

STRESS, SLEEP, AND COPING SELF-EFFICACY

“Stress, Sleep, and Coping Self-Efficacy in Adolescents” Supplemental Online Materials (SOM)

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Trait vs. State Coping Self-Efficacy

Another novel element to our study was daily fluctuations in CSE, which has typically been measured as an individual trait (Bandura, 1993). We were surprised to find evidence for temporal causality, with time-lagged associations indicating that PS on a given day relative to a student's own average stress predicted CSE on the next day, but not vice versa. This demonstrates that CSE can vary on a daily basis; however, it is not clear what may create these fluctuations. Our results show that while CSE does have stability, there is also room for variation and potential to alter even daily endorsements of more positive self-efficacy beliefs about coping.

Pre-Registration Checklist

The authors certify that we submitted an analysis pre-registration document for our previously collected dataset to the Open Science Framework on 9/5/18, prior to beginning any data analysis.

The following aspects of the pre-registration analysis were completed as planned:

- Primary and secondary questions addressed, with no questions dropped or added.
- All pre-registered hypotheses are reflected in this paper.
- No changes to the sampling, inclusion, or exclusion criteria were made from the pre-registration. The final sample consisted of 381 students; we pre-registered "roughly 360," as we had not yet examined the data.
- There was no change from the missing data strategy for analysis.
- There was no change from the measures and items pre-registered for analysis.
- As pre-registered, we tested cross-sectional associations with multilevel models containing random intercept effects and lagged temporal associations with multilevel models containing both random intercept and slope effects. As pre-registered, we also tested cumulative effects by looking at associations between cumulative mean levels predicting a subsequent day's outcome. As pre-registered in secondary (exploratory) plans, we examined covariates as possible moderators.

Below we list all changes from the pre-registered analysis:

- Rather than testing hypotheses with separate multilevel models, we included all variables of interest in a single dynamic structural equation model (DSEM).
- We did not explicitly state the pre-registered "Secondary (Exploratory) Hypotheses" in this paper, because they were not the focus of the final publication.
- Instead of using the R packages *nlme* and *lmer* to run multilevel models using frequentist assumptions as pre-registered, we ran a DSEM with Bayesian estimators using MPlus. This allowed us to test all models as fully specified with both random intercept and slope effects, according to our pre-registered plan, and to determine point estimates and credible intervals rather than relying on null significance hypothesis testing.
- In our pre-registration, we planned to control for hours in bed as an index of sleep opportunity; however, the DSEM was unable to converge when this variable was included at the within-person level. We therefore left it out of the final model.
- In our pre-registration, we said we would test both between- and within-person components of cumulative effects. Although we did analyze these components using DSEM, we do not report results here because DSEM is a very conservative test of causality and no effects remained after controlling for autoregression.
- We decided not to complete one proposed secondary (exploratory mechanism) mediation, as we did not find significant moderation by other covariates and determined that it was ultimately outside the scope of the paper.

MPlus Analysis Syntax

Data:

File is [].dat;

Variable:

Names are ID SCHOOL AGE SEX RACE
MAT_COLL PUBER DEPR DAY TIME
SQ PS CSE SLPDUR NEG_RAT NEG_INT;
Missing are all (-9999);

CLUSTER = id;

LAGGED = ps(1) cse(1) sq(1); ! 1 lag

Usevariables are sq ps cse school age sex
race mat_coll puber depr day time;

ANALYSIS:

TYPE = TWOLEVEL RANDOM;

ESTIMATOR = BAYES;

PROCESSORS = 2;

THIN = 2;

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BITERATIONS = 20000;

MODEL:

%WITHIN%

!AR and CL terms

SQSQ|sq ON sq&1;

SQC|sq ON cse&1;

SQP|sq ON ps&1;

CSQ|cse ON sq&1;

CC|cse ON cse&1;

CP|cse ON ps&1;

PSQ|ps ON sq&1;

PC|ps ON cse&1;

PP|ps ON ps&1;

!Co-movements:

sq cse ps WITH sq cse ps;

!Co-variates

day ON sq cse ps;

time on sq cse ps;

%BETWEEN%

!Co-variates

sq cse ps ON school age sex race

mat_coll puber depr;

SQSQ-PP ON school age sex race

mat_coll puber depr;

!Co-variances

sq cse ps SQSQ-PP WITH sq cse ps SQSQ-PP;

OUTPUT:TECH1 TECH8 SVALUES STDYX;

PLOT:TYPE=PLOT3; FACTORS = ALL;

Supplementary Results Tables

See below.

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Supplementary Table 1: Between-person associations among mean levels of SQ, CSE, PS, and demographic covariates. Standardized posterior estimates are listed with 95% credible intervals.

Mean Between-Person Levels with	Between-Person Covariates	Fixed Effects (Between-Person Means)	95% Credible Interval - Lower	95% Credible Interval - Upper	Significance Level
Sleep Quality (SQ)					
	Age	0.053	-0.066	0.173	N.S.
	Depression	-0.150	-0.267	-0.030	**
	Maternal Education	-0.074	-0.212	0.060	N.S.
	Puberty	0.065	-0.078	0.207	N.S.
	Race	0.020	-0.101	0.140	N.S.
	School	0.096	-0.033	0.224	N.S.
	Sex	0.072	-0.051	0.196	N.S.
Coping Self-Efficacy (CSE)					
	Age	0.066	-0.046	0.173	N.S.
	Depression	-0.293	-0.398	-0.181	***
	Maternal Education	-0.137	-0.248	-0.019	*
	Puberty	0.086	-0.046	0.220	N.S.
	Race	-0.001	-0.117	0.113	N.S.
	School	0.055	-0.061	0.172	N.S.
	Sex	0.210	0.097	0.320	***
Perceived Stress (PS)					
	Age	-0.063	-0.171	0.050	N.S.
	Depression	0.244	0.126	0.351	***
	Maternal Education	0.107	-0.012	0.222	N.S.
	Puberty	-0.001	-0.130	0.125	N.S.
	Race	-0.067	-0.177	0.046	N.S.
	School	-0.185	-0.299	-0.063	***
	Sex	-0.230	-0.341	-0.111	***

Significance level is represented as N.S. for $p > 0.05$, * for $p \leq 0.05$, ** for $p \leq 0.01$, and *** for $p \leq 0.001$.

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Supplementary Table 2: Associations of within-person results and demographic covariates. Standardized posterior estimates are listed with 95% credible intervals.

Within-Person Associations with	Between-Person Covariates and Within-Person Associations	Fixed Effects (Between-Person Means)	95% Credible Interval - Lower	95% Credible Interval - Upper	Significance Level
That Day Sleep Quality → Next Day Sleep Quality					
	Age	0.086	-0.109	0.269	N.S.
	Depression	-0.257	-0.417	-0.076	**
	Maternal Education	-0.333	-0.530	-0.133	***
	Puberty	-0.006	-0.211	0.203	N.S.
	Race	0.120	-0.046	0.282	N.S.
	School	0.227	0.036	0.403	**
	Sex	0.189	0.007	0.366	*
That Day Coping Self-Efficacy → Next Night Sleep Quality					
	Age	0.143	-0.130	0.403	N.S.
	Depression	-0.220	-0.429	0.004	N.S.
	Maternal Education	0.113	-0.142	0.359	N.S.
	Puberty	0.045	-0.204	0.304	N.S.
	Race	-0.012	-0.251	0.225	N.S.
	School	0.110	-0.130	0.323	N.S.
	Sex	-0.180	-0.434	0.071	N.S.
That Day Perceived Stress → Next Night Sleep Quality					
	Age	0.162	-0.077	0.387	N.S.
	Depression	-0.053	-0.274	0.174	N.S.
	Maternal Education	0.080	-0.136	0.305	N.S.
	Puberty	0.172	-0.072	0.417	N.S.
	Race	-0.036	-0.233	0.157	N.S.
	School	0.086	-0.155	0.306	N.S.
	Sex	-0.161	-0.383	0.062	N.S.
Prev. Night Sleep Quality → That Day Coping Self-Efficacy					
	Age	-0.002	-0.213	0.210	N.S.
	Depression	-0.122	-0.321	0.087	N.S.
	Maternal Education	0.002	-0.231	0.223	N.S.
	Puberty	-0.109	-0.342	0.143	N.S.
	Race	-0.056	-0.262	0.146	N.S.
	School	0.057	-0.191	0.286	N.S.
	Sex	-0.202	-0.412	0.017	N.S.
That Day Coping Self-Efficacy → Next Day Coping Self-Efficacy					
	Age	-0.069	-0.276	0.136	N.S.
	Depression	-0.126	-0.313	0.064	N.S.
	Maternal Education	-0.150	-0.358	0.061	N.S.

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That Day Perceived Stress → Next Day Coping Self-Efficacy	Puberty	0.403	0.200	0.593	***
	Race	0.075	-0.126	0.268	N.S.
	School	-0.125	-0.311	0.079	N.S.
	Sex	0.018	-0.188	0.214	N.S.
Prev. Night Sleep Quality → That Day Perceived Stress	Age	-0.074	-0.304	0.160	N.S.
	Depression	-0.207	-0.444	0.043	N.S.
	Maternal Education	-0.050	-0.297	0.211	N.S.
	Puberty	0.228	-0.088	0.480	N.S.
	Race	-0.010	-0.227	0.204	N.S.
	School	-0.077	-0.350	0.197	N.S.
	Sex	-0.030	-0.271	0.211	N.S.
	That Day Coping Self-Efficacy → Next Day Perceived Stress	Age	-0.017	-0.210	0.186
Depression		0.239	0.042	0.414	**
Maternal Education		0.198	-0.002	0.394	N.S.
Puberty		0.110	-0.101	0.320	N.S.
Race		0.106	-0.086	0.297	N.S.
School		-0.240	-0.431	-0.025	*
Sex		-0.051	-0.240	0.135	N.S.
That Day Perceived Stress → Next Day Perceived Stress		Age	-0.019	-0.222	0.192
	Depression	-0.029	-0.222	0.161	N.S.
	Maternal Education	0.013	-0.189	0.224	N.S.
	Puberty	-0.347	-0.560	-0.132	***
	Race	-0.075	-0.283	0.136	N.S.
	School	0.019	-0.191	0.231	N.S.
	Sex	0.039	-0.165	0.245	N.S.
	That Day Perceived Stress → Next Day Perceived Stress	Age	0.025	-0.169	0.215
Depression		0.034	-0.150	0.216	N.S.
Maternal Education		0.007	-0.180	0.191	N.S.
Puberty		-0.172	-0.361	0.035	N.S.
Race		-0.024	-0.203	0.155	N.S.
School		0.000	-0.194	0.192	N.S.
Sex		0.001	-0.184	0.184	N.S.

Significance level is represented as N.S. for $p > 0.05$, * for $p \leq 0.05$, ** for $p \leq 0.01$, and *** for $p \leq 0.001$.

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Supplementary Table 3: Associations of within-person results and demographic covariates. Standardized posterior estimates are listed with 95% credible intervals.

Mean Between-Person Levels with	Within-Person Associations	Fixed Effects (Between-Person Means)	95% Credible Interval - Lower	95% Credible Interval - Upper	Significance Level
Sleep Quality (SQ)					
	That Day Sleep Quality → Next Day Sleep Quality	-0.128	-0.389	0.153	N.S.
	That Day Coping Self-Efficacy → Next Night Sleep Quality	0.276	-0.041	0.562	N.S.
	That Day Perceived Stress → Next Night Sleep Quality	0.149	-0.139	0.421	N.S.
	Prev. Night Sleep Quality → That Day Coping Self-Efficacy	0.215	-0.063	0.477	N.S.
	That Day Coping Self-Efficacy → Next Day Coping Self-Efficacy	0.004	-0.295	0.288	N.S.
	That Day Perceived Stress → Next Day Coping Self-Efficacy	0.163	-0.142	0.463	N.S.
	Prev. Night Sleep Quality → That Day Perceived Stress	-0.004	-0.260	0.268	N.S.
	That Day Coping Self-Efficacy → Next Day Perceived Stress	0.007	-0.259	0.305	N.S.
	That Day Perceived Stress → Next Day Perceived Stress	0.004	-0.230	0.238	N.S.
Coping Self-Efficacy (CSE)					
	That Day Sleep Quality → Next Day Sleep Quality	-0.062	-0.310	0.190	N.S.
	That Day Coping Self-Efficacy → Next Night Sleep Quality	0.189	-0.154	0.528	N.S.
	That Day Perceived Stress → Next Night Sleep Quality	0.149	-0.170	0.439	N.S.
	Prev. Night Sleep Quality → That Day Coping Self-Efficacy	0.101	-0.154	0.345	N.S.
	That Day Coping Self-Efficacy → Next Day Coping Self-Efficacy	0.050	-0.243	0.327	N.S.
	That Day Perceived Stress → Next Day Coping Self-Efficacy	0.104	-0.225	0.397	N.S.
	Prev. Night Sleep Quality → That Day Perceived Stress	-0.127	-0.367	0.113	N.S.
	That Day Coping Self-Efficacy → Next Day Perceived Stress	0.017	-0.252	0.296	N.S.
	That Day Perceived Stress → Next Day Perceived Stress	-0.014	-0.249	0.227	N.S.
Perceived Stress (PS)					
	That Day Sleep Quality → Next Day Sleep Quality	0.123	-0.148	0.374	N.S.
	That Day Coping Self-Efficacy → Next Night Sleep Quality	-0.045	-0.369	0.267	N.S.
	That Day Perceived Stress → Next Night Sleep Quality	-0.065	-0.377	0.265	N.S.
	Prev. Night Sleep Quality → That Day Coping Self-Efficacy	0.016	-0.252	0.280	N.S.

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That Day Coping Self-Efficacy → Next Day Coping Self-Efficacy	-0.185	-0.461	0.108	N.S.
That Day Perceived Stress → Next Day Coping Self-Efficacy	-0.234	-0.556	0.118	N.S.
Prev. Night Sleep Quality → That Day Perceived Stress	-0.111	-0.349	0.134	N.S.
That Day Coping Self-Efficacy → Next Day Perceived Stress	0.072	-0.200	0.323	N.S.
That Day Perceived Stress → Next Day Perceived Stress	-0.025	-0.271	0.221	N.S.

Significance level is represented as N.S. for $p > 0.05$, * for $p \leq 0.05$, ** for $p \leq 0.01$, and *** for $p \leq 0.001$.

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Supplementary Table 4: Associations among fixed within-person effects. Standardized posterior estimates are listed with 95% credible intervals.

Within-Person Associations with	Within-Person Associations	Fixed Effects (Between-Person Means)	95% Credible Interval - Lower	95% Credible Interval - Upper	Significance Level	
That Day Sleep Quality → Next Day Sleep Quality	That Day Coping Self-Efficacy → Next Night Sleep Quality	-0.060	-0.434	0.341	N.S.	
	That Day Perceived Stress → Next Night Sleep Quality	0.099	-0.275	0.475	N.S.	
	Prev. Night Sleep Quality → That Day Coping Self-Efficacy	0.431	0.065	0.718	*	
	That Day Coping Self-Efficacy → Next Day Coping Self-Efficacy	-0.130	-0.481	0.253	N.S.	
	That Day Perceived Stress → Next Day Coping Self-Efficacy	-0.039	-0.460	0.378	N.S.	
	Prev. Night Sleep Quality → That Day Perceived Stress	-0.322	-0.614	0.030	N.S.	
	That Day Coping Self-Efficacy → Next Day Perceived Stress	0.098	-0.305	0.448	N.S.	
	That Day Perceived Stress → Next Day Perceived Stress	-0.215	-0.525	0.151	N.S.	
	That Day Coping Self-Efficacy → Next Night Sleep Quality	That Day Perceived Stress → Next Night Sleep Quality	0.302	-0.134	0.647	N.S.
		Prev. Night Sleep Quality → That Day Coping Self-Efficacy	0.055	-0.309	0.404	N.S.
That Day Coping Self-Efficacy → Next Day Coping Self-Efficacy		0.066	-0.339	0.450	N.S.	
That Day Perceived Stress → Next Day Coping Self-Efficacy		0.007	-0.393	0.419	N.S.	
Prev. Night Sleep Quality → That Day Perceived Stress		0.171	-0.249	0.511	N.S.	
That Day Coping Self-Efficacy → Next Day Perceived Stress		0.160	-0.293	0.533	N.S.	
That Day Perceived Stress → Next Day Perceived Stress		0.024	-0.401	0.405	N.S.	
That Day Perceived Stress → Next Night Sleep Quality		Prev. Night Sleep Quality → That Day Coping Self-Efficacy	0.016	-0.329	0.373	N.S.
	That Day Coping Self-Efficacy → Next Day Coping Self-Efficacy	-0.276	-0.640	0.158	N.S.	
	That Day Perceived Stress → Next Day Coping Self-Efficacy	0.139	-0.323	0.562	N.S.	
	Prev. Night Sleep Quality → That Day Perceived Stress	-0.038	-0.408	0.286	N.S.	
	That Day Coping Self-Efficacy → Next Day Perceived Stress	0.064	-0.314	0.450	N.S.	
	That Day Perceived Stress → Next Day Perceived Stress	-0.190	-0.519	0.178	N.S.	
	Prev. Night Sleep Quality → That Day Coping Self-Efficacy					

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	That Day Coping Self-Efficacy → Next Day Coping Self-Efficacy	-0.068	-0.409	0.316	N.S.
	That Day Perceived Stress → Next Day Coping Self-Efficacy	0.041	-0.392	0.443	N.S.
	Prev. Night Sleep Quality → That Day Perceived Stress	-0.427	-0.693	-0.066	*
	That Day Coping Self-Efficacy → Next Day Perceived Stress	-0.141	-0.501	0.225	N.S.
	That Day Perceived Stress → Next Day Perceived Stress	-0.066	-0.440	0.316	N.S.
That Day Coping Self-Efficacy → Next Day Coping Self-Efficacy					
	That Day Perceived Stress → Next Day Coping Self-Efficacy	0.309	-0.101	0.626	N.S.
	Prev. Night Sleep Quality → That Day Perceived Stress	-0.067	-0.417	0.307	N.S.
	That Day Coping Self-Efficacy → Next Day Perceived Stress	-0.450	-0.697	-0.099	**
	That Day Perceived Stress → Next Day Perceived Stress	-0.105	-0.450	0.273	N.S.
That Day Perceived Stress → Next Day Coping Self-Efficacy					
	Prev. Night Sleep Quality → That Day Perceived Stress	0.166	-0.221	0.534	N.S.
	That Day Coping Self-Efficacy → Next Day Perceived Stress	-0.159	-0.513	0.240	N.S.
	That Day Perceived Stress → Next Day Perceived Stress	-0.493	-0.738	-0.147	**
Prev. Night Sleep Quality → That Day Perceived Stress					
	That Day Coping Self-Efficacy → Next Day Perceived Stress	0.239	-0.124	0.541	N.S.
	That Day Perceived Stress → Next Day Perceived Stress	0.079	-0.248	0.400	N.S.
That Day Coping Self-Efficacy → Next Day Perceived Stress					
	That Day Perceived Stress → Next Day Perceived Stress	0.457	0.175	0.677	***

Significance level is represented as N.S. for $p > 0.05$, * for $p \leq 0.05$, ** for $p \leq 0.01$, and *** for $p \leq 0.001$.

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Supplementary Table 5: Results from piecewise time-lagged multilevel models predicting perceived stress, sleep quality, and coping self-efficacy at time $t+1$ from time t , controlling for the outcome variable at time t . Models representing 'x_{within-person} + x_{between-person} predicting y' are labeled with the predictor on the left of the arrow, the outcome variable on the right of the arrow, and any covariates. Lines separate families of models. All models adjust for random slope and intercept effects of individual students, as well as time of day, diary day, and sex. Models of sleep quality at the bottom of the table additionally adjust for time in bed.

Models x → y, adjusting for covariate	Between- Person Unstd. Estimate	Significance Level	95% Credible Interval	Within-Person Unstd. Estimate	Significance Level	95% Credible Interval	R ²
That Day Stress → Next Night Sleep Quality	-0.27	*	-0.33, -0.21	0.01	N.S.	-0.02, 0.04	0.47
That Day Stress → Next Night Sleep Quality, Adj. for That Day Coping Self- Efficacy	-0.26	*	-0.32, -0.19	0.01	N.S.	-0.02, 0.04	0.47
That Day Stress → Next Night Sleep Quality, Adj. for That Day Time in Bed	-0.27	*	-0.34, -0.21	0.01	N.S.	-0.02, 0.04	0.48
That Day Stress → Next Night Time in Bed	-0.19	*	-0.28, -0.10	0.04	N.S.	-0.01, 0.08	0.42
Prev. Night Sleep Quality → That Day Stress	-0.58	*	-0.71, -0.45	-0.20	*	-0.28, -0.13	0.44
Prev. Night Sleep Quality → That Day Stress, Adj. for That Day Coping Self- Efficacy	-0.53	*	-0.67, -0.40	-0.19	*	-0.27, -0.12	0.44
Prev. Night Sleep Quality → That Day Stress, Adj. for Prev. Time in Bed	-0.55	*	-0.59, -0.41	-0.19	*	-0.27, -0.11	0.44
That Day Stress → Next Day Coping Self- Efficacy	-0.39	*	-0.45, -0.33	0.11	*	0.06, 0.15	0.47
That Day Coping Self-Efficacy → Next Day Stress	-0.65	*	-0.75, -0.55	0.06	N.S.	-0.02, 0.14	0.44
Prev. Night Sleep Quality → That Day Coping Self-Efficacy	0.42	*	0.32, 0.54	0.15	*	0.09, 0.21	0.50
Prev. Night Sleep Quality → That Day Coping Self-Efficacy, Adj. for Prev. Day Stress	-0.39	*	-0.45, -0.32	0.15	*	0.09, 0.21	0.48
Prev. Night Sleep Quality → That Day Coping Self-Efficacy, Adj. for Prev. Time in Bed	0.43	*	0.32, 0.54	0.16	*	0.09, 0.22	0.50
That Day Coping Self-Efficacy → Next Night Sleep Quality	0.32	*	0.24, 0.40	-0.01	N.S.	-0.05, 0.03	0.48
That Day Coping Self-Efficacy → Next Night Sleep Quality, Adj. for That Day Stress	-0.63	*	-0.73, -0.53	0.07	N.S.	-0.01, 0.15	0.44
That Day Coping Self-Efficacy → Next Night Sleep Quality, Adj. for That Day Time in Bed	0.32	*	0.24, 0.40	-0.01	N.S.	-0.05, 0.03	0.48
That Day Coping Self-Efficacy → Next Night Time in Bed	0.23	*	0.11, 0.35	-0.02	N.S.	-0.09, 0.05	0.45

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Prev. Night Time in Bed → That Day Stress	-0.18	*	-0.27, -0.08	-0.10	*	-0.15, -0.05	0.43
Prev. Night Time in Bed → That Day Coping Self-Efficacy	0.16	*	0.09, 0.23	0.03	N.S.	-0.02, 0.08	0.47
Prev. Night Time in Bed → Next Night Sleep Quality	0.34	*	0.27, 0.40	-0.02	N.S.	-0.05, 0.02	0.5
Prev. Night Sleep Quality → Next Night Time in Bed	0.68	*	0.54, 0.81	-0.12	*	-0.20, -0.04	0.45

Estimates denoted with * reached the significance threshold, meaning that the 95% credible intervals did not contain 0. Estimates that did not reach significance threshold, meaning that the 95% credible intervals did contain 0, are denoted with N.S.