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Research Letter

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Trait-level cognitive and psychological factors associated with longitudinal resilience to sleep disturbance under chronic stress

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The negative impact of the COVID-19 pandemic on clinical sleep disruption has been well established through multiple meta-analyses. Reviewing 179 papers from 39 countries, Alimoradi et al. reported the prevalence of sleep problems was 37% of the general population, with higher numbers during lockdowns (46%) and in longitudinal studies (62%) [1]. Night-to-night variability in sleep also increased during lockdowns [2]. More broadly, the pandemic can serve as a model of a systemic stressor of uncertain duration, severity, and consequences, and these characteristics have contributed to the associated sleep problems [3]. Few studies have sought to identify factors potentially protective against negative sleep outcomes, beyond demographics and chronotype. One study did report a measure of global resilience was negatively correlated with global sleep quality during the initial lockdown period in Italy [4]. The aim here was to examine the association between specific cognitive and psychological trait-level factors and resilience to sleep disruption across a 95-day period early in the pandemic.

Data were derived from a longitudinal on-line survey conducted through Boston College (United States) [5]. English-speaking adults 18+ years old, from any country, were eligible. See Cunningham et al. for complete study details [5]. Information directly relevant to this report follows. Methods and analysis plan were pre-registered (10.17605/OSF.IO/U8Q6M).

Data were collected 20MAR20-30JUN20 from 628 individuals (526 [83.8%] females, age: 39.1 ± 17.2 years; 129 ethnic/racial minority [20.5%]) living in the United States. Participants completed up to 70 nights of sleep diaries (median = 35 nights), starting from the date of initial enrollment. Time was normalized so Day 0 equaled the first day of lockdown in each participant's local region, resulting in sleep data from −6 to +95 days since lockdown. At the end of this period, participants completed four trait measures: (1) Brief Self Control Scale [6], a 13-item measure assessing behavioral self-control; (2) Intolerance of Uncertainty [7], a 12-item measure assessing the extent to an unpredictable future causes distress and inaction; (3) Emotion Regulation Questionnaire [8], a 10-item measure assessing cognitive reappraisal and expressive suppression emotion regulation styles; and (4) Short Impulsive Behavior Scale [9], a 20-item measure assessing impulsivity (five subscales: perseverance, negative urgency, positive urgency, premeditation, and sensation seeking).

We examined the association of each trait measure with the mean and variability over time in three sleep diary outcomes: (1) sleep opportunity (time-in bed [TIB]: the amount of time spent attempting to sleep during the major sleep episode); (2) sleep quantity (total sleep time [TST]: minutes of sleep during the major sleep episode); and (3) sleep quality (sleep efficiency [SE]: % of time spent asleep during the major sleep period). Analyses were Bayesian mixed effects location-scale models with random intercepts and time slopes. Location-scale models test predictors of the average and variability simultaneously with assumed distributional form: $y_{ij} \sim N(\eta_{\mu,ij}, \exp(\eta_{\sigma,ij}))$ where y_{ij} is the outcome for the ith person on the jth day and $\eta_{\mu,\,ij}$ and $\eta_{\sigma,ij}$ are the linear predicted values for the mean (location) and variance (scale), respectively, which both include fixed and random effects by participant. Importantly, compared to methods such as individual standard deviation, variability estimates can be adjusted for covariates and account for uncertainty. Covariates were weekday/weekend, age, sex, race, education, location, and employment. Covariates and Time (linear and quadratic) x Trait Measure interactions were in all models on $\eta_{\mu,\,ij}$ and $\eta_{\sigma,ij}$. Credible intervals (99%) and significance tests (α = 0.01) integrate out random effects to produce interpretable average estimates on the response scale (average marginal effects).

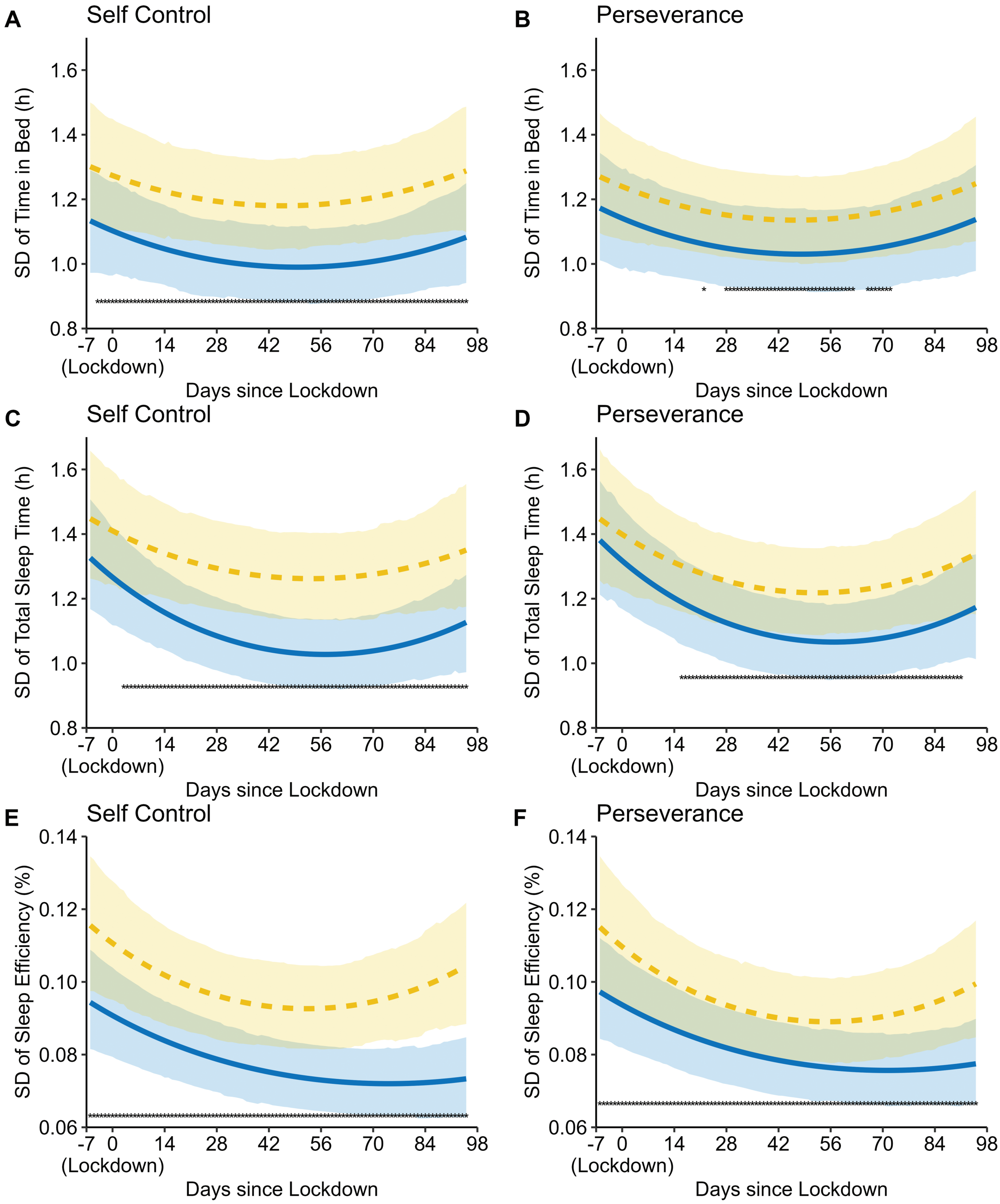

Figure 1. Sleep variability over time by self-control and perseverance. Graphs show the average estimate of the standard deviation (SD) of each sleep measure as a function of time and trait. Solid blue lines show high levels of each trait (1 SD above the mean). Dashed gold lines show low levels of each trait (1 SD below the mean). Estimates are average marginal effects and 99% credible intervals. Asterisks indicate days when the two lines differed at $p \leq .01$. All results are adjusted for covariates and individual differences in mean sleep parameters via random effects in the models.

Average Sleep

Higher perseverance was associated with less TIB, particularly ≥2 months following the start of lockdown. Greater self-control was associated with longer TST, particularly in the first month after the start of lockdown. Greater self-control, lower intolerance of uncertainty, greater use of cognitive reappraisal emotional regulation, and higher perseverance all predicted greater SE throughout the study. All other measures showed non-significant associations with mean sleep measures at all time points.

Sleep Variability

Greater self-control predicted lower TIB variability. Starting ~1 month into lockdown, greater self-control, higher perseverance, less negative urgency, and less positive urgency (the tendency to act impulsively when experiencing intense negative or positive emotions, respectively) were each associated with lower TIB variability. Lower variability in TST was predicted by greater self-control, greater use of cognitive reappraisal, and several impulsivity subscales (higher perseverance, less negative urgency, less positive urgency, and greater premeditation). Greater self-control

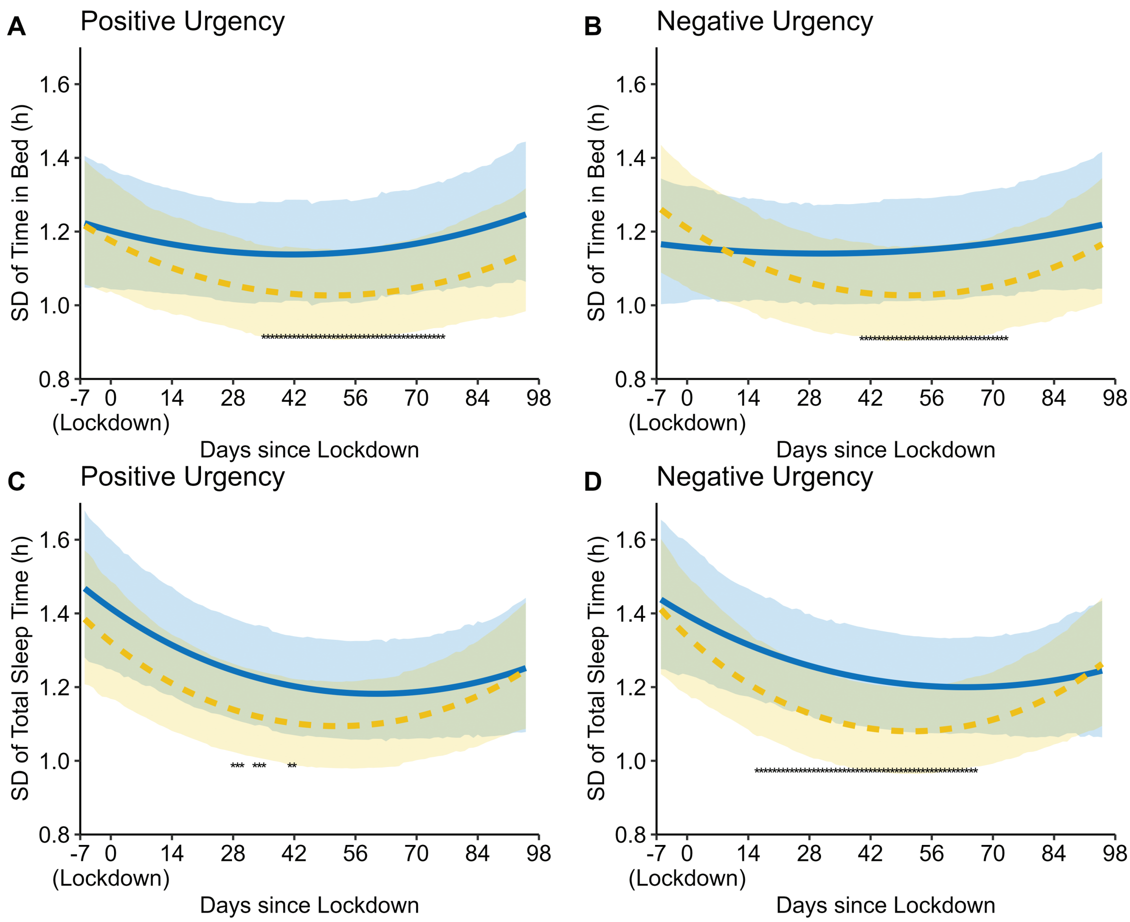

Figure 2. Sleep variability over time by positive and negative urgency. Graphs show the average estimate of the standard deviation (SD) of each sleep measure as a function of time and trait. Solid blue lines show high levels of each trait (1 SD above the mean). Dashed gold lines show low levels of each trait (1 SD below the mean). Estimates are average marginal effects and 99% credible intervals. Asterisks indicate days when the two lines differed at $p \leq .01$. All results are adjusted for covariates and individual differences in mean sleep parameters via random effects in the models.

and higher perseverance predicted lower variability in SE. Greater cognitive reappraisal and lower negative urgency also predicted lower SE variability. See Figures 1 and 2.

This is one of the first studies to examine trait-level cognitive and psychological predictors of resilience to sleep disruption longitudinally. Few measures predicted average sleep across 3 months. In contrast, trait-level factors more consistently predicted less night-to-night variability in sleep across the study period (i.e. 6/8 measures predicted TST variability and 4/8 predicted each of TIB and SE variability). Resilience against increased sleep variability is critical, given greater variability has been associated with a variety of poor mental and physical outcomes [10].

Behavioral self-control was the most robust predictor of sleep. Self-control predicted greater average TST and SE, as well as lower variability over time in all three measures (TIB, TST, and SE). Given the significant disruption to daily routines during the early stages of the pandemic, especially in lockdowns, the ability to regulate one's behavior in the service of longer-term goals appeared to help individuals maintain regular, healthy sleep habits. Perseverance, the ability to stick with an activity despite adversity, was the second most robust predictor. Perseverance predicted lower average TIB and higher SE, as well as lower variability over time in all three sleep measures. This suggests that even when challenged with a chronic, systemic stressor, and unpredictability of when the situation would improve, high trait perseverance also helped individuals maintain healthy, regular sleep habits.

Interestingly, self-control and perseverance have recently been proposed as part of a suite of cognitive traits underlying optimal cognitive performance across various applied high-performance settings [11]. Our findings suggest they may also relate to how individuals regulate sleep (and perhaps maintain other healthy habits) during a chronic, pervasive, societal-level stressor. Training programs aimed at bolstering these traits may help build resilience to future systemic stressors.

Supplementary material

Supplementary material is available at *SLEEP* online.

Disclosure Statement

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Data Availability

All data for this study and the larger Boston College survey is publically available on Open Science Framework: https://osf.io/gpxwa/.

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