On the interplay of motivational characteristics and school grades: The role of Need for Cognition

Anja Strobel[1*], Alexander Strobel[2*], Franzis Preckel[3], & Ricarda Steinmayer[4]

[1] Department of Psychology, Chemnitz University of Technology, Chemnitz, Germany

[2] Faculty of Psychology, Technische Universität Dresden, Dresden, Germany

[3] Department of Psychology, University of Trier, Trier, Germany

[4] Department of Psychology, TU Dortmund University, Dortmund, Germany

Author Note

[adjust according to APA style] * These authors contributed equally to this work.

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Correspondence concerning this article should be addressed to Anja Strobel, Department of Psychology, Chemnitz University of Technology, 09120 Chemnitz, Germany. E-mail: anja.strobel@psychologie.tu-chemnitz.de

Abstract

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In recent decades, a great deal of research has been conducted on the prediction of school performance. Meta-analyses indicate that intelligence is the strongest predictor for academic achievement (e.g., Deary, Strand, Smith, & Fernandes, 2007; Kriegbaum, Becker, & Spinath, 2018). Still, motivational variables have consistently been found to also have predictive value for school performance (e.g., Kriegbaum et al., 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 performance came into the focus of research in this field: Need for Cognition (NFC), the stable intrinsic motivation of an individual to engage in and enjoy challenging intellectual activity (Cacioppo, Petty, Feinstein, & Jarvis, 1996). According to Investment Theory (Ackerman & Heggestad, 1997), traits 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 performance 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, especially in longitudinal studies, or integrated into models for the prediction of performance in school.

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 school performance (Lavrijsen, Vansteenkiste, Boncquet, & Verschueren, 2021). Their results showed intelligence and NFC to be the strongest predictors of school 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 school grades.

To follow-up on these findings and to provide new insights in the interplay of school performance, 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 school grades across different subjects in a longitudinal approach in a sample of secondary school children.

Achievement Motivation and its relation to school performance

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 (Steinmayr et al., 2019). They have found their way into essential models of achievement motivation (Kriegbaum et al., 2018; e.g., Wigfield & Eccles, 2000), 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 on the basis of 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). Such ability perceptions of students affect their 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 school performance. Moreover, ability self-concept and school performance 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), describes task values. Such task values focus on importance, perceived utility, and interest in a task (cf. Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). Specifically on the domain of interest, a number of papers are available on the relationship with school performance, 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 performance

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 performance NFC 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 school performance 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 school performance, here depending on the type of school, with the associations between NFC and performance 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 (Cacioppo & Petty, 1982; Olson, Camp, & Fuller, 1984; Tolentino, Curry, & Leak, 1990).

Concerning the interplay of intelligence and NFC in the context of school performance, 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 belief which in turn had a positive effect on academic performance. 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. Comparable findings are also reported by Bless, Wänke, Bohner, Fellhauer, and Schwarz (1994). In a large sample of 7th grade students, Lavrijsen et al. (2021) found a strong correlation with performance 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 performance 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 school performance and found intelligence, NFC and the ability self-concept to be the most strongest predictors of math grades and performance in standardized math tests.

The present study

All in all, NFC has been proven to be a very promising predictor of school performance 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 could be shown to be a relevant predictor of academic performance (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 school grades (GPA, German, math, physics, and chemistry) at two points of time. By applying latent change score modelling, we will be able to determine the influence of our different predictors on the change of school performance over time. At the same time, mutual influences of changes in school performance, NFC and motivational constructs can be detected (i.e., correlated change). We examine the following hypotheses and research questions:

1. What is the incremental value of Need for Cognition in the prediction of school performance over and above different motivational constructs and prior achievement in school?
2. Is Need for Cognition able to predict changes in school achievement over time?
3. Are changes in motivational variables, Need for Cognition and school performance related over time?

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://github.com/alex-strobel/NFC-Grades. 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. 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-β = .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.

School Grades in general, i.e., Grade Point Average (GPA), and grades in German, math, chemistry, and physics were assessed 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 (Gjesme & Nygard, 2006; 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 (…) to 5 (…). 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 1 (…) to 5 (…). The scales have high internal consistency, Cronbach's $\alpha \geq .89$, and retest reliability, $r_{tt} = .72$ across six months (Steinmayr & Spinath, 2010).

Procedure

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

To examine which variables measured at T1 would be significant predictors of school grades at T2, we ran five regression analyses with the GPA and the four subject-specific grades as criterion and used the results of the first regression analysis (with the domain-general Ability Self-Concept, Interest in School, Hope for Success and Fear of failure, and NFC measured at T1 as predictors and GPA at T2 as criterion) to select the variables for latent change score modeling. Significant predictors in this model were used for all latent change score models even if for certain subjects, the predictors were not significant in the respective regression models. Regression models were fitted via *lavaan*, using MLR as estimation technique and—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., school grades) 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, and 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 school grades, 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 school grades, 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 Sx to Sy). As regards multiple regression analyses (see Supplementary Table Sz), 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 in order to provide new insights in the interplay of school performance, NFC and motivational variables. In a sample of secondary school children, we examined the incremental value of NFC, considering ability self-concept, interest (both, general and domain-specific), hope for success and fear of failure as well as prior achievement in the prediction of school grades (GPA, German, Math, Physics, and Chemistry). By applying latent change score modelling, we determined the influence of these predictors on the change of school performance over time. At the same time, we examined mutual influences of changes in all variables. The main results are discussed below.

Predictive value of NFC

Concerning associations of all predictors examined and school grades we found typical correlational patterns: in line with former findings (Steinmayr et al., 2019; **Hailikari?**) 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 was highest correlated with school grades, this was true 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 school grades and NFC pointing to the relevance of this variable in the school context.

Interplay of all predictors

The importance of NFC becomes even more apparent by looking at the prediction models: Multiple regression analyses found NFC – with the exception of the prediction of the Math grade - to incrementally predict school grades over and above prior achievement. A more differentiated picture is provided by the latent change score models. For GPA, German and Chemistry, prior achievement predicted changes in grades, as did (general and domain specific, respectively) ability self-concept and NFC. Concerning Physics, besides prior achievement only NFC was able to predict changes in grades for this subject, while for Math grades prior achievement was the only relevant predictor. All in all 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 influences on grades.

By applying latent change score modelling we were also able to get further 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 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 in German. 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, stronger improvement in grades were accompanied by more pronounced changes in ability self-concept and vice versa. This is a plausible interplay as ability self-concept is subject to changes 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 changes in NFC in German, Math and Physics. Thus, improvement in grades was accompanied by greater changes 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, all findings lend support to self-enhancement as well as skill-development processes for both, ability self-concept and NFC. While this is a well-confirmed interplay concerning ability self-concept (Marsh & Craven, 2006; **Marsh2008?**; **Möller2011?**), to our knowledge, this has not yet been a subject of consideration for NFC. School achievement and NFC influence and can mutually strengthen or weaken each other. Following this line of arguments, fostering NFC at school can therefore be an essential part of ensuring that children can develop their intellectual potential to the full. The findings of Meier et al. (2014) support this assumption: for the attendance of a gifted class, the level of NFC in school children 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 school settings, so, despite of having a sample size that was large enough in terms of statistical power we had a convenience sample. Furthermore, there were many missing values in the data and we had to impute them in order to raise power for our analyses. We did not have the opportunity to examine the predictive value of intelligence alongside the predictors we included. Though we examined prior achievement as a relevant predictor also mirroring intellectual potential, further studies should assess intelligence, too, 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 could show 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, too. As a last aspect, it could 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 to be made.

Conclusion

Taken together, the present study provides evidence that NFC is a relevant variable to include when aiming at a comprehensive picture for the prediction of school performance. Results demonstrate that associations of NFC with grades are 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 school performance 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 NFC to be included in models aiming at explaining performance in school and therewith to expand them to include another trait with a motivational focus. Following this, we deem fostering the general joy of thinking and conquering cognitively challenging tasks a worthwhile endeavour to help children to unfold their potential.

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Table 1

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

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

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

Table 2

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

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

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

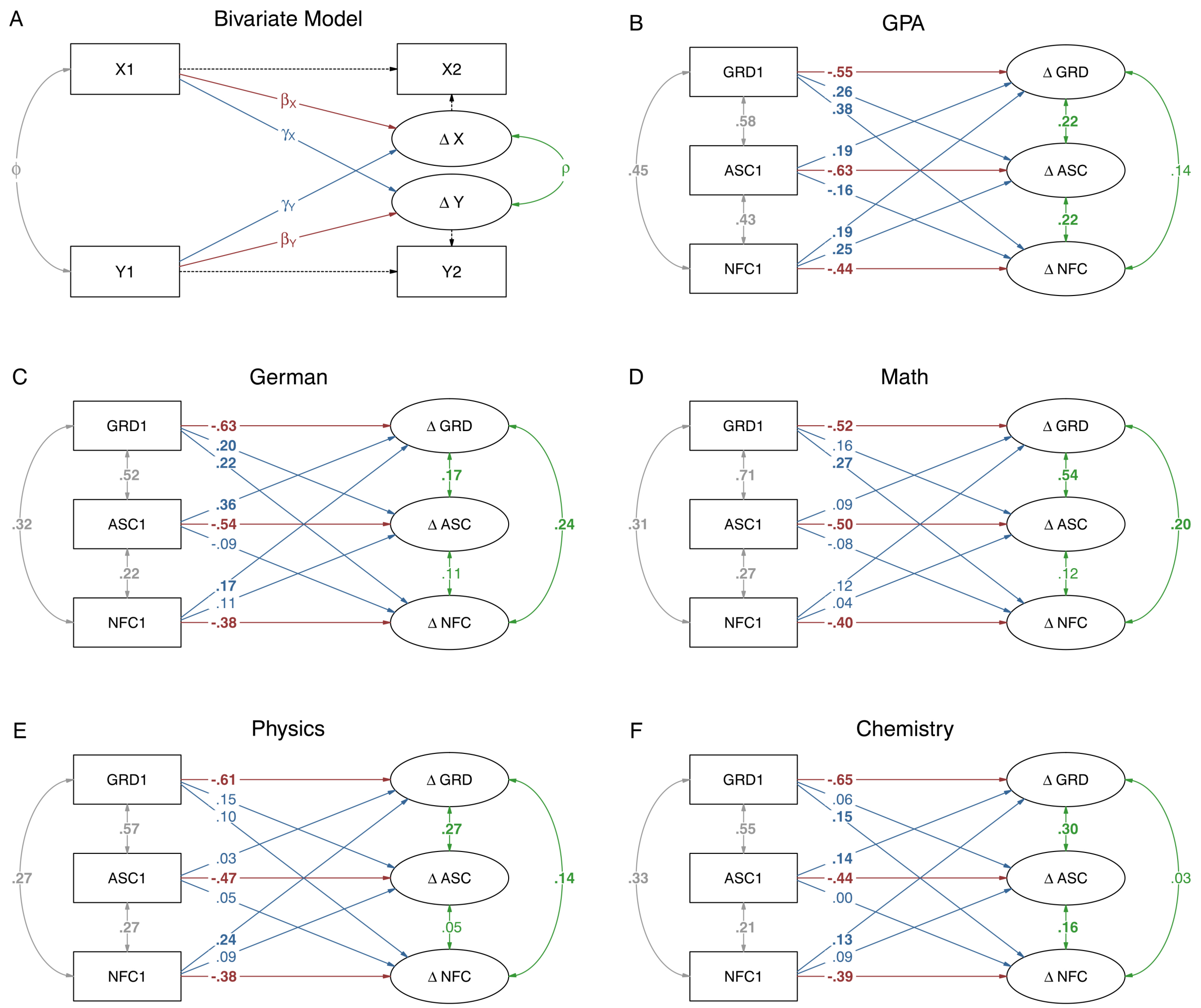

Figure 1. Latent change score models. (A) Example of a bivariate latent change score model (for details see text); legend to lines: dotted = loadings fixed to zero, red = self-feedback β, blue = cross-domain coupling γ, grey = correlation ϕ of predictors at T1, green = correlated change ρ; (B) Grade Point Average (GPA) and (C) to (F) subject-specific changes in grades at T2 (indicated by prefix Δ) as predicted by their respective T1 levels as well as by Need for Cognition (NFC) and (overall as well as subject specific) Ability Self-Concept (ASC) at T1; coefficients are standardized coefficients.