

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

Supplementary Material

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Supplementary Methods

We used *RStudio* (version 2023.6.1.524, Posit Team, 2023) with R (version 4.3.1; R Core Team, 2023) and the R-packages *lavaan* (version 0.6.-15; Rosseel, 2012), *nanian* (version 1.0.0; Tierney & Cook, 2023), *papaja* (version 0.1.0.9997; Aust & Barth, 2018), *psych* (version 2.3.6; Revelle, 2023), and *pwr* (version 1.3-0; Champely, 2020). We also employed the packages *haven* (version 2.5.3; Wickham et al., 2023) and *xlsx* (version 0.6.5; Dragulescu & Arendt, 2020) for reading/writing data, *here* (version 1.0.1; Müller, 2020) for file handling, and *shape* (version 1.4.6; Soetaert, 2021) for figure creation.

Supplementary Tables

Tables 1-5 provide the intercorrelations of the variables involved in the correlation analyses for overall grades as well as grades in the subjects German, Math, Physics, and Chemistry. For details, see main text.

Table S1*Reliabilities of the variables of interest*

	T1		T2		Retest
	α	ω	α	ω	r_{tt}
Grades					
Overall					.79
German					.59
Math					.60
Physics					.69
Chemistry					.76
<i>Ability Self-Concept</i>					
Overall	.84	.84	.84	.85	.83
German	.93	.94	.92	.91	.90
Math	.95	.95	.95	.94	.85
Physics	.95	.95	.96	.97	.77
Chemistry	.96	.96	.96	.97	.81
<i>Interest</i>					
Overall	.88	.89	.87	.89	.81
German	.92	.92	.91	.91	.79
Math	.94	.93	.94	.94	.80
Physics	.94	.95	.94	.94	.81
Chemistry	.95	.94	.94	.94	.80
<i>Motivational Traits</i>					
Hope for Success	.86	.87	.87	.87	.72
Fear of Failure	.88	.88	.90	.91	.75
Need for Cognition	.88	.88	.90	.89	.88

Note. $N = 277$ except for Grades ($N = 276$); T1 and T2 = measurement occasions, interval: 53-59 weeks, α = Cronbach's alpha and ω = MacDonald's omega are not available for Grades, r_{tt} = retest reliability (Spearman rank correlations)

Table S2

Robust correlations of the variables in the analyses on German grades

	T1 intercorrelations					Self-feedback and cross-domain coupling					
	ASC1	INT1	HFS1	FOF1	NFC1	Δ GRD	Δ ASC	Δ INT	Δ HFS	Δ FOF	Δ NFC
GRD1	.53	.46	.27	-.19	.33	-.58	.17	.04	.03	-.13	.13
ASC1	—	.68	.17	-.15	.22	.32	-.48	.31	-.14	.12	-.07
INT1		—	.15	-.11	.23	-.05	.03	-.55	.07	-.03	-.03
HFS1			—	-.39	.82	-.20	-.07	-.02	-.98	.26	-.22
FOF1				—	-.52	-.05	-.11	-.04	.04	-.27	-.21
NFC1					—	.32	.13	-.05	.94	-.27	-.19
Correlated change											
Δ GRD						—	.13	.18	.06	-.05	.20
Δ ASC							—	.44	-.01	.02	.08
Δ INT								—	.08	.04	.14
Δ HFS									—	-.15	.49
Δ FOF										—	-.14

Note. $N = 276$ - 277 ; bold-faced coefficients $p < .05$; GRD = German grades, ASC = Ability Self-

Concept German, INT = Interest in German, HFS = Hope for Success, FOF = Fear of Failure, NFC =

Need for Cognition, suffix 1 indicates the respective score at measurement occasion 1, Δ denotes the respective change score

Table S3

Robust correlations of the variables in the analyses on Math grades

	T1 intercorrelations					Self-feedback and cross-domain coupling					
	ASC1	INT1	HFS1	FOF1	NFC1	Δ GRD	Δ ASC	Δ INT	Δ HFS	Δ FOF	Δ NFC
GRD1	.70	.58	.31	-.22	.35	-.56	.04	.00	-.09	.02	.20
ASC1	—	.81	.32	-.22	.32	.07	-.63	.22	.18	-.03	-.02
INT1		—	.35	-.21	.36	.08	.22	-.59	.06	-.04	-.06
HFS1			—	-.39	.82	-.12	-.03	-.05	-1.02	.27	-.21
FOF1				—	-.52	-.10	-.06	.04	.06	-.27	-.21
NFC1					—	.17	.02	.16	.94	-.29	-.21
Correlated change											
Δ GRD						—	.53	.45	.07	.04	.17
Δ ASC							—	.65	.05	-.05	.12
Δ INT								—	.14	.01	.22
Δ HFS									—	-.15	.51
Δ FOF										—	-.15

Note. $N = 276$ - 277 ; bold-faced coefficients $p < .05$; GRD = Math grades, ASC = Ability Self-Concept Math, INT = Interest in Math, HFS = Hope for Success, FOF = Fear of Failure, NFC = Need for Cognition, suffix 1 indicates the respective score at measurement occasion 1, Δ denotes the respective change score

Table S4

Robust correlations of the variables in the analyses on Physics grades

	T1 intercorrelations					Self-feedback and cross-domain coupling					
	ASC1	INT1	HFS1	FOF1	NFC1	Δ GRD	Δ ASC	Δ INT	Δ HFS	Δ FOF	Δ NFC
GRD1	.57	.46	.27	-.17	.31	-.62	.14	.11	.03	-.02	.09
ASC1	—	.83	.25	-.13	.30	.05	-.63	.17	.05	.14	.08
INT1		—	.25	-.10	.30	-.04	.31	-.51	.09	-.19	-.09
HFS1			—	-.39	.82	.00	.15	.08	-.98	.26	-.22
FOF1				—	-.52	.07	-.08	.03	.04	-.26	-.21
NFC1					—	.31	-.10	.09	.89	-.27	-.19
Correlated change											
Δ GRD						—	.25	.21	.10	-.10	.12
Δ ASC							—	.72	.15	-.12	.07
Δ INT								—	.18	-.10	.12
Δ HFS									—	-.15	.49
Δ FOF										—	-.15

Note. $N = 276-277$; bold-faced coefficients $p < .05$; GRD = Physics grades, ASC = Ability Self-

Concept Physics, INT = Interest in Physics, HFS = Hope for Success, FOF = Fear of Failure, NFC =

Need for Cognition, suffix 1 indicates the respective score at measurement occasion 1, Δ denotes the respective change score

Table S5

Robust correlations of the variables in the analyses on Chemistry grades

	T1 intercorrelations					Self-feedback and cross-domain coupling					
	ASC1	INT1	HFS1	FOF1	NFC1	Δ GRD	Δ ASC	Δ INT	Δ HFS	Δ FOF	Δ NFC
GRD1	.55	.49	.34	-.24	.36	-.67	.05	.05	.11	-.06	.11
ASC1	—	.84	.28	-.16	.25	.10	-.67	.16	-.07	.05	-.04
INT1		—	.24	-.08	.26	.01	.39	-.50	.07	-.05	.05
HFS1			—	-.39	.82	-.08	.10	.05	-.99	.26	-.22
FOF1				—	-.52	.04	-.04	.02	.05	-.27	-.21
NFC1					—	.23	-.03	.03	.91	-.27	-.21
Correlated change											
Δ GRD						—	.26	.24	.02	-.11	.01
Δ ASC							—	.74	.13	-.01	.16
Δ INT								—	.08	.01	.17
Δ HFS									—	-.15	.48
Δ FOF										—	-.14

Note. $N = 276-277$; bold-faced coefficients $p < .05$; GRD = Chemistry grades, ASC = Ability Self-Concept Chemistry, INT = Interest in Chemistry, HFS = Hope for Success, FOF = Fear of Failure, NFC = Need for Cognition, suffix 1 indicates the respective score at measurement occasion 1, Δ denotes the respective change score

Table S6

Results of latent change score modeling of the interplay of German grades, German ability self-concept, interest in German, and motivational traits

Criterion	T1 Predictor	<i>B</i>	<i>SE</i>	<i>CI.LB</i>	<i>CI.UB</i>	<i>beta</i>	<i>p</i>
Δ Grade	Grade*	-0.43	0.05	-0.53	-0.33	-.58	< .001
	Ability Self-Concept	0.24	0.06	0.12	0.36	.32	< .001
	Interest	-0.03	0.05	-0.12	0.06	-.05	.512
	Hope for Success	-0.23	0.12	-0.45	0.00	-.20	.047
	Fear of Failure	-0.06	0.07	-0.19	0.07	-.05	.359
	Need for Cognition	0.23	0.08	0.07	0.38	.32	.005
Δ Ability Self-Concept	Grade	0.07	0.03	0.02	0.13	.17	.013
	Ability Self-Concept*	-0.21	0.04	-0.28	-0.14	-.48	< .001
	Interest	0.01	0.03	-0.04	0.06	.03	.683
	Hope for Success	-0.05	0.06	-0.16	0.07	-.07	.450
	Fear of Failure	-0.07	0.04	-0.14	0.01	-.11	.075
	Need for Cognition	0.05	0.04	-0.03	0.13	.13	.202
Δ Interest	Grade	0.03	0.05	-0.06	0.12	.04	.468
	Ability Self-Concept	0.24	0.07	0.10	0.38	.31	.001
	Interest*	-0.36	0.06	-0.46	-0.25	-.55	< .001
	Hope for Success	-0.03	0.12	-0.27	0.21	-.02	.813
	Fear of Failure	-0.05	0.07	-0.18	0.08	-.04	.458
	Need for Cognition	-0.03	0.08	-0.18	0.12	-.05	.668
Δ Hope for Success	Grade	0.02	0.03	-0.04	0.07	.03	.551
	Ability Self-Concept	-0.07	0.03	-0.14	0.00	-.14	.037
	Interest	0.03	0.03	-0.02	0.08	.07	.198
	Hope for Success*	-0.77	0.07	-0.92	-0.63	-.98	< .001
	Fear of Failure	0.03	0.05	-0.07	0.13	.04	.552
	Need for Cognition	0.46	0.05	0.36	0.56	.94	< .001
Δ Fear of Failure	Grade	-0.07	0.03	-0.14	0.00	-.13	.041
	Ability Self-Concept	0.07	0.04	-0.02	0.15	.12	.141
	Interest	-0.01	0.04	-0.09	0.06	-.03	.721
	Hope for Success	0.21	0.08	0.06	0.36	.26	.006
	Fear of Failure*	-0.21	0.07	-0.34	-0.08	-.27	.002
	Need for Cognition	-0.14	0.06	-0.25	-0.02	-.27	.017
Δ Need for Cognition	Grade	0.06	0.03	0.01	0.12	.13	.024
	Ability Self-Concept	-0.03	0.04	-0.12	0.05	-.07	.421
	Interest	-0.01	0.03	-0.08	0.05	-.03	.715
	Hope for Success	-0.16	0.08	-0.32	-0.01	-.22	.038
	Fear of Failure	-0.15	0.06	-0.27	-0.04	-.21	.008
	Need for Cognition*	-0.09	0.06	-0.20	0.02	-.19	.120

Note. $N = 276$ - 277 ; coefficients indicate cross-domain coupling and self-feedback (*); 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 -value; bold-faced coefficients $p < .05$

Table S7

Results of latent change score modeling of the interplay of Math grades, Math ability self-concept, interest in Math, and motivational traits

Criterion	T1 Predictor	<i>B</i>	<i>SE</i>	<i>CI.LB</i>	<i>CI.UB</i>	<i>beta</i>	<i>p</i>
Δ Grade	Grade*	-0.52	0.07	-0.66	-0.37	-.56	< .001
	Ability Self-Concept	0.07	0.10	-0.12	0.26	.07	.492
	Interest	0.07	0.08	-0.08	0.22	.08	.353
	Hope for Success	-0.22	0.17	-0.56	0.12	-.12	.207
	Fear of Failure	-0.17	0.12	-0.40	0.06	-.10	.138
	Need for Cognition	0.20	0.12	-0.04	0.44	.17	.099
Δ Ability Self-Concept	Grade	0.02	0.04	-0.06	0.10	.04	.581
	Ability Self-Concept*	-0.33	0.06	-0.45	-0.20	-.63	< .001
	Interest	0.11	0.04	0.02	0.19	.22	.013
	Hope for Success	-0.04	0.11	-0.25	0.18	-.03	.742
	Fear of Failure	-0.06	0.07	-0.20	0.08	-.06	.389
	Need for Cognition	0.01	0.07	-0.12	0.15	.02	.844
Δ Interest	Grade	0.00	0.06	-0.11	0.11	.00	.974
	Ability Self-Concept	0.15	0.07	0.00	0.29	.22	.043
	Interest*	-0.37	0.06	-0.49	-0.25	-.59	< .001
	Hope for Success	-0.07	0.15	-0.35	0.22	-.05	.655
	Fear of Failure	0.05	0.10	-0.14	0.24	.04	.610
	Need for Cognition	0.14	0.10	-0.06	0.35	.16	.166
Δ Hope for Success	Grade	-0.03	0.03	-0.09	0.02	-.09	.217
	Ability Self-Concept	0.07	0.04	-0.01	0.14	.18	.082
	Interest	0.02	0.03	-0.03	0.08	.06	.442
	Hope for Success*	-0.81	0.07	-0.95	-0.67	-1.02	< .001
	Fear of Failure	0.05	0.05	-0.05	0.14	.06	.351
	Need for Cognition	0.46	0.05	0.37	0.55	.94	< .001
Δ Fear of Failure	Grade	0.01	0.03	-0.06	0.07	.02	.852
	Ability Self-Concept	-0.01	0.05	-0.11	0.09	-.03	.825
	Interest	-0.01	0.04	-0.09	0.06	-.04	.716
	Hope for Success	0.22	0.08	0.07	0.38	.27	.005
	Fear of Failure*	-0.21	0.07	-0.35	-0.08	-.27	.002
	Need for Cognition	-0.15	0.06	-0.26	-0.03	-.29	.011
Δ Need for Cognition	Grade	0.08	0.03	0.02	0.13	.20	.010
	Ability Self-Concept	-0.01	0.05	-0.10	0.08	-.02	.851
	Interest	-0.02	0.04	-0.10	0.05	-.06	.579
	Hope for Success	-0.16	0.08	-0.31	0.00	-.21	.044
	Fear of Failure	-0.15	0.06	-0.26	-0.04	-.21	.008
	Need for Cognition*	-0.10	0.05	-0.21	0.01	-.21	.067

Note. $N = 276-277$; coefficients indicate cross-domain coupling and self-feedback (*); 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 -value; bold-faced coefficients $p < .05$

Table S8

Results of latent change score modeling of the interplay of Physics grades, Physics ability self-concept, interest in Physics, and motivational traits

Criterion	T1 Predictor	<i>B</i>	<i>SE</i>	<i>CI.LB</i>	<i>CI.UB</i>	<i>beta</i>	<i>p</i>
Δ Grade	Grade*	-0.45	0.05	-0.54	-0.35	-.62	< .001
	Ability Self-Concept	0.04	0.07	-0.10	0.18	.05	.580
	Interest	-0.03	0.06	-0.14	0.08	-.04	.607
	Hope for Success	0.01	0.14	-0.27	0.28	.00	.965
	Fear of Failure	0.10	0.08	-0.06	0.26	.07	.232
	Need for Cognition	0.28	0.09	0.11	0.44	.31	.001
Δ Ability Self-Concept	Grade	0.10	0.05	0.00	0.19	.14	.049
	Ability Self-Concept*	-0.45	0.09	-0.62	-0.28	-.63	< .001
	Interest	0.19	0.07	0.06	0.33	.31	.005
	Hope for Success	0.21	0.15	-0.09	0.50	.15	.166
	Fear of Failure	-0.10	0.09	-0.27	0.07	-.08	.245
	Need for Cognition	-0.08	0.10	-0.28	0.11	-.10	.397
Δ Interest	Grade	0.08	0.05	-0.02	0.17	.11	.113
	Ability Self-Concept	0.11	0.08	-0.04	0.27	.17	.146
	Interest*	-0.31	0.06	-0.43	-0.19	-.51	< .001
	Hope for Success	0.10	0.15	-0.19	0.39	.08	.480
	Fear of Failure	0.04	0.09	-0.13	0.21	.03	.664
	Need for Cognition	0.08	0.10	-0.12	0.27	.09	.450
Δ Hope for Success	Grade	0.01	0.02	-0.03	0.06	.03	.557
	Ability Self-Concept	0.02	0.04	-0.06	0.10	.05	.615
	Interest	0.03	0.03	-0.02	0.09	.09	.232
	Hope for Success*	-0.78	0.07	-0.92	-0.64	-.98	< .001
	Fear of Failure	0.03	0.05	-0.07	0.13	.04	.549
	Need for Cognition	0.44	0.05	0.34	0.53	.89	< .001
Δ Fear of Failure	Grade	-0.01	0.03	-0.08	0.06	-.02	.768
	Ability Self-Concept	0.06	0.05	-0.03	0.15	.14	.211
	Interest	-0.07	0.04	-0.15	0.01	-.19	.074
	Hope for Success	0.21	0.08	0.06	0.37	.26	.006
	Fear of Failure*	-0.21	0.07	-0.34	-0.08	-.26	.002
	Need for Cognition	-0.14	0.06	-0.25	-0.03	-.27	.012
Δ Need for Cognition	Grade	0.04	0.03	-0.02	0.09	.09	.192
	Ability Self-Concept	0.03	0.04	-0.05	0.12	.08	.460
	Interest	-0.03	0.04	-0.10	0.04	-.09	.389
	Hope for Success	-0.16	0.08	-0.32	-0.01	-.22	.036
	Fear of Failure	-0.15	0.06	-0.26	-0.04	-.21	.007
	Need for Cognition*	-0.09	0.06	-0.20	0.02	-.19	.107

Note. $N = 276-277$; coefficients indicate cross-domain coupling and self-feedback (*); 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 -value; bold-faced coefficients $p < .05$

Table S9

Results of latent change score modeling of the interplay of Chemistry grades, Chemistry ability self-concept, interest in Chemistry, and motivational traits

Criterion	T1 Predictor	<i>B</i>	<i>SE</i>	<i>CI.LB</i>	<i>CI.UB</i>	<i>beta</i>	<i>p</i>
Δ Grade	Grade*	-0.43	0.04	-0.51	-0.36	-.67	< .001
	Ability Self-Concept	0.06	0.05	-0.04	0.16	.10	.235
	Interest	0.01	0.05	-0.08	0.10	.01	.889
	Hope for Success	-0.09	0.10	-0.28	0.11	-.08	.368
	Fear of Failure	0.04	0.07	-0.09	0.17	.04	.536
	Need for Cognition	0.17	0.06	0.04	0.30	.23	.009
Δ Ability Self-Concept	Grade	0.03	0.05	-0.06	0.13	.05	.485
	Ability Self-Concept*	-0.44	0.08	-0.59	-0.29	-.67	< .001
	Interest	0.23	0.06	0.11	0.35	.39	< .001
	Hope for Success	0.14	0.12	-0.09	0.37	.10	.241
	Fear of Failure	-0.05	0.09	-0.21	0.12	-.04	.593
	Need for Cognition	-0.03	0.08	-0.19	0.13	-.03	.730
Δ Interest	Grade	0.04	0.05	-0.06	0.14	.05	.445
	Ability Self-Concept	0.11	0.09	-0.07	0.30	.16	.225
	Interest*	-0.32	0.08	-0.48	-0.17	-.50	< .001
	Hope for Success	0.07	0.14	-0.20	0.33	.05	.626
	Fear of Failure	0.03	0.10	-0.16	0.22	.02	.734
	Need for Cognition	0.03	0.09	-0.15	0.21	.03	.773
Δ Hope for Success	Grade	0.05	0.02	0.00	0.09	.11	.033
	Ability Self-Concept	-0.03	0.04	-0.10	0.04	-.07	.457
	Interest	0.03	0.03	-0.03	0.08	.07	.397
	Hope for Success*	-0.78	0.07	-0.93	-0.63	-.99	< .001
	Fear of Failure	0.04	0.05	-0.06	0.14	.05	.475
	Need for Cognition	0.45	0.05	0.35	0.54	.91	< .001
Δ Fear of Failure	Grade	-0.03	0.04	-0.10	0.04	-.06	.428
	Ability Self-Concept	0.02	0.05	-0.08	0.12	.05	.702
	Interest	-0.02	0.04	-0.10	0.07	-.05	.678
	Hope for Success	0.22	0.08	0.06	0.37	.26	.005
	Fear of Failure*	-0.21	0.07	-0.34	-0.08	-.27	.001
	Need for Cognition	-0.14	0.06	-0.25	-0.03	-.27	.011
Δ Need for Cognition	Grade	0.04	0.03	-0.01	0.10	.11	.090
	Ability Self-Concept	-0.01	0.05	-0.10	0.08	-.04	.753
	Interest	0.02	0.04	-0.06	0.09	.05	.637
	Hope for Success	-0.17	0.08	-0.32	-0.01	-.22	.033
	Fear of Failure	-0.15	0.06	-0.27	-0.04	-.21	.008
	Need for Cognition*	-0.10	0.06	-0.21	0.02	-.21	.091

Note. $N = 276$ - 277 ; coefficients indicate cross-domain coupling and self-feedback (*); 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 -value; bold-faced coefficients $p < .05$

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