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SELF AND IDENTITY
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James W. Butterworth, Constantine Sedikides, Tim Wildschut and Nicholas J. Kelley

Centre for Research on Self and Identity, School of Psychology, University of Southampton, Southampton, UK

ABSTRACT

We addressed the relation between sleep quality and aspects of the self. In particular, we conducted three studies using cross-sectional and longitudinal, as well as subjective and behavioral, methods to examine the link between sleep quality and four self-aspects: self-esteem, self-compassion, self-control, self-continuity. Past month sleep quality positively related to trait levels of all four self-aspects (Studies 1–2). Daily reports of sleep quality were positively associated with state levels of all four self-aspects across 14 days (Study 2) and 7 days (Study 3). Cross-lagged paths revealed that subjective sleep quality predicted the four self-aspects but not vice-versa (Studies 2–3). A behavioral index of sleep quality (i.e. sleep efficiency) did not predict any self-aspect, but self-compassion and self-continuity predicted sleep efficiency (Study 3). The findings clarify the association between sleep quality and the self, providing explanations for the psychological benefits of a good night's sleep.

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Sleep quality; self-compassion; self-control; self-esteem; self-continuity

Sleep and the self are intertwined with consciousness. The absence of consciousness defines dreamless sleep (Tononi et al., 2024), and the presence of consciousness produces the self (Sedikides & Gregg, 2003). Perhaps due to their ties to the conscious mind, their importance has been advocated since antiquity (Barbera, 2008; Remes & Sihvola, 2008). Yet, the relation between sleep and the self has been infrequently studied and in a piecemeal fashion replete with methodological limitations. Here, we adopted a comprehensive approach using correlational and longitudinal methods, alongside subjective and behavioral measures, of sleep quality to examine its relation with the self. We focused, in particular, on four key self-aspects. Two of them (i.e., self-esteem, self-compassion) represent affective aspects of the self, whereas the other two (i.e., self-control, self-continuity) represent cognitive aspects of the self.

CONTACT Nicholas J. Kelley n.j.kelley@soton.ac.uk Centre for Research on Self and Identity, School of Psychology, University of Southampton, B44 University Rd, Southampton SO17 1PS, UK

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Sleep and self-esteem

Self-esteem is defined as feelings of self-worth (Donnellan et al., 2015; Orth & Robins, 2022). In cross-sectional studies, higher self-esteem is associated with better sleep quality across the life span (Araghi et al., 2013; Barry & Wong, 2020; Becker, 2014; Chai & Han, 2023; Chawak et al., 2020; Coleman et al., 2016; El-Sheikh & Arsiwalla, 2011; El-Sheikh et al., 2010; Ellison et al., 2023; Garcia Meneguci et al., 2021; Graham & Streitel, 2010; Kamysheva et al., 2008; Lauer et al., 2021; Lee & Sibley, 2019; Lemola et al., 2011, 2013; Loizou & Petkari, 2019; Montagni et al., 2020; Randler, 2011; Thumann et al., 2019; Woods & Scott, 2016; Younes et al., 2016; X. Zhao et al., 2021). In longitudinal studies, sleep quality predicts trajectories of self-esteem over time (Brand et al., 2015; El-Sheikh et al., 2010; Fredriksen et al., 2004; Vazsonyi et al., 2021; Wong et al., 2024; Yip, 2015), and self-esteem strengthens the predictive effect of sleep on cognitive functioning (e.g., language comprehension, reasoning, sensory processing; Saini et al., 2021). However, the predictive effect of self-esteem on sleep quality has yet to be tested, although indirect support for it has been obtained in a 3-year longitudinal study, conceptualizing self-esteem as a component of intrapersonal adjustment alongside depressive symptoms and stress (Tavernier & Willoughby, 2014). Thus, although sleep quality predicts self-esteem over time, the possibility that self-esteem directly predicts trajectories of sleep needs to be addressed.

Sleep and self-compassion

Much like self-esteem, self-compassion reflects affective reactions toward the self. Whereas self-esteem focuses mostly on affective reactions to successes, self-compassion reflects reactions toward failure with a focus on minimizing psychological suffering. The construct has been defined in terms of self-kindness (being kind and understanding to oneself without criticism and judgment), common humanity (perceiving one's own experience as a shared human experience without feelings of isolation and separation), and mindfulness (being aware of painful thoughts and feelings without overidentifying with them; Neff, 2003). At the trait level, self-compassion is associated with better subjective sleep quality both cross-sectionally (Barry & Wong, 2020; Bian et al., 2022; Butz & Stahlberg, 2018; C. Kim & Ko, 2018; J. J. Kim et al., 2021; Kurebayashi, 2020; Rakhimov et al., 2022) and meta-analytically (Brown et al., 2021; Butz & Stahlberg, 2020; Phillips & Hine, 2021). Further, self-compassion interventions increase sleep quality the next day (Butz & Stahlberg, 2018, Study 2) and predict better sleep quality two-weeks later in some studies (Y. Hu et al., 2018) and up to 6 months later in others (Tout et al., 2024). Thus, although self-compassion has been shown to predict sleep quality over time, the possibility that sleep directly predicts trajectories of self-compassion needs to be addressed.

Sleep and self-control

Whereas self-esteem and self-compassion reflect an affective orientation toward the self, self-control reflects a cognitive orientation, that is, the ability to inhibit or override impulses of the self (Baumeister et al., 2007; Tangney et al., 2004). In cross-sectional studies, trait and state self-control are associated with greater sleep quality (Clinton et al., 2020; Deng et al., 2024; Exelmans & Van den Bulck, 2018; Keller et al., 2019; J. Liu et al., 2020; Q.-Q. Liu et al., 2018; Meldrum et al., 2015; Owens et al., 2016; Przepiórka et al., 2019; Schmidt et al., 2023; Vazsonyi et al., 2018; Welsh et al., 2018, Yang et al., 2024; M. X. Zhang & Wu, 2020; S. Zhao, 2023; Zhu et al., 2021). Meta-analyses have corroborated these findings (Guarana et al., 2021; Hill et al., 2022). Ecological momentary assessment (Freeman & Gottfredson, 2018), experience sampling (Baumeister et al., 2019), and daily diary (Hisler et al., 2019) studies show that poor sleep quality reduces subsequent self-control. Longitudinal studies indicate that poor sleep reduces self-control over longer durations form months (Yang et al., 2024) to years (Royle & Connolly, 2024; K. E. Williams & Sciberras, 2016) later. Daily diary studies also suggest that trait self-control buffers the influence of poor sleep quality on cognitive (e.g., procrastination; Van Eerde & Venus, 2018) and emotional (e.g., discrepancies between felt and required emotions, Diestel et al., 2015) outcomes, but beliefs that self-control is limited produce poor sleep habits in response to stress (Bernecker & Job, 2020). An additional daily diary study reports that self-control predicts better sleep throughout adolescence (Bub et al., 2016). Only one study has examined the reciprocal longitudinal associations between self-control and sleep demonstrating that, during adolescence, self-control predicts subsequent sleep quality but not vice versa (Partin et al., 2022). Hence, although prior work suggests that self-control may shape sleep over time, the possibility that sleep quality also influences the development of self-control has received limited attention in longitudinal research and remains an open question.

Self-continuity

We define self-continuity as the perceived connection between one's present and future selves (Hong et al., 2024; Sedikides et al., 2023). Although self-continuity has not been examined in the context of sleep, there is indirect evidence that self-continuity promotes good sleep. In particular, self-continuity contributes to mental health (Levin et al., 2023; Martin-Storey et al., 2021; Sadeh & Karniol, 2012; Szabó, 2022) and subjective wellbeing (Chu & Lowery, 2024; Sokol & Serper, 2019; Y. Zhang & Chen, 2018), both of which are linked to better sleep (Bacaro et al., 2023; Baglioni et al., 2016; Weinberg et al., 2016). Furthermore, longitudinal studies indicate that self-continuity predicts better coping (Pi et al., 2024), reduced negative emotions (Mao & Li, 2024), and lower depression (Xue et al., 2023), all of which are related to sleep quality over time (Arora et al., 2022; Palmer et al., 2024; Zhai et al., 2015). Together, although self-continuity has not been directly linked to sleep, its established connections to mental health, wellbeing, and emotional functioning suggest it may be both a predictor and an outcome of sleep quality over time.

Overview

The literature linking the self to sleep has five limitations. First, although it has examined the roles of self-esteem, self-compassion, and self-control in sleep quality, it has not examined the role of self-continuity, despite its relevance to psychological functioning. Second, this literature has relied mostly on cross-sectional studies. Third, the literature has tested associations between sleep and the self in a piecemeal fashion, that is, one self-aspect at a time. Due to idiosyncrasies across individual studies, this approach makes it difficult to directly compare the relative strength of the associations between self-aspects and sleep. Fourth, the small number of longitudinal studies has focused almost exclusively on unidirectional pathways from sleep to the self, leaving open questions about reciprocal relations, especially for self-esteem, self-compassion, and (to a lesser extent) self-control Fifth, most studies (cross-sectional and longitudinal) assessed subjective rather than behavioral sleep quality.

We addressed these limitations. In Study 1, we cross-sectionally examined the links between sleep quality and four self-aspects (self-control, self-esteem, self-compassion, self-continuity). We hypothesized that sleep quality would be associated with all four self-aspects. We then tested the relations between sleep and self-aspects in two longitudinal daily diary studies using subjective (Studies 2–3) and behavioral (Study 3) measures of sleep quality. Given longstanding inconsistencies in how sleep quality is defined, sometimes referring to single subjective ratings, global composites, or specific physiological parameters, we clarify our operationalization across studies. In Studies 1 and 2, we assessed subjective sleep quality using Component 1 of the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989), which captures participants' global sense of how well they slept. In Study 3, we assessed sleep efficiency with actigraphy, a behavioral index of the time spent asleep relative to the amount of time in bed (Åkerstedt et al., 1994; Krystal & Edinger, 2008). We used sleep efficiency as an index of sleep quality, following the National Sleep Foundation's recommendation that it is a reliable indicator (Ohayon et al., 2017). Although we use the term "sleep quality" for consistency with prior work on the self, we specify its operationalization in each study to reflect the distinct components being measured. We hypothesized that better sleep would prospectively and positively predict the four self-aspects. However, given that there is limited longitudinal evidence for reciprocal relations, particularly for self-esteem, self-compassion, and self-control, we also explored whether these self-aspects would predict subsequent sleep quality. We present the research protocol in Supplementary Material.

Study 1

In cross-sectional Study 1, we examined the association between subjective sleep quality and the four self-aspects. This study was approved by the University of Southampton Faculty Ethics Committee (Approval Number: 54014).

Method

Participants and sample size determination

We conducted a power analysis in G*Power 3.1 (Faul et al., 2009) via the "Correlation: Point biserial model" statistical test from the t-tests family. For effect size estimate, we used the meta-analytically derived median correlation coefficient in self research ($r = .29$; Lovakov & Agadullina, 2021). Ninety one participants were needed to detect this effect size with 80% power and a two-tailed test. Given that simulation studies show that correlations as small as $r = .20$ stabilize at samples of 250 participants (Schönbrodt & Perugini, 2013), we sought to recruit at least that number. We tested 315 participants through the online platform Prolific (https://www.prolific.co). We excluded participants if they did not complete all of the measures ($n = 6$). At the end, we asked them to indicate, in good faith, if their data were usable. We excluded those who responded "no" ($n = 10$). The final sample consisted of 299 participants. They were 18–75 years old ($M_{years} = 37.02$, $SD_{years} = 14.06$) UK residents. Most of them were women ($n = 226$, 76.1%), non-Hispanic ($n = 297$, 99.34%), and White ($n = 273$, 91.9%).

Procedure

Sleep quality. We assessed sleep quality with the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). It comprises 19 questions from which seven component scores are derived. The focus of the current study was the first component, subjective sleep quality. Participants indicate the subjective quality of their sleep over the last month ("Over the last month how would you rate your sleep quality overall) from 0 (*very good*) to 3 (*very bad*). In the current study scores ranged from 0 to 3 ($M = 2.49$, $SD = 0.76$). The PSQI has good reliability and validity (Buysse et al., 1989; Fabbri et al., 2021).

Self-esteem. We assessed self-esteem with the 10-item Rosenberg Self-Esteem Scale (RSE; Rosenberg, 1965). A sample item is: "On the whole, I am satisfied with myself" (1 = *strongly agree*, 6 = *strongly disagree*). The RSE is the most widely used self-esteem measure (Orth & Robins, 2022), with satisfactory validity and reliability (Sinclair et al., 2010). In the current study, scores ranged from 1.00 to 6.00 ($M = 3.92$, $SD = 1.14$, $\alpha = .94$)

Self-compassion. We assessed self-compassion with the 12-item self-compassion scale – short Form (SCS-SF; Raes et al., 2011). Participants indicated how they typically acted toward their self in difficult times (1 = *almost never*, 5 = *almost always*). Two items assess each of six facets of self-compassion: self-kindness (e.g., "When I'm going through a very hard time, I give myself the caring and tenderness I need"), self-judgment (e.g., "I'm disapproving and judgmental about my own flaws and inadequacies"; reverse-scored), common humanity (e.g., "I try to see my failings as part of the human condition"), isolation (e.g., "When I fail at something that's important to me, I tend to feel alone in my failure"; reverse-scored), mindfulness (e.g., "When something painful happens I try to take a balanced view of the situation"), over-identification (e.g., "When I fail at something important to me I become consumed by feelings of inadequacy"; reverse-scored). In the current study, scores ranged from 1.17 to 5.00 ($M = 2.82$, $SD = 0.69$, $\alpha = .86$)

Self-control. We assessed self-control with the brief version of the Self-Control Scale (BSCS; Tangney et al., 2004). Participants rated the extent to which they identified with 13 statements about behavioral self-control (e.g., "I am good at resisting temptation"; 1 = *not at all like me*, 5 = *very much like me*). In the current study, scores ranged from 1.23 to 4.85 ($M = 3.18$, $SD = 1.23$, $\alpha = .84$).

Self-continuity. We assessed self-continuity with the 8-item self-continuity scale, minorly adapted from Sedikides et al. (2015). Participants indicated their level of agreement with statements about their sense of personal and temporal continuity (e.g., "Important aspects of my life will remain the same in the future") and discontinuity (e.g., "I feel disconnected with my future self"; 1 = *strongly disagree*, 7 = *strongly agree*). In the current study, scores ranged from 1.00 to 7.00 ($M = 4.38$, $SD = 1.36$, $\alpha = .93$)

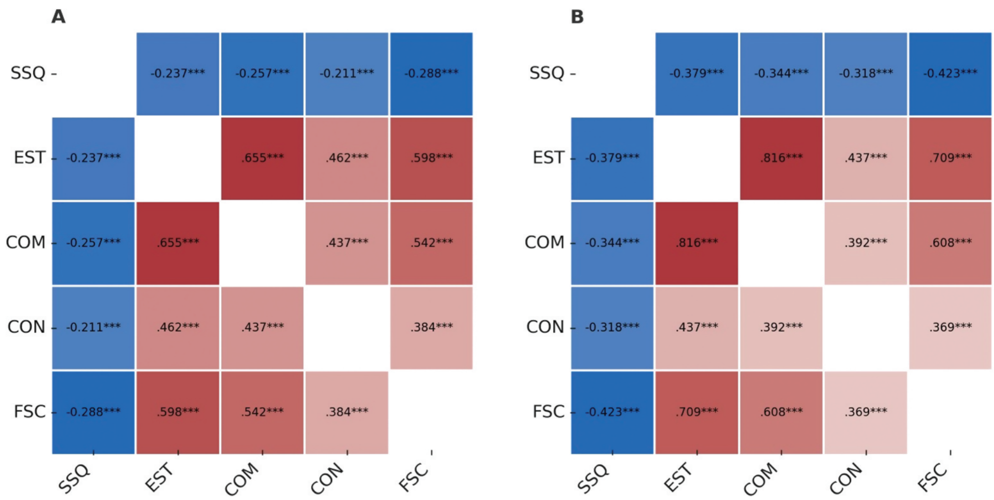

Figure 1. Bivariate correlations between subjective sleep quality and the self in study 1 (panel A) and study 2 (panel B). Note. SSQ = Subjective Sleep Quality; EST = Self-esteem; COM = Self-compassion; CON = Self-control; GSE = General Self-efficacy; SCC = Self-concept clarity; FSC = Future self-continuity. ***$p < .001$. **$p < .01$.

Results and discussion

We depict bivariate correlations among all study variables in Figure 1(A). As hypothesized, better sleep quality was associated with higher self-esteem, self-compassion, self-control, and self-continuity. The associations were moderately sized (i.e., > .20; Gignac & Szodorai, 2016).

Study 2

In longitudinal Study 2, we implemented random-intercept cross-lagged panel models (RI-CLPMs; Hamaker et al., 2015) to examine the directionality between subjective sleep quality and the four self-aspects over a 14-day period. This study was approved by the University of Southampton Faculty Ethics Committee (Approval Number: 60427).

Method

Participants and sample size determination

We used the powRICLPM R-Package (Mulder, 2023) to estimate the number of participants required for detecting moderately sized cross-lagged effects (.07) with 80% power. We based our effect size estimate on prior meta-analysis and effect size guidelines (Orth et al., 2021). We used the following specifications: cross-lagged effects = .07; autoregressive effects = .20; variances and covariances for the within-unit components = .40; proportion of between-unit variance = .50; correlation between the random intercepts = .35. We also included 12 repeated measures, constrained cross-lagged paths to be equal across time, and conducted 1,000 Monte Carlo simulations. We did not control for multiplicity for the purpose of reducing type II errors. We based our decision on arguments against the practice of adjusting for multiple comparisons when the data are natural and observational (as opposed to random), because such a practice would result in more errors of interpretation and ultimately undermine the fundamental premise of empirical research (Rothman, 1990). Based on these parameters, 200 participants were needed to detect moderately sized cross-lagged effects with 80% power.

Hedging against attrition, we oversampled recruiting 239 participants. Of them, 171 were University of Southampton psychology undergraduates taking part for course credit and 68 were Prolific workers remunerated with £1.00 for completing a 10-minute survey the first day and £0.50 for a 5-minute survey on each subsequent day. We excluded participants if they did not complete the Day 1 survey ($n_{\text{students}} = 5$, $n_{\text{Prolific workers}} = 1$) or did not complete at least 5 days of the longitudinal phase ($n_{\text{students}} = 18$, $n_{\text{Prolific workers}} = 16$).

The final sample comprised 199 participants ($n_{\text{students}} = 148$, $n_{\text{Prolific workers}} = 51$). They were 18–67 years old ($M = 23.23$, $SD = 9.24$). Students were younger ($M = 18.99$, $SD = 1.23$) than Prolific workers ($M = 35.51$, $SD = 11.26$), $F(1, 197) = 310.84$, $p < .001$, $\eta^2 = .612$. Most participants were women ($n = 174$, 87.44%); the remaining were men ($n = 24$, 12.06%) or did not report their gender ($n = 1$, 0.50%). These proportions did not vary between students and Prolific workers, $X^2(2) = 3.99$, $p = .136$. Also, participants were predominantly White ($n = 160$, 80.40%), with additional participants reporting being Black ($n = 9$, 4.52%), Asian ($n = 18$, 9.05%), Other ($n = 8$, 4.02%), or Multi-Racial ($n = 4$, 2.01%). These proportions did not vary between students and Prolific workers, $X^2(4) = 2.40$, $p = .662$.

Procedure

Participants completed a brief (5-minute) online survey for 14 consecutive days. The survey was distributed via e-mail at 5 pm (GMT), and participants were instructed to complete each survey between their final meal of the-day and before they went to bed (in accordance with instructions from the PSQD Bedtime; Buysse et al., 1989). Day 1 consisted of trait measures and demographics to test the replicability of Study 1 results. Next, participants entered the longitudinal phase (Days 2–14), where they reported their self-esteem, self-compassion, self-control, and self-continuity that day as well as how well they slept the night before (i.e., subjective sleep quality) as part of the Pittsburgh Sleep Diary. We presented measures in a randomized order each day (Y. Hu et al., 2018; Van Eerde & Venus, 2018).

Day 1 (trait measures). Participants completed trait measures of self-esteem, self-compassion, self-control, and self-continuity. They also completed a measure of subjective sleep quality over the last month.

Longitudinal phase. Beginning on Day 2 and ending on day 14 (13 days total), participants reported daily self-esteem, self-compassion, self-control, and self-continuity, as well as the preceding night's subjective sleep quality.

State sleep quality. We administered a modified version of the Pittsburgh Sleep Diary (PSD; Monk et al., 1994) by combining the waketime and bedtime surveys into one. Our measure of subjective sleep quality was embedded in this measure and asked participants, "How would you rate your sleep quality last night?" from 1 (very bad) to 7 (very good). Daily scores were lowest on Day 3 ($M = 4.61$, $SD = 1.66$) and highest on Day 7 ($M = 4.99$, $SD = 1.67$).

State self-esteem. We assessed state self-esteem with the Single-Item Self-Esteem Scale (Robins et al., 2001). We asked participants to rate the veracity of the statement "I have high self-esteem," preceded by the stem "Right now" (1 = *not very true of me*, 7 = *very true of me*). Daily scores were lowest on Day 2 ($M = 4.03$, $SD = 1.88$) and highest on Day 10 ($M = 4.50$, $SD = 1.94$).

State self-compassion. We created a 6-item state self-compassion scale (after Neff et al., 2021). For each of the six self-compassion facets, we selected the item that loaded highest on their respective facet of self-compassion (e.g., "Today, I was tolerant of my own flaws and inadequacies"; 1 = *strongly disagree*, 7 = *strongly agree*). Daily scores were lowest on Day 11 ($M = 4.37$, $SD = 1.19$) and highest on Day 6 ($M = 4.60$, $SD = 1.10$). The scale demonstrated good reliability across days, with Cronbach's α ranging from .76 to .88.

State self-control. We assessed state self-control with Brief State Self-Control Capacity Scale (Lindner et al., 2019). Participants responded to five statements referring to their self-control at the moment (, "I feel like my willpower is gone"; 1 = *not true*, 7 = *very true*). Daily scores were lowest on Day 2 ($M = 4.05$, $SD = 1.31$) and highest on Day 10 ($M = 4.41$, $SD = 1.38$). The scale demonstrated good reliability across days, with Cronbach's α ranging from .79 to .87.

State self-continuity. We assessed state self-continuity with a single face-valid item adapted from Hong et al. (2024); "I feel connected to my future self"; 1 = *not true*, 7 = *very true*). Daily scores were lowest on Day 9 ($M = 4.54$, $SD = 1.66$) and highest on Day 10 ($M = 4.70$, $SD = 1.73$).

Statistical analysis

We employed bivariate correlations to examine Day 1 trait data. On Day 2, participants entered the longitudinal phase where we used a series of Random-Intercept Cross Lagged Panel Models (RI-CLPM, Hamaker et al., 2015) in SAS (Hamaker et al., 2018) to test bidirectional relations between sleep quality and self-aspects. The RI-CLPM approach allowed us to test for: (1) Prospective effects of temporary deviations from the trait level of each self-aspect on change in the temporary deviation from the trait level of sleep quality (self-aspect → sleep cross-lagged path), and (2) Prospective effects of temporary deviations from the trait level of sleep quality on change in the temporary deviation from the trait level of each self-aspect (sleep → self-aspect cross-lagged path). We ran separate models for self-esteem, self-compassion, self-control, and self-continuity.

We used RI-CLPMs because they outperform other model types for assessing prospective effects of deviations form trait levels of the constructs of interest (Orth et al., 2021). To deal with missing data, we employed full information maximum likelihood estimation, which produces less biased and more reliable results compared to listwise deletion (Schafer & Graham, 2002; Widaman, 2006). In the RI-CLPMs reported below, we placed equality constraints on the auto-regressive and cross-lagged paths. This is a common approach that is more parsimonious, improves statistical power, and improves precision of parameter estimates (Orth et al., 2021). It requires assuming that the effects are equal between the different time points (e.g., the association between Day 2 self-esteem and Day 3 sleep quality will be the same as the association between Day 3 self-esteem and Day 4 sleep quality). This approach is justifiable in a study such as this, because time intervals between measurement waves are equal and model fit was not reduced compared to a model without these equality constraints (Mulder & Hamaker, 2021).[1] We implemented the following criteria to evaluate model fit: Comparative Fit Index (CFI) > .90, Root Mean Square Error of Approximation (RMSEA) < .08, Standardized Root Mean Square Residual (SRMR) < .08 (L. T. Hu & Bentler, 1999).

Results

Day 1 (trait measures)

As in Study 1, subjective sleep quality was associated with higher self-esteem, self-compassion, self-control, and self-continuity (Figure 1(B)).

Model 1 (self-aspect→ sleep short lag; sleep → self-aspect long lag)

We distributed (via e-mail) assessments of sleep quality and self-aspects at the same time every evening (5PM). As such, we recorded self-aspects in the moment ("how much [they] agree with the statement RIGHT NOW"), but sleep quality retrospectively (e.g., "last night I went to sleep at"). Assuming a hypothetical participant who completed surveys every day at 5 PM and the midpoint of their sleep cycle was 5AM, each assessment coupled measures of self-aspects with measures of sleep covering a period 12 hours earlier. For example, if we wanted to use Day 2 self-aspects to predict Day 3 sleep quality, we would subtract these 12 hours from the standard 24-hour lag, resulting in self-aspect → sleep lags of 12 hours. We term this 12-hour lag "short lag." Likewise, if we wanted to use Day 2 sleep quality to predict Day 3 self-aspects, we would add these 12 hours into the standard 24-hour lag resulting in sleep → self-aspects lags of 36-hours ("long lag"). This lag pattern is reflected in the analyses below, where we fit self-aspects and sleep quality to a series of RI-CLPMs (see Figure 2 for a conceptual diagram and Table 1 for a summary of findings).

Self-esteem. The model fit the data well, X^2 (305) = 395.61, $p < .001$ (CFI = .97, RMSEA = .04, 90%CI [.027, .049], SRMR = .066). The between-subjects covariation between sleep quality and self-esteem was significant, $B = 0.69$, $SE = .12$, $t(305) = 5.57$, $p < .001$. The Autoregressive path from earlier self-esteem to later self-esteem (δ) was significant, $B = 0.18$, $SE = .02$, t(305) = 7.41, $p < .001$. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, $B = 0.07$, $SE = .02$, $t(305) = 2.98$, $p = .003$. The cross-lagged path from earlier sleep quality to later self-esteem (β) was not significant, $B = -0.02$, $SE = .02$, $t(305) = -0.95$, $p = .340$. The cross-lagged path from earlier self-esteem to later sleep quality (γ) was not significant, $B = 0.04$, $SE = .03$, $t(305) = 1.26$, $p = .207$.

Self-compassion. The model fit the data well, X^2 (305) = 422.02, $p < .001$ (CFI = .94, RMSEA = .04, 90%CI [.033, .054], SRMR = .077). The between-subjects covariation between sleep

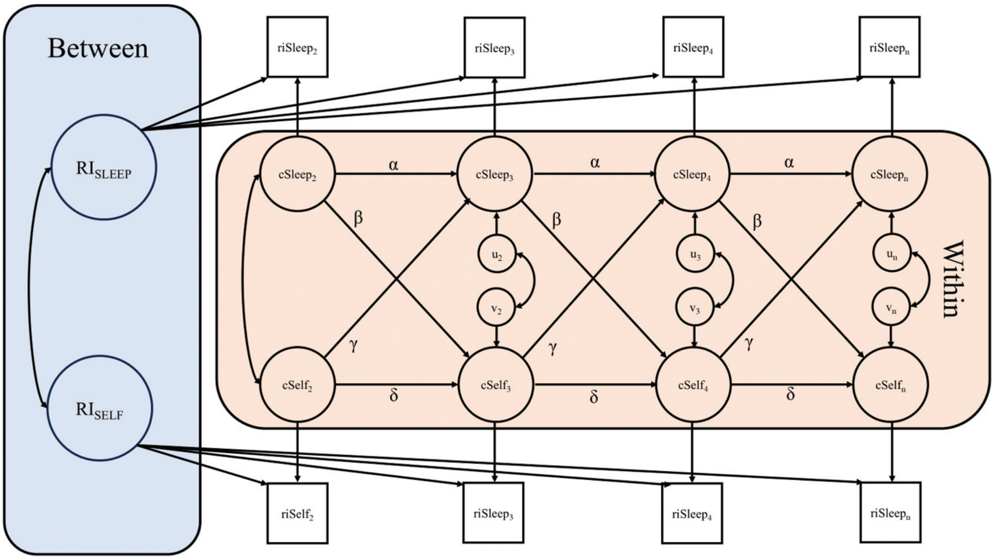

Figure 2. Conceptual diagram of random intercept cross-lagged panel model 1 (self→ sleep short lag; sleep → self long lag). Note. RI = Random Intercept; cSleep = Within-person variance in sleep; cSelf = Within-person variance in self; u = error variance in sleep' v = error-variance in self; α = autoregressive paths from earlier to later sleep; δ = autoregressive paths form earlier to later self; β = cross-lagged paths form earlier sleep to later sleep; γ = cross-lagged paths form earlier self to later sleep. Figure is adapted from Hamaker (2018).

quality and the self-compassion was significant, $B = 0.40$, $SE = .07$, $t(305) = 6.02$, $p < .001$. The Autoregressive path from earlier self-compassion to later self-compassion (δ) was significant, $B = 0.14$, $SE = .02$, $t(305) = 5.68$, $p < .001$. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, $B = 0.07$, $SE = .02$, $t(305) = 2.92$, $p = .003$. Also,

Table 1. Random-intercept cross lagged panel models testing the bidirectional relations between subjective sleep quality and self-aspects (Study 2).

Model 1 (Self-Aspect → Sleep Short Lag; Sleep → Self-Aspect Long Lag)								Auto-regressive Paths		Cross-lagged Paths	
Self-aspect	X^2	*df*	CFI	RMSEA	90% CI	SRMR	BS COV	δ	α	β	γ
Self-esteem	395.61***	305	0.97	0.04	[.027, .049]	0.066	0.69***	0.18***	0.07**	0.02	0.04
Self-compassion	422.02***	305	0.94	0.04	[.033, .054]	0.077	0.40***	0.14***	0.07**	−0.01	0.05
Self-control	416.10***	305	0.95	0.04	[.032, .053]	0.084	0.53***	0.15***	0.08**	−0.03	0.00
Self-continuity	438.16***	305	0.95	0.05	[.037, .056]	0.064	0.62***	0.21***	0.08**	0.01	0.04
Model 2 (Self-Aspect → Sleep Long Lag; Sleep → Self-Aspect Short Lag)								Auto-regressive Paths		Cross-lagged Paths	
Self-aspect	X^2	*df*	CFI	RMSEA	90% CI	SRMR	BS COV	δ	α	β	γ
Self-esteem	327.80***	257	0.97	0.04	[.024, .049]	0.061	0.65***	0.16***	0.07**	.21***	0.01
Self-compassion	329.00***	257	0.96	0.04	[.024, .049]	0.072	0.37***	0.10***	0.07**	0.18***	0.08*
Self-control	344.51***	257	0.95	0.04	[.029, .052]	0.080	0.51***	0.11***	0.07**	.31***	0.01
Self-continuity	327.91***	257	0.97	0.04	[.024, .049]	0.059	0.60***	0.18***	0.07**	0.15***	0.02

Note. CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual, BS COV = Between-subjects covariation.

the cross-lagged path from earlier sleep quality to later self-compassion (β) was not significant, $B = -0.01$, $SE = .01$, $t(305) = -0.97$, $p = .330$. Finally, the cross-lagged path from earlier self-compassion to later sleep quality (γ) was not significant, $B = 0.05$, $SE = .04$, $t(305)$ 1.16, $p = .246$.

Self-control. The model fit the data well, X^2 (305) = 416.10, $p < .001$ (CFI = .95, RMSEA = .04, 90%CI [.032, .053], SRMR = .084). The between-subjects covariation between sleep quality and self-control was significant, $B = 0.53$, $SE = .08$, $t(305) = 6.84$, $p < .001$. The Autoregressive path from earlier self-control to later self-control (δ) was significant, $B = 0.15$, $SE = .03$, $t(305) = 5.86$, $p < .001$. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, $B = 0.08$, $SE = .03$, $t(305) = 3.22$, $p = .001$. In addition, the cross-lagged path from earlier sleep quality to later self-control (β) was not significant, $B = -0.03$, $SE = .01$, $t(305) = -1.53$, $p = .127$. Lastly, the cross-lagged path from earlier self-control to later sleep quality (γ) was not significant, $B = 0.004$, SE = .04, $t(305) = 0.10$, $p = .917$.

Self-continuity. The model fit the data well, X^2 (305) = 438.16, $p < .001$ (CFI = .95, RMSEA = .05, 90%CI [.037, .056], SRMR = .064). The between-subjects covariation between sleep quality and self-continuity was significant, $B = 0.62$, $SE = .11$, $t(305) = 5.64$, $p < .001$. The Autoregressive path from earlier self-continuity to later self-continuity (δ) was significant, $B = 0.21$, $SE = .02$, $t(305) = 8.56$, $p < .001$. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, $B = 0.08$, $SE = .02$, t (305) = 3.11, $p = .002$. Moreover, the cross-lagged path from earlier sleep quality to later self-continuity (β) was not significant, $B = 0.01$, $SE = .02$, $t(305) = 0.42$, $p = .675$. Finally, the cross-lagged path from earlier self-continuity to later sleep quality (γ) was not significant, $B = 0.04$, $SE = .03$, $t(305) = 1.40$, $p = .162$.

Model 2 (self-aspect→ sleep long lag; sleep → self-aspect short lag)

The second set of RI-CLPMs uncoupled daily self-aspect and sleep quality assessments and then recoupled self-aspects with next day sleep quality. This approach reduced the sleep → self-aspect lags from 36 to 12 hours (short lag) and increased the self-aspect → sleep lag from 12 to 36 hours (long lag). See Figure 3 for a conceptual diagram and Table 1 for a summary of findings.

Self-esteem. The model fit the data well, X^2 (257) = 327.80, $p < .001$ (CFI = .97, RMSEA = .04, 90%CI [.024, .049], SRMR = .062). The between-subjects covariation between sleep quality and self-esteem was significant, $B = 0.65$, $SE = .12$, $t(257) = 5.30$, $p < .001$. The autoregressive path from earlier self-esteem to later self-esteem (δ) was significant, $B = 0.16$, $SE = .02$, $t(257) = 6.54$, $p < .001$. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, $B = 0.07$, $SE = .02$, $t(257) = 2.94$, $p = .003$. The cross-lagged path from earlier sleep quality to later self-esteem (β) was significant, $B = 0.21$, $SE = .02$, $t(257) = 12.00$ $p < .001$. Lastly, the cross-lagged path from earlier self-esteem to later sleep quality (γ) was not significant, $B = 0.01$, $SE = .03$, $t(257) = 0.28$, $p = .777$.

Self-compassion. The model fit the data well, X^2 (257) = 329.00, $p < .001$ (CFI = .96, RMSEA = .04, 90%CI [.024, .049], SRMR = .072). The between-subjects covariation

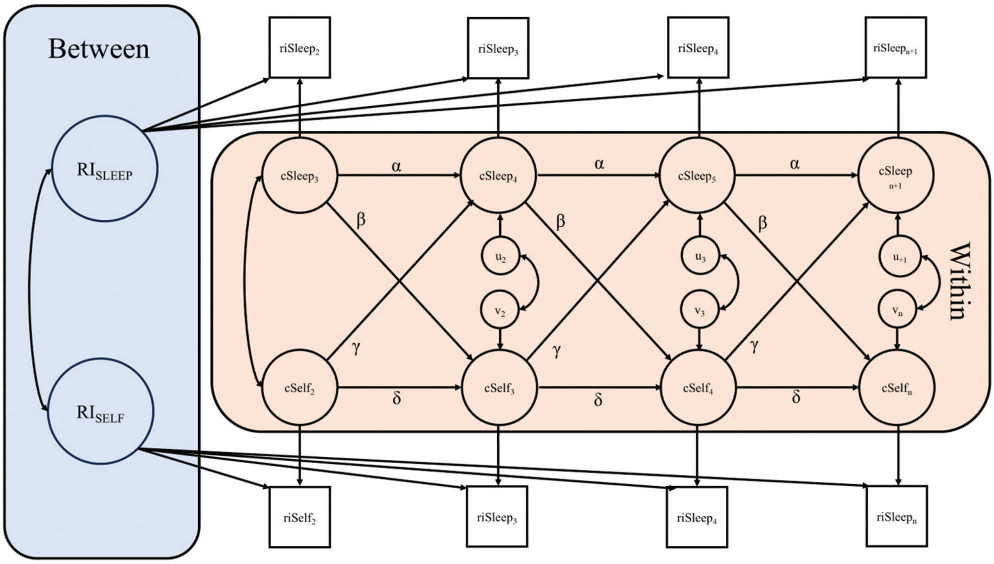

Figure 3. Conceptual diagram of random intercept cross-lagged panel model 2 (self→ sleep long lag; sleep → self short lag). Note. RI = Random Intercept; cSleep = Within-person variance in sleep; cSelf = Within-person variance in self; u = error variance in sleep' v = error-variance in self; α = autoregressive paths from earlier to later sleep; δ = autoregressive paths form earlier to later self; β = cross-lagged paths form earlier sleep to later sleep; γ = cross-lagged paths form earlier self to later sleep. Figure is adapted from Hamaker (2018).

between sleep quality and the self-compassion was significant, $B = 0.37$, $SE = .07$, $t(257) = 5.61$, $p < .001$. The autoregressive path from earlier self-compassion to later self-compassion (δ) was significant, $B = 0.10$, $SE = .02$, $t(257) = 4.18$, $p < .001$. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, $B = 0.07$, $SE = .02$, $t(257) = 3.04$, $p = .002$. Additionally, the cross-lagged path from earlier sleep quality to later self-compassion (β) was significant, $B = 0.18$, $SE = .01$, $t(257) = 13.62$, $p < .001$. And the cross-lagged path from earlier self-compassion to later sleep quality (γ) was significant, $B = 0.08$, $SE = .04$, $t(257) = 2.02$, $p = .044$.

Self-control. The model fit the data well, X^2 $(257) = 344.51$, $p < .001$ (CFI = .95, RMSEA = .04, 90%CI [.029, .052], SRMR = .080). The between-subjects covariation between sleep quality and self-control was significant, $B = 0.51$, $SE = .08$, $t(257) = 6.64$, $p < .001$. The autoregressive path from earlier self-control to later self-control (δ) was significant, $B = 0.11$, $SE = .02$, $t(257) = 4.66$, $p < .001$. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, $B = 0.07$, $SE = .02$, $t(257) = 2.82$, $p = .005$. The cross-lagged path from earlier sleep quality to later self-control (β) was significant, $B = 0.31$, $SE = .01$, $t(257) = 20.90$, $p < .001$. Furthermore, the cross-lagged path from earlier self-control to later sleep quality (γ) was not significant, $B = 0.01$, $SE = .03$, $t(257) = 0.42$, $p = .677$.

Self-continuity

The model fit the data well, X^2 (257) = 327.91, $p < .001$ (CFI = .97, RMSEA = .04, 90%CI [.024, .049], SRMR = .059). The between-subjects covariation between sleep quality and self-continuity was significant, $B = 0.60$, $SE = .11$, $t(257) = 5.44$, $p < .001$. The autoregressive path from earlier self-continuity to later self-continuity (δ) was significant, $B = 0.18$, $SE = .02$, $t(257) = 7.28$, $p < .001$. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, $B = 0.07$, $SE = .02$, $t(257) = 2.81$, $p = .005$. The cross-lagged path from earlier sleep quality to later self-continuity (β) was significant, $B = 0.15$, $SE = .01$, $t(257) = 9.25$, $p < .001$. Lastly, the cross-lagged path from earlier self-continuity to later sleep quality (γ) was not significant, $B = 0.02$, $SE = .03$, $t(257) = 0.67$, $p = .505$.

Discussion

We replicated trait level associations between sleep quality and self-aspects. These effects were also present at the state level in terms of between-subjects covariation in the RI-CLPMs. At the within-person level, sleep quality predicted increased self-esteem, self-compassion, self-control, and self-continuity 12 (but not 36) hours later. The self-aspects generally did not predict increased sleep quality 12 or 36 hours later. The lone exception was self-compassion, which predicted increased sleep quality 36 hours later. In all, Study 2 provided directionality and temporal boundaries to the associations between sleep quality and self-aspects. However, we relied exclusively on self-report. We addressed this limitation next.

Study 3

Across two studies we observed robust between-subjects variation in the associations between sleep quality and the self-aspects. In Study 2, higher subjective sleep quality predicted state increases in the self-aspects 12 (but not 36) hours later. In Study 3, we sought to replicate and extend Study 2 by examining behavioral sleep quality via actigraphy. This study was approved by the University of Southampton Faculty Ethics Committee (Approval Number: 70716).

Method

Participants and sample size determination

There is considerable heterogeneity in longitudinal watch-based actigraphy studies of healthy young adults i.e., university students). Across 19 studies, sample sizes ranged from 8 to 145 (BaHammam et al. (2014); Barclay et al. (2020); Bartsch et al. (2021); Cellini et al. (2016); Das-Friebel et al., 2020; Hoopes et al. (2023); Irish et al. (2021); Khalsa et al. (2016); McGowan and Coogan (2018); Mongrain et al. (2005); Mullin et al. (2013); Rupp and Balkin (2011); Takeshima et al. (2014); Thurman et al. (2018); Tonetti et al. (2013); Valomon et al. (2014); Van Der Meijden et al. (2016); Winzeler et al. (2014); Wong et al. (2017). We used the median number of participants from this set of studies ($N = 51$) as our recruitment goal. In anticipation of attrition, we recruited 63 University of Southampton undergraduates. We reduced the number of days from 14 (Study 2) to 7, because only 5–6 nights of actigraphy are needed to obtain reliable readings (Aili et al., 2017). We excluded data if participants terminated their involvement with the study early ($n = 1$), removed the actigraphy watch ($n = 4$), had excessive missing data ($n = 5$), or if the actigraphy watch ran out of battery ($n = 10$). This left 40 participants for the analyses reported below. Participants in the final sample were 18–34 years old ($M = 19.45$, $SD = 2.99$), and predominantly women ($n = 34$, 85.00%) and White ($n = 31$, 77.50%).

Procedure

On Day 1 participants visited the laboratory, where we then fastened an actigraph watch to their wrist and instructed them not to remove it until the end of the study. Beginning the evening of Day 1, participants completed the same online survey every day for 7 days (as in Study 2). We instructed them to complete each survey between their final meal of the day and before they went to bed (in accordance with PSQD Bedtime; Buysse et al., 1989). After seven days (168 hours), participants returned the Micro Mini-Motionlogger actigraph to the laboratory.

Actigraphy

We measured behavioral state sleep quality over the duration of the full 7-day study using ambulatory wrist actigraphy. Participants wore a small watch-like actigraph (Micro Mini-Motionlogger, Ambulatory Monitoring Inc., Ardsley, NY) that requires no user interface. The Micro Mini-Motionlogger provides a behavioral measure of sleep quality via a series of movement-based components. Specifically, the Micro Mini-Motionlogger produces a voltage each time the actigraph is moved by the participants, with the voltage being generated by a precision piezoelectric bimorph-ceramic cantilevered beam. The voltage is then transferred to the analogue circuitry, where the original signal is amplified and filtered according to the 2–3 Hz bandpass filter. The Micro Mini-Motionlogger is a widely used, noninvasive actigraph that provides a reliable and valid behavioral measure of sleep. It captures circadian and sleep parameters on par with other commercially available and professional devices (Bellone et al., 2016). We focused on sleep efficiency, given that it is commonly used (Åkerstedt et al., 1994; Krystal & Edinger, 2008) and recommended by the National Sleep Foundation as a reliable indicator of sleep quality (Ohayon et al., 2017). Sleep efficiency is defined by the amount of time spent asleep relative to the amount of time in bed; it therefore accounts for duration of effort trying to sleep and sleep disturbances during the night.

Actigraphy pre-processing

We processed actigraphy data using the zero-crossing method. This method estimates sleep activity with the highest accuracy compared to others (e.g., Proportional Integrating Measure). The method is a measure of movement frequency, whereby activity signals are compared with a fixed sensitivity threshold. A reference voltage is initially set at zero (no movement activity), and, when any activity breaches this references voltage, a zero marker is set. A second zero marker is set when the activity then drops to or below the reference voltage. For every epoch, the frequency of zero crossings is recorded and stored in the device memory. Upon their retrieval, the data are presented as a histogram, with movement activity depicted on the y-axis. Sleep is interpreted as a movement that does not cross the signal threshold. Movement can still occur in lighter sleep. As such, the full duration of a sleep epoch does not end with shorter movement activity within a larger duration of sleep activity. However, this differentiation between lighter and deeper sleep allows for more accurate analysis of sleep components. We followed the guidelines set by the manufacturer and prior research (Jean-Louis et al., 2001).

We scored sleep efficiency as a percentage, calculated by dividing sleep duration by the full sleep epoch duration and multiplying by 100. We defined sleep duration as the total number of minutes scored as sleep. The full sleep epoch included light movement activity before, during, and after periods of consolidated sleep. We cross-referenced all sleep epochs with participants' self-reported sleep measures to verify their accuracy. Participants also completed the PSD, reporting the time they went to bed, the time they believed they fell asleep, and the time they woke up. When self-reported times did not align with actigraphy-derived estimates, we manually adjusted sleep epochs to match participants' reports. Discrepancies primarily arose from participant interference (e.g., removing the device for prolonged periods during activities such as showering or exercise) or from technical malfunctions, including battery depletion or a broken strap. We instructed participants to log any such events and report the time of device removal, allowing us to cross-reference these records with anomalous actigraphy data.

Results

Subjective sleep quality RI-CLPMs

Model 1 (self-aspect→ sleep short lag; sleep → self-aspect long lag). As in Study 2, we started by conducting a series of RI-CLPMs with a short (12-hour) lag for self-aspect → sleep cross-lagged paths and a long (36-hour) lag for sleep → self-aspect cross-lagged paths. See Figure 2 for a conceptual diagram and a summary of findings in Table 2.

Self-esteem. The model fit the data well, with the exception of SRMR, X^2 (77) = 96.68, p = .064 (CFI = .91, RMSEA = .08, 90%CI [.000, .126], SRMR = .122). The between-subjects covariation between sleep quality and self-esteem was not significant, B = 0.24, SE = .19,

Table 2. Random-intercept cross lagged panel models testing the bidirectional relations between subjective sleep quality and self-aspects (Study 3).

Model 1 (Self-Aspect → Sleep Short Lag; Sleep → Self-Aspect Long Lag)								Auto-regressive Paths		Cross-lagged Paths	
Self-aspect	X^2	*df*	CFI	RMSEA	90% CI	SRMR	BS COV	δ	α	β	γ
Self-esteem	96.98*	77	0.91	0.08	[.000, .126]	0.122	0.24	0.18*	0.09	0.03	0.12
Self-compassion	100.36*	77	0.82	0.08	[.022, .132]	0.127	0.28*	0.06	0.14	0.05	−0.12
Self-control	98.61*	77	0.85	0.08	[.005, .129]	0.139	0.26*	0.14	0.04	0.01	0.20
Self-continuity	122.02***	77	0.77	0.12	[.078, .160]	0.165	0.35*	0.17*	0.15	.10†	−0.04
Model 2 (Self-Aspect → Sleep Long Lag; Sleep → Self-Aspect Short Lag)								Auto-regressive Paths		Cross-lagged Paths	
Self-aspect	X^2	*df*	CFI	RMSEA	90% CI	SRMR	BS COV	δ	α	β	γ
Self-esteem	41.81	53	0.99	0.00	[.000, .055]	0.102	0.40	0.09	0.12	.10†	−0.33*
Self-compassion	56.92	53	0.97	0.04	[.000, .111]	0.119	0.32*	0.15	0.10	0.06	−0.20
Self-control	68.57†	53	0.87	0.09	[.005, .139]	0.135	0.28*	0.04	0.14	.32***	−0.18
Self-continuity	64.87	53	0.91	0.07	[.000, .131]	0.151	0.42*	0.31*	0.15	.15*	−0.07

CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual, BS COV = Between-subjects covariation.

$t(77) = 1.25$, $p = .211$. The autoregressive path from earlier self-esteem to later self-esteem (δ) was significant, $B = 0.18$, $SE = .08$, $t(77) = 2.10$, $p = .036$. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, $B = 0.09$, $SE = .09$, $t(77) = 0.95$, $p = .340$. Also, the cross-lagged path from earlier sleep quality to later self-esteem (β) was not significant, $B = 0.03$, $SE = .05$, $t(77) = 0.63$, $p = .531$. The cross-lagged path from earlier self-esteem to later sleep quality (γ) was not significant either, $B = 0.12$, $SE = .11$, $t(77) = 1.06$, $p = .287$.

Self-compassion. The model fit the data poorly, X^2 (77) = 100.36, $p = .038$ (CFI = .82, RMSEA = .08, 90%CI [.022, .132], SRMR = .127). The between-subjects covariation between sleep quality and self-compassion was significant, $B = 0.28$, $SE = .11$, $t(77) = 2.50$, $p = .013$. The autoregressive path from earlier self-compassion to later self-compassion (δ) was not significant, $B = 0.06$, $SE = .09$, $t(77) = 0.66$, $p = .511$. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (α) was not significant, $B = 0.14$, $SE = .10$, $t(77) = 1.40$, $p = .162$. Additionally, the cross-lagged path from earlier sleep quality to later self-compassion (β) was not significant, $B = 0.05$, $SE = .04$, $t(77) = 1.06$, $p = .288$. The cross-lagged path from earlier self-compassion to later sleep quality (γ) was not significant, $B = -0.12$, $SE = .17$, $t(77) = -0.71$, $p = .478$.

Self-control. The model did not fit the data well, X^2 (77) = 98.61, $p = .049$ (CFI = .85, RMSEA = .08, 90%CI [.005, .129], SRMR = .139). The between-subjects covariation between sleep quality and self-control was significant, $B = 0.26$, $SE = .13$, $t(77) = 1.97$, $p = .049$. The autoregressive path from earlier self-control to later self-control (δ) was not significant, $B = 0.14$, $SE = .09$, $t(77) = 1.63$, $p = .103$. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, $B = 0.04$, $SE = .11$, $t(77) = 0.42$, $p = .676$. The cross-lagged path from earlier sleep quality to later self-control (β) was not significant, $B = 0.01$, $SE = .06$, $t(77) = 0.24$, $p = .812$. Finally, the cross-lagged path from earlier self-control to later sleep quality (γ) was not significant, $B = 0.20$, $SE = .13$, $t(77) = 1.55$, $p = .122$.

Self-continuity. The model fit the data poorly, X^2 (77) = 122.02, $p < .001$ (CFI = .77, RMSEA = .12, 90%CI [.078, .160], SRMR = .165). The between-subjects covariation between sleep quality and self-continuity was significant, $B = 0.35$, $SE = .17$, $t(77) = 2.04$, $p = .041$. The autoregressive path from earlier self-continuity to later self-continuity (δ) was significant, $B = 0.17$, $SE = .09$, $t(77) = 1.99$, $p = .047$. The autoregressive path from earlier subjective sleep quality to later sleep quality (α) was not significant, $B = 0.15$, $SE = .10$, $t(77) = 1.52$, $p = .131$. The cross-lagged path from earlier sleep quality to later self-continuity (β) was trending, $B = 0.10$, $SE = .06$, $t(77) = 1.72$, $p = .085$. Lastly, the cross-lagged path from earlier self-continuity to later sleep quality (γ) was not significant, $B = -0.04$, $SE = .12$, $t(77) = -0.34$, $p = .728$.

Model 2 (self-aspect→ sleep long lag; sleep → self-aspect short lag). Also as in Study 2, we carried out a series of RI-CLPMs with a long (36-hour) lag for self-aspect → sleep cross-lagged paths and a short (12-hour) lag for sleep → self-aspect cross-lagged paths. We present a conceptual diagram in Figure 3 and a summary of findings in Table 2.

Self-esteem. The model fit the data well, with the exception of SRMR, X^2 (53) = 41.81, p = .866 (CFI = .99, RMSEA = .00, 90%CI [.000, .055], SRMR = .102). The between-subjects covariation between sleep quality and self-esteem was significant, B = 0.40, SE = .20, t (53) = 1.95, p = .052. The autoregressive path from earlier self-esteem to later self-esteem (δ) was not significant, B = 0.09, SE = .09, t(53) = 1.01, p = .312. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, B = 0.12, SE = .10, t (53) = 1.14, p = .253. The cross-lagged path from earlier sleep quality to later self-esteem (β) was trending, B = 0.10, SE = .06, t(53) = 1.84 p = .066. Finally, the cross-lagged path from earlier self-esteem to later sleep quality (γ) was significant, B = –0.33, SE = .14, t(53) = 2.40, p = .016.

Self-compassion. The model fit the data well, with the exception of SRMR, X^2 (53) = 56.92, p = .332 (CFI = .97, RMSEA = .04, 90%CI [.000, .111], SRMR = .119). The between-subjects covariation between sleep quality and the self-compassion was significant, B = 0.32, SE = .13, t(53) = 2.56, p = .011. The autoregressive path from earlier self-compassion to later self-compassion (δ) was not significant, B = 0.15, SE = .09, t(53) = 1.57, p = .116. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, B = 0.10, SE = .10, t(53) = 0.99, p = .320. The cross-lagged path from earlier sleep quality to later self-compassion (β) was not significant, B = 0.06, SE = .04, t(53) = 1.40, p = .161. Further, the cross-lagged path from earlier self-compassion to later sleep quality (γ) was not significant, B = –0.20, SE = .18, t(53) = – 1.10, p = .273.

Self-control. The model did not fit the data well X^2 (53) = 68.57, p = .074 (CFI = .87, RMSEA = .09, 90%CI [.000, .139], SRMR = .135). The between-subjects covariation between sleep quality and self-control was significant, B = 0.28, SE = .14, t(53) = 2.06, p = .040. The autoregressive path from earlier self-control to later self-control (δ) was not significant, B = 0.04, SE = .08, t(53) = 0.55, p = .573. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, B = 0.14, SE = .11, t(53) = 1.25, p = .211. The cross-lagged path from earlier sleep quality to later self-control (β) was significant, B = 0.32, SE = .05, t(53) = 6.09 p < .001. Lastly, the cross-lagged path from earlier self-control to later sleep quality (γ) was not significant, B = –0.18, SE = .14, t(53) = –1.28, p = .200.

Self-continuity. The model fit the data well, with the exception of SRMR, X^2 (53) = 64.87, p = .127 (CFI = .91, RMSEA = .07, 90%CI [.000, .131], SRMR = .151). The between-subjects covariation between sleep quality and self-continuity was significant, B = 0.42, SE = .19, t (53) = 2.27, p = .023. The autoregressive path from earlier self-continuity to later self-continuity (δ) was significant, B = 0.31, SE = .11, t(53) = 2.96, p = .003. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, B = 0.15, SE = .11, t(53) = 1.33, p = .184. The cross-lagged path from earlier sleep quality to later self-continuity (β) was significant, B = 0.15, SE = .06, t(53) = 2.37, p = .018. The cross-lagged path from earlier self-continuity to later sleep quality (γ) was not significant, B = –0.07, SE = .13, t(53) = –0.57, p = .572.

Behavioral sleep quality RI-CLPMs

Model 1 (self-aspect→ sleep short lag; sleep → self-aspect long lag).. We next conducted a series of RI-CLPMs with a short (12-hour) lag for self-aspect → behavioral

Table 3. Random-intercept cross lagged panel models testing the bidirectional relations between behavioral sleep quality and self-aspects (Study 3).

Model 1 (Self-Aspect → Sleep Short Lag; Sleep → Self-Aspect Long Lag)								Auto-regressive Paths		Cross-lagged Paths	
Self-aspect	X^2	*df*	CFI	RMSEA	90% CI	SRMR	BS COV	δ	α	β	γ
Self-esteem	52.44	53	0.99	0.00	[.000, .098]	0.118	0.06	.21†	0.08	−0.13	0.09
Self-compassion	57.82	53	0.96	0.05	[.000, .114]	0.141	.15†	0.11	0.20	0.08	.21*
Self-control	55.79	53	0.96	0.04	[.000, .108]	0.131	−0.06	0.17*	0.07	−0.07	−0.01
Self-continuity	59.56	53	0.96	0.06	[.000, .118]	0.121	0.09	0.33*	0.11	−0.07	.16*
Model 2 (Self-Aspect → Sleep Long Lag; Sleep → Self-Aspect Short Lag)								Auto-regressive Paths		Cross-lagged Paths	
Self-aspect	X^2	*df*	CFI	RMSEA	90% CI	SRMR	BS COV	δ	α	β	γ
Self-esteem	77.85	77	0.99	0.02	[.000, .092]	0.122	−0.06	0.19*	0.16	−0.12	0.06
Self-compassion	94.71†	77	0.89	0.08	[.000, .123]	0.158	−0.04	0.10	0.17*	−0.05	0.08
Self-control	84.83	77	0.93	0.05	[.000, .106]	0.139	−0.06	0.13	0.16*	−0.08	−0.06
Self-continuity	90.38	77	0.93	0.07	[.000, .116]	0.122	0.07	0.22*	0.12	−0.03	0.08

CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual, BS COV = Between-subjects covariation.

sleep cross-lagged paths and a long (36-hour) lag for behavioral sleep → self-aspect cross-lagged paths. We depict a conceptual diagram in Figure 2 and a summary of findings in Table 3.

Self-esteem. The model fit the data well with the exception of SRMR, X^2 (53) = 52.44, p = .496 (CFI = .99, RMSEA = .00, 90%CI [.000, .098], SRMR = .118). The between-subjects covariation between sleep quality and self-esteem was not significant, B = 0.06, SE = .13, t(53) = 0.48, p = .632. The autoregressive path from earlier self-esteem to later self-esteem (δ) scores was significant, B = 0.21, SE = .11, t(53) = 1.94, p = .052. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, B = 0.08, SE = .09, t(53) = 0.91, p = .364. The cross-lagged path from earlier sleep quality to later self-esteem (β) was not significant, B = −0.13, SE = .12, t(53) = −1.12, p = .261. The cross-lagged path from earlier self-esteem to later sleep quality (γ) was not significant either, B = 0.09, SE = .07, t(53) = 1.23, p = .217.

Self-compassion. The model did fit the data well with the exception of SRMR, X^2 (53) = 57.82, p = .302 (CFI = .96, RMSEA = .05, 90%CI [.000, .114], SRMR = .141). The between-subjects covariation between sleep quality and self-compassion was trending, B = −0.15, SE = .09, t(53) = −1.65, p = .098. The autoregressive path from earlier self-compassion to later self-compassion (δ) was significant, B = 0.11, SE = .11, t(53) = 1.01, p = .311. The auto-regressive path from earlier sleep quality to later sleep quality (α) was not significant, B = 0.20, SE = .15, t(53) = 1.34, p = .181. The cross-lagged path from earlier sleep quality to later self-compassion (β) was not significant, B = 0.08, SE = .11, t(53) = 0.74, p = .553. Finally, the cross-lagged path from earlier self-compassion to later sleep quality (γ) was significant, B = 0.21, SE = .09, t(53) = 2.39, p = .017.

Self-control. The model fit the data well with the exception of SRMR, X^2 (53) = 55.79, p = .371 (CFI = .96, RMSEA = .04, 90%CI [.000, .108], SRMR = .131). The between-subjects covariation between sleep quality and self-control was not significant, B = –0.06, SE = .08, t(53) = –0.76, p = .445. The autoregressive path from earlier self-control to later self-control (δ) scores was significant, B = 0.17, SE = .09, t(53) = 1.95, p = .051. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, B = 0.07, SE = .10, t(53) = 0.73, p = .466. Moreover, the cross-lagged path from earlier sleep quality to later self-control (β) was not significant, B = –0.07, SE = .10, t(53) = –0.68, p = .497. The cross-lagged path from earlier self-control to later sleep quality (γ) was not significant, B = –0.01, SE = .07, t(53) = –0.11, p = .912.

Self-continuity. The model fit the data well with the exception of SRMR, X^2 (53) = 59.56, p = .249 (CFI = .96, RMSEA = .06, 90%CI [.000, .118], SRMR = .121). The between-subjects covariation between sleep quality and self-continuity was not significant, B = 0.09, SE = .13, t(53) = 0.70, p = .483. The autoregressive path from earlier self-continuity to later self-continuity (δ) was significant, B = 0.33, SE = .16, t(53) = 2.06, p = .039. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, B = 0.11, SE = .09, t(53) = 1.18, p = .238. The cross-lagged path from earlier sleep quality to later self-continuity (β) was not significant, B = –0.07, SE = .14, t(53) = –0.53, p = .597. However, the cross-lagged path from earlier self-continuity to later sleep quality (γ) was significant, B = 0.16, SE = .07, t(53) = 2.33, p = .020.

Model 2 (self-aspect→ sleep long lag; sleep → self-aspect short lag). We next conducted a series of RI-CLPMs with a long (36-hour) lag for self-aspect → sleep efficiency cross-lagged paths and a short (12-hour) lag for sleep efficiency → self-aspect cross-lagged paths. (see Figure 3 for a conceptual diagram and Table 3 for a summary of findings).

Self-esteem. The model fit the data well with the exception of SRMR, X^2 (77) = 77.85, p = .451 (CFI = .99, RMSEA = .02, 90%CI [.000, .092], SRMR = .122). The between-subjects covariation between sleep quality and self-esteem was not significant, B = –0.06, SE = .13, t(77) = 0.44, p = .663. The autoregressive path from earlier self-esteem to later self-esteem (δ) scores was significant, B = 0.19, SE = .09, t(77) = 2.26, p = .024. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, B = 0.16, SE = .08, t(77) = 1.93, p = .053. The cross-lagged path from earlier sleep quality to later self-esteem (β) was not significant, B = –0.12, SE = .10, t(77) = –1.25, p = .212, and neither was the cross-lagged path from earlier self-esteem to later sleep quality (γ), B = 0.06, SE = .08, t(77) = 1.10, p = .273.

Self-Compassion. The model did not fit the data well, X^2 (77) = 94.71, p = .083 (CFI = .89, RMSEA = .08, 90%CI [.000, .123], SRMR = .158). The between-subjects covariation between sleep quality and self-compassion was not significant, B = –0.04, SE = .08, t(77) = –0.57, p = .570. The autoregressive path from earlier self-compassion to later self-compassion (δ) was not significant, B = 0.10, SE = .09, t(77) = 1.08, p = .281. The autoregressive path from earlier sleep efficiency to later sleep quality (α) was significant, B = 0.17, SE = .08, t(77) = 1.99, p = .046. Finally, the cross-lagged path from earlier sleep quality to later self-compassion (β) was not significant, $B = -0.05$, $SE = .08$, $t(77) = -0.60$, $p = .553$, and neither was the cross-lagged path from earlier self-compassion to later sleep quality (γ), $B = -0.08$, $SE = .09$, $t(77) = -0.90$, $p = .369$.

Self-Control. The model fit the data well with the exception of SRMR, X^2 (77) = 84.83, $p = .253$ (CFI = .93, RMSEA = .05, 90%CI [.000, .106], SRMR = .139). The between-subjects covariation between sleep quality and self-control was not significant, $B = -0.06$, $SE = .08$, $t(77) = -0.76$, $p = .445$. The autoregressive path from earlier self-control to later self-control (δ) scores was not significant, $B = 0.13$, $SE = .08$, $t(77) = 1.54$, $p = .124$. The autoregressive path from earlier sleep quality to later sleep quality (α) was significant, $B = 0.16$, $SE = .08$, $t(77) = 1.97$, $p = .049$. Lastly, the cross-lagged path from earlier sleep quality to later self-control (β) was not significant, $B = -0.08$, $SE = .09$, $t(77) = -0.88$, $p = .380$, and neither was the cross-lagged path from earlier self-control to later sleep quality (γ), $B = -0.06$, $SE = .06$, $t(77) = -1.01$, $p = .313$.

Self-Continuity. The model fit the data well with the exception of SRMR, X^2 (77) = 90.38, $p = .141$ (CFI = .93, RMSEA = .07, 90%CI [.000, .116], SRMR = .122). The between-subjects covariation between sleep quality and self-continuity was not significant, $B = 0.07$, $SE = .12$, t(77) = 0.61, $p = .541$. The autoregressive path from earlier self-continuity to later self-continuity (δ) was significant, $B = 0.22$, $SE = .09$, $t(77) = 2.43$, $p = .015$. The autoregressive path from earlier sleep quality to later sleep quality (α) was not significant, $B = 0.12$, $SE = .08$, $t(77) = 1.56$, $p = .118$. Moreover, the cross-lagged path from earlier sleep quality to later self-continuity (β) was not significant, $B = -0.03$, $SE = .10$, $t(77) = -0.36$, $p = .720$, and neither was the cross-lagged path from earlier self-continuity to later sleep quality (γ), $B = 0.08$, $SE = .05$, $t(77) = 1.47$, $p = .143$.

Correlations between subjective and behavioral sleep measures

Same day associations between subjective and behavioral reports ranged from −.07 to .44. Associations between earlier subjective reports and the next day's behavioral reports ranged from −.19 to .36. Associations between earlier behavioral reports and the next day's subjective reports ranged from −.01 to .25. Only two of the 16 associations were significant (Figure 4).

Discussion

We replicated state-like variation between subjective sleep quality and the self -aspects via in the context of the RI-CLPMs. As in Study 2, subjective sleep quality predicted self-esteem, self-control, and self-continuity 12 hours later (short lag). Unlike Study 2, subjective sleep quality did not predict self-compassion, likely due to the lower sample size of Study 3. Also, unlike subjective sleep quality, between-subjects covariation between behavioral sleep quality and self-aspects was not significant. Further, behavioral sleep quality did not predict the self-aspects either 12-hours (short lag) or 36-hours (long lag) later. Finally, self-compassion and self-continuity predicted behavioral sleep quality 12 hours later (short lag).

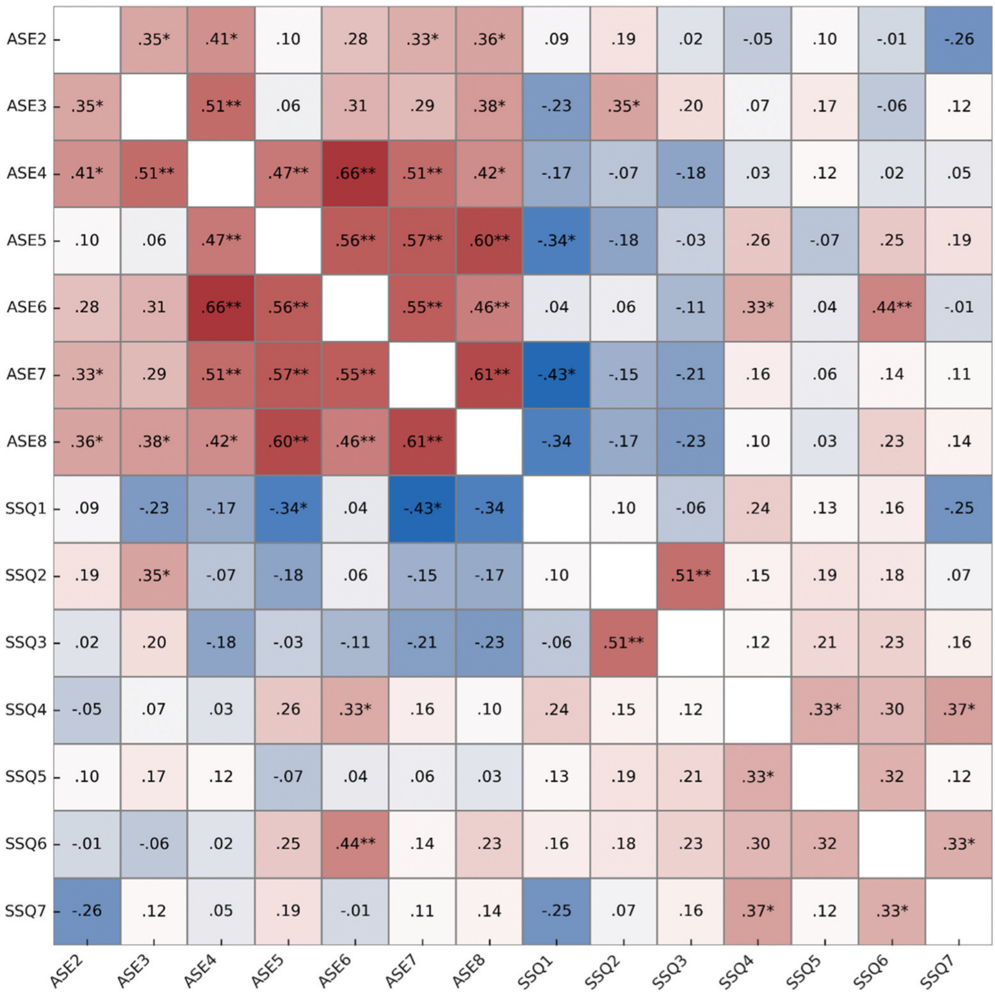

Figure 4. Bivariate correlations between subjective and behavioral sleep quality. *Note*. ASE = Actigraphy Sleep Efficiency; SSQ = Subjective Sleep Quality. ASE data begin on Day 2 and end on Day 8, while SSQ data begin on Day 1 and end on Day 7. On Day 1, participants had not yet worn the actigraphy watch, allowing them to self-report the prior night's sleep (SSQ) but not provide actigraphy data (ASE). On Day 8, participants returned their actigraphy watches before completing self-report measures, resulting in missing SSQ data for that day.

General discussion

Summary of findings

We adopted a comprehensive approach to examining the associations between sleep quality and the self. Subjective (but not behavioral) sleep quality was related to self-aspects in a trait-like manner. Subjective (but not behavioral) sleep quality predicted all four self-aspects 12 hours later, whereas only two self-aspects (self-compassion, self-continuity) predicted better behavioral sleep quality 12 hours later. Neither self-aspects nor sleep reliably predicted each other 36 hours later.

In Study 1, we examined the associations between subjective sleep quality and self-aspects that had been investigated previously (self-esteem, self-compassion, self-control) as well as a novel one, self-continuity. Consistent with findings regarding self-esteem (Lemola et al., 2013), self-compassion (Brown et al., 2021; Phillips & Hine, 2021), and self-control (Guarana et al., 2021; Hill et al., 2022), we replicated associations between these variables and subjective sleep quality. Finally, we showed for the first time that self-continuity is associated with subjective sleep quality.

We then examined bidirectional relations between the four self-aspects and sleep quality in two longitudinal diary studies. In Study 2, we replicated associations between subjective sleep quality on the one hand, and self-esteem, self-compassion, and self-control on the other. In a series of RI-CLPMs, we showed that subjective sleep quality predicts increased self-esteem, self-control, self-compassion, and self-continuity 12 (but not 36) hours later. We then tested the replicability of these findings in Study 3, replicating state-like variation between subjective sleep quality and the self-aspects in the RI-CLPMs. As in Study 2, subjective sleep quality predicted self-esteem, self-control, and self-continuity 12 hours later (short lag). In Studies 2 and 3, self-aspects generally did not predict subjective sleep quality 12 or 36 hours later, with the exception of Study 2 where self-compassion predicted a small increase in sleep quality 36 hours later. We also examined in Study 3 behavioral sleep quality (i.e., sleep efficiency) via actigraphy. Whereas between-subjects variation in subjective sleep quality was related to the self-aspects, behavioral sleep quality was not. Further, behavioral sleep quality did not predict self-esteem, self-compassion, self-control, or self-continuity either 12 hours (short lag) or 36 hours (long lag) later. However, self-compassion and self-continuity predicted sleep efficiency 12 hours later (short lag).

Theoretical implications

Self-esteem

Our findings align with longitudinal studies showing that sleep quality predicts trajectories of self-esteem (Brand et al., 2015; El-Sheikh et al., 2010; Fredriksen et al., 2004; Vazsonyi et al., 2021; Wong et al., 2024; Yip, 2015). We extend this work by offering the first empirical test of the reverse pathway, examining whether self-esteem predicts subsequent sleep quality. Across Studies 2 and 3, this reverse direction was not supported, suggesting a possible asymmetry in how these constructs relate over time. The consistent predictive effect of sleep quality on self-esteem can be interpreted through sociometer theory, which conceptualizes self-esteem as a gauge of one's perceived relational value that adjusts in response to cues of social acceptance or exclusion (Leary & Baumeister, 2000; Leary et al., 1995). From this perspective, sleep may serve a regulatory function by modulating sensitivity to interpersonal threat. When well rested, individuals may be better equipped to regulate emotional responses to social feedback, maintaining a stable sense of self-worth. Supporting this interpretation, the link between perceived rejection and hurt feelings becomes more pronounced under conditions of poor sleep, suggesting that sleep buffers against the emotional toll of social threat (Gilbert et al., 2015). In this way, sleep may stabilize the affective processes that underlie self-esteem by reducing emotional volatility in response to daily social experiences.

Although self-esteem did not predict sleep quality in our studies, future research may uncover this association by considering longer timescales or drawing on complementary theoretical frameworks. Hierometer theory offers one such account. This theory conceptualizes self-esteem as a status-tracking system that monitors one's relative position within social hierarchies and guides behavioral responses accordingly (Mahadevan et al., 2016, 2021). High self-esteem reflects perceived high status and promotes assertive, agentic behavior, whereas low self-esteem reflects low status and fosters more inhibited or avoidant responses. Socioeconomic status (SES), a key status-relevant domain in this framework, has been shown to influence self-esteem both cross-sectionally and experimentally (Mahadevan et al., 2023a, 2023b). Crucially, SES is also a well-established predictor of sleep health, with meta-analytic findings linking lower SES to shorter sleep duration, poorer efficiency, and greater fragmentation (Sosso et al., 2021). These patterns suggest that status-based factors such as SES, and by extension self-esteem, may shape sleep through slower-developing, cumulative processes not easily detected in short-term diary designs. From this standpoint, diminished self-esteem may function as an internal signal of low social standing that heightens vigilance and disrupts sleep over time. This pathway may be especially consequential for individuals navigating chronic disadvantage, compounding the effects of inequality across domains such as health, cognition, and well-being (Buckhalt, 2011). Follow-up investigation could test these possibilities.

Self-compassion

Although most of the literature on self-compassion and sleep is cross-sectional, a smaller number of longitudinal studies indicate that self-compassion supports sleep over time. For instance, interventions designed to enhance self-compassion improve sleep the following day (Butz & Stahlberg, 2018) and predict better sleep quality weeks to months later (Y. Hu et al., 2018; Tout et al., 2024). Our research builds on this work by offering the first evidence of a reciprocal association. In Study 2, self-compassion predicted improvements in subjective sleep quality 36 hours later. In Study 3, self-compassion predicted behavioral sleep efficiency over a 12-hour window. These findings complement past work linking self-compassion to healthier routines (Sirois et al., 2015) and reduced nighttime procrastination (Sirois et al., 2019). Importantly, we also showed that better sleep quality predicted greater self-compassion. One explanation is that high-quality sleep helps restore cognitive and emotional resources, allowing individuals to respond to themselves with greater kindness and acceptance.

This emerging evidence for reciprocity raises the question of why sleep and self-compassion are mutually reinforcing. Evolutionary theorizing offers a compelling account. Evolutionary theorists have proposed that newer physical and psychological processes may emerge from or coopt older, existing mechanisms for their own use; this process is known as exaptation (Gould, 1991). Consistent with this view, scaffolding theories of the mind suggest that new psychological capacities emerge by building on older, evolutionarily established systems (L. E. Williams et al., 2009). For example, disgust may have initially evolved to protect the body from physical contaminants but later became useful for defending the psychological self against existential threats (Kelley et al., 2015). In a similar fashion, compassion for the self may have emerged by building on the mammalian caregiving system that originally evolved to promote nurturance toward others. The self itself is thought to have evolved later in evolutionary history and likely scaffolded upon this existing caregiving system (Sedikides & Skowronski, 1997; Skowronski & Sedikides, 2019). From this perspective, self-compassion may have scaffolded onto caregiving responses originally designed for others, creating a pathway for internal soothing, acceptance, and self-directed care.

The neurobiology of caregiving supports this account. The caregiving system is rooted in a conserved subcortical network that includes the medial preoptic area, ventral tegmental area, amygdala, and nucleus accumbens, and is modulated by oxytocin to support bonding and caregiving motivation. In humans, this network is supplemented by cortical regions such as the prefrontal cortex, anterior insula, and temporal-parietal junction, which allow for empathy, mentalizing, and flexible social responses (Feldman, 2016). These systems regulate more than just social connection. They also play a central role in dampening threat responses. Activation of the caregiving system, particularly through secure attachment, has been shown to dampen neural and physiological reactivity to threat (Norman et al., 2015; Stupica et al., 2019). When attachment representations are activated, especially in individuals low in avoidant attachment, threat-related responses are inhibited and vagal pathways are engaged to facilitate calming and connection (Bryant & Hutanamon, 2018; Karl et al., 2021; Maunder et al., 2006). According to polyvagal theory, the vagus nerve enables this shift from sympathetic arousal to parasympathetic regulation, supporting behaviors that require calm and safety. Heart rate variability, a key marker of vagal tone, reflects this transition and has been linked to emotion regulation and responsiveness (Porges, 2003, 2011).

Consistent with this scaffolding view, self-compassion has been associated with activation in caregiving-related brain regions (Berry et al., 2020; Guan et al., 2021; G. Liu et al., 2022; Parrish et al., 2018; K. Williams et al., 2020), as well as with greater parasympathetic activity (Arch et al., 2014; Luo et al., 2018; Petrocchi et al., 2017; Svendsen et al., 2016). As sleep requires the downregulation of arousal and suspension of vigilance, it is more likely to occur when threat detection is dampened and safety is perceived (Dahl, 1996). If self-compassion helps deactivate the threat system by drawing on caregiving pathways, it may promote better sleep by supporting internal calm and security.

Polyvagal theory further helps to explain the bidirectional association we observed. Restorative sleep enhances parasympathetic activity, facilitating recovery from physiological strain. In contrast, poor sleep impairs this process (Gorlova et al., 2019; Westphal et al., 2021). Longitudinal research shows that better sleep quality predicts higher daily heart rate variability, which mediates the link between sleep and increased daily positive emotion (Ballesio et al., 2023). Positive emotional states may, in turn, enhance one's capacity for self-compassion. Consistent with this possibility, a recent longitudinal study found reciprocal links between happiness and self-compassion, with stronger effects from happiness to self-compassion (Pastore et al., 2023). Together, these theoretical and empirical findings support the bidirectional results we reported: sleep fosters physiological and emotional conditions that make self-compassion more accessible, whereas self-compassion reduces arousal and supports the quality of sleep.

Self-control

A growing literature suggests that sleep quality and self-control are closely linked across a variety of timescales. In the short term, ecological momentary assessment

(Freeman & Gottfredson, 2018), experience sampling (Baumeister et al., 2019), and daily diary studies (Hisler et al., 2019) show that poor sleep quality predicts reduced self-control the next day. Longitudinal studies similarly indicate that inadequate sleep undermines self-regulatory capacity over months or even years (Royle & Connolly, 2024; K. E. Williams & Sciberras, 2016; Yang et al., 2024). However, fewer studies have explored the reverse direction. In one study (Bub et al., 2016), adolescents with stronger self-control reported better sleep across multiple days. In the single study that explicitly tested bidirectional longitudinal associations, self-control predicted later sleep quality but not the reverse (Partin et al., 2022). Our research represents only the second attempt to examine reciprocal associations between self-control and sleep. In contrast to the last-mentioned study (i.e., Partin et al.) and in line with the bulk of short-term studies, higher subjective sleep quality predicted greater self-control.

Theoretical models of effort, self-control, and sleep account for these effects. Effort refers to the use of both mental and physical resources to carry out a task. It involves directing energy toward the pursuit of any goal that requires exertion (Gendolla & Wright, 2009). Effort plays a key role in self-control by reflecting the energy needed for goal-directed actions and is considered a central mechanism influencing whether and how self-control is exercised (Kotabe & Hofmann, 2015). The energy allocation theory of sleep (Schmidt, 2014) conceptualizes sleep as a biological strategy for managing limited energy resources, proposing that sleep helps regulate when and how energy is distributed across competing demands such as physical exertion, cognitive effort, and self-regulatory control. From this perspective, sleep may support self-control by replenishing the energy required for effortful, goal-directed behavior.

Consistent with these lines of theorizing and our results, sleep may influence how individuals engage in effortful self-control. Experimental findings indicate that poor sleep reduces willingness to exert mental effort. For example, after a night of poor sleep, participants chose easier math problems, indicating reduced effort investment, an effect replicated under total sleep deprivation (Engle-Friedman et al., 2003). These results imply that well-rested individuals are more likely to engage in demanding self-control tasks, including those that involve delaying gratification. Supporting this interpretation, people with habitually good sleep between seven and nine hours showed greater preference for larger but delayed rewards (Curtis et al., 2018). Similarly, poorer sleep quality was associated with reduced preference for high-effort, high-reward choices on the Effort Expenditure for Reward Task (Boland et al., 2022). Theoretical accounts propose that poor sleepers may be more inclined to prioritize immediate rewards such as staying up late for entertainment over actions like going to bed early that support long-term goals including health and productivity (Massar & Chee, 2019). From this standpoint, variability in daily sleep quality may reflect the strength of self-regulatory habits. Given that good habits can sustain goal pursuit when self-control resources are low (Neal et al., 2013), sleep quality may influence how individuals respond to reward-based choices following effortful exertion.

Self-continuity

We also examined the associations between self-continuity and sleep quality both cross-sectionally and longitudinally. Across all studies, sleep quality was consistently related to trait-level self-continuity. In both the 14-day and 7-day diary studies, better subjective sleep quality predicted higher self-continuity, which in turn predicted improved behavioral sleep quality 36 hours later. These findings suggest a potentially reciprocal process in which sleep quality and temporal self-continuity reinforce one another.

One possible mechanism for this reciprocity lies in the role of sleep in stabilizing autobiographical memory. According to the Self-Memory System (Conway, 2005; Conway & Pleydell-Pearce, 2000; Conway et al., 2004), the self is constructed from a layered architecture of episodic memories, autobiographical knowledge, and a higher-order self-concept. Sleep plays a key role in consolidating autobiographical memory (Berres & Erdfelder, 2021; Hokett et al., 2021), helping to preserve a coherent self-narrative that links past experiences to present identity. If sleep supports the integration of these memory systems, it may also help maintain a sense of continuity between one's current and future self.

This possibility is supported by work showing that individuals frequently project themselves into imagined futures through self-defining future events, which contribute to long-term identity structure (D'Argembeau et al., 2012). Imagining such events has been shown to increase self-reflection and enhance perceived continuity with the future self (D'Argembeau & Garcia Jimenez, 2024). These findings suggest that future-oriented identity processes are embedded within the same autobiographical systems that sleep helps to stabilize. In this way, sleep may ground the self not only in the past but also in the future, supporting a stable experience of self across time.

At the same time, a temporally integrated self may promote behaviors that improve sleep quality. Theorizing on the future self suggests that individuals who feel emotionally and psychologically connected to their future selves are more likely to engage in behaviors that support long-term outcomes (H. E. Hershfield, 2019, Ersner-Hershfield, Garton, et al., 2009; H. E. Hershfield & Bartels, 2018). Consistent with this possibility, higher future self-continuity predicts greater delay of gratification (Chishima & Wilson, 2021; Ersner-Hershfield, Garton, et al., 2009; Ersner-Hershfield, Wimmer, et al., 2009; Qi et al., 2022; Sun et al., 2023; Zeng & Ouyang, 2020; H. Zhao et al., 2024), greater engagement in self-controlled behavior (Adelman et al., 2017; Blouin-Hudon & Pychyl, 2015, 2017; Engle-Friedman et al., 2022; H. E. Hershfield et al., 2012; Macrae et al., 2017; Shen et al., 2023, 2024; X. Zhao et al., 2022), and healthier habits including financial saving and exercise (Ersner-Hershfield, Wimmer, et al., 2009; Rutchick et al., 2018). These patterns suggest that self-continuity functions as a form of temporal self-regulation, guiding individuals to make choices aligned with their long-term goals.

Our results indicate that individuals who feel more connected to their future selves may be more likely to prioritize sleep-supportive behaviors, whereas higher-quality sleep may preserve the autobiographical memory systems that undergird a coherent self-concept over time. Moreover, given evidence that sleep is more strongly related to effort discounting than temporal discounting (Boland et al., 2022), individuals high in self-continuity may, by virtue of better sleep, be more willing to exert physical or cognitive effort in the pursuit of future goals. These bidirectional dynamic merits further investigation, particularly regarding how sleep and future-oriented identity processes interact to support long-term well-being.

Integrating affective and cognitive dimensions of the self

Taken together, our findings highlight that bidirectional associations with sleep emerged selectively across the broader affective and cognitive self-domains. Within the affective domain, self-compassion showed reciprocal associations with sleep, whereas self-esteem did not. This pattern may reflect functional differences: self-compassion involves responding to distress with kindness and reducing negative self-evaluations, but self-esteem reflects more general positive self-regard. As such, affective self-aspects that dampen negative self-views may be more likely to reciprocally influence sleep, whereas those emphasizing positive self-views may not.

Within the cognitive domain, future self-continuity, but not self-control, demonstrated reciprocal links with sleep. Both constructs are components of self-regulation, defined as a suite of capacities that enable individuals to guide their thoughts, feelings, and behaviors in a purposeful manner (Kelley et al., 2019). These include persistence (the sustained pursuit of effortful goals), impulse control (inhibiting immediate urges), and delay behavior (prioritizing long-term outcomes over short-term rewards). Although self-control is primarily tied to impulse inhibition (Kelley & Schmeichel, 2016), future self-continuity reflects a future-oriented mind-set and maps more closely onto delay behavior (H. Hershfield, 2023; H. E. Hershfield, 2011, 2019). Our findings suggest that cognitive self-aspects grounded in future-oriented delay behavior may be more likely to engage in reciprocal dynamics with sleep, compared to those emphasizing short-term impulse control.

Clinical implications

The findings have implications for understanding the robust associations between poor sleep and poor psychological (Bagautdinova et al., 2023; Baglioni et al., 2016; Cox & Olatunji, 2020; Scott et al., 2022) or physical (Kwok et al., 2018; Song et al., 2021) health. We illustrated that sleep quality contributes to higher self-esteem, self-compassion, self-control, and self-continuity. Higher self-esteem (Orth et al., 2012; Sowislo & Orth, 2013), self-compassion (MacBeth & Gumley, 2012; Phillips & Hine, 2021), self-control (Andrade & Hoyle, 2023; Powers et al., 2020), and self-continuity (Rutchick et al., 2018; Sedikides et al., 2023) are all associated with better psychological and physical health. It follows that poor sleep quality may erode the integrity of the self, resulting in worse self-esteem, self-compassion, self-control, and self-continuity, leading to worsening psychological and physical health. Follow-up research should examine the extent to which the self-aspects impact the links among sleep quality, psychological health, and physical health over a range of timescales.

Limitations

We obtained robust trait-like associations between sleep quality and the self. We also found that subjective sleep quality predicts subsequent self-esteem, self-compassion, self-control, and self-continuity. These findings may have been driven in part by common-method bias (Podsakoff et al., 2003), as all measures were self-report. Notwithstanding the limitation of the self-report method (Paulhus & Vazire, 2007), future research can circumvent common-method bias by incorporating implicit measure of self-esteem (Buhrmester et al., 2011), self-compassion (Koop, 2024), self-control (Keatley et al., 2017), and self-continuity (Rutt & Löckenhoff, 2016) alongside equivalent explicit measures.

Another limitation concerns causality. Although diary studies such as ours offer some insights into directionality, we cannot infer causality. Experimentally-induced sleep deprivation is needed to make causal claims. Meta-analytic evidence indicates that experimentally-induced sleep deprivation reduces wellbeing by lowering positive affect, increasing depression symptoms, and raising anxiety symptoms (Palmer et al., 2024). Experimentally-induced sleep deprivation alters neural signatures of self-referential information processing (Mi et al., 2023) and conduces to lower self-control (Dorrian et al., 2019; Meldrum et al., 2015), but its effects on self-esteem, self-compassion, and self-continuity have not been directly tested. Understanding how sleep loss causally alters self-referential information processing will enrich appreciation of sleep's influence on wellbeing and psychopathology.

A third limitation of our research was the univariate approach to behavioral sleep quality in Study 3. Although actigraphy is a reliable and valid method for assessing behavioral sleep quality (Acebo & LeBourgeois, 2006; Rosipal et al., 2013), sleep quality is multifaceted and difficult to distil into one single variable (Buysse et al., 1991). This may be why we did not find an association between behavioral sleep quality and either self-esteem, self-compassion, self-control, or self-continuity in Study 3. Future research could implement a multivariate approach (Kaplan et al., 2017; Krystal & Edinger, 2008) incorporating polysomnography (Spielmanns et al., 2019) and cyclic alternating pattern of non-REM sleep (Hartmann et al., 2020; Krystal & Edinger, 2008) alongside actigraphy. Such an approach promises to provide a more precise understanding of how sleep behaviorally influences the self and vice-versa.

A related limitation concerns the sample size of Study 3. Our sample size was just below the median sample size for longitudinal actigraphy studies in healthy young adults. Thus, it is likely that Study 3 was underpowered. Given that low statistical power reduces the likelihood of detecting true effects and increases the likelihood that statistically significant results do not reflect true effects (Button et al., 2013), the behavioral sleep quality results of Study 3 should be viewed with caution and will need to be independently replicated in larger samples. Despite statistical power concerns, the pattern of subjective sleep quality results (both in terms of cross-lagged effects and between-subjects covariation) was consistent with the results of Study 2.

Finally, all participants were from the U.K. and thus the generality of our results are constrained by cultural context. There are cultural differences in sleep (Canever et al., 2024; Jeon et al., 2021; Lin et al., 2019; Mindell et al., 2010) and the representation of the self (Markus & Kitayama, 1991, 2010). In particular, there are cultural differences in self-esteem (Buhrmester et al., 2011), self-compassion (Miyagawa & Neff, 2023), self-control (Li et al., 2018), and self-continuity (Ji et al., 2019). Given that culture can shape the link between sleep and physical health (Cheung et al., 2021), it may also shape the link between sleep and self-aspects. Research is needed to test this possibility.

Conclusion

People spend one-third of their lives asleep. The other two-thirds of their lives (i.e., waking life) are organized and filtered through the lens of the self. The current research represents an attempt to link these two fundamental aspects of psychological experience. Subjective sleep quality contributes to the integrity of the self, as reflected in higher next day self-esteem, self-compassion, and self-continuity. In turn, higher self-compassion and self-continuity contribute to behaviorally more efficient sleep. The bi-directional associations highlighted here have implications for psychological and physical health.

Note

1. In the RI-CLPMs, we imposed equality constraints across time points (e.g., Day 2 self-esteem → Day 3 sleep quality = Day 3 self-esteem → Day 4 sleep quality) and compared these to unconstrained models using the Akaike Information Criterion (AIC; Akaike, 1974). AIC balances fit and complexity, with lower values indicating better fit while avoiding overfitting. In all cases, equality-constrained models had lower AIC values (see Supplemental Materials, Table S1).

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

James W. Butterworth http://orcid.org/0000-0002-0867-7353
Constantine Sedikides http://orcid.org/0000-0002-7563-306X
Nicholas J. Kelley http://orcid.org/0000-0003-2256-0597

Data availability statement

The data reported in this paper are available upon request from the Corresponding Author.

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