehensive picture of the prediction of academic achievement.

To follow-up on these findings and to provide new insights in the interplay of academic achievement, NFC and motivational variables, we examined the incremental value of NFC, considering well-established motivational constructs as well as prior achievement in the prediction of academic achievement across different subjects in a longitudinal approach in a sample of secondary school students.

Achievement Motivation and its relation to academic achievement

Achievement motivation is operationalized through various variables and can be seen as an essential predictor of academic achievement (e.g., Hattie, 2009; Steinmayr & Spinath, 2009; Wigfield & Cambria, 2010). Well-established concepts such as ability self-concept, hope for success and fear of failure, or variables such as interests and values can be found under this term (Hulleman, Barron, Kosovich, & Lazowski, 2016; Steinmayr et al., 2019). These constructs are part of prominent motivational theories (cf., Eccles & Wigfield, 2020; Elliot & Church, 1997; Wigfield & Eccles, 2000), and they positively predict academic achievement (e.g., Steinmayr & Spinath, 2009; Steinmayr, Weidinger, & Wigfield, 2018), which is why they were included in this study as important motivational indicators. They are briefly introduced below.

Ability Self-concept. Ability self-concept can be described as generalized or subject-specific ability perceptions that students acquire based on competence experiences in the course of their academic life (Möller & Köller, 2004). They thus reflect cognitive representations of one's level of ability (Marsh, 1990), which affects students' academic performance (e.g., Wigfield & Eccles, 2000). A meta-analysis found moderate correlations with academic achievement ($r = .34$, Huang, 2011), whereas the association was lower (r .20) when controlled for prior achievement (e.g., Marsh & Martin, 2011). Steinmayr et al. (2019) demonstrated that among several motivational indicators, domain-specific ability self-concept was the strongest predictor of academic achievement. Moreover, ability self-concept and academic achievement influence each other and can thus mutually reinforce or weaken each other (e.g., Guay, Marsh, & Boivin, 2003).

Hope for Success/Fear of Failure. Murray (1938) considered the Need for Achievement as one of the basic human needs and as a relatively stable personality trait. His concept was extended by McClelland, Atkinson, Clark, and Lowell (1953), who differentiated the achievement motives hope for success (the belief of being able to succeed accompanied by the experience of positive emotions) and fear of failure (worry about failing in achievement situations and the experience of negative emotions). Such affective tendencies in the context of achievement motivation are reflected, for instance, in the choice of task difficulty, affinity for risk, and quality of task completion (Diseth & Martinsen, 2003). Hope for success may facilitate knowledge acquisition, whereas fear of failure may impede it (Diseth & Martinsen, 2003). A meta-analysis found achievement motivation in the sense of hope for success weakly to moderately positively related to academic achievement ($r = .26$, Robbins et al., 2004). For the association of fear of failure and academic achievement, findings from individual studies suggest a relationship of similar magnitude but in a different direction (e.g., $r = -.26$, Dickhäuser, Dinger, Janke, Spinath, & Steinmayr, 2016).

Task values - Interest. Another important motivational indicator that was also included in the influential model of Wigfield and Eccles (2000); see also Eccles and Wigfield (2020), describes task values. Such task values focus on importance, perceived utility, and interest in a task and costs associated with it, whereas the latter is often omitted (cf. Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). Findings on relations between task values and academic achievement point to reciprocal relationships between them (Li, Huebner, & Tian, 2021). Furthermore, there is some evidence that the interaction of task values and self-concept may be of special relevance for predicting academic achievement, although the state of evidence on this is still mixed (Meyer, Fleckenstein, & Köller, 2019). Specifically on the domain of interest, a number of papers are available on the relationship with academic achievement in school, with correlations being in a low to moderate range (for an overview, see Steinmayr et al., 2019). A meta-analysis on the relationship between interest and achievement found moderate positive correlations between these two variables (Schiefele, Krapp, & Winteler, 1992).

Need for Cognition and academic achievement

NFC describes the stable intrinsic motivation of an individual to engage in and enjoy challenging intellectual activity (Cacioppo et al., 1996). While individuals with lower NFC scores tend to rely more on other people, cognitive heuristics or social comparisons in decision making, individuals with higher NFC scores show a tendency to seek, acquire and reflect on information (Cacioppo et al., 1996). NFC, mirroring the typical cognitive performance of a person, has been shown to be rather modestly related to intelligence and its fluid (Fleischhauer et al., 2010) and crystallized (von Stumm & Ackerman, 2013) components.

NFC correlates with academic achievement across different stages of school and university: For example, Preckel (2014) reported a weak positive correlation primarily for Math in secondary school. Ginet and Py (2000) found a mean correlation of $r = .33$ between NFC and academic achievement in school across all school years studied, with lower correlations in earlier and higher correlations in later school years, a pattern that can also be found in Luong et al. (2017). Colling, Wollschläger, Keller, Preckel, and Fischbach (2022) also report differences in the strength of the correlations with academic achievement in school, here depending on the type of school, with the associations between NFC and academic achievement being strongest in the highest and weakest in the lowest school track. As regards university, low to medium correlations were found for NFC and average grades (see Richardson, Abraham, & Bond, 2012; von Stumm & Ackerman, 2013). A similar picture emerges for the correlation of NFC and university entrance tests results (Cacioppo & Petty, 1982; Olson, Camp, & Fuller, 1984; Tolentino, Curry, & Leak, 1990).

Concerning the interplay of intelligence and NFC in the context of academic achievement, Strobel, Behnke, Grass, and Strobel (2019) found that reasoning ability and NFC both significantly predicted higher grade point average (GPA). Interestingly, NFC also moderated the relation between intelligence and GPA: at higher levels of NFC, the relation of reasoning ability and GPA was diminished. Although this finding requires independent replication, it could point to a potentially compensating effect of NFC.

NFC and motivational aspects of learning

The increased willingness to invest mental effort and attention in task and information processing that is typical for individuals with higher NFC is also associated with positive correlations to various traits, behaviours and indicators relevant to learning. Evans et al. (2003) found associations of NFC with deeper processing while learning. Dickhäuser and Reinhard (2010) reported strong associations of NFC with the general ability self-concept and smaller correlations with subject-specific ability self-concepts. Luong et al. (2017) not only reported moderate to high correlations of NFC with aspects of the ability self-concept, but also with learning orientation, processing depth and the desire to learn from mistakes. Preckel (2014) found medium correlations of NFC with learning goals and interest in various school subjects (for the latter association, see also Keller et al., 2019). Furthermore, Elias and Loomis (2002) found NFC and efficacy beliefs to be moderately correlated. Their results suggested that the relationship between NFC and GPA was mediated by efficacy beliefs, in a way that individuals with higher NFC had higher efficacy beliefs which in turn had a positive effect on academic achievement. Diseth and Martinsen (2003) examined another indicator of performance motivation: In a student sample, they found a high positive correlation between NFC and hope for success and a medium negative relationship between NFC and fear of failure. Bless, Wänke, Bohner, Fellhauer, and Schwarz (1994) report comparable findings. In a large sample of 7th grade students, Lavrijsen et al. (2021) found a strong positive correlation with achievement motivation and no relation of NFC to fear of failure.

Several studies examined NFC along with other motivational variables and found NFC to explain variance in academic achievement beyond established motivational variables such as learning orientation or ability self-concept (Keller et al., 2019; Luong et al., 2017). Meier, Vogl, and Preckel (2014) examined potential predictors of the attendance of a gifted class. They found that NFC, compared to other motivational constructs like academic interests and goal orientations, significantly predicted the attendance of a gifted class even when controlling for cognitive ability and other factors like parental education level or ability self-concept. Lavrijsen et al. (2021) examined the predictive value of intelligence, personality (Big Five and NFC) and different motivational constructs for academic achievement and found intelligence, NFC, and the ability self-concept to be the strongest predictors of Math grades and performance in standardized Math tests.

The present study

Overall, NFC has been proven to be a very promising predictor of academic achievement over and above other motivational constructs. Yet, so far the evidence on its incremental predictive value is limited by the mainly cross-sectional nature of available studies and by the fact that only a few school subjects were considered. Furthermore, up to now, prior achievement was not integrated as performance predictor in studies examining NFC. This is a limitation insofar as besides students' cognitive abilities their prior achievement is a relevant predictor of future academic achievement (e.g., Hailikari, Nevgi, & Komulainen, 2007; Steinmayr et al., 2019).

With the present study, we aim at adding to the existing body of research by examining NFC, motivational indicators (ability self-concept, hope for success and fear of failure, interests, each of them general and subject-specific) and academic achievement (assessed via GPA, and grades in German, Math, Physics, and Chemistry) at two points of time. By considering GPA plus four subject grades we extend the existing literature on predicting academic achievement in school not only in general and in the domains of math and German (see Steinmayr & Spinath, 2009), but also on focusing on the further domains Physics and Chemistry. By applying latent change score modelling, we will be able to determine the influence of our different predictors on the change of academic achievement in general and in different domains in school over time. At the same time, mutual influences of changes in academic achievement, NFC and motivational constructs can be detected (i.e., correlated change). We examine the following research questions and assumptions:

1. Is Need for Cognition able to predict changes in academic achievement over time? Because of evidence of relations of NFC with academic achievement in cross-sectional studies, we expect NFC to also be able to predict changes in academic achievement over time.
2. What is the incremental value of Need for Cognition in the prediction of academic

achievement over and above different motivational constructs and prior achievement in school? Based on previous findings, we assume that NFC will predict academic achievement even when the influence of established motivational variables and prior achievement is controlled for.

3. Are longitudinal changes in motivational variables, Need for Cognition and academic achievement in school related? To our knowledge, there is no prior evidence on correlated change of NFC and the other variables examined here. Therefore, we can only speculate that NFC and academic achievement will mutually influence each other as has been observed for the interplay between motivational variables and academic achievement.

Methods

Openness and transparency

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study (cf. Simmons, Nelson, & Simonsohn, 2012) and follow JARS (APA Publications and Communications Board Working Group on Journal Article Reporting Standards, 2008). Data were analyzed using R (version 4.1.1, R Core Team, 2018). All data and code for reproducing our analyses are permanently and openly accessible at https://osf.io/34yav/?view_only=3bf5e46b6a444bd8b69300041f838523 (project blinded for review, and to ensure blind review, please do not follow the “View this file on GitHub” link). This study was not preregistered.

Participants

Sample size was determined by pragmatic considerations, i.e., to collect as many participants given existing time constraints and the longitudinal nature of the project. We eventually managed to recruit a sample of $N = 277$ participants (60% women) at the first measurement occasion (T1) of which $N = 251$ participants (61% women) also took part at the second measurement occasion (T2) that took place 53-59 weeks later. Students attended eleventh grade at two academic-track schools in Baden-Württemberg at T1. Age range was 14-19 years (median = 17 years) at T1 and 15-20 years (median = 18 years) at T2. With the sample size accomplished at T2, we were able to detect correlations of $r \geq .18$ at $\alpha = .05$ (two-sided) and 1-$\beta = .80$. Yet, we tried to impute missing values to raise power (see below, *Statistical analyses*).

Material

We used the following self-report measures to assess the measures of interest for the present study.

Academic achievement We assessed school grades in general, i.e., Grade Point Average (GPA), and grades in German, Math, Physics, and Chemistry via self-report. In Germany, school grades range from 1 (excellent) to 6 (insufficient). For better interpretability, we reversed this coding via $6 - grade$, so the values we used for statistical analyses ranged from 0 (insufficient) to 5 (excellent).

Need for Cognition (NFC) was assessed with the 16-item short version of the German NFC scale (Bless et al., 1994). Responses to each item (e.g., "Thinking is not my idea of fun", recoded) were recorded on a four-point scale ranging from -3 (completely disagree) to +3 (completely agree) and were summed to the total NFC score. The scale has a comparably high internal consistency, Cronbach's $\alpha > .80$ (Bless et al., 1994; Fleischhauer et al., 2010), and retest reliability, $r_{tt} = .83$ across 8 to 18 weeks (Fleischhauer, Strobel, & Strobel, 2015).

Hope for Successs and *Fear of Failure* were assessed using the Achievement Motive Scales (German version: Göttert & Kuhl, 1980). For the present study, we used a short form measuring each construct with seven items. All items were answered on a four-point scale ranging from 1 (does not apply at all) to 4 (fully applies). Example items for the two scales are "Difficult problems appeal to me" and "Matters that are slightly difficult disconcert me". Both scales exhibit high internal consistencies, Cronbach's $\alpha \geq .85$ (Steinmayr & Spinath, 2009).

The *Ability Self-Concept* in school in general and in the four subjects German, Math, Physics, and Chemistry were assessed with four items per domain using the Scales for the Assessment of Academic Self-Concept (Schöne, Dickhäuser, Spinath, & Stiensmeier-Pelster, 2002) (example item: "I can do well in ... (school, Math, German, Physics, Chemistry)."). Items were answered on a 5-point scale ranging from 1 (does not apply at all) to 5 (fully applies). The scales' internal consistency, Cronbach's $\alpha \geq .80$, and retest reliability, $r_{tt} \geq .59$ across six months, can be considered as high.

Interest in school in general and in the above four subjects were measured using Interest subscales of the Scales for the Assessment of Subjective Values in School (Steinmayr & Spinath, 2010). Answers to three items per domain (example item: "How much do you like ... (school, Math, German, Physics, Chemistry).") were recorded on a 5-point scale ranging from ranging from 1 (does not apply at all) to 5 (fully applies). The scales have high internal consistency, Cronbach's $\alpha \geq .89$, and retest reliability, $r_{tt} = .72$ across six months (Steinmayr & Spinath, 2010).

Procedure

Testing took place during a regular school day between March 2008 and 2009. Tests were administered at school during a regular class, which was scheduled for our study. Parents of underaged students (age < 18) provided informed consent. As the school actively supported the study participation rate was very high (96%). However, some students could not participate at measurement point 1 or 2 due to illness or other reasons (T1: $n = 18$; T2: $n = 26$). Students were separated into groups of about 20 and tested by trained research assistants. The test sessions lasted approximately 45 minutes.

Statistical analysis

We used *RStudio* (Version 2021.9.0.351, RStudio Team, 2016) with R (Version 4.1.1; R Core Team, 2018) and the R-packages *lavaan* (Version 0.6.10; Rosseel, 2012), *naniar* (Version 0.6.1; Tierney, Cook, McBain, & Fay, 2021), *psych* (Version 2.1.9; Revelle, 2018), and *pwr* (Version 1.3.0; Champely, 2018). This manuscript was created using R Markdown with the packages *papaja* (Version 0.1.0.9997, Aust & Barth, 2018), *knitr* (Version 1.37, Xie, 2015), and *shape* (Version 1.4.6, Soetaert, 2018). Additionally, the packages *renv* (Version 0.14.0, Ushey, 2021) and *here* (Version 1.0.1, Müller, 2020) were employed to enhance the reproducibility of the present project (see https://github.com/alex-strobel/NFC-Grades).

First the variables were separated into four sets, each containing the T1 and T2 measurements of the variables Hope for Success (HfS), Fear of Failure (FoF), and Need for Cognition (NFC) as well as either GPA, overall ability self-concept regarding school, and general interest in school, or domain-specific grades, ability self-concept and interest in German, Math, Physics, and Chemistry. All measures were initially analyzed with regard to descriptive statistics, reliability (retest-reliability r_{tt} as well as Cronbach's α), and possible deviation from univariate and multivariate normality. Almost all relevant variables deviated from univariate normality as determined using Shapiro-Wilks tests with a threshold of $\alpha = .20$, all $p \leq .089$ except for NFC at T2, $p = .461$. Also, there was deviation from multivariate normality as determined using Mardia tests, all p_{skew} and $p_{kurtosis} < .001$. Therefore, we used robust variants for the statistical tests to be performed, i.e., Spearman rank correlations (r_s) for correlation analyses and Robust Maximum Likelihood (MLR) for regression analyses and latent change score modeling.

Possible differences between the measurement occasions T1 and T2 were descriptively assessed via boxplots but 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 academic achievement at T2, we ran five regression analyses with the GPA and the four subject-specific grades as criterion. We then 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—because missing data were missing completely at random (MCAR), all $p \geq .169$—the Full-Information Maximum Likelihood (FIML) approach to impute missing values. Due to missing patterns, this resulted in an effective sample size of N = 271-276. To assess 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 Kievit et al., 2018), one can examine (1) whether true change in a variable has occurred via a latent change score that is modeled from the respective measurements of this variable at different measurement occasions, here T1 and T2, (2) to what extent the change in a variable is a function of the measurement of the *same* variable at T1 (self-feedback), and

(3) to what extent the change in this variable is a function of the measurement of *other* variables in the model at T1 (cross-domain coupling). Thereby, cross-domain effects, i.e., whether the change in one domain (e.g., academic achievement) is a function of the baseline score of another (e.g., NFC) and vice versa can be examined. In addition, correlated change in the variables of interest can be examined, i.e., to what extent does the change in one variable correlate with the change in another variable. Fig. 1A provides an example of a bivariate latent change score model. For latent change score modeling, again MLR estimation and imputation of missing values via FIML was employed.

Results

Domain-general grades

Table 1 gives the descriptive statistics and intercorrelations of the variables of interest in this analysis step, i.e., the T1 and T2 measurements of GPA, domain-general ability self-concept, and general interest in school as well as the variables Hope for Success, Fear of Failure, and NFC. As can be seen in the diagonal and the upper right of the correlation table, all variables exhibited good internal consistency, Cronbach's $\alpha \geq .83$, and retest reliability, $r_{tt} \geq .56$. Among the predictors at T1, GPA at T1 showed the strongest relation to GPA at T2, $r_s = .75$, followed by the domain-general ability self-concept, $r_s = .53$, and NFC at T1, $r_s = .46$, all $p < .001$. The other variables at T1 showed significant correlations with GPA at T2 as well, $|r_s| \geq .20$, $p \leq .004$.

A multiple regression analysis involving all measures at T1 (see Table 2) showed that apart from GPA at T1, $B = 0.61$, 95% CI [0.49, 0.73], $p < .001$, the only significant predictors were the domain-general ability self-concept, $B = 0.12$, 95% CI [0.01, 0.22], $p = .031$, and NFC, $B = 0.09$, 95% CI [0.01, 0.17], $p = .024$. Model fit was better for a model that included GPA, the ability self-concept, and NFC at T1 (while all other predictors were set to zero), $\chi^2(3) = 3.68$, p .299, CFI = 1.00, RMSEA = .03 with 90% CI [0.00, 0.11], SRMR = .01, than a model that included GPA and the ability self-concept only, $\chi^2(4) = 10.91$, p .028, CFI = 0.96, RMSEA = .08 with 90% CI [0.02, 0.14], SRMR = .02. A χ^2-difference test supported the superiority of the former compared to the latter model, $\chi^2(1) = 6.34$, $p = .012$.

We therefore further examined a trivariate latent change score model involving academic achievement, the ability self-concept, and NFC. Fig. 1B gives the results of the latent change score modeling with regard to the prediction of change and correlated change in overall academic achievement, i.e., GPA. While the best predictor of change on GPA was GPA at T1 (i.e., self-feedback via prior achievement), B = -0.37, 95% CI [-0.48, -0.25], $p < .001$, β = -.55, there was also evidence for cross-domain coupling, as the overall ability self-concept and NFC at T1 also significantly predicted change in GPA, $B = 0.13$, 95% CI [0.02, 0.24], $p = .020$, $\beta = .19$, and $B = 0.08$, 95% CI [0.02, 0.15], $p = .009$, $\beta = .19$, respectively. Correlated change was observed for GPA and the ability self-concept, B = 0.03, 95% CI [0.01, 0.05], $p = .001$, $\beta = .22$, and the ability self-concept and NFC, B = 0.05, 95% CI [0.02, 0.08], p.001, $\beta = .22$, while the correlated changes in GPA and NFC did not reach significance, $B = 0.03$, 95% CI [0.00, 0.05], $p = .053$, $\beta = .14$.

Domain-specific grades

For the four subjects examined, i.e., German, Math, Physics, and Chemistry, similar results were obtained with regard to correlation analyses (see Supplementary Tables S1 to S4). As regards multiple regression analyses (see Table 3), for all subjects, grades at T1 were significant predictors of grades at T2, $p < .001$. The subject-specific ability self-concept at T1 was a significant predictor of grades at T2 in German only, $B = 0.29$, 95% CI [0.15, 0.43], $p < .001$. NFC at T1 was a significant predictor of T2 grades in German, $B = 0.18$, 95% CI [0.05, 0.32], $p = .007$ and physics, $B = 0.22$, 95% CI [0.07, 0.37], $p = .004$. In both cases, models with NFC as predictor together with grades at T1 and ability self-concept were superior to models with grades at T1 and ability self-concept only, German: $\chi^2(1) = 9.31$, $p = .002$, physics: $\chi^2(1) = 13.49$, $p = < .001$.

As regards the latent change score models, there was evidence for significant self-feedback for all subjects, all $p < .001$. With regard to the subject-specific ability self-concept, cross-domain coupling with changes in grades was observed for German, $B =$ 0.28, 95% CI [0.16, 0.40], $p < .001$, $\beta = .36$, and Chemistry, $B = 0.09$, 95% CI [0.00, 0.18], $p = .042$, $\beta = .14$. NFC at T1 showed cross-domain coupling with grades at T2 for German, $B = 0.13$, 95% CI [0.04, 0.21], $p = .005$, $\beta = .17$, Physics, $B = 0.23$, 95% CI [0.13, 0.33], $p < .001$, $\beta = .24$, and Chemistry, $B = 0.10$, 95% CI [0.00, 0.20], $p = .047$, $\beta = .13$. Correlated change between grades and the subject-specific ability self-concept was observed for all subjects, while correlated change between grades and NFC was observed for German, Math, and Physics only (see Fig. 1C-F).

Discussion

The present study was conducted to provide new insights into the interplay of academic achievement, motivational variables and NFC. In a sample of secondary school students, we examined the incremental value of NFC, considering ability self-concept, interest (general and domain-specific), hope for success and fear of failure as well as prior achievement in the prediction of academic achievement (assessed via GPA and grades in German, Math, Physics, and Chemistry. By applying latent change score modelling, we determined the influence of these predictors on the change of academic achievement over one year. At the same time, we examined mutual influences of change in these variables. The main results are discussed below.

Predictive value of NFC

Concerning associations of all predictors examined and academic achievement, we found typical correlation patterns: In line with former findings (Hailikari et al., 2007; Steinmayr et al., 2019), prior achievement showed a strong relation to GPA at the second time of assessment. Also mirroring previous findings (Steinmayr et al., 2019), among the motivational variables, ability self-concept showed the highest correlations with academic achievement, and this held for general as well as domain-specific ability self-concept. Furthermore, comparable to associations reported by Ginet and Py (2000) or Luong et al. (2017), moderate to strong associations were found for academic achievement and NFC pointing to the relevance of this variable in the school context.

Incremental value of NFC

The importance of NFC becomes even more apparent when looking at the prediction models: Multiple regression analyses showed NFC to incrementally predict academic achievement as reflected in GPA, German and Physics grades over and above prior achievement and the general or domain-specific ability self-concept. A more differentiated picture is provided by the latent change score models. For GPA, German and Chemistry, prior achievement positively predicted changes in grades, as did general, or domain specific ability self-concept, respectively, and NFC. Concerning Physics, only NFC was found to predict changes in grades for this subject alongside with prior achievement, while for Math grades, prior achievement was the only relevant predictor. The findings are thus slightly varying within the school subjects, with the results for Maths being particular different from the others. It is noteworthy that the stability of the Maths grade is lower than that of the other subjects included. There could be many possible reasons for this finding. For example, there could have been a change of teachers or changes in the conditions in the different subjects. However, we are not able to draw firm conclusions on the basis of the available information: Since the examination of individual subjects was not the core of the study and we investigated a convenience sample, no further information about the teaching (e.g., via diary entries) was collected. This should be addressed in further studies. Apart from this limitation, with regard to all grades examined and comparable to the results of Lavrijsen et al. (2021), NFC proved to be a valuable predictor that should be considered alongside established motivational variables in order to gain a comprehensive picture of the factors that influence grades.

Interplay of all predictors

By applying latent change score modelling, we were also able to gain insights into the interplay of prior achievement, ability self-concept, and NFC. For all three variables, their level at the first measurement occasion predicted changes in their respective level at the second time of assessment. Changes in NFC could also be predicted by prior achievement (with the exception of Physics) while for changes in ability self-concept, prior achievement was only predictive for GPA and German grades. Furthermore, concerning correlated change, the amount of change in grades at the second measurement occasion correlated with changes in ability self-concept for GPA and all subjects, that is, changes in grades were accompanied by changes in ability self-concept and vice versa. This is a plausible interplay as ability self-concept is subject to change through feedback and the experience of success or failure (e.g., Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Spinath & Spinath, 2005). The same association was observable for changes in grades and NFC in German, Math and Physics. Thus, change in grades was accompanied by larger change in the enjoyment of and motivation for thinking, particularly in these subjects. Changes in ability self-concept and NFC, in turn, were correlated for GPA and Chemistry. Taken together, this lends support to self-enhancement and skill-development processes for both, ability self-concept and NFC. While such reciprocal relations of academic achievement and the ability self-concept are well-confirmed (Marsh & Martin, 2011; Möller, Retelsdorf, Köller, & Marsh, 2011; Möller, Zitzmann, Machts, Helm, & Wolff, 2020), to our knowledge, this has not yet been demonstrated for NFC as well. Academic achievement and NFC appear to mutually strengthen or weaken each other. Therefore, fostering NFC at school can be an essential part of ensuring that children can develop their full intellectual potential. The findings of Meier et al. (2014) support this assumption: for the attendance of a gifted class, the level of NFC played a pivotal role even after controlling for cognitive ability or ability self-concept.

Limitations and further directions

Some limitations of our study have to be noted. We assessed all data in a convenience sample, and while it was large enough to have adequate power to detect small to medium correlations, it was not representative for the German population of adolescents. Furthermore, there were missing values in the data and we had to impute them in order to increase power for our analyses. Yet, the FIML approach to treat missing values employed here was shown to lead to adequate estimates for the standard error of regression estimates (Larsen, 2011). Also, we did not have the opportunity to examine the predictive value of intelligence together with the predictors in our study. Although we assessed prior achievement as a relevant predictor also mirroring intellectual potential, further studies should also assess intelligence in order to gain a more comprehensive picture of the interplay of all variables of relevance. Furthermore, because of the trait-character of NFC, hope for success and fear of failure, we did not assess these variables in a domain-specific way. As research concerning NFC showed that there is also a domain-specific component for this variable (Keller, Strobel, Martin, & Preckel, 2019) which is especially relevant in Math, it could be worthwhile to incorporate domain-specific measures at least of NFC in future research. This could also be helpful to further clarify the reasons for the observed differences in results for the subjects examined here. As a last aspect, it would be interesting to longitudinally investigate the potential of NFC together with established motivational variables in school especially in *critical* stages of school life, for instance when decisions about school tracks are made.

Conclusion

Taken together, using a longitudinal approach and including a large set of established predictors of academic achievement, the present study shows that NFC is of incremental value when aiming at a comprehensive picture on the prediction of academic achievement. Associations of NFC with grades were comparable or even stronger than for well-established motivational variables. In the prediction of grades over time, NFC could largely consistently prove its predictive value over and above prior achievement. Furthermore, a mutual influence of NFC and academic achievement could be demonstrated with first evidence for skill-development as well as self-enhancement processes taken place in this interplay. To sum up, we propose that NFC should be included in models aiming at comprehensively explaining academic achievement in school. In addition, we consider fostering the general joy of thinking and conquering cognitively challenging tasks a 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 $|r_s| > .18$; 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 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	0.091	0.107	-0.118	0.300	.070	.392
Physics						
Intercept	-0.234	0.381	-0.979	0.512	-.252	.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

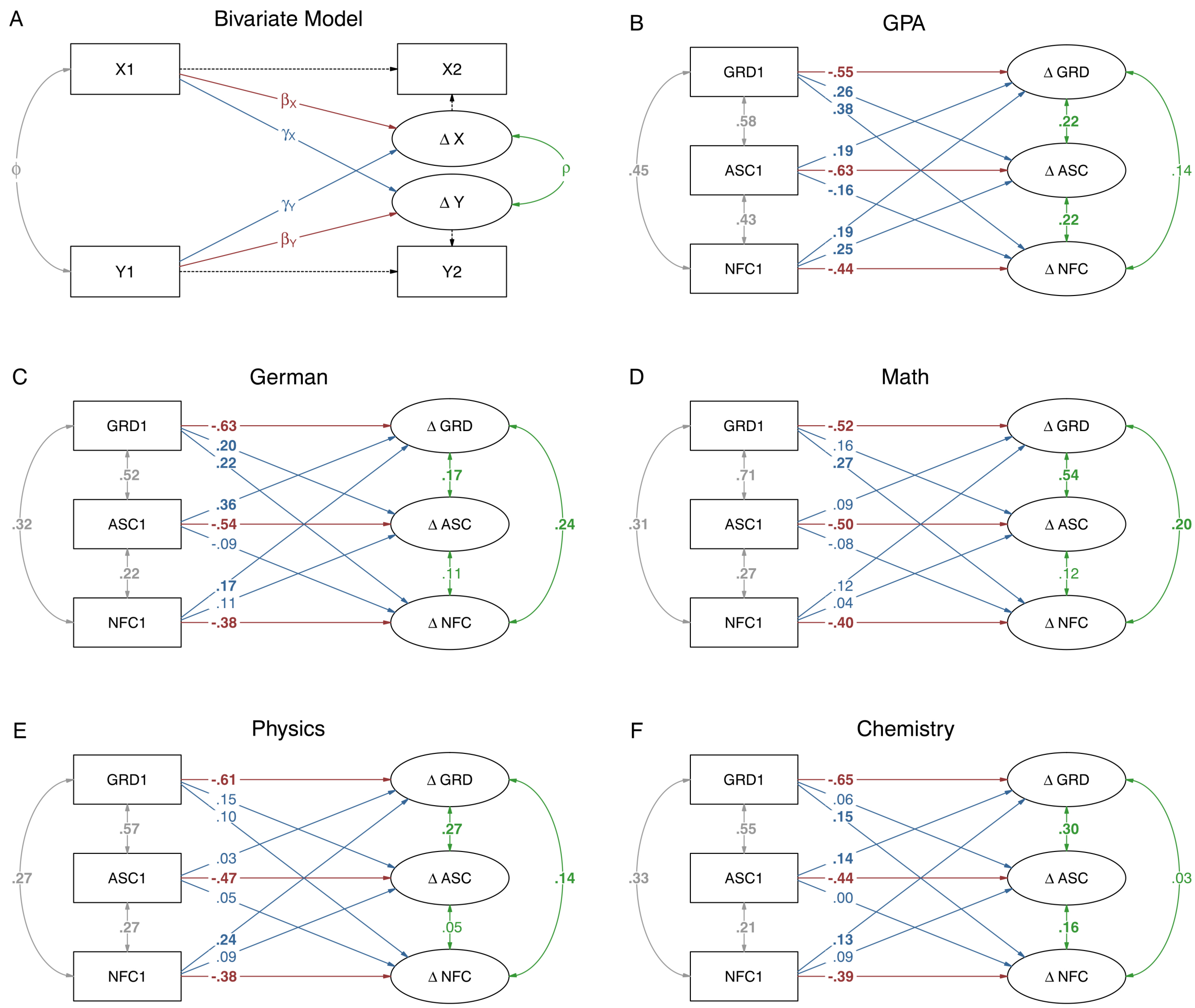

Figure 1

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 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.