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), *naniar* (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

Table S1 informs about the reliabilities of the variables of interest in the present study. Tables S2-5 provide the intercorrelations of the variables involved in the correlation analyses for grades in the subjects German, Math, Physics, and Chemistry. Results for specific grades can be found in the Supplementary Tables S2-5 with regard to intercorrelations (analogous to Table 1 in the main text) and S6-9 with regard to detailed statistics on these intercorrelations (analogous to Table 2 in the 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
Ability Self-Concept					
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
Interest					
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
Motivational Traits					
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	ΔGRD	ΔASC	ΔINT	ΔHFS	ΔFOF	ΔNFC
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					
ΔGRD						—	.13	**.18**	.06	-.05	**.20**
ΔASC							—	**.44**	-.01	.02	.08
ΔINT								—	.08	.04	.14
ΔHFS									—	**-.15**	**.49**
ΔFOF										—	-.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	ΔGRD	ΔASC	ΔINT	ΔHFS	ΔFOF	ΔNFC
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					
ΔGRD						—	**.53**	**.45**	.07	.04	**.17**
ΔASC							—	**.65**	.05	-.05	.12
ΔINT								—	.14	.01	**.22**
ΔHFS									—	**-.15**	**.51**
ΔFOF										—	**-.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	ΔGRD	ΔASC	ΔINT	ΔHFS	ΔFOF	ΔNFC
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					
ΔGRD						—	**.25**	**.21**	.10	-.10	.12
ΔASC							—	**.72**	**.15**	**-.12**	.07
ΔINT								—	**.18**	**-.10**	.12
ΔHFS									—	**-.15**	**.49**
ΔFOF										—	**-.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	ΔGRD	ΔASC	ΔINT	ΔHFS	ΔFOF	ΔNFC
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					
ΔGRD						—	**.26**	**.24**	.02	-.11	.01
ΔASC							—	**.74**	.13	-.01	**.16**
ΔINT								—	.08	.01	**.17**
ΔHFS									—	**-.15**	**.48**
ΔFOF										—	**-.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	*B*	*SE*	*CU.LB*	*CI.UB*	*beta*	*p*
ΔGrade	**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**
ΔAbility 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
ΔInterest	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
ΔHope 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**
ΔFear 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**
ΔNeed 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	*B*	*SE*	*CU.LB*	*CI.UB*	*beta*	*p*
ΔGrade	**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
ΔAbility 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
ΔInterest	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
ΔHope 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**
ΔFear 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**
ΔNeed 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	*B*	*SE*	*CU.LB*	*CI.UB*	*beta*	*p*
ΔGrade	**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**
ΔAbility 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
ΔInterest	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
ΔHope 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**
ΔFear 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**
ΔNeed 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	*B*	*SE*	*CU.LB*	*CI.UB*	*beta*	*p*
ΔGrade	**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**
ΔAbility 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
ΔInterest	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
ΔHope 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**
ΔFear 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**
ΔNeed 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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