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Sleep Quality and The Self: An Investigation of the Relationship Between Sleep Quality and the Multidimensional Self.

by

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Abstract

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The self and sleep are two of the most widely investigated psychological phenomena, but limited research has examined their isolated relationship. Such research has focused primarily on how subjective sleep quality relates to individual dimensions of the self, such as self-esteem or self-control. In this PhD thesis, I present four studies that aim to clarify the relationship between sleep quality and the self, on a more holistic level. I am particularly concerned with four self-constructs – self-compassion, self-control, self-esteem, self-continuity – although I test exploratorily an assortment of others. This research utilises cross-sectional and longitudinal, as well as subjective and objective, methods. Study 1 revealed that sleep quality was positively related to self-compassion, self-control, self-esteem, and self-continuity at the trait level; but held no significant relationship with self-expression, self-enhancement, or self-concept clarity . At the state level, three succeeding longitudinal diary studies (Studies 2-4) reinforced these significant findings, focusing only on self-control, self-compassion, self-esteem, and self-continuity. Study 2 revealed a predictive effect of subjective sleep quality on all four self-constructs, but no predictive effective of these self-constructs on subjective sleep quality. Study 3 used actigraphy to objectively measure sleep efficiency. Here, subjective sleep quality predicted self-control, self-continuity, and self-esteem (trendingly), but not self-compassion. Objective sleep quality did not predict any self-construct. In the reverse direction, none of the self-constructs predicted subjective sleep quality, although objective sleep quality was predicted by self-compassion and self-continuity. Study 4 implemented experimental manipulations to increase effortful self-compassion, self-control, and self-esteem. This method aimed to amplify the effect of these self-constructs on subjective sleep quality, relative to the typical (effortless) behaviours of Studies 2 and 3. Results show that subjective sleep quality predicted all three self-constructs, and also subjective sleep quality was predicted by self-compassion and self-esteem, but not self-control. S Taken together, this PhD thesis is the first to identify a bidirectional predictive relationship between sleep quality and multiple dimensions of the self.

Keywords: Sleep Quality; Self-Compassion, Self-Control, Self-Esteem, Self-Continuity.

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Research Thesis: Declaration of Authorship

Print name: James W. Butterworth

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I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University.
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
3. Where I have consulted the published work of others, this is always clearly attributed.
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
5. I have acknowledged all main sources of help.
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.
7. None of this work has been published before submission.

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Abbreviations

BSCS ....Brief Self Control Scale

BSSCCS.................................Brief State Self Control Capacity Scale

CFI ....Comparable Fit Index

CSD ....Consensus Sleep Diary

CLPM ....Cross-Lagged Panel Models

EEG ....Electroencephalography

EEfRT ....Effort Exertion for Reward Task

FSCS.....................................Future Self Continuity Scale

GMT.....................................Greenwich Mean Time

MTURK ....Amazon Mechanical Turk

PSD ....Pittsburgh Sleep Diary

PSQI.....................................Pittsburgh Sleep Quality Index

REM ....Rapid Eye Movement

RI-CLPM...............................Random Intercept Cross-Lagged Panel Model

RMSEA.................................Root Mean Square Error for Approximation

RSE ....Rosenberg Self Esteem Scale

SCC ....Self Concept Clarity Scale

SCS.......................................Self Compassion Scale

SCS-SF.................................Self Compassion Scale Short Form

SMS ....Self Memory System

SRMR...................................Standardized Root Mean Square Residual

SWS ....Slow Wave Sleep

VEQ......................................Value of Expression Questionnaire

Chapter 1 Introduction

> "The virtuous man contents himself with dreaming that which the wicked man does in actual life."
>
> - Sigmund Freud (*The Interpretation of Dreams*, 2017)

Human emotion, *cognition*, and behaviour are all filtered through the lens of *the self*. Much is known about how the self impacts emotion (Inwood & Ferrari, 2018; Lazuras et al., 2019), cognition (De Bortoli et al., 2019; Dougherty & Guillette, 2018), and behaviour (Alicke & Sedikides, 2009; Sedikides & Spencer, 2007) in a variety of contexts (Watson & Tharp, 2013; Weinstein, 1989). Although the self can only be experienced consciously during waking hours, people interject these daily practices with the subconscious experience of *sleep*. The self encapsulates the very essence of psychology, as far as people seek to understand their own mind, feelings, and behaviour.

William James, commonly regarded as the father of American psychology (Snarey and Coleman, 2011), describes the self as the sum total of all that a person can call their own (James, 1918). In the time that people do not consciously experience the self, they sleep. Sleep is inevitable, naturally occurring, and fundamental for survival. Individuals spend roughly 1/3 of their lives asleep (368 months; Miller, et al., 2014), and the remaining 2/3 experiencing the self. These two phenomena are tied in a revolving cycle, as natural as night and day, alternating control to permit restoration, like a psychological changing of the guard.

Sleep and the self have a long history of companionship, extending back over thousands of years. Ancient Greek tales write of sleep as a spell cast on people by the God of Sleep (Hypnos; hence, Hypnosis) to protect them from the harsh realities of life, to trick them into a state of vulnerability, or to introduce them to darkness and death (as written in Homer's The Odyssey and Iliad [Homer, 2011] and Stephen Fry's Mythos [Fry, 2017]). The ancient Greek physician and philosopher Hippocrates (who lived around 400bc; Askitopoulou, 2015) reintroduced the power of sleep as a determinant of health and interpreted dreams as a tool for insight into the symptoms and treatments of medical conditions (Askitopoulou, 2015). More recent theories, such as the Inactivity Theory (Siegel, 2009), suggest that sleep evolved as a survival mechanism, designed to keep us still and quiet during the night, when we are most vulnerable to predators. Other theories consider sleep as a process intended to physically and mentally restore activities of the waking self. For example, the Energy Conservation Theory (Horne, 1988) posits that sleep restores and saves energy, facilitating the alertness of the waking self. Yet, despite its long history, the association between the quality of one's sleep and their waking self is not fully understood.

The opening quote of this thesis implies a direct relationship between sleep and the self. Freud argued that one purpose of dreaming is to functionally trick ourselves into thinking we are achieving certain natural desires (Freud, 1899). The Rebound Effect or Dream Rebound (Wegner et al., 2004) is the idea that suppressed desires are manifested in our dreams. In doing so, people are less likely to act on these impulses in waking life, feeling like they have already successfully accomplished them. By extension, such theory (as supported by more up-to-date empirical research; Taylor and Bryant, 2007; Malinowski et al., 2019; Conte et al., 2021) demonstrates how waking exhibitions of the self (e.g., *self-control*, *self-esteem*, *self-compassion*) are governed by the subconscious manifestations we interact with in sleep. As such, people can live healthily in a society of rules and regulations without fear of breaching the barriers of social, cultural, and legal sanction. Outside of psychodynamic theorizing (Freud, 1899; 1923; Frosh, 2012; Jung, 1913), researchers emphasize other key functions of sleep, such as the consolidation of memories (Stickgold, 2005), psychological and physical restoration (Steptoe et al., 2008), and the reflection of our personality (desired or observed) through the events and actions experienced in dreams (Mullen, 2006). Running parallel to these ideas, it is apparent that one's waking self can have as much of an impact on sleep as sleep can on one's waking behaviours. While it is important to acknowledge the effects of dreams on the waking self, and that dreams may indeed be a factor of *sleep quality*, it should be noted that the present research to does not examine dreams. The objective of the preset research is to explore the relationship between the self and a more holistic concept of sleep quality. As such, the concept of dreams is not discussed further in this thesis, although future research should seek to investigate the relationships between the self and sleep quality, with regard for the impact of dreams.

In this thesis, I examine sleep quality and the self. I focus on specific aspects of the self, henceforth "*self-constructs*", building on the foundations of the large literature exploring the self and sleep quality. I begin by outlining theories and conceptualisations of the self and sleep quality, before turning to four distinct self-constructs: *self-compassion*, *self-control*, *self-esteem*, *self-continuity*. I summarize the literature on sleep quality and each self-construct, before describing the four groundbreaking studies of my research.

1.1 The Value of Sleep

The virtues of good sleep have been praised for a long time. Researchers have echoed this sentiment, documenting associations with rewarding long-term goal pursuits including increased physical health (Chaput et al., 2020), mental health (Baglioni et al., 2016), financial security (Hall et al., 2009), and optimal decision-making (Harrison & Horne, 2000). Sleep effects on psychological wellbeing and cognitive functioning have also been well established (Lemola et al., 2013; Saini et al., 2020; Yip, 2015; Wang & Yip, 2020). Yet, questions remain.

1.1.1 Theories of Sleep

Marcos Frank (2006) proposed four parameters of sleep theories: phylogeny, ontogeny, regulation, and primacy. Phylogeny refers to the recognition that sleep occurs in nearly all organisms (some, like jellyfish, do not appear to sleep); so, theories should account for why the evolution of sleep is shared across species. Ontology seeks to explain fluctuations in sleep and sleep cycles in development and across the lifespan. For example, rapid eye-movement (REM) sleep is much longer in early stages of human life and reduces as in later years (Espiritu 2008; Moraes et al., 2014; Scullin & Bliwise, 2015). Therefore, theories of sleep should explain the role of developing sleep through life. Regulation is the processes whereby sleep is determined and responds to environmental factors, independent of internal factors (e.g., *circadian rhythms*). Benington (2000) argued that sleep is "homeostatically regulated", as far as connections between biological systems involved in sleep can be traced through *sleep deprivation* and subsequently related to the proposed function. Hence, Benington argues that any strong and valid theories of sleep should account for the way sleep function relates to the homeostatic process. Finally, primacy refers to a theoretical explanation for why the proposed function only occurs during sleep (e.g., loss of consciousness, lower body temperature).

One of the first theories that attempted to outline the function of sleep is the Evolutionary Theory of sleep (Kleitman, 1964). This theory posits that sleep is an adaptive phenomenon that has evolved in animals as a mechanism for survival (Krueger et al., 2016; Siegel, 2018). In hunter-gatherer societies in years past, it may seem necessary to remain awake at night-time due to increased vulnerability, when vigilance would be necessary. However, two lines of thought contradict this account. First, Inactivity Theory (Siegel, 2009), which posits that sleep evolved in early ancestors as a survival mechanism, a method for remaining still and quiet during the night, when humans were most vulnerable. This would provide a safer state for the individual, as detection was less likely than waking vigilance. The complete separation from consciousness allows maximum restoration, as opposed to simple fatigue as the human would continue using cognitive and physical resources. Second, differences in modern day *chronotypes* suggest variation in biological sleep-wake cycles, whereby humans have naturally different sleep-wake cycles, with some feeling tired later in the day than others. This would imply that, in hunter gather societies of old, some humans were assigned the role of night watchman whereby they stayed awake at night keeping watch for predators while the rest slept. Supporting evidence for such an evolved chronotype comes in the form of social jetlag (Roenneberg et al., 2019; Wittman et al., 2009), and Energy Conservation Theory (Horne, 1988), according to which sleep is designed to regenerate and save energy when one has no use for it, allowing the waking selves to best utilize it. This resembles the Restorative Theory of sleep (Brinkman et al., 2018), which postulates that the primary function of sleep is reparation and healing of physical, emotional, and cognitive components. There is evidence that one's wounds heal faster when sleeping (Adam & Oswald, 1984; Mostaghimi et al., 2005). Also, people feel more emotionally and mentally refreshed and alert following a good night's sleep (Goldstein & Walker, 2014; Kecklund et al., 1997; Rosen et al., 2006), not entirely due to exertion avoidance, but due to cognitive restoration. Lastly, people restore depleted cognitive capacities, such as self-control (Butterworth et al., 2021; Vohs et al., 2010) and memory (Cellini, 2017; Fowler et al., 1973; Walker 2008) after having slept well. Many psychologists agree that a primary role of sleep is to re-charge and restore these cognitive capacities (Brinkman et al., 2018; Goldstein & Walker, 2014; Horne, 1988; Siegel, 2009) or perhaps to simply reduce the harms of sleep deprivation (Deak & Stickgold, 2010; Walker 2008).

Along similar lines, cognitive theories propose that sleep is essential for developing cognitive abilities and improving proficiency for cognitive processes (Deak & Stickgold, 2010; McCoy & Strecker, 2011; Walker, 2009). Consolidation of memory is an example (Stickgold, 2005; Stickgold & Walker, 2005; Zhang et al., 2022). Hebb (1942) argued that memories are consolidated by strengthening connections between synapses, as revisiting and revising content causes synapses to pass more frequent chemical signals to each other ("neurons that fire together, wire together"; Shatz, 1992, p. 64). Indeed, slow-wave sleep (SWS) and REM sleep work together to strengthen synaptic associations (Touzet, 2015), providing physiological evidence for sleep-induced memory consolidation. Similarly, empirical findings have shown that participants have better memory for experimental content after a night of sleep than periods of wake (Fischer et al., 2002; Huber et al., 2004; Stickgold et al., 2000; Walker et al., 2002). The tasks in these studies rely on different cognitive capacities, and reveal differing areas of brain activity, but all show memory improvements after sleep. Other cognitive abilities are also well associated with sleep, such as brain development throughout life stages (Frank, 2006), attention (Balkin et al., 2008), emotional reactivity (McCoy & Strecker, 2011; Walker, 2009), and decision making (Butterworth et al., 2021; Fulda & Schultz, 2001; Jones & Harrison, 2001).

In summary, sufficient evidence demonstrates that sleep has survival utility and serves multiple functions such as restoration and conservation of physical and mental capacities, as well as developing and maintaining complex cognitive skills. The self, too, is survival-relevant (Sedikides, 2021), related to restorative processes (Horne, 1988; Krueger et al., 2016; Siegel, 2009; Walker 2008), and important for complex cognition (McCoy & Strecker, 2011; Stickgold & Walker, 2005). The functional similarities and strength of theoretical links between the self and sleep promotes the prospect of *bidirectional* associations between sleep and self-constructs.

1.1.2 Measuring Sleep Quality

The most common self-report measures of sleep quality are the Pittsburgh Sleep Quality Index (PSQI; Buysse, et al., 1989) and the Consensus Sleep Diary (C*SD*; Carney et al. 2012). These break down quality of sleep into multiple dimensions, which add up to an overall *composite score*. The PSQI utilises the components of *subjective sleep quality* (how one rates their quality of sleep), *sleep latency* (the time it takes to fall asleep after one has started trying), *sleep duration* (the amount of time one is asleep), *sleep efficiency* (hours asleep relative to time in bed), *sleep disturbances* (the number of times one is woken by external disruption), *medication use* (whether one uses medicine or treatment to aid sleep), and *mood/alertness during the day* (the degree to which one felt active and in a positive mood). Yet, these two measures are self-report, and so open to the idiosyncratic interpretation by respondents. Further, as sleep is a change in state of consciousness, one cannot accurately report certain details (e.g., the moment one passes from awake to asleep). Objective measures are a solution. *Actigraphy* is a wearable monitor of sleep wake cycles that tracks movement as an indication of sleep or wake (Krystal & Edinger, 2008). The gold standard for measuring sleep quality is polysomnography: this records brain waves, the blood-oxygen levels, heart rate and breathing, as well as bodily movements (Krystal & Edinger, 2008). Using this information, one can accurately determine the depth and duration of sleep cycles, alongside sleep disturbances and sleep efficacy. These measures, however, are invasive, expensive, and virtually restricted to use in clinical sleep disorder research and may lack ecological validity.

Recent research employed physiological methods has provided insight into the effects of good sleep quality, while accounting for the need to address the multiple dimensions of sleep. Lee and Lawson (2021) recorded participants' sleep quality via both self-reported surveys and actigraphy to examine the effects of sleep health (a sleep-wake activity cycle that promotes positive mental and physical wellbeing; Buysse, 2014) on perceived stress and chronic physical conditions. Greater perceived stress and increased number of chronic conditions positively predicted greater sleep health problems. Of importance, this study highlighted the necessity to recognize the effectiveness of applying appropriate dimensions of sleep measures to one's research. Lee and Lawson (2021) measure sleep health via a composite score generated from combined actigraphy and self-reported sleep data. Subsequently, despite the significance of their findings, it is hard to truly understand the relationship between sleep health, perceived stress and chronic conditions when sleep health (is a composite of six distinct components of sleep quality. Beyond this, the study found that actigraphy-measured sleep duration was not associated with perceived stress or chronic conditions, however self-reported sleep satisfaction was. This demonstrates the importance of differentiating components of sleep quality in research. Much of the literature on the effects of sleep quality has used sleep duration as the primary measure of sleep quality, but this does not account for sleep efficacy, conscious depth, or environmental interference (e.g., sleep disturbances). In fact, in Lee and Lawson's (2021) study, sleep duration (as measured by actigraphy) was unrelated to perceived stress of chronic conditions, whereas self-reported sleep satisfaction and the composite sleep quality score was. Thus, this research demonstrates the effect of sleep quality on psychological and physical wellbeing but also establishes the importance of recognizing the multiple dimensions of sleep quality.

1.1.3 Good Versus Bad Sleep Quality

One common method for studying the effects of a phenomenon is to examine the effects of its absence. In sleep research this is done through experimental *sleep deprivation*. Relevant experiments find that sleep loss causes deficits in memory, attention, executive function, and emotion (McCoy & Strecker, 2011). A famous case study of sleep deprivation is that of Randy Gardener (Ahlheim, 2013; Choroverty, 2009; Kushida, 2004; Mullington, 2007; Zhang, 2004). In 1965, Randy Gardner, a 17-year-old American high school student, attempted to break the Guinness World Record for the longest amount of time spent awake. He succeeded in setting the record at 264 hours. The magnitude of this sleep deprivation had severe psychological consequences. Initially, symptoms reflected extreme tiredness (e.g., slow reaction times, general grouchiness). On the third day, Gardner started to experience memory loss, or, more specifically, became unable to create new memories (i.e., anterograde amnesia). He was unable to pay full attention to events and therefore unable to process the information correctly. As more time passed, the symptoms of sleep deprivation worsened; in an infamous radio interview, Gardner became aggressive with the hosts, believing he was being pranked by them. As 11 days went by, he experienced hallucinations, total apathy, and an inability to form coherent sentences. On the 11th day, during a medical test, he was asked to complete a serial-sevens test, which is where the participant is required to count backwards from a larger number in sequences of 7, Gardner stopped after a few rounds because, while struggling with the maths, he forgot what he was doing. This case study is supportive of cognitive theories of sleep, as far as sleep must be necessary for memory consolidation, attention and information processing, and emotion regulation. Significantly, the first night of sleep was almost completely restorative: Gardner slept for 14 hours, experienced no lasting effects of the sleep deprivation, and was back at school within a couple of days. In all, sleep quality can impact the self, with emphasis on my own definition of the self through my aforementioned multidimensional model.

Generally, experimental methods such as this are well valued and offer a stronger degree of certainty of effect, compared to other methods (Colavito et al., 2013; Imai et al., 2013). In sleep deprivation studies, the removal of sleep (compared to typical sleep) provides insight into the causal relationship between sleep and a host of variables. Although, a key flaw with experimental sleep deprivation research is that the recorded sleep quality does not reflect natural sleep quality. For instance, controlled sleep deprivation (such as waking a participant prior to REM sleep) interrupts natural circadian rhythms and related hormone production, unlike natural sleep disruption (such as the temperature being too hot) where waking is a natural response dictated by homeostatic regulation (Zisapel, 2007). Similarly, insomnia is a symptom and disorder of sleep characterised by an inability to enter or maintain good sleep quality (Bonnet & Arand, 2010; Roth & Roehrs, 2003). Insomnia is associated with abnormal physiological states, such as increased heart rate, body, and metabolic activation, inappropriate hormone secretion and elevated high-frequency EEG activity (Bonnet & Arand, 2010). Experimentally induced sleep deprivation, such as the case of Randy Gardner, do not account for the factors involved in clinical or natural sleep deprivation. Furthermore, sleep deprivation studies often require participants to sleep in artificial settings (such as a sleep lab) in order to closely monitor sleep-related physiology changes. A novel environment, accompanied by unfamiliar physiological equipment and laboratory staff may cause discomfort not typical of regular sleep (Stroemel-Scheder & Lautenbacher, 2021). Hence, despite the significant and influential findings of Randy Gardner’s experiment, the findings lack generalisability and ultimately fail to account for confounding factors that may influence the results specific to one individual in a highly controlled setting. What is more, the case study of Randy Gardner lacks replicability due to the uniqueness of the case and the evident health risks. Nonetheless, experimental sleep deprivation remains a fundamental method for establishing causal effects of sleep (Babson et al., 2010; Durmer & Dinges, 2005; Gillin et al., 2001).

Other lines of theorising propose that sleep deprivation may be an effective treatment for depression. Induced-Wakefulness Therapy (Pflug & Tölle; 1971) was established as an effective clinical treatment for depressive symptoms. Participants with clinical depressive disorders are required to stay awake for one full night and subsequently report significant improvements in depressive symptoms. Since then, sleep deprivation as a clinical treatment for depression has consistently been shown to have a positive effect on depressive symptoms (Giedke & Schwärzler, 2002; Rudolph & Tölle, 1978; Wu & Bunney, 1990). However, this line of research is shrouded in controversy. Some research argues that total sleep deprivation is not necessary, but the absence of REM sleep, or partial sleep deprivation, reduces depressive symptoms (Giedke et al., 2003; Schilgen & Tölle, 1980). More recent research reports lower response rates than earlier research (Giedke & Schwärzler, 2002; Elsenga, 1992). Furthermore, despite the clinical effectiveness of sleep deprivation, considerable research reports that this effect is short-lived (Giedke & Schwärzler, 2002; Ioannou et al., 2021), participants often relapse following as little as one-night of recovery sleep (Ioannou et al., 2021; Wirz-Justice et al., 1999; 2013), and at least 30-40% of participants report no effect at all (Hemmeter et al., 2010). A recent systematic review of sleep deprivation as a treatment for depression (Ioannou et al., 2021) examined 10 studies (totalling 1193 participants) and found that sleep deprivation combined with standard clinical treatments did not reduce depressive symptoms 1 week after starting treatment, and that sleep deprivation was no more effective than standard antidepressants. Randy Gardner offers an insightful example of the cognitive and affective detriments that follow total sleep deprivation, albeit in an extreme case. Yet, studies of more natural sleep loss sleep suggest that sleep deprivation may be beneficial for affective disorders (e.g., depression), although more recent research refutes such theories.

Cognitive deficits are a common symptom of poor sleep quality. As already discussed, sleep is involved in strengthening memories (Ellenbogen et al., 2006; Stickgold, 2005). Ellenbogen et al. (2006) describes two ways in which sleep affects memory. First, sleep deprivation and sleep disturbances prevent people from fully attending to information. Second, sleep deprivation prevents the consolidation of memories. Findings are consistent with this argument (Bennington & Frank, 2003; Block et al., 1981; Grosvenor & Lack, 1984). Also, those who experience greater sleep quality learn new skills quicker and retain the skill for longer (Ellenbogen, et al., 2006). This is relevant to the current consideration of the relationship between sleep, memory, and the self. Given that the self is embedded in memory (Sedikides & Skowronski, 2000) and sleep consolidates memory, sleep likely influences self-perceptions.

1.2 The Quest for The Self

The self has long been pondered by poets, artists, philosophers, and social or behavioural scientists. Philosophers and psychologists concur that the self may be conceptualized as a mass of distinct and palpable properties or powers, accumulating to a holistic self. Consider, for example, the value people place on themselves (self-esteem), recognizing that they exist as an entity (self-awareness), or believing that they are capable of completing tasks (self-efficacy).

1.2.1 Defining The Self

Thagard (2012) outlined a multilevel system accounting for the social, individual, neural, and molecular mechanisms that interlink to form the self. These levels are interactive and dynamic as they change individually (responding to environmental stimuli) and interconnect (responding to each other). This multilevel approach is quantifiable, and can help to determine the predictive, casual, and directional effects of the self as a whole, as individual sub-facets, and as collective levels. Sedikides et al. (2013) presents a three-tiered hierarchy of the self (perhaps referring to identity, distinct from the self). This theory suggests that the self is a trichotomous system of components of the self which vary in importance and meaningfulness. The individual self (the individual differences that make a person unique), sits at the top of the hierarchy, followed by the relational self (perceived characteristics which are shared in close relationships, differentiated from other relationships), and finally the collective self (characteristics that are shared in wider social groups). Other theorizing (Sedikides & Skowronski, 2000) suggests that the self is a human-specific symbolic concept that has three components. The first is the representational self, which refers to one’s cognitive representation of important attributes that characterize their personality. The second is the executive self, which regards the self as an entity with intentions and goal-directed behaviours. The third is reflexive potential, which refers to one’s awareness as a conscious being. Congruent with the above theorizing, I assume that the self is (1) a system of measurable self-constructs, (2) embedded in memory, and (3) dynamic.

1.2.2 The Dynamic Self

The self is dynamic. The aspects of the *self-concept* which are more salient to an individual varies on a day-to-day basis. People continuously process new experiences, recall and organize new memories, and react to events in their environment. I will briefly discuss the dynamism of self-control, self-esteem, self-compassion, and self-continuity. Here, I define the term *Dynamic* as characterised by continuous change, progress, or actively responded to context or environment.

Self-Control. People may implement generous amounts of self-control one day, but scarce amounts on another day. In a 14-day study, Park et al. (2016) measured daily self-control depletion and stressors over a 14-day survey study on 1442 participants. Daily self-control depletion had a bidirectional predictive relationship with number of stressors on the same day. Also, the effect of daily stressors on self-control depletion remained overnight, but the reverse direction did not carry over to the following day. This raises the possible role of sleep, whereby sleep restored self-control overnight thus reducing (or removing) the cycle of stress and self-control; a pattern demonstrated in earlier research (Hagger, 2010; Hagger et al. 2010; Libedinsky et al., 2013). Similar lines of research support the notion that self-control is dynamic, varying from day to day. In particular, Hofmann et al. (2012) used an experience sampling method to examine everyday changes in self-control. They found that self-reported feelings of desire were frequent but varying in intensity, and they further established individual differences in the way participants managed to resist those desires. Personality, situations, and interpersonal factors moderated self-control (i.e., desire strength, desire resistance). People, then, use distinct desire resistance strategies for different desires, such as goal reminders and reassurance of future indulgences implemented for stronger desires (Milyavskaya et al., 2020).

Other research using experience sampling methods show that daily changes in self-control are predicted by changes in sleep quality (Baumeister et al., 2018), as far as worse self-control follows nights of poorer sleep quality. In a previous experiment (unrelated to the thesis at hand), I obtained a similar pattern, whereby sleep quality moderated the effect of ego-depletion on self-control (Butterworth et al. 2021). Using a between-subjects design, participants either completed a free-writing task (*write about a recent holiday for 10 minutes*) or a controlled-writing task (*write about a recent holiday for 10 minutes, without using the letters A or N)* which was designed to drain cognitive capacity for self-control (ego-depletion). All participants then completed a delay discounting task (*select either a small immediate reward, or large delayed reward*). We also measured self-reported sleep quality. We found that participants in the controlled writing task demonstrated greater self-control (preference for delayed reward), but only when they reported above average sleep quality. In other words, participants who slept worse showed greater impulsivity following an effortful task (greater ego-depletion). This studied showed that sleep quality moderated the effect of ego-depletion on self-control. Studies such as this demonstrated that capacity to implement self-control is influenced by state factors (immediately preceding cognitive activity), and trait factors (general sleep quality).

Self-Esteem. Self-esteem is defined as the extent to which one values themselves (Garcia et al., 2019) or feels authentic pride (Tracy et al., 2009). Daily stressors and negative life events reduce state self-esteem, particularly for those low in trait self-esteem (DeHart & Pelham, 2007). Also, state self-esteem changes following rejection or negative feedback from a romantic partner. This effect is moderated by attachment style, that is, individuals with a secure (vs. insecure) attachment orientation exhibited greater fluctuation in state self-esteem (Hepper & Carnelley, 2011). In two studies, Zadro et al. (2004) focused on sensitivity to rejection as a function of ostracism. In Study 1, participants learned that they would play a Cyberball game against either another real person or the computer. Participants reported decreases in self-esteem following ostracism from both the computer and real person. In Study 2, participants learned that the competitor (either computer or real person) was following a script and the feedback was predetermined. Still, participants reported reduced self-esteem following ostracism. However, in a meta-analysis, social rejection (vs. control) did not decrease self-esteem, whereas social acceptance (vs. control) increased it (Blackhart et al., 2009). Despite some inconsistencies and lack of clarity, it remains evident that state self-esteem often fluctuates as function of extrinsic forces and social context (De Ruiter et al., 2018).

Self-Compassion. Self-compassion is the act of minimizing one's own mental suffering by managing positive and negative emotions. Neff (2023) defined self-compassion in terms of self-kindness (being kind and understanding to oneself without self-criticism and judgement), 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). The effect of fluctuating self-compassion has been well documented. Relevant research has shown that self-compassion is inversely related to depression (Ford et al., 2017) and stress (Gard et al. 2012), and palliates eating disorders (Kelly et al., 2014). Also, meta-analyses link higher self-compassion to improved wellbeing. For example, a meta-analysis by Ferrari et al. (2019) showed that self-compassion interventions benefit 11 psychological conditions (e.g., lower depression, anxiety, stress, and rumination), and Zessin et al. (2015) meta-analytically established a strong association between self-compassion and wellbeing. Moreover, some research has examined the effects of self-compassion on health behaviours: daily increases in self-compassion predict less vulnerability to goal inhibition (Hope et al., 2014), reduced stress and healthier eating behaviours (Kelly & Stephen, 2016; Li et al., 2020), and better body appreciation and body image (Kelly & Stephen, 2016).

A small body of literature has also been concerned with the relation between self-compassion and sleep quality. Hu et al. (2018) conducted a diary study addressing the link between daily self-compassion and following nights' sleep. Self-compassion predicted sleep quality, and this effect was mediated by stress. Here, self-compassion likely improved sleep quality by inhibiting the influence of stress on sleep quality. Also, this effect was specific to sleep latency similar to Ferrari et al. (2019). The identified effect of self-compassion on sleep quality via the route of stress may be indicative of rumination, which might have prevented the individual from falling asleep. Nighttime rumination whereby an individual fixates on negative past short- and long-term experiences (Watkins et al., 2020), keeps the brain active and delays sleep onset (Cooney et al.,2010; Jacob et al., 2020) therefore reducing quality of sleep; the findings of Hu et al. (2018), may be explained by self-compassion's buffering effect on rumination, subsequently permitting sleep onset. Collectively, evidence indicates self-compassion improves sleep quality, although it remains unclear whether this is a direct effect or mediated effect.

While a large body of literature identifies an association between self-compassion and a range of variables, such studies focus on the benefits of self-compassion, or more general trait association. Little evidence identifies the factors of self-compassion, leaving a literature gap that explores why self-compassion might fluctuate. Interventions specifically designed to increase self-compassion have been consistently recognised as effective methods to improve self-compassion and subsequent health and personality variables (Kirby et al. 2017; Ferrari et a. 2019), which indicates that self-compassion can be manipulated. Such interventions tend to utilise therapies to teach attitudes and behaviours that promote self-kindness and reduce self-judgement (Galili-Weinstock et al., 2018); implying that self-compassion is a skill that can be practiced (Neff, 2023). Yet, there is no known research that explores contextual or environmental factors that alter state self-compassion. In the forthcoming chapters, I examine sleep quality as a factor of self-compassion, and whether the documented influence of self-compassion on wellbeing extends to sleep quality.

Self-Continuity. Self-continuity is defined as the subjective sense of connection to one's own past and future selves (Sedikides et al., 2023). Research into self-continuity is very limited, due to the concept being relatively young. Research has found that self-continuity increases following experimentally induced nostalgia (Sedikides et al., 2016) and involvement in tasks that require holistic (as opposed to analytic) thinking (Hong et al., 2020). More generally, self-continuity is associated with daily healthy eating behaviours and autonomous motivation (Lopez et al., 2023). Also, self-continuity improves wellbeing (Sedikides et al., 2016, 2023). These findings imply that regard for personal future consequences might play a role in daily decision-making that benefits long-term health, sacrificing immediate gratification. However, there is an extensive literature gap that does not address the state factors of self-compassion, beyond experimentally induced nostalgia and analytical thinking. In the forthcoming chapters, I examine whether sleep quality is one such factor, and also whether the influence of self-continuity on wellbeing extends to sleep quality.

1.2.3 A Multidimensional Model of the Self

As argued above, the self is multidimensional (Baumeister 2019; Brown, 2014; Greenwald et al., 1984; Strawson, 1997). Here, I conceptualize the self as a novel multidimensional model, formed of six core components: affective self, motivational self, executive self, interpersonal self, temporal self, and representational self.

The Affective Self. The affective self refers to an *emotional experience*, or the experience of acting in response to a stimulus, as driven by self-related emotion (Slaby 2012). I refer to the affective self as comprising of moods, emotions, and feelings (Emde, 2017; Slaby 2012) or how one feels about oneself. The affective self is well-represented by self-esteem and self-compassion, due their strong associations with wellbeing (Diener & Diener, 1995; Kim and Ko, 2018; Richardson et al., 2021). Self-esteem, a part of the self-concept (Monteiro et al., 2021), encompasses the extent to which one values themselves (Garcia et al., 2019) or feels authentic pride (Tracy et al., 2009), and positively predicts social and personal wellbeing (Sedikides & Gregg, 2003). Work by Brown and Marshall (2001) demonstrated that self-esteem is associated with self-relevant emotional states, and that self-esteem mediates the relation between personality traits and wellbeing in response to successes and failures. This work also showed that emotional reactions to failure were predicted by self-esteem, but non-self-relevant emotional reactions were unrelated to self-esteem. The relationship between self-esteem and the affective self is stable across time, as far as self-esteem predicts affective self-regulation (beliefs in one's abilities to manage negative and express positive emotions; Caprara et al., 2013).

Self-compassion entails minimizing one's own suffering by managing positive and negative emotions. Neff (2023) defined self-compassion in terms of self-kindness (being kind and understanding to oneself without self-criticism and judgement), 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). In a meta-analysis, higher self-compassion was associated with decreased symptoms of depression, anxiety, and stress (MacBeth & Gumley, 2012). Self-compassion can be used as an intervention to promote mental health by improving sleep disturbances (Kemper et al., 2015), and by regulating emotions to reduce depressive symptoms (Diedrich et al., 2014a; Gilbert & Proctor, 2006).

Self-esteem and self-compassion are positively related (Leary et al., 2007; Neff, 2003a; Neff, 2011) and are linked to wellbeing (Pandy et al., 2019). Donald et al. (2017) investigated the synergetic relationship between self-esteem and self-compassion by comparing annual trait reports over four years. Self-esteem predicted self-compassion, but the reverse was not true. Yet, self-compassion is more controlled than self-esteem, and less involved in self-protection (Neff, 2011). Taken together, these two self-constructs, although conceptually distinct, are well associated with one another; likely linked by their association with the affective experiences of the self.

The Motivational Self. The motivational self is the *desire* to think well of oneself (Alicke & Sedikides, 2011; Sedikides & Alicke, 2009; Sedikides, 2021), and to shield oneself from negative perceptions and social threat (Alicke & Sedikides, 2012; Leary, 2007; Seo & Ilies, 2009). Sedikides (2021) describes the motivation to feel good as "psychological homeostasis", as manifested by the *self-enhancement* and self-protection motives. These motives increase self-esteem and facilitate internal homeostasis or well-being (Sedikides, 2021). Self-enhancement is defined as a process or instrumental action that promotes interests in reasonable and defensible proximity to one's desired identity (Sedikides & Alicke, 2009). Self-protection is differentiated as a defence mechanism triggered by threat to one's identity (Sedikides & Alicke, 2009). Self-esteem and self-enhancement are conceptually similar, as far as they both consider sense of personal value and worth, however I differentiate them into the affective self and motivational self, respectively, by the mitigating role of the self-serving bias (Sedikides, 1999) or motivational bias (Sedikides, 2021). The self-serving bias is a heuristic approach to information processing, where purposive encoding skews information processing to foster a desired identity (Alicke et al., 2020) and ignore social rejections. Such a bias is characteristic of self-enhancement, but not of self-esteem. Self-esteem permits a more objective and rational approach to information processing, to maintain healthy psychological homeostasis, rather than hedonism (Sedikides & Alicke, 2009) and defines one's own identity accordingly.

The Executive Self. This self refers to one's *agency*, and their capacity and willingness to self-direct their behaviour (Baumeister & Vohs, 2003; Hofmann et al., 2012). The executive self is active and intentionally involved in cognitive thoughts, feelings, behaviours, and is not simply passive or observational (Baumeister & Vohs, 2003). It is expressed through self-regulation and self-control, manifested in operations of working memory, impulse suppression, and switching between tasks (Baumeister & Vohs, 2003; Hofmann et al., 2012). In a behavioural genetics study (Neiss et al., 2005), shared environmental actors influenced self-esteem and negative affectivity, but these were unique from those that influenced the executive self. Nonshared environmental influences uniquely explained most of the variance between self-control, self-esteem, and negative affectivity. However, this study by Neiss et al. (2005) analysed secondary data, originally collected by a larger independent study. As such, the authors do not detail the specific environmental factors that might influences self-esteem and self-control separately. Nonetheless, there is still reliable evidence that suggests a genetic and environmental distinction between the executive self and the affective self, despite leaving a literature gap for specific variables and factors.

Another route of distinction is that the executive self reflects a wilful regard for the future, as opposed to in-the-moment reactionary behaviours or cognitions (Baumeister & Vohs, 2003).

Delayed gratification, rejecting small immediate rewards for future larger rewards, is an example. In my own unrelated research (Butterworth et al., 2021) I investigated the role of mental effort exertion on decision making. Participants completed either a controlled writing task or a free writing task. Then, they completed a delayed gratification task, choosing between small-immediate rewards or large-delayed rewards. Participants who exerted greater mental effort in the controlled writing task showed greater self-control (less impulsivity), showing a preference for large-delayed rewards, compared to the control condition. Participants likely instigated analytical decision-making processes in the writing task, thus making the more rational option easier to access. This awareness of future consequences links the executive self to the temporal self, although I distinguish these dimensions as relative to one's immediate actions (agency; executive self) compared to past and present identity (perception; temporal self).

The Temporal Self. This self refers to perceptions of consistency of oneself and identity over *time*, that is, mental time travel between current and future selves (Peetz & Wilson, 2008). The temporal self is best manifested by self-continuity, defined as the subjective sense of connection to one's own past and future selves (Sedikides et al., 2023). The temporal self can be conceptually distinguished from other components of the self by the distinct emphasises on the magnitude of change in the self across time. Rather, we can mentally revisit our past selves to explore the changes in identity across our past selves, which we compare to the self we are right now. Importantly, we may use this sense of connection as a guide to understand who we will be in the future, with which comes decision making and motivated desires to achieve or avoid the future self. Wilson and Ross (2000) examined the frequency of temporal comparisons in descriptions of the present self. They found that participants made more comparisons to their past selves than social comparisons. Comparison to one's past self is beneficial for self-enhancement and self-esteem due to the indication of progression and improvement over time, relative to one's desired (self-enhancement) and rational (self-esteem) self-worth. Social comparisons are perhaps more indicative of self-enhancement, where people have a motivation to compare themselves to others. Self-continuity increases with age, as far as older generations feel more connected to past and future selves (Rutt & Löckenhoff, 2016). This is potentially do the increasing familiarity with mortality, and acceptance of decreasing time to dramatically change, while simultaneously recognising the most significant personal landmarks of days gone. This additionally highlights an important concept, my model of a multidimensional self differentiates 6 distinct and independently measurable dimensions, they are indeed connected and interactive.

The Interpersonal Self. This component reflects one's perception of their *social context*, and how people interact with each other and how the individual is perceived by others (Green, 2007; Neisser, 1993; Zahavi 2015). Here, the interpersonal self is distinguished from the other components by the emphasise on self presentation (Neisser, 1991) and is therefore partly indicated by *self-expression* (Gibas et al., 2016; Singelis, 1994). Personality traits and characteristics fluctuate, becoming more or less salient depending on situational cues (Aaker, 1999). They way that people present themselves, and the way they are perceived, are similarly dependent on situational cues. Thus, the role of self-expression lies in the ability to express oneself in a context-appropriate manner. There is a close link between the interpersonal self and the motivational and executive selves, whereby people inhibit inappropriate expressions in order to maximize social acceptance (Ayduk et al., 2000; Morf, 2006). I differentiate the interpersonal self as the willingness to openly present one's *authentic* identity (such as personal opinions, beliefs, or characteristics). Expressed identity (behaviours, beliefs, attitudes) ties us to social groups, familial groups, and romantic relationships (Tice & Baumeister, 2001).

The Representational Self. This component reflects awareness of one's *conscious existence* (Kriegel & Williford, 2006; Kriegel, 2009) and their self-understanding (Neill, 2005). The representational self is embedded in one's memory (Klein & Loftus 1988; Ray et al. 2009). This means that the way in which people recognise themselves as individual and active beings is accessed through stored memories of past experiences. It is typically manifested through *self-concept clarity* (Campbell et al., 1996), which is defined as one's beliefs about themselves (Lodi-Smith & DeMarree, 2018) which are internal, stable over time, and clearly defined (Campbell et al., 1996; Na et al., 2016). A longitudinal diary study (Schwartz et al., 2011) examined the relationship between self-concept clarity and identity processes. They showed that daily fluctuations in self-concept clarity co-occurred with reciprocal fluctuations in identity commitment (commitment to one's identity, or aversion to self-exploration; Berzonsky, 2004). This supports the notion that self-concept clarity is related to a stable (committed) sense of identity. An argument could be made that there is strong overlap between the Representational and Temporal selves, due to the emphasis on changes across time. Rather, there is an evident conceptual link between dimensions where self-concept clarity and self-continuity reflect more spiritual dimensions of the self and require self-reflection to better identify the present self. The distinction between these concepts (and the associated dimensions) is found in the emphasises on how time is operationalised. Self-concept clarity is a clear and stable state identity (who I am right now) as *defined* by the past. In other words, our sense of self is governed by an appreciation or respect for past behaviours and attitudes which influence the current state (i.e. who I was made who I am), yet the emphasis remains on the current state. Whereas self-continuity focuses on the *magnitude of change* across time, rather than the effect of change, with a unique emphasis on future change. Self-continuity establishes that our expectation of future changes is reflective of changes in the past. As such, I distinguish the Representational self from the Temporal self by respective emphasise on the present self as determined by the past self, as opposed to the present self in comparison to the past and *future* self.

In summary, the self is a holistic structure built of individual components. The self is dynamic, as are the individual components. These components are defined by their distinct capacities to interact and react to the implicit and explicit environment. I present a multidimensional model which proposes that the self can be examined as the product of 6 core dimensions: affective self, motivational self, executive self, interpersonal self, temporal self, and representational self. While these dimensions are conceptually distinct, the multitude of self-constructs that operationalise these dimensions must have synergetic and interrelated relationships to govern the self as a whole. Each dimension and the associated self-constructs are presented in Table 1a. This model is innovative and theoretically rationalised, although empirical evidence is lacking. Study 1 of this thesis is the first empirical research study to explore this multidimensional model of the self. First, however, we must address the other significant variable in this research: sleep.

1.3 Sleep and The Multidimensional Self

1.3.1 Sleep and Self-Compassion

Self-compassion is a complex trait, and described as the act, physical or psychological, of reducing one's own mental pain or suffering, and to mentally care for oneself during challenging times (Semenchuk et al., 2021). Neff (2003a) redefined this construct by breaking it down into three sub-components: self-kindness (being kind and understanding to oneself without self-criticism and judgement); 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). Individuals who display greater levels of trait self-compassion have been consistently shown to indicate improved psychological wellbeing, across a multitude of manifestations: lower depression (Odou & Brinker, 2014; Wadsworth et al., 2018) and anxiety (MacBeth & Gumley, 2012; Neff, 2004; Neff, 2003a; Neff et al., 2005; Raes, 2010), and increased happiness and optimism (Neff, 2003a; Neff et al., 2007). Research has also identified self-compassion as a mechanism for coping with daily hassles such as failure, rejection, and embarrassment (Leary et al., 2007). The direct link between psychological wellbeing and self-compassion has been extensively investigated, with current indications of self-compassion being an effective intervention for improving mental health (Leary et al., 2007; Neff, 2004; Neff, 2003a; Neff, 2015; Neff & Germer, 2017; Raes, 2010; Wilson et al., 2019).

Individuals who report greater self-compassion also report greater sleep quality. Self-compassion can be used strategically to promote resilience against mental health problems and related sleep disturbances (Kemper et al., 2015). A *cross-sectional* study of 203 by Kim and Ko (2018) identified significant negative correlations between trait self-compassion and sleep disturbance, anxiety, depression, and discomfort. By inference of a matching pattern analysed through multivariate linear regression, the authors demonstrate that positive self-compassion acts as a buffer against symptoms of poor sleep quality and mental health problems, whilst simultaneously increasing life satisfaction. Although, it should be noted that self-compassion was not manipulated in this study, so their conclusions may have statistical support, but lack causal evidence. Recent research has demonstrated self-compassion to be an effective mechanism for improving sleep quality in individuals displaying depressive symptoms (Bian et al., 2020). These authors show that the relationship between sleep quality and depression is mediated by rumination; however, this self-compassion moderated this mediation effect, where the mediating role of rumination was stronger for individuals with low (compared to high) self-compassion. These findings support the idea that self-compassion can improve poor sleep quality by enhancing psychological health. Similar to Kim and Ko (2018), this research used self-reported cross-sectional methods, and no experimental methods were utilised to examine a causal effect. The minimal experimental studies of self-compassion and sleep quality reveal a significant literature gap, where causal evidence of an effect is missing.

Previous research adds weight to such suggestions by revealing that individuals high in trait self-compassion engaging in proactive health behaviours such as exercise and relaxation (Sirois, 2015), and procrastinate less before bed (Sirois, 2019), whereas individuals with depressive symptoms show contrary behaviours (Cooney et al., 2013; Guo et al., 2020; Yong et al., 2020). Similarly, in a systematic literature review, Brown et al. (2020) documented a positive association between self-compassion and sleep quality, but none of the included studies used objective measures. Collectively, elevated levels of trait self-compassion seem to possess protective qualities against sleep disturbances, and the improved sleep quality resulting from greater self-compassion may conduce to greater psychological wellbeing. Individuals high on self-compassion may be more likely to implement healthier sleep behaviours, such as less bedtime procrastination (Sirois et al., 2018). Indeed, self-compassion interventions improved sleep quality in student populations and inpatients with depression and student populations (Butz & Stahlberg, 2018, 2020).

Neff and Garner (2018) conceptualized self-compassion as "action-orientated" and "comforting". Action-orientated self-compassion represents the pro-active and physical act of changing their environment to reduce mental pain or suffering, whereas comforting self-compassion is the mental aspect of regulating introspective states to provide self-care. In the realm of sleep quality, Semenchuk (2021) showed that self-compassion negatively associated with poor sleep quality; this association, though, was mediated by less self-blame (comforting self-compassion) but not proactive health focus (action-orientated self-compassion). It is possible, then, that the psychological mechanisms that connect these two forms of compassion are psychological (rather than physical. Indeed, findings indicate that self-compassion is related to more effective emotion regulation, reduced stress, and lower levels of psychopathology (Rakhimov et al., 2023). Also, low self-compassion is related to poor sleep quality, with this relation being mediated by sleep anxiety and perceived stress (Rakhimov et al., 2023). Further, Rakhimov et al. (2023) explored the mediating role of *sleep hygiene* (regular pre-sleep habits and behaviours); although sleep hygiene did not independently significantly mediate the relationship between self-compassion and sleep quality. This parallels the findings of Semenchuk (2021), concluding that self-compassion improves sleep quality via routes of comforting, affective, and emotional mechanisms, rather than action-orientated self-compassionate behaviours. By extension this adds support to my multidimensional model of the self, whereby the Affective Self dimension is characterised by self-compassion as meta self-evaluation (e.g., "it's ok that I am not ok").

Research into mindfulness, a component of self-compassion, has demonstrated that individuals who are typically more mindful have better overall quality of sleep (Bogusch et al., 2016; Ding et al, 2020; Howell et al., 2010; Hu et al. 2018), possibly because mindfulness is related to lower susceptibility to sleep disturbances (Garland et al. 2013). Further, Ding et al. (2020) reported that negative emotions mediated the link between mindfulness and sleep quality, and neuroticism had a moderating effect, whereby the direction of mindfulness to sleep quality was stronger in those with lower neuroticism. Mindfulness training and interventions are effective in improving other components of wellbeing (Choo et al., 2019). In a diary study, Hu et al. (2018) tested the role of daily self-compassion on sleep quality over two-weeks. Better nights of sleep quality followed days where participants experienced lower-level stressors, and this effect was moderated by self-compassion: high self-compassion was linked with a less negative influence of stressor on sleep quality. However, this study did not record state self-compassion. Taken together, sleep quality and self-compassion are positive related, in that greater engagement in self-compassionate behaviours improve sleep quality.

1.3.2 Sleep and Self-Esteem

Self-esteem is recognized as the value that an individual places on themselves, including their self-worth and self-respect (Garcia et al., 2019), and valence of self-evaluation (Brown and Mankowski, 1993). Self-esteem is one of the most commonly explored self-constructs (Monteiro et al., 2021), and has been implicated as a key determinant of many components of psychological wellbeing (Freire & Tavares, 2011; Paradise & Kernis, 2005; Richardson et al., 2021; Saini et al., 2020; Steiger et al. 2014), academic achievement (Alves-Martins et al., 2002), life satisfaction (Diener & Diener, 1995), psychopathology (O'Brien et al., 2006; Zeigler-Hill, 2011), and other metrics of personality (Amirazodi & Amirazodi, 2011; Robins et al., 2001). Higher self-esteem is associated with better physical health (Marmot 2003; Muhlenkamp & Sayles, 1986; Reitzes & Mutran, 2006) and psychological wellbeing (Dogan et al., 2013; Padhy et al., 2011). Researchers examined the extent to which self-esteem predicts psychological wellbeing, finding that participants with high self-esteem tended to be more emotionally stable, more extraverted, more conscientious, more agreeable, and more open to experience (Amirazodi & Amirazodi, 2011; Robins et al., 2001).

In addition, self-esteem is associated with sleep quality (Conti et al., 2014; Lemola et al. 2013), such that lower sleep quality is associated with lower self-esteem at a state level. Sleep quality and self-esteem should theoretically have a direct causal relationship, whereby better sleep quality causes and is caused by greater self-esteem, as sleep quality has been repeatedly found to have a direct relationship with physical (Fox, 1999) and mental dimensions of well-being (Azizi Kutenaee et al. 2020; Conti et al., 2014; Lemola et al. 2013), which themselves are strongly associated with self-esteem. A study by Yip (2015) explored the effects of racial discrimination and sleep quality on depressive symptoms and self-esteem over a three-year study. They show that low self-esteem is associated with poorer sleep quality, although they only measure sleep quality at one time point. No studies could be found that directly explore the *longitudinal* relationship between sleep quality and self-esteem. The exclusive cross-sectional comparison leaves a crucial gap in the literature, preventing us from drawing predictive conclusions regarding day-by-day interactions.

Research by Lee and Sibley (2019) provide insight into the relationship between sleep quality and self-esteem, by addressing the misconception that better sleep quality is characterised by longer sleep duration (i.e., more sleep is good sleep). Lee and Sibley (2019) examined the relationship between sleep duration and wellbeing in a sample of over 20,000 New Zealanders. First, they showed that almost half of the participants (42%) were not sleeping for the optimal time (between 7-9 hours), and stemming from this, they also show that participants who experienced less than optimal sleep (37%) had significantly lower self-esteem compared to those with optimal sleep, while those who experienced more than optimal sleep (4.5%) showed a higher number of depression symptoms (although no relationship with self-esteem). Additional research identifies a similar pattern, by assessing self-report data of 1805 adults in the USA (Lemola et al., 2013). This study revealed that individuals with symptoms of insomnia (showed lower self-esteem, and that both short (<6 hours) and long (>9 hours) sleep duration was associated with lower self-esteem, compared to individuals with moderate sleep duration (7-8 hours). There are two key points to draw from these studies: first, duration of sleep has a relationship with self-esteem, whereby lower amounts of sleep correlate with lower self-esteem; second, this relationship does not appear to be linear. In other words, less sleep is related to less self-esteem, but this does not mean that more sleep will result in more self-esteem. There is evidently a threshold of optimal sleep (Chaput et al.,2020; Kitamura et al., 2016; Lee and Sibley, 2019), beyond which self-esteem will decline once again. Studies such as these highlight the importance of recognizing the appropriate dimensions of sleep quality; in this case, sleep duration and sleep disturbances, as opposed to sleep latency or sleep depth, for example.

Some lines of theorising suggest that low self-esteem is prevalent as a symptom of depression, which is caused by abnormalities of REM sleep (Palagini et al., 2013; Ray et al., 2021). Sleep problems, such as prolonged sleep latency and frequent disturbances, are prevalent in up to 90% of individuals with depression (Mendlewicz, 2009; Nutt et al., 2008; Riemann et al., 2001), and poor response to antidepressants has been associated with increased REM density (Clark et al., 2000; Sandor & Shapiro, 1994). Physiological measures of sleep quality (such as polysomnography and EEG) have identified that individuals with depression show reduced REM onset latency, and increased REM duration and density (Nutt et al., 2008; Palagini et al., Pillai et al., 2011; 2013; Steiger, 2007). However, as previously discussed, some evidence suggests that total (Giedke & Schwärzler, 2002; Pflug & Tölle; 1971; Rudolph & Tölle, 1978; Wu & Bunney, 1990) and partial (Giedke et al., 2003; Schilgen & Tölle, 198) sleep deprivation temporarily improves symptoms of depression. Yet, although limited, research has found that partial sleep deprivation predicts decreased self-esteem (Fredriksen et al., 2012; Lemola et al., 2013; Roberts et al., 2009). This suggests the temporary reduction of depressive symptoms, following sleep deprivation, does not apply to self-esteem.

Self-esteem is also a moderator of the relation between sleep quality and cognitive functioning (Saini et al., 2020; Yip, 2015; Wang & Yip, 2020). Wang and Yip (2020) demonstrated the effects of higher quality sleep on coping mechanisms in days following prior days of discrimination. Participants completed a longitudinal diary study, whereby sleep quality was measured objectively with actigraphy, and problematic events of discrimination and stress were self-recorded over the course of two weeks. Participants who slept longer and with better quality were more likely to implement coping mechanisms the following day (e.g., support seeking behaviours, problem solving), and had greater wellbeing. Coping mechanisms have been well established as a reflection of self-esteem, as far as greater engagement in coping mechanisms increases self-esteem, and self-esteem facilitates engagement with coping mechanisms (Jambor & Elliott, 2005; Shrout & Weigel, 2020). Earlier research concurs with Wang and Yip (2020), indicating that lower quality sleep is related to increased rumination of prior stressful events (Liu et al., 2018; Palmer et al., 2018). Therefore, there is a clear theoretical link between self-esteem and sleep quality, whereby lower self-esteem increases levels of rumination, subsequently deteriorating sleep quality.

Collectively, research shows a well-established link between self-esteem and sleep quality, although there is a gap in the research whereby direct longitudinal associations between sleep and self-esteem are missing. The study by Lemola et al. (2013) establish a direct link, but only at a cross-sectional basis, whereas the study by Wang and Yip (2020) applied a longitudinal method but using self-esteem only as a moderator. This latter point is a limitation of the research on self-esteem but also other self-constructs; these studies explore one construct of the self in isolation, which is not representative of natural experiences – rather, the multitude of self-constructs interlink and co-occur with each other. So, it is unclear whether the examined self-construct (be it self-compassion, self-control, or self-esteem) is solely responsible for the observed effect.

1.3.3 Sleep and Self-Control

High self-control is associated with good physical (Hagger, 2010; Hagger et al., 2019; Miller et al., 2011) and psychological health (Bowlin & Bear, 2012; Hofmann et al., 2014; Li et al., 2021; Moffit et al., 2013). A large-scale longitudinal study by Moffit et al., (2011) followed a cohort of 1000 participants from birth to 32 years old. Childhood greater self-control was a key determinant of positive physical health and negative substance dependence. Similarly, Junger and van Kampen (2010) measured self-control capacity and physical health. Participants who reported greater self-control also reported healthier eating patterns, greater physical activity, and lower BMI. Regarding psychological wellbeing, three studies conducted by Li et al. (2021) reveal that trait self-control is positively associated with hedonic and eudemonic wellbeing. Further, in a meta-analysis, Guarana et al. (2021) established a positive association between self-control and sleep quality.

Considerable literature has associated poor sleep quality with abnormal reward processing (Boland et al., 2020; Libedinsky et al., 2013; Palagini et al., 2019), particularly with reductions in effort discounting (Boland et al., 2022; Libedinsky et al., 2013). Individuals with greater sleep deprivations will exert less physical effort to obtain a reward and devalue the reward if greater effort is required to obtain it. However, more recent studies have reported contradictory findings, in that poorer sleep-quality predicts increased willingness to work for the reward on the EEfRT (Boland et al., 2022).

Curtis et al. (2018) recently examined the duration of sleep as a measure of sleep quality, and the relationship with reward responsivity as a measure of self-control. Participants completed the PSQI and a delay discounting task (Lowenstein, 1988). Relative to habitually poor sleep (> 6 hours), habitually good sleep (7-9 hours) was associated with a preference for larger-but-delayed rewards. Massar and Chee (2019) found concurring results in their study of sleep quality and reward reposit and suggested that individuals who get habitually poor (vs. good) sleep make decisions before bedtime that provide immediate benefit or satisfaction (e.g., staying up late to watch television), instead of opting for long-term benefits (such as health or productivity) achieved by healthier sleep hygiene. The relationship between self-control and sleep quality via this route of sleep hygiene has recently become popular in psychological research, with empirical research (Dorrian et al., 2019; Kroese et al. 2014; Massar & Chee, 2019) and literature reviews (Pilcher et al., 2015) providing support. Pilcher et al. (2015) concluded that self-control is replenished by sleep, although self-control is more quickly depleted than replenished. Indeed, it is common to experience intermittent days of low self-control despite healthy sleep habits. A reason is that habitual sleep patterns are more strongly linked to individual differences in self-control and discounting than a single night of deprivation, such as more or less habitual implementation of self-control, whereby some individuals show more than others, requiring more replenishment. Although, an unexplored line of theorising concerns whether such an outcome is due to an increased ability for self-control or lack of motivation to employ it. In all, this research demonstrates the effects of sleep quality on self-control and reward responsivity and highlights the importance of using the appropriate dimensions of sleep quality (as per Lee & Lawson, 202).

Some researchers focused on the consequences of sleep deprivation as a way to understand the link between sleep and self-control. In a cross-sectional investigation, Meldrum et al. (2015) found that sleep deprivation was related to low self-control. However, concurring findings have not been observed in studies of total sleep deprivation. For example, Libedinsky et al. (2013) assessed self-control in participants who were either permitted typical night's rest or totally sleep deprived. Sleep deprivation resulted in significantly increased effort discounting but did not affect delay discounting. That is, participants who were sleep deprived showed no difference in preference for delayed-but-larger rewards over immediate-but-smaller rewards compared to the typical sleep condition, but sleep deprived participants were more likely to choose rewards that required less effort to obtain, regardless of reward value. Sleep deprivation devalued rewards when greater effort was required to obtain it. Additional support for such a conclusion comes from neural studies (Dorrian et al., 2019), indicating that that sleep deprived individuals show less activity in brain areas (responsible for executive function, leading to a lack of impulse control in response to food cues (Demos et al. 2017; Satterfield et al., 2018), increased positive perceptions of neutral cues (Gujar et al., 2011), and emotion recognition in facial expressions (Cote et al., 2014; Killgore et al., 2017). Take together, research into sleep deprivation reveals an impairment on neural and behavioural self-control, as far as self-control is typically weaker in individuals lacking sleep.

Sleep quality has been frequently identified as a predictor and moderator of day-to-day self-regulatory behaviours (Diestel et al., 2015; Przepiorka et al., 2019; van Eerde & Venus, 2018). Such research has revealed that trait self-control capacity moderates the day-specific interactions of sleep quality and emotional dissonance (displaying emotions due to social context, opposing truly felt emotions; Diestel et al., 2015), and work-related procrastination (Przepiorka et al., 2019; van Eerde & Venus, 2018), in that procrastination is negatively related to prior night's sleep quality, especially in those with low trait self-control. Diestel et al. (2015) conducted two diary studies testing how self-control and sleep quality mediate the effect of daily emotional labour on wellbeing. Although days of increased emotional labour impaired wellbeing, this effect was attenuated when the participants had experienced greater sleep quality the night before. Similarly, participants showing higher self-control also experienced this effect to a lesser degree. However, the researchers assessed typical experiences instead of daily self-control. Van Eerde and Venus (2018) did just that, showing that sleep quality was negatively related to procrastination the next day, although this pattern was only present in those low on self-control. Yet, in other research, procrastination predicted sleep-problems but sleep problems negatively predicted procrastination (Przepiorka et al., 2019): poorer sleep was a result of increased procrastination the day before, although less procrastination followed nights of poor sleep. As such, poorer sleep quality may contribute to greater immediate self-control (less procrastination). These empirical discrepancies might be due to different manifestations of self-control. Some research assessed self-control via self-report (Meldrum et al., 2015; Pilcher et al., 2015), whereas others did so via objective tasks (Curtis et al., 2018; Kelley et al, 2021; Libedinsky et al., 2013). In the same vein, some researchers use reward responsivity as a measure of self-control (Curtis et al., 2018; Kelley, Butterworth, Boland & Sedikides, 2021; Libedinsky et al., 2013;), whereas others regard procrastination as a measure of self-control (Kroese et al. 2014; Massar & Chee, 2019; Przepiorka et al., 2019). In the latter case (Przepiorka et al., 2019), it is possible that this finding is due to moderating effects of stress or anxiety. For example, should an individual have an upcoming exam or deadline, and there is a desperate need to for productivity, then it is likely that individual will work later into the evening (pushing back their sleep onset) and wake up earlier in order to continue working (reducing duration of sleep). On the surface, this might appear to reflect poorer sleep quality leading to better self-control, whereas it may instead be the case that this relationship is being heavily moderated by external factors, such as stress or motivation. Nonetheless, contrary findings such as these, coupled with the lack of consistency between measurement and product of these concepts, leave the relationship between sleep quality and self-control unclarified.

In summary, there is converging support for the notion that better sleep quality is associated with greater self-control (Curtis et al., 2018; Kelley et al., 2021; Meldrum et al., 2015; Pilcher et al., 2015). However, there are discrepancies between manifestation of self-control (Przepiorka et al., 2019) and method of measurement (Libedinsky et al., 2013). Therefore, it is important that self-control and sleep quality be examined across a diverse range of measurement and manifestations.

1.3.4 Sleep and Self-Continuity

Self-continuity is the subjective sense of connection to one's own past and future selves (Sedikides et al., 2023). Self-continuity is associated with greater health (Rutchick et al., 2018) and academic achievement motivation (Chrishima & Wilson, 2021). Given the youth of this self-construct, there is only one empirical study that identifies a relationship between self-continuity and sleep quality. A recent thesis by Samuel Brotkin (2015) used cross-sectional self-report survey data to explore the relationship between self-continuity and health behaviour. In this study, they incorporate sleep as a facet of health and show that stronger feelings of self-continuity were associated with better health variables, including sleep quality. This study by Brotkin is the only published work that considers sleep in a study of self-continuity, and despite the link between sleep quality and self-continuity, any inferences are limited as it only explores sleep as a sub-component or covariate of other variables.

Nonetheless, the connection between sleep quality and self-continuity is theoretically relevant for two reasons. First, self-continuity is a property of the self-concept (Dunkel, 2005, 2010), which implies that self-continuity may be another integral part of the holistic (multidimensional) self. Simultaneously, self-continuity is related to self-control, as individuals who have a more vivid and positive perspective if their future selves make decisions that hold long term benefit over short-term benefit (Hershfield, 2011). In addition, self-continuity is related to self-concept clarity (Jiang et al., 2020; 2022), as participants with low self-concept clarity report lower connection to their past selves and also have less trait self-control and implemented less self-control in experimental tasks, with these effects being mediated by self-continuity.

Second, self-continuity may be connected to sleep quality through memory. The self is memorial in the sense that self-knowledge or autobiographical experiences are represented in memory (Conway & Pleydell-Pearce, 2000; Conway 2005; Conway et al., 2019). Autobiographical knowledge influences self-perception, and the self governs storage and retrieval of memories. For example, should one believe they have good self-control, they can only believe this by accessing the stored memories of the times they did or did not implement self-control. Bluck and Alea (2008) further show that participants who report low self-concept clarity use their autobiographical memories as a source of improving self-continuity. As mentioned earlier, a key function of sleep is to consolidate and encode memories (Stickgold & Walker, 2005; Stickgold, 2005; Zhang et al., 2022). A recent study by Khormizi et al. (2019) specifically tested the effect of sleep deprivation on autobiographical memory. Following a night of sleep deprivation (8-12 hours shift working), compared to a control group (usual night sleep), participants performed worse on a test of autobiographical memory. Rather, participants were unable to consolidate or encode what they had learned. This study also showed that sleep deprived participants recalled more negative cues than positive, suggesting a confounding role of emotion regulation. Thus, memory is a bridge between sleep quality and self-continuity.

Evidence from neural studies is consistent with this proposition. Martinelli et al. (2012) conducted three meta-analyses of neuropsychological studies that explored the neural underpinnings of episodic autobiographical memoires, semantic autobiographical memories, and representations of the self. Each of these memory types was more active in independent brain regions, with the self primarily activating the medial prefrontal cortex. Shan et al. (2017) compared participants with chronic fatigue syndrome against a control group, using MRI to examine the association between sleep quality and brain structure variations. They found lower intensity activation in the medial prefrontal cortex for chronically fatigued patients. Other research has found that the medial prefrontal cortex plays a key role in self-referential processes (Lemogne et al., 2012), including self-evaluation (Beer et al., 2010) and self-representation (Wagner et al., 2012). Also, neurophysiological research shows that sleep deprivation impairs hippocampal response and neuronal plasticity (Deak & Stickgold, 2010; Kreutzmann et al., 2015) and inhibits neurogenesis (Deak & Stickgold, 2010; Kreutzmann et al., 2015 Zucconi et al., 2006). The impaired neural plasticity and neurogenesis inhibits an individual’s capacity to retrieve memories or encode new memories. Together, poor quality of sleep evidently has a detrimental effect on neural mechanisms responsible for encoding new memories and retrieval of old memories. Relevant to theories of the self, I propose that self-continuity and sleep quality are linked via the memory network, as far as better sleep quality associates with stronger self-continuity.

1.3.5 Sleep and Self-Enhancement

Self-enhancement is the motivation to seek out favourable feedback which boosts self-esteem (Dunning, 1995; Sedikides & Alicke, 2009; Sedikides, 2021). Self-enhancement motives may be observed as comparisons to the average peer (Zell et al., 2020) or to a set of external criteria (Gregg et al., 2011). Some research suggesting that self-enhancement is positively associated with physical health (Segerstrom and Roach, 2008), whereas other research reports null findings (Zell et al., 2022). No work has tested the relationship between self-enhancement and sleep quality. However, self-enhancement is often operationalized in terms of narcissism (Sedikides, 2021; Yang et al., 2019; Zell et al., 2022), where grandiose narcissism is characterised by high irrationally high self-esteem, arrogance, and entitlement, and vulnerable narcissism is characterised by irrationally low self-esteem, social withdrawal, and defensiveness (Crowe et al., 2019; Miller et al., 2017; 2019). Other theorising differentiates adaptive from maladaptive narcissism, characterised by authority and self-sufficiency vs entitlement and manipulativeness, respectively (Von Kanel, et al., 2017; Cai and Luo, 2018). However, the link between narcissism and sleep quality has been tested with contradictory results, where some authors report that narcissists have worse sleep quality than typical individuals (Schwarzkopf et al., 2016; Annen et al., 2020), others suggest adaptive narcissists have better sleep quality, but maladaptive narcissists have worse sleep quality (Von Kanel, et al., 2017) and other research suggesting no relationship at all (Yang et al., 2019). Together, it is evident that further investigation is warranted to establish a clearer association between sleep quality and self-enhancement, and by extension, the motivational self.

1.3.6 Sleep and Self-Expression

Self-expression is regarded as the manifestation of one's point of view or their engagement in socially appropriate beliefs and emotions (Green, 2007; Sripada, 2016). It is a representation of the social or presented self (as opposed to the authentic self; Neisser, 1991; Neisser, 1993; Zahavi 2015). Self-expression is indicative of the Interpersonal Self (as it is operationalised by presentation of the self within a social context (Green, 2007; Neisser, 1993; Zahavi 2015). No known relevant research has directly considered how sleep quality is associated with self-expression. Researchers, though, have examined similar variables, such as emotion suppression (effortfully withholding true opinions or motivations, opposite to emotional expression), or emotional intelligence (appropriately selecting context relevant expressions). Zhu et al. (2023) explored whether cultural differences moderate the effect of emotion suppression on sleep. The researchers used actigraphy to measure objective sleep quality across 14 days, while participant also self-reported subjective sleep quality and emotion suppression in a daily diary format. On days of greater emotion suppression, the participants reported less sleep duration in the preceding nights; also, greater emotion suppression was associated with lower subjective sleep quality across the two-week study. However, these results were present among European Americans, but not East Asians. Regardless, this pattern was replicated by others (Latif et al., 2019; Vantieghem et al., 2016). Similarly, sleep quality is associated with higher emotional intelligence (Emert et al., 2017; Killgore et al., 2022) although results are not entirely consistent (Heidari et al., 2019). Greater self-expression, then, is likely to be related to better sleep quality, inferred through the empirical findings of similar comparable variables of the Interpersonal Self. Although, it must be noted that such empirical findings are inconsistent, and there is some hypothetical link between self-constructs. Furthermore, there is an argument to be made that emotional suppression and emotional intelligence are equally representative of the Executive Self, as they are characterised by a capacity and willingness to self-direct behaviour (Baumeister & Vohs, 2003; Neiss et al., 2005). Nonetheless, while this may reflect the interaction between dimensions of the self, it certainly deepens the literature gap for research that explores the Interpersonal Self and sleep quality.

1.3.7 Sleep and Self-Concept Clarity

Self-concept clarity refers to the lucidity with which one defines their personality (Campbell et al., 1996; Kriegel and & Williford, 2006) and is the operationalization of the representational self (Campbell et al., 1996). Little research, if any, has been conducted investigating the relationship between self-concept clarity and sleep quality. At best, there is a world of research into sleep quality and memory capabilities, where we recognize that self-concept clarity is embedded in one's memory (Klein and & Loftus 1988; Ray et al. 2009). Although, research into memory and sleep quality rarely targets the self as a primary variable. It is through the medium of memory that it is logical to propose that better sleep quality will associate with a greater sense of self-concept clarity, as better sleep quality results in better memory consolidation (Stickgold & Walker, 2005; Stickgold, 2005; Zhang et al., 2022). However, there is no known research that directly explores the relationship between sleep quality self-concept clarity. Hence, to the best of this author's knowledge, the present research is the first to explore sleep quality and its association with the representational self. It is here that we find ourselves at the doorstep of the present research.

1.4 The Present Research

The self is multidimensional, as far as one's own self-identity extends beyond solely physical, or emotional, or attitudinal displays, but rather all self-constructs accumulate to define the self. Therefore, in order to understand the self, we must explore all dimensions independently, and the self as a holistic concept. Simultaneously, sleep plays a vast role in the manifestation of the human condition; rather, sleep is a determinant of many of our biological and psychological behaviours and attitudes. Despite hundreds of years' worth of research on sleep, it is apparent that we do not fully understand the complete function and impact of sleep. The self and sleep quality are bonded phenomena, that much is clear; however, the full extent of this relationship is not. I have identified three crucial literature gaps that require acknowledgement.

First, research that has aimed to directly explore this relationship has placed a heavy focus on a limited number of self related variables, only examining a few self-constructs at a time, which only presents a narrow understanding of the way sleep quality and self-constructs interact. There is a large gap in the literature for research that seeks to explicitly explore the relationship between sleep quality and a wider range of self-constructs, expanding throughout the many dimensions of the self. Second, despite the reasonable amount of research that has considered sleep quality, self-compassion, self-control, self-esteem, and self-continuity, it is apparent that very little research has explicitly targeted the relationship between these specific variables. Rather, the vast majority of research has considered these variables in studies of broader aims, including them as confounding variables. Third, no research has examined the causal relationship between sleep and the self. While limited research has explored the relationship between sleep quality and these self-constructs, few have attempted to address whether sleep quality is the determinant of these self-constructs, or vice versa; alternatively, perhaps both directions are evident, and the direction of relationship between these variables is in fact a casual cycle. Particularly, there is a lack of experimental and longitudinal studies that attempt to examine how daily changes in self-constructs relate to nightly changes of sleep quality. I conducted four studies that aim to address these gaps.

I begin by testing the dispositional associations between sleep quality and seven core self-constructs (Study 1), exploring the strength of associations with intention to select the most promising associations for follow-up studies. I then conducted a series of longitudinal studies that test the bidirectional effects of sleep quality and the selected self-constructs (Study 2 - 4). I ask how nightly sleep quality predicts the succeeding days self-constructs, and how these self-constructs predict succeeding night's sleep quality. The four studies use complementary methodological designs, including cross-sectional and longitudinal, subjective and objective, and experimental and natural.

Chapter 2 Study 1

"There is a time for many words, and there is also a time for sleep."

- Homer (*The Odyssey*, 2011)

Studies on sleep quality and the self are limited and have been conducted in a piecemeal fashion. The general trend of such research is to examine one or two self-constructs within a wider frame, focusing on alternative research objectives, and ignoring the interactive and dynamic processes of the self. In many cases, self-constructs are considered in sleep research simply as confounding variables or sub-components of larger concepts. Thus, although some self-constructs (such as self-esteem, self-compassion, and self-control) are well associated with sleep quality, they have not been studied in a multidimensional context. There is a large number of empirical studies which support an association between sleep quality and the affective and executive self, but little or no research that examines the remaining four dimensions. All six dimensions of the multidimensional self model can be theoretically associated with sleep quality, but empirical support is necessary to uncover the full connection between sleep quality the self. The purpose of Study 1 is to target the relationship between sleep quality and the self with a more holistic perspective by examining how self-constructs representative of the multidimensional self are associated with sleep quality. I conducted a thorough review of the literature, drawing on any research that has specifically considered the relationship between sleep quality and at least one self-construct. I included all self-constructs that have been empirically tested in prior sleep research as either a primary (main effect) or secondary (co-variant) factor of sleep quality. To that effect, in a cross-sectional study, I administered a battery of self measures that reflected the six core components of the self (Table 1a). To assess the affective component of the self (i.e., how one feels about the self) I administered measures of self-esteem and self-compassion. To assess the executive component of the self (i.e., what guides the self) I administer a measure of self-control. To assess the motivational component of the self (i.e., what drives the self) I administer a measure of self-enhancement motivation. To assess the representational component of the self (i.e., how the self is represented in memory) I administer a measure of self-concept clarity. To assess the interpersonal self (i.e., how the self is expressed to others) I administered a measure of self-expression. Finally, to assess the temporal component of the self (i.e., how stable the self is across time) I administer a measure of self-continuity.

2.1 Hypotheses

I measure seven self-constructs, as manifestations of the six components of the self. However, I only make hypotheses about those self-constructs that have empirical grounds based in prior literature. I hypothesise that higher self-control, self-esteem, and self-compassion will all be associated with better subjective sleep quality. I adopt an exploratory approach for the remaining self-constructs.

2.2 Method

2.2.1 Participants

I tested 315 participants via the online platform Prolific (https://www.prolific.co). This web service allows access to approximately 150,000 screened participants (Palan & Schitter, 2018; Prolific.com, 2024). Peer et al. (2017) compared Prolific to other crowdsourcing platforms (e.g., MTurk) and a university subject pool. The quality of data collected via Prolific is comparable in terms of reliability and effect sizes to that of data collected in behavioural laboratories. Moreover, Prolific participants are more naïve to common experimental research tasks, and more demographically (e.g., geographic location, age, ethnicity) diverse than other crowdsourcing platforms or university subject pools. I excluded participants from the study if they did not complete all the measures ($N = 6$). At the end of the study, I asked participants if I should use their data in the study. I excluded those who responded "no" ($N = 10$). The final sample consisted of 299 participants. They were 18-75 years old (Myears = 37.02, *SD*years = 14.06) UK residents, most of whom were women ($N = 226$, 76.1%), non-Hispanic ($N = 297$, 99.34%), and White ($N = 273$, 91.9%). I also asked participants to report on their marital status, education, employment, and income. The majority of participants were unmarried ($N = 185$, 61.46%), held a university degree ($N = 166$, 55.15%), were currently working ($N = 188$, 62.46%), and earned below the UK median income ($N = 159$, 52.82%).

2.2.2 Measures and Procedure

Participants responded to a series of questionnaires referring to sleep quality and the six self-constructs. I report all scales in Appendix A.

Sleep Quality. I assessed sleep quality with the PSQI (Buysse et al., 1989), a widely used self-report instrument for assessing subjective past-month sleep quality. The scale consists of 19 questions from which seven component scores are derived representing habitual sleep duration, disturbance, latency, efficiency, quality, sleep medication use, and daytime dysfunction due to sleepiness.

Component scores are combined to yield a total score ranging from 0 to 21, with greater scores indicating worse sleep quality (Buysse et al., 1989). On some questions, participants respond on a 4-point scale (e.g., "During the past month, how often have you had trouble sleeping because you cannot get to sleep within 30 minutes?"; Not during the past month, Less than once a week, Once or twice a week, Three or more times a week) and other questions permit open-ended responses (e.g., "During the past month, what time have you usually gone to bed at night? "). Despite being open-ended questions, the answers to these questions are very limited (but allow more accurate response); therefore, these responses were manually coded by changing answers to a single numerical value, to permit statistical analysis (e.g., "About 10:30, sometimes 11:00" becomes "22:30"). A cut-off score of 5 has good specificity (86.5%) for detecting poor sleepers, with scores lower than 5 reflecting good sleepers. Here, for clarity, I reversed-score these components so that higher scores reflect better sleep quality. The scale has demonstrated acceptable re-test reliability and validity in studies of good versus poor sleepers (Buysse et al. 1989) and manifested high correlations with polysomnographic data and sleep diary data in patients with sleep disorders (Backhaus et al. 2002). Smyth (2012) provided a Cronbach's Alpha of α = .83 for the scale.

Self-Compassion. I assessed self-compassion with the 12-item self-compassion scale – short Form (SCS-SF; Raes et al., 2011). Participants indicate how they typically act toward their self in challenging 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-judgement (e.g., "I'm disapproving and judgmental about my own flaws and inadequacies"; reverse coded), 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 coded), 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 coded). Raes et al. (2011) confirmed the reliability and validity of the SCS-SF in their original two studies of Dutch samples (*N* = 456) in addition to a third study of English participants (*N* = 415); they also reported a Cronbach's alpha of .86 across samples.

Self-Esteem. I assessed self-esteem with the 10-item Rosenberg Self-Esteem Scale (RSE; Rosenberg, 1989). A sample item is: "On the whole, I am satisfied with myself" 1 = strongly agree, 6 = strongly disagree). The RSE is the most popular measures of self-esteem (Sinclair et al. 2010), with good predictive validity and retest reliability (Torrey, et al., 2000). Sinclair et al. (1020) tested over 500 participants and reported a Cronbach Alpha of α = .81.

Self-Control. I assessed self-control with the brief (13-item) version of the Self-Control Scale (BSCS; Tangney et al., 2004). Participants rate the extent to which they identify with 13 statements about behavioural self-control (e.g., "I am good at resisting temptation"; 1 = not at all like me, 5 = very much like me). In their original study, the authors conducted two studies that used the BSCS alongside measures of impulsivity and self-control and reported high reliability (Cronbach's Alpha scores of α = .83 and α =.85 in Study 1 and 2, respectively), and high retest reliability (.87).

Self-Continuity. The self can refer not only to past or present attributes (as many self measures assess) but also future or possible attributes (Markus & Nurius, 1986; Oyserman & Markus, 1990). Accordingly, I assessed self-continuity with the 8-item future self-continuity scale adapted from Sedikides et al. (2015) to future or possible attributes as a complement to the other measures where I assess past or present attributes. This specific scale was selected due the emphasis on one's connection to their future self, unlike other brief questionnaires of self-continuity (e.g., Self-Continuity Index; Sedikides et al., 2016) which place emphasis on the past self and may not be clearly distinguishable from self-concept clarity. The selected self-continuity scale is also more practical and applicable in this research than other measures (such as Ersner-Hershfield's Future Self-Continuity Measure which requires participants to select one of seven overlapping circles indicative of their subjective connection between the current and future self (Ersner-Hershfield et al., 2009). The 8-item future self-continuity scale requires participants to indicate 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") using a Likert scale (1 = strongly disagree, 7 = strongly agree). Sedikides et al. (2015) reported strong test-retest reliability in both personal (α = 0.83), and temporal (α = 0.67) self-continuity items.

Self-Enhancement. I assessed self-enhancement with the two relevant items from the self-motives scale (Gregg et al., 2011). This scale tests self-motives via four sub-headings: self-enhancement, self-assessment, self-verification, and self-improvement. Each subscale uses two items. I only included the self-enhancement subscale. The items are: "In general, I LIKE to hear that I am a GREAT person" and "In general, I WANT to discover that I have EXCELLENT qualities" (1 = strongly agree, 7 = strongly disagree). I reverse-scored and averaged the responses, so that higher scores reflected stronger self-enhancement. Gregg et al. (2011) reported significant test-retest reliability, plus content and predictive validity. Gong et al. (2013) reports a Cronbach's Alpha of α = .93.

Self-Expression. I assessed self-expression with the 11-item version of the value-of-expression questionnaire (VEQ; Kim & Sherman, 2007). Participants indicate the extent to which they value self-expression in their behaviours (e.g., "I express my feelings publicly, regardless of what others say") and beliefs (e.g., "Freedom of expression is one of the most important rights that people should have"; 1 = strongly disagree, 8 = strongly agree. Kim and Sherman (2007) reported moderate test-retest reliability for both components of self-expression (behaviour $\alpha = 0.64$; belief $\alpha = 0.62$), along with significant convergent validity with a self-construal scale (Singelis, 1994; see also Gibas et al., 2016), assessing the independent and interdependent selves.

Self-Concept Clarity. I assessed self-concept clarity with the 12-item self-concept clarity scale (SCC; Campbell et al., 1996). It measures the extent to which the self is clearly defined (e.g., "In general, I have a clear sense of who I am"), internally consistent (e.g., "My beliefs about myself are often in conflict with one another"; reverse coded), and stable (e.g., "On one day I might have one opinion of myself and on another day I might have a different opinion"; reverse coded), from 1 (disagree very much) to 6 (agree very much). This measure is not only well validated ($\alpha = .86$; Campbell et al., 1996), but the measure emphasises clarity of the self as defined by the past (e.g. "I seldom experience conflict between the different aspects of my personality"), distinguishing self-concept clarity from more temporal measures of the self, such as self-continuity.

2.3 Results

2.3.1 Sample Size Determination

First, I conducted a power analysis in G*Power 3.1 (Faul et al., 2009) using the "Correlation: Point biserial model" statistical test from the t-tests test family. For the effect size estimate, I used the median correlation coefficient in self research ($r = .29$) derived from a recent empirically derived guidelines for effect size interpretation in social psychology (Lovakov & Agadullina, 2021). 91 participants were needed to detect these effects with 80% power and a two-tailed test. Given that simulation studies show correlations stabilize at samples of 250 participants (Schönbrodt & Perugini, 2013), I sought to recruit at least that number. Thus, the study was well-powered ($N = 299$).

2.3.2 Bivariate Linear Correlations

First, I conducted bivariate correlations on the relationship between sleep quality, self-control, self-esteem, self-compassion, self-enhancement motivation, self-concept clarity, self-expression, and self-continuity (Table 1a). Better sleep was associated with greater self-control (r (299) = -.20, $p < .001$), self-esteem (r (299) = -.23, $p < .001$), self-compassion (r (299) = -.23, $p < .001$), and self-continuity (r (299) = -.22, $p < .001$). Although better sleep was associated with greater self-concept clarity (*r* (299) = -.14, *p* = .014), this comparison did not survive Bonferroni adjustment for multiple comparisons (.05/7 = .007). Finally, neither self-enhancement motivation (*r* (299) = .01, *p* = .805) nor self-expression (*r* (299) = -.05, *p* = .422) were significantly associated with PSQI global scores.

Next, I compared intercorrelations between the self-constructs. All self-constructs significantly correlated with each other where *p* < .001, except for self-enhancement. Self-enhancement only significantly correlated with self-expression. Table 1b displays the full correlation matrix.

2.3.3 Multiple Regression

Next, I conducted a series of individual linear regressions to determine a predictive relationship between sleep quality and the 7 tested self-constructs. The respective ANOVAS revealed a significant negative predictive relationship between sleep quality and self-compassion (*F*(1, 297) = 16.41, *p* < .001), as did self-control (*F*(1, 297) = 12.24, *p* < .001), self-esteem (*F*(1, 297) = 17.08, *p* < .001), self-continuity (*F*(1, 297) = 15.28, *p* < .001), and self-concept clarity (*F*(1, 297) = 6.17, *p* = .014). No significant predictive relationship was found for self-expression (*F*(1, 297) = .65, *p* = .422) or self-enhancement (*F*(1, 297) = .061, *p* = .805). These results imply that poorer sleep quality predicts poorer self-compassion, self-control, self-esteem, self-continuity, and self-concept clarity.

Then, I conducted a multiple regression analysis to determine whether each of 7 self-constructs predicted sleep quality, when controlling for the other variables. The results of the ANOVA were significant (*F*(7, 291) = 3.83, *p* < .001), where the model (including all 7 self-constructs) explained 8.4% of the variance. However, no individual self-constructs significantly predicted sleep-quality when controlling for the other variables (Table 1c).

2.3.4 Comparison of Means between Good and Bad Sleepers

Following the guidelines of the PSQI, I compared categorically good sleepers (*N* = 166; PSQI Global ≤ 5) to bad sleepers (*N* = 133; PSQI Global ≥ 6) by way of independent samples t-test (Table 1d) . Good sleepers (*M* = 3.28, *SD* = 0.61) scored significantly higher in self-control than bad sleepers (*M* = 3.05, *SD* = 0.59), (*t*(297), 3.25, *p* < .001, Cohen's *d* = 0.38, 95% CI [0.15, 0.61]. Good sleepers (*M* = 4.14, *SD* = 1.08) scored significantly higher in self-esteem than bad sleepers (*M* = 3.63, *SD* = 1.15), (*t*(297), 3.97, *p* < .001, Cohen's *d* = 0.46, 95% CI [0.23, 0.69]. Good sleepers (*M* = 2.95, *SD* = 0.68) scored significantly higher in self-compassion than bad sleepers (*M* = 2.66, *SD* = 0.68), (*t*(297), 3.64, *p* < .001, Cohen's *d* = 0.42, 95% CI [0.19, 0.65]. Good sleepers (*M* = 4.65, *SD* = 1.29) scored significantly higher in self-continuity than bad sleepers (*M* = 4.05, *SD* = 1.37), (*t*(297), 3.87, *p* < .001, Cohen's *d* = 0.45, 95% CI [0.22, 0.68]. Although good sleepers (*M* = 3.77, *SD* = 1.08) scored higher in self-concept clarity than bad sleepers (*M* = 3.50, *SD* = 1.05), (*t*(297), 2.17, *p* = .031, Cohen's *d* = 0.25, 95% CI [0.02, 0.48], this effect did not survive Bonferroni adjustment for multiple comparisons (.05/7 = .007). Self-enhancement motivation did not differ significantly between good sleepers (*M* = 5.31, *SD* = 1.05) and bad sleepers (*M* = 5.36, *SD* = 0.92), (*t*(297), -0.44, *p* = .657, Cohen's *d* = -0.05, 95% CI [-0.28, 0.18]. Finally, self-expression did not differ significantly between good sleepers (*M* = 5.22, *SD* = 0.71) and bad sleepers (*M* = 5.19, *SD* = 0.74), (*t*(297), 0.36, *p* = .717, Cohen's *d* = 0.04, 95% CI [-0.19, 0.27]. The greatest significant difference between good and bad sleepers is seen in self-continuity, followed by self-esteem, self-compassion and finally self-control (Figure 1a).

2.3.5 Factor Analysis

To support the distinct dimensions of the multidimensional model of the self, I ran an exploratory factor analysis using the mean scores of the 7 tested self-constructs. Factor analysis assumptions were met indicating applicability of factor analysis; Kaiser-Meyer-Olkin test of sampling adequacy was above 0.6 (KMO = .845) , and Bartlett's tests of sphericity was significant (*p* < .001). Maximum Likelihood Estimation was used for extraction of factors (following guidance of Le Cam, 1990), and an oblique rotation (Direct Oblimin where Delta = 0) was applied due to the correlations across variables. The factor model fit the data well (χ^2 (8) = 13.55, *p* = 0.1). The proportion of variance explained by the extracted factors for each individual variable are presented in Table 1f.

Total Initial Eigenvalues reveal two components with values greater than 1. These two components explain 62.8% of the variance (Table 1e and Figure 1b). The factor loadings after rotation are presented in Table 1g, and the correlations between variables and factors are presented in Table 1h. Component 1 consists of self-compassion, self-control, self-esteem, self-continuity, and self-concept clarity. Component 2 consists of self-enhancement and self-expression. The factor weights of both components support the bivariate linear correlations, however, do not support the initial hypothesis of 6 factors (dimensions).

2.4 Discussion

Study 1 is the first research study to simultaneously explore the relationship between sleep quality and six dimensions of the self. I highlight three key findings. First, sleep quality significantly correlated with four self-constructs, with low-medium effect sizes. This is indicative of a sound relationship between sleep quality and the self. Second, as hypothesised, self-compassion, self-esteem and self-control were *positively* related to sleep quality, suggesting that more positive sleep quality is associated with increased self-control, self-compassion, and self-esteem. In light of the absence of prior research, I finally hypothesised that self-continuity would positively correlate with sleep quality, and indeed the results indicated that self-continuity was among the strongest correlates of sleep quality.

Self-concept clarity was also a significant correlate of sleep quality, and independently predicted sleep quality. Although this relationship is noticeably weaker than the other four self-constructs, and this relationship diminished when a Bonferroni correction was applied. This is unexpected given the theoretical and conceptual similarities between self-concept clarity and self-continuity. Self-continuity was a strong predictor of sleep quality, and correlated very well with self-concept clarity, yet there is a clear difference in strength of relationship with sleep quality. In cases such as this, the Bonferroni correction is particularly important. The number of statistical tests conducted increases the likelihood of Type I errors (false positives). While the number of individual tests in this analysis justifies such a statistical adjustment, the noticeably weaker relationship between sleep quality and self-concept clarity further heightens the possibility of a false positive. Despite the conceptual similarities between self-concept clarity and self-continuity, the contrasting significance may support the theory that these self-constructs are indeed representative of distinct dimensions of the self. Yet, it should be noted that an inherent issue with applying a Bonferroni correction is the increased chance of Type II errors (false negative). In this case, self-concept clarity may have a true relationship with sleep quality, and the observed weak correlation may be the result of other factors, such as sample size or outliers. Nonetheless, this method serves as a rigorous evaluation of reliability and subsequently supports the conclusion that sleep quality is significantly associated with self-compassion, self-control, self-esteem, and self-continuity.

Conversely, self-expression and self-enhancement did not correlate with sleep quality. Also, all self-constructs significantly correlated with each other, with the exception of self-enhancement, which only significantly correlated with self-expression. One argument for this finding is that self-enhancement is distinct from the other self-constructs as not representative of the *true* self. Rather, self-enhancement is defined as a measure of the desired self. This might also explain the significant correlation and co-factored variable of self-expression. Where self-expression is defined as a presentation of the authentic self, this measure be may subject to a social desirability bias, as far as individuals express a self that is appropriate for the context; this is not dissimilar to a desired self. We may therefore conclude that sleep quality is well related to the authentic self, but not the desired or presented self.

Such a conclusion is support by the results of the exploratory factor analysis, which was conducted to identify the underlying variables across the 7 tested self-constructs. It was expected that 6 factors would be identified, evidencing the 6 distinct dimensions of the multidimensional model. However, only two factors were identified. While this does not support the theorised dimensions of this model, it does provide some insight into the underlying network of the self. The identified factors suggests that the self is better categorised into two dimensions: one including self-compassion, self-control, self-esteem, self-continuity, and self-concept clarity; the other including self-enhancement and self-expression. Given the distinctive characteristics of each dimension outlined earlier in this thesis, the factors may be defined by their implicit and explicit nature. Here, I recognise the implicit self as more representative of the authentic self, or the self that exists regardless of social or contextual influence. In comparison, the explicit self is more reflective of the self that is presented to others, or the self which we wish others to be perceive us as (the desired self). An alternative explanation may be a distinction of contextually dynamic compared to internally stable self-constructs. Where self-expression is defined by one's ability to tailor their presented beliefs in a contextually appropriate manner, and self-enhancement is the trait of exaggerating one's self-worth or value. Self-enhancement is a trait that may be more or less relevant depending on context. Both lines of theorising are plausible, but further research is necessary to scrutinise such theory.

The other side to this factor analysis is the grouping of self-esteem, self-control, self-compassion, self-continuity, and self-concept clarity. The discussed explanations are applicable to these variables, whereby these five self-constructs are implicit, as defined by their authenticity and lack of regard for social desirability. However, given their distinct definitions, this grouping does not account for the nuance across these self-constructs. Perhaps this can be explained by the inclusion of only 1 self-construct per dimension (two for the Affective self). In the present research, 7 self-constructs were measured, which restricts the number of correlations and subsequent components possible from this analysis. As factor analysis examines similarities (correlations) rather than the differences between variables (Barron, 2018), perhaps there are simply too few distinct patterns to differentiate the self-constructs in each factor. Furthermore, it is considered a "rule of thumb" that each factor must contain at least 3 variables (Lloret-Segura et al., 2014; Yong & Pearce, 2013) to be considered reliable or stable. Hence, to reliability propose 6 distinct factors in this model, at least 18 self-constructs would be required. Future research should follow such guidance and examine a larger number of self-constructs to support the initial dimensions outlined in this thesis or indeed provide support for the latter implicit-explicit theorising. Given the novelty of this approach and scarce prior research, the multidimensional model of the self remains a theoretical model.

The results of Study 1 are consistent with prior literature identifying an association between sleep quality and self-compassion (Bian et al., 2020; Brown et al., 2020; Butz & Stahlberg, 2020; Kemper et al., 2015; Kim and Ko, 2018; Semenchuk, 2021), self-control (Boland et al., 2020; Libedinsky, et al., 2013; Palagini et al., 2019), and self-esteem (Azizi Kutenaee et al., 2020; Conti et al., 2014; Fox, 1999; Lee & Sibley, 2019; Lemola et al., 2013). The association between self-continuity and sleep quality is novel, and consistent with my hypothesis. The results for self-expression, self-enhancement, and self-concept clarity do not support my initial hypotheses drawn from theoretical interpretations of prior literature (Vantieghem et al., 2016; Latif et al., 2019; Zhu et al., 2023), although they can be theoretically justified. These findings were consistent across correlation and independent linear regressions. However, multiple linear regression did not uphold these findings when controlling for other self-constructs. Following these initial tests, participants were categorised into “good” and “bad” sleepers, and a comparison of means test was also conducted. The power of regression and correlation analysis are maintained in their capacity to detect strength and direction of relationships. Subsequently, the outcome of these analyses makes a comparison of means test somewhat redundant, because results can be inferred. Nonetheless, in the present research there is still value in a comparison of means tests. That is, we can categorially identify significant differences between those we objectively define as good or bad sleepers, without relying on predictive inference. Utilizing both methods increases robustness of conclusion. Study 1 provides a sturdy foundation for the notion that sleep quality and the self are well associated, and that this association is primarily driven by self-compassion, self-control, self-esteem, and self-continuity.

Study 1 relied only on cross-sectional self-report data. This presents limitations on three fronts. First, the correlational analysis prevents us from drawing directional casual effects of these variables. The findings of the multiple regression analysis may also be explained by the absence of longitudinal data. Second, administering trait measures prevents us from drawing conclusions about daily changes in these inherently dynamic variables. Finally, the subjectivity of the self-report measures restricts the validity of the responses. The following three studies were produced to act on these limitations and provide deeper insight into the relationship between sleep quality and the multidimensional self.

Chapter 3 Study 2

"A well-filled day brings blessed sleep."

- Leonardo da Vinci (*The Notebooks of Leonardo Da Vinci*, 1970)

In Study 1, sleep quality was positively associated with self-compassion, self-control, self-esteem, and self-continuity. Is better sleep causing changes in these variables or is it the other way around? I addressed this question in Study 2 by conducting a two-week longitudinal study. Much of what we know about sleep-self links come from cross-sectional correlational studies. Many studies cross-sectionally link higher self-compassion (Bian et al., 2020; Brown et al., 2020; Kemper et al., 2015; Kim & Ko, 2018; Sirois, 2015; Sirois, 2019), self-control (Curtis et al., 2018; Dorrian, et al., 2019; Kroese et al. 2014; Massar & Chee, 2019; Meldrum et al., 2015), self-esteem (Azizi Kutenaee et al. 2020; Cain & Gradisar; 2010; Conti et al., 2014; Lemola et al. 2013; Woods & Scott, 2016), and self-continuity (Brotkin, 2015) to better subjective sleep quality. Longitudinal studies have replicated these between-person associations and also found within-person links between higher sleep quality and higher self-compassion (Hu et al., 2018; Rakhimov et al., 2023; Semenchuk, 2021), and self-control (Diestel et al., 2015; Przepiorka, Blachnio, & Siu, 2019; van Eerde & Venus, 2018), self-esteem (Lemola et al., 2013; Lee & Sibley, 2019; Saini et al., 2020; Wang & Yip, 2020; Yip, 2015). No longitudinal studies have assessed links between subjective sleep quality and self-continuity. Moreover, the longitudinal studies above have commonly examined *unidirectional cross-lagged* associations between self-constructs and sleep. In Study 2, a within-subjects daily diary style method was instigated whereby participants reported their subjective sleep quality, self-compassion, self-esteem, self-control, and self-continuity every day for two weeks. I implemented Random-Intercept Cross-Lagged Panel Models (RI-CLPM, Hamaker et al., 2015) to test for bidirectional associations. This would allow me to go beyond cross-sectional associations and examine how daily fluctuations in each self-construct co-occur with fluctuations in sleep quality the night preceding and succeeding the daily self-construct. Furthermore, minimal intervention in the daily lives of participants permits stronger external validity. Experimental sleep deprivation studies are a popular method for experimentally testing the effects of poor sleep on cognitive (Block et al., 1981; Grosvenor & Lack, 1984; Ellenbogen et al., 2006; McCoy & Strecker, 2011), affective (Cote et al., 2014; Gujar et al., 2011; Killgore et al., 2017; Zhang, 2004), and behavioural (Boland, Kelley, et al., 2020; Kelley et al., 2021; Zhang, 2004) outcomes. However, they do not characterise poor sleep in daily life, restricting external validity. Longitudinal studies additionally remove confounding variables ignored by (and sometimes magnified by) deprivation studies. Thus, a longitudinal approach was most appropriate for this study.

3.1 Hypotheses

Participants filled out trait measures of self-compassion, self-control, self-esteem, self-continuity, and last month subjective sleep quality prior to completing a 13-day longitudinal study. Given the positive correlations of Study 1 and the findings and theory of aforementioned literature, I hypothesise that participants will report positively greater subjective sleep quality than usual following days of higher-than-average self-compassion (1A), self-control (2A), self-esteem (3A), and self-continuity (4A). Likewise, I hypothesise that participants will report higher-than-average self-compassion (1B), self-control (2B), self-esteem (3B), and self-continuity (4B), following nights of positively greater subjective sleep quality. Finally, considering within-subjects associations, I hypothesise positive trait-like associations between self-constructs and sleep quality (Hypotheses 5). I use RI-CLPM to test these hypotheses.

3.2 Method

3.2.1 Participants

Participants were 239 UK Prolific workers (*N* = 68) and University of Southampton undergraduates (*N* = 171), who agreed to participate in a 14-day longitudinal study. Prolific participants were renumerated with £1.00 for completing a 10-minute survey the first day and £0.50 for a 5-minute survey on each subsequent day. University of Southampton participants were renumerated with 2 credits toward a course requirement for completing a 10-minute survey the first day and 1 credit for a 5-minute survey on each subsequent day. I excluded participants if they did not complete the Day 1 survey (n Southampton = 5, n Prolific = 1) or did not complete at least 5 days of the longitude phase (n Southampton = 18, n Prolific = 16). This left 199 participants (n Southampton = 148, n Prolific = 51) for the analyses reported below.

Participants in the final sample were 18 to 67 years old (*M* = 23.23, *SD* = 9.24). University of Southampton students were significantly younger (*M* = 18.99, *SD* = 1.23) than Prolific workers (*M* = 35.51, *SD* = 11.26), ($F(1, 197) = 310.84$, $p < .001$, partial $\eta 2 = .612$. Most participants were women (*N* = 174, 87.44%); the remaining participants were men (*N* = 24, 12.06%) or did not report their gender (*N* = 1, 0.5%). These proportions did not vary between Prolific and University of Southampton participants, $X2$ (2) = 3.99, $p = .136$. Participants were also 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%), and Multi-Racial (*N* = 4, 2.01%). These proportions did not vary between Prolific and University of Southampton participants, *X2* (4) = 2.40, *p* = .662.

3.2.2 Sample Size Determination

I used the powRICLPM R-Package (Mulder, 2022) to estimate the number of participants required for detecting moderately sized cross-lagged effects (.07) with 80% power. The effect size estimate used here comes from the Orth et al. (2022) meta-analysis and effect size guidelines from RI-CLPMs. I 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; and the correlation between the random intercepts = .35. In addition to these parameters, I included 12 repeated measures, constrained cross-lagged paths to be equal across time, and conducted 1,000 Monte Carlo simulations. Based on these parameters, 200 participants are needed to detect moderately sized cross-lagged effects with 80% power. I did not control for multiplicity to reduce the chance of type II errors. Rothman (1990) argues against a policy of making adjustments for multiple comparisons when the data is natural and observational (as opposed to random), because this results in fewer errors of interpretation and ultimately undermines the fundamental premise of empirical research.

3.2.3 Procedure

Participants completed a brief (5 minute) online survey for 14 consecutive days. The survey was distributed via email at 5pm (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, so that I could replicate the results of Study 1. Following this, participants entered the longitudinal phase (Days 2-14), where they reported on their self-esteem, self-control, self-compassion, and self-continuity that day as well as how well they slept the night before. Measures were presented in a randomized order each day. All measure can be found in Appendix A. Procedure is verified by comparable studies (Hu et al., 2018; Van Eerde & Venus, 2018).

3.2.4 Day 1 (Trait Measures)

To replicate the cross-sectional correlational findings from Study 1, participants completed trait measures of self-esteem, self-control, self-compassion, and self-continuity. They also completed a measure of their sleep quality over the last month. The measures used were the same as in Study 1 (see Appendix A).

3.2.5 Longitudinal Phase

Beginning on Day 2, I used a longitudinal design and recorded daily self-compassion, self-control, self-esteem, self-continuity, and sleep quality over the course of 13 days (no state measures were recorded on Day 1).

State Sleep Quality. I assessed state sleep quality with an amended version of The Pittsburgh Sleep Diary (PSD; Monk et al. 1993). This scale uses two self-report surveys that allow participants to report their sleep quality responses on a waketime and bedtime survey. As this study was concerned with state sleep quality once per day, I combined the two PSD surveys into one survey and removed some theoretically irrelevant questions out of this survey in order to make the survey briefer and manageable (Appendix A). The survey records sleep quality using both open ended questions and Likert scale. Some questions (e.g., "last night I went to sleep at") use an open-ended question to allow participants to report a more specific and personal responses, whereas other questions ("how many times did you wake up during the night?") use a Likert scale (0 to 5). The PSD has been well validated in prior research and shown to be a reliable method for recording state sleep quality (Monk et al. 1993).

State Self-Compassion. I assessed state self-compassion with a version of the self-compassion scale that I shortened (Appendix A). As explained above, the self-compassion scale has 6 components. I selected the item from each component that had the higher factor loading (Neff, 2003). In three cases, the item with the highest factor loading did not appropriately transfer to a state version of the item (e.g., "When I'm going through a very hard time, I give myself the caring and tenderness I need."), in which case a more transferable item was selected ("I'm tolerant of my own flaws and inadequacies."). Next, I altered the phrasing of the question to reflect state (rather than trait) items. The stem was "using the following scale, indicate how much you agree with each statement TODAY." As an example, the item "I'm tolerant of my own flaws and inadequacies" became "Today, I was tolerant of my own flaws and inadequacies" (1 = strongly disagree, 7 = strongly agree).

State Self-Esteem. I assessed state self-esteem with the Single-Item Self-Esteem Scale (Robins et al. 2002): "I have high self-esteem" (1 = not very true of me, 7 = very true of me). The participants were presented with the initial instruction to respond to this question (among other questions unrelated to this thesis) to indicate "how much [they] agree with the statement RIGHT NOW", to measure the state (rather than trait) variable. No Cronbach's coefficient (internal consistency reliability) can be measured for a single-item scale; however, Robins et al. (2002) compared the *Heise* procedure to estimate the retest reliability of the Single-Item Self-Esteem Scale (.75) to the Rosenburg Self-Esteem Scale (.88), indicating sufficient retest reliability.

State Self-Control. I assessed state self-control with the Brief State Self-Control Capacity Scale (BSSCCS; Lindner et al., 2019). This scale was originally designed to measure feelings of capacity to implement self-control following achievement situations. I used it because it is more theoretically relevant and appropriate for every-day response, compared to a more general self-control scale (Tangney, 2004). The five items are: "I feel drained" "I feel calm and rational" "I feel lazy" "I feel sharp and focused," "I feel like my willpower is gone" (1 = Not True, 7 = Very True). Responses were recorded at the end of every day. The instructions for this measure were altered to indicate how the items applied to the participant "at the moment".

State Self-Continuity. I assessed state self-continuity with 2 items: "I feel connected to my future self," "I have a sense of continuity in my life" (1 = not very true of me, 7 = very true of me). The participants were presented with the initial instruction to respond to this question (among other questions unrelated to this thesis) to indicate "how much [they] agree with the statement RIGHT NOW", to measure the state (rather than trait) variable. The original article from Sedikides et al. (2015) suggests strong test-retest reliability in both personal (α = 0.83), and temporal (α = 0.67) self-continuity items.

3.2.6 Statistical Analysis

I used bivariate correlations and multiple regression analyses of the Day 1 trait data using SPSS 28 to replicate the results of Study 1. On Day 2, participants entered the longitudinal phase where I used a series of RI-CLPM(in SAS to examine bidirectional relationships between subjective sleep quality and self-related constructs. The RI-CLPM approach allowed me to test for: (1) Prospective effects of temporary deviations from the trait level of each self construct on change in the temporary deviation from the trait level of Sleep Quality (self → 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 construct (sleep → self cross-lagged path). I ran separate models for self-esteem, self-control, self-compassion, and self-continuity as well as a composite of the four self-constructs.

The initial *cross-lagged panel model* (CLPM) was proposed as a statistical model that applied *autoregressive* relationships to control for the stability of trait constructs in longitudinal research, in order to infer causal inference (Hamaker et al., 2015). Where autoregression statistically examines a single variable across separate time points (assuming that a variable depends linearly on its own previous values), cross-lagged models examine the linear relationship of two variables across separate time points (assuming that a dependent variable depends on the value of a predictor variables at a previous time point; Hamaker et al. 2015; Mulder & Hamaker, 2021). Statistically significant autoregressive effects indicate linear stability of a variable. As cross-lagged regression coefficients measures whether changes in a predictor variable at an earlier time point predict changes in the dependent variable at a later time point, while controlling for the autoregressive effects of the variables' previous values, statistical significance is reliably indicative of a causal relationship between variables (Hamaker et al. 2015; Mulder & Hamaker, 2021). Despite providing the foundations of an invaluable statistical model, the application of CLPM has been heavily disputed (Asendorf, 2021; Hamaker et al., 2015; Lucas, 2023; Ludtke & Robitzsch, 2021; Orth et al., 2021). CLPM does not separate within-person effects from between-person effects, so unmeasured stable individual differences are not account for (Hamaker et al., 2015; Orth et al., 2021). CLPM measures how a variable at an earlier time predicts a different variable at a later time point, without controlling for such confounding variables, restricting the reliability of causal inference (Lucas, 2023). Herein lies the benefit of including Random Intercepts into the model (Hamaker et al., 2021; Lucas, 2023). Specific to the present research, RI-CLPM tests each relationship between a single self-construct and sleep quality, controlling for subject-specific individual differences. This method allows us to examine the changes in sleep quality and changes in each self-construct over time, within each individual (Lucas, 2023). This provides are clearer interpretation of complex data, especially in the context of the present research where the variables are dynamic. For a full review of RI-CLPM as a more appropriate method over CLPM, see Lucas (2013).

Following the recommendations of Orth et al. (2020), RI-CLPMs were employed because they outperform other model types for assessing prospective effects of deviations form trait levels of the constructs of interest. To deal with missing data, I used 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, I specified time equality constraints placed on the auto-regressive and cross-lagged paths. Here, structural coefficients (autoregressive and cross-lagged effects) are assessed at equally separated time points for consistency across models and within-model response times. This is a common approach that improves the statistical power, precision of parameter estimates, interpretability, and validity of conclusions (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 subjective sleep quality will be the same as the association between Day 3 self-esteem and Day 4 subjective 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 (Mulder & Hamaker, 2021). I used the following criteria to evaluate model fit: Comparative Fit Index (CFI) > .90 , Root Mean Square Error of Approximation (RMSEA) < .08 and Standardized Root Mean Square Residual (SRMR) < .08 (Hu & Bentler, 1999; Kline, 2011).

My assessment of subjective sleep quality and self-related constructs were distributed (via email) to participants at the same time every evening (5PM). This meant that self-reported self-constructs were recorded in the moment ("how much [they] agree with the statement RIGHT NOW"), but sleep quality was recorded retrospectively (e.g., "last night I went to sleep at"). Assuming a hypothetical participant who completed surveys every day at 5PM and the midpoint of their sleep cycle was 5AM – each assessment coupled measures of self-constructs with measures of sleep covering a period 12 hours earlier. For example, if I want to use Day 2 self-esteem to predict Day 3 subjective sleep quality, these 12 hours are subtracted from the standard 24-hour lag resulting in self-esteem → sleep lags of 12 hours. This 12-hour lag is termed "Short Lag". Likewise, if I want to use Day 2 subjective sleep quality to predict Day 3 self-esteem, these 12 hours are added into the standard 24-hour lag resulting in sleep → self-esteem lags of 36 hours. This 36-hour lag is termed "Long Lag". The first set of RI-CLPMs used this approach (Model 1: Figure 2ai). The second set of RI-CLPMs uncoupled daily self and sleep assessments and then recoupled self-constructs with next day sleep quality. This approach reduces the sleep → self lags from 36 to 12 hours (Short Lag) and increases the self → sleep lag from 12 to 36 hours (Long Lag; Model 2: Figure 2aii).

3.3 Results

3.3.1 Day 1 (Trait Measures)

Higher levels of subjective sleep quality over the last month were associated with greater trait self-compassion ($r(199) = .34$, $p < .001$), self-control ($r(199) = .32$, $p < .001$), self-esteem ($r(199) = .38$, $p < .001$), and self-continuity ($r(199) = .42$, $p < .001$). I report bivariate correlations in Table 2a.

3.3.2 Longitudinal Analyses: Random Intercept Cross-Lagged Panel Models

I tested the casual effects of state subjective sleep quality on each of the four state subjective self-constructs, and vice versa. Each day's reported state subjective sleep quality and state self-constructs were inputted into separate RI-CLPM. I generated two models to examine how self-compassion, self-control, self-esteem, and self-continuity predicted succeeding night's sleep quality at the short (12-hour) and long (36-hour) lag across consecutive 13 days. Then, I examined the reverse direction of how each night's subjective sleep quality predicted self-compassion, self-control, self-esteem, and self-continuity at the short (12-hour) and long (36-hour) lag across 13 consecutive days. The first model (Model 1) shows short self → sleep and long sleep → self lagged effects. The second model (Model 2) shows short sleep → self and long self → sleep lagged effects.

Model 1

Self-Composite. I fit the self-composite and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (305) = 464.66, $p < .001$ (CFI = .95, RMSEA = .05, 90% CI [.042, .061], SRMR = .069). The between-subjects covariation (μ) between subjective sleep quality and the self-composite was significant, $B = 0.56$, $SE = .09$, t (305) = 6.52, $p < .001$. The Autoregressive path from earlier self-composite to later self-composite scores (ζ) were significant, $B = 0.26$, $SE = .02$, ($t(257) = 8.55$, $p < .001$. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was significant, $B = 0.07$, $SE = .03$, ($t(305) = 2.61$, $p = .009$. The cross-lagged path from earlier sleep to later self-composite (κ) was significant, $B = 0.20$, $SE = .03$, ($t(305) = 10.13$, $p < .001$. However, the cross-lagged path from earlier self-composite to later sleep (ε) was not significant, $B = 0.06$, $SE = .05$, ($t(305) = 1.34$, $p = .180$.

Self-Compassion. I fit self-compassion and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (305) = 422.02, $p < .001$ (CFI = .94, RMSEA = .04, 90% CI [.033, .054], SRMR = .077). The between-subjects covariation (μ) between subjective sleep 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 (ζ) was significant, $B = 0.14$, $SE = .02$, ($t(305) = 5.68$, $p < .001$. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was significant, $B = 0.07$, $SE = .02$, ($t(305) = 2.92$, $p = .003$. The cross-lagged path from earlier sleep to later self-compassion (κ) was not significant, $B = -0.01$, $SE = .01$, ($t(305) = -0.97$, $p = .330$. The cross-lagged path from earlier self-compassion to later sleep (ε) was not significant, $B = 0.05$, $SE = .04$, ($t(305)$ 1.16, $p = .246$.

Self-Control. I fit self-control and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (305) = 416.10, $p < .001$ (CFI = .95, RMSEA = .04, 90% CI [.032, .053], SRMR = .084). The between-subjects covariation (μ) between subjective 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 (ζ) was significant, $B = 0.15$, $SE = .03$, ($t(305) = 5.86$, $p < .001$. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was significant, $B = 0.08$, $SE = .03$, ($t(305) = 3.22$, $p = .001$. The cross-lagged path from earlier sleep to later self-control (κ) was not significant, *B* = -0.03, *SE* = .01, t (305) = -1.53, *p* = .127. The cross-lagged path from earlier self-control to later sleep (*ε*) was not significant, *B* = 0.004, *SE* = .04, (*t*(305) = 0.10, *p* = .917.

Self-Esteem. I fit self-esteem and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (305) = 395.61, *p* < .001 (CFI = .97, RMSEA = .04, 90% CI [.027, .049], SRMR = .066). The between-subjects covariation (*μ*) between subjective 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 (*ζ*) was significant, *B* = 0.18, *SE* = .02, (*t*(305) = 7.41, *p* < .001. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (*δ*) was significant, *B* = 0.07, *SE* = .02, (*t*(305) = 2.98, *p* = .003. The cross-lagged path from earlier sleep to later self-esteem (*κ*) was not significant, *B* = -0.02, *SE* = .02, t (305) = -0.95, *p* < .001. The cross-lagged path from earlier self-esteem to later sleep (*ε*) was not significant, *B* = 0.04, *SE* = .03, (*t*(305) = 1.26, *p* = .207.

Self-Continuity. Finally, I fit self-continuity and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (305) = 438.16, *p* < .001 (CFI = .95, RMSEA = .05, 90% CI [.037, .056], SRMR = .064). The between-subjects covariation (*μ*) between subjective 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 (*ζ*) was significant, *B* = 0.21, *SE* = .02, (*t*(305) = 8.56, *p* < .001. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (*δ*) was significant, *B* = 0.08, *SE* = .02, t (305) = 3.11, *p* = .002. The cross-lagged path from earlier sleep to later self-continuity (*κ*) was not significant, *B* = 0.01, *SE* = .02, (*t*(305) = 0.42, *p* = .675. The cross-lagged path from earlier self-continuity to later sleep (*ε*) was not significant, *B* = 0.04, *SE* = .03, (*t*(305) = 1.40, *p* = .162.

See Figure 2aiii for applied example of the conceptual model.

Model 2

Self-Composite. I fit the self-composite and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (257) = 379.15, *p* < .001 (CFI = .96, RMSEA = .05, 90% CI [.038, .059], SRMR = .065). The between-subjects covariation (*μ*) between subjective sleep quality and the self-composite was significant, *B* = 0.53, *SE* = .09, (*t*(257) = 6.19, *p* < .001. The autoregressive path from earlier self-composite to later self-composite scores (*ζ*) were significant, *B* = 0.20, *SE* = .02, (*t*(257) = 8.55, *p* < .001. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (*δ*) was significant, *B* = 0.07, *SE* = .02, (*t*(257) = 2.79, *p* = .005. The cross-lagged path from earlier sleep to later self-composite (*κ*) was significant, *B* = 0.20, *SE* = .01, t (257) = 18.50, *p* < .001. However, the cross-lagged path from earlier self-composite to later sleep (*ε*) was not significant, *B* = 0.05, *SE* = .05, (*t*(257) = 1.07, *p* = .286.

Self-Compassion. I fit self-compassion and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (257) = 329.00, *p* < .001 (CFI = .96, RMSEA = .04, 90% CI [.024, .049], SRMR = .072). The between-subjects covariation (*μ*) between subjective 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 (*ζ*) was significant, *B* = 0.10, *SE* = .02, (*t*(257) = 4.18, *p* < .001. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (*δ*) was significant, *B* = 0.07, *SE* = .02, (*t*(257) = 3.04, *p* = .002. The cross-lagged path from earlier sleep to later self-compassion (*κ*) was significant, *B* = 0.18, *SE* = .01, (*t*(257) = 13.62, *p* < .001. The cross-lagged path from earlier self-compassion to later sleep (*ε*) was significant, *B* = 0.08, *SE* = .04, (*t*(257) = 2.02, *p* = .044.

Self-Control. I fit self-control and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (257) = 344.51, *p* < .001 (CFI = .95, RMSEA = .04, 90% CI [.029, .052], SRMR = .079). The between-subjects covariation (*μ*) between subjective 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 (*ζ*) was significant, *B* = 0.11, *SE* = .02, (*t*(257) = 4.66, *p* < .001. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (*δ*) was significant, *B* = 0.07, *SE* = .02, (*t*(257) = 2.82, *p* = .005. The cross-lagged path from earlier sleep to later self-control (*κ*) was significant, *B* = 0.31, *SE* = .01, (*t*(257) = 20.90 *p* < .001. The cross-lagged path from earlier self-control to later sleep (*ε*) was not significant, *B* = 0.01, *SE* = .03, t (257) = 0.42, *p* = .677.

Self-Esteem. I fit self-esteem and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (257) = 327.80, *p* < .001 (CFI = .97, RMSEA = .04, 90% CI [.024, .049], SRMR = .079). The between-subjects covariation (*μ*) between subjective 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 (*ζ*) was significant, *B* = 0.16, *SE* = .02, (*t*(257) = 6.54, *p* < .001. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (*δ*) was significant, *B* = 0.07, *SE* = .02, (*t*(257) = 2.94, *p* = .003. The cross-lagged path from earlier sleep to later self-esteem (*κ*) was significant, *B* = 0.21, *SE* = .02, (*t*(257) = 12.00 *p* < .001. The cross-lagged path from earlier self-esteem to later sleep (*ε*) was not significant, *B* = 0.01, *SE* = .03, (*t*(257) = 0.28, *p* = .777.

Self-Continuity. Finally, I fit self-continuity and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (257) = 327.91, *p* < .001 (CFI = .97, RMSEA = .04, 90% CI [.024, .049], SRMR = .059). The between-subjects covariation (*μ*) between subjective 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 (ζ) was significant, $B = 0.18$, $SE = .02$, ($t(257) = 7.28$, $p < .001$. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was significant, $B = 0.07$, $SE = .02$, ($t(257) = 2.81$, $p = .005$. The cross-lagged path from earlier sleep to later self-continuity (κ) was significant, $B = 0.15$, $SE = .01$, ($t(257) = 9.25$, $p < .001$. The cross-lagged path from earlier self-continuity to later sleep (ε) was not significant, $B = 0.02$, $SE = .03$, ($t(257) = 0.67$, $p = .505$.

See Figure 2aiiii for applied example of the conceptual model.

3.4 Discussion

In Study 1, I examined the link between sleep quality and self-constructs. The strongest correlates of past month subjective sleep quality were self-compassion, self-control, self-esteem, and self-continuity. In Study 2, I replicated these trait-level findings, where self-continuity was once-again the strongest correlate of sleep quality, followed by self-esteem, self-compassion, and then self-control. I also tested between- and within-person associations in a 14-day longitudinal investigation. The self → sleep hypotheses were not supported. Specifically, when self-compassion (Hypothesis 1A), self-control (Hypothesis 2A), self-esteem (Hypothesis 3A), and self-continuity (Hypothesis 4A) were higher than usual, participants did not experience a subsequent increase in subjective sleep quality at either short (12-hour) or long (36-hour) lags. However, I obtained partial support for the sleep → self hypotheses. When individuals had higher subjective sleep quality than usual, they experienced a subsequent increase in self-compassion (Hypothesis 1B), self-control (Hypothesis 2B), self-esteem (Hypothesis 3B), and self-continuity (Hypothesis 4B) at short (12-hour) but not long (36-hour) lags. Only the self-composite was increased following a higher subjective sleep quality than usual at long lags. Finally, I observed significant between-person associations between all self-constructs and subjective sleep quality (Hypothesis 5). In both models, all variables showed significant autoregressive correlations, indicating linear stability whereby the given variable is determined by its own previous value. Collectively, these results provide suggestive evidence that deviations from normal sleep influence self-constructs rather than the other way around.

This was the first study to examine longitudinal associations between sleep quality and self-continuity, and only the second to examine associations on a between-subject basis (Brotkin, 2015). The results are consistent with past longitudinal studies; insofar as positively greater sleep quality predicts positively higher self-esteem (Lee & Sibley, 2019; Saini et al., 2020; Wang & Yip, 2020; Yip, 2015), self-compassion (Hu et al., 2018; Rakhimov et al., 2023; Semenchuk, 2021), and self-control

(Diestel et al., 2015; Przepiorka, Blachnio, & Siu, 2019; van Eerde & Venus, 2018). Study 2 extends these results, as it assesses all three outcomes simultaneously. However, I assessed self-constructs and sleep quality via self-report, limiting objective evaluations. Study 3 addressed this limitation.

See Figure 2b for a cumulative graphic of associations between sleep quality and the self.

Chapter 4 Study 3

"Even where sleep is concerned, too much is a bad thing."

- Homer (*The Odyssey*, 2011)

In Study 1 I observed associations between trait (past month) subjective sleep quality and trait level self-constructs. These associations were strongest for self-compassion, self-control, self-esteem, and self-continuity. I replicated and extended these findings in Study 2 with a 14-day longitudinal design, obtaining a consistent pattern of cross-lagged effects from sleep to self-constructs over the short (12-hour) lag, but not from self-constructs to sleep.

The relation between subjective sleep quality and objective sleep quality has been reported to be weak (Aili et al., 2017; Buysse et al., 2008; Iwasaki et al., 2010; Girschik et al., 2012; Jackowska et al., 2011; Landry et al., 2015; Lemola et al., 2013; Tworoger et al., 2005; Van Den Berg et al., 2008), suggesting that they track different components of sleep. Other possibilities are that they do not relate strongly due to the retrospective nature of the PSQI (Buysse et al. 1989), or that the PSQI is heavily skewed by components of mood ad alertness upon waking. Here, I assessed objective sleep quality via actigraphy in addition to subjective sleep quality. This allows me to replicate and extend the findings of Study 2. As in Study 2, I implemented RI-CLPM to test for bidirectional associations between the self (self-compassion, self-control, self-esteem, self-compassion) and sleep quality (subjective reports, actigraphy).

4.1 Actigraphy

Actigraphy, a reliable and valid measure of sleep quality (Acebo & LeBourgeois, 2006; Martin & Hakim, 2011), is a frequently used objective measure of sleep quality (Martin & Hakim, 2011; Sadeh, 2011). Actigraphy lies in the middle of the spectrums of practicality and robustness of data, presenting a balanced measure of sleep quality. In other words, actigraphy is a more practical approach to measuring sleep quality than polysomnography but less so than a self-report survey, and it furnishes more verifiable data than a self-report survey but less so than polysomnography. This is why actigraphy remains a popular measure of objective sleep quality (Martin & Hakim, 2011). Recorded through devices that resemble a wristwatch (Sadeh, 2005), actigraphy is typically recorded as limb-movement activity. Activity is presented in a histogram, with larger physical movements and longer durations of movement recorded as waking activity, and little physical movement and shorter durations of movement recorded as sleep activity. Less limb-movement and associated sleep activity has been repeatedly observed, providing further validation for the use of actigraphy as an objective measure of sleep (Chae et al., 2009; Jean-Louis et al., 2001; van Hees et al., 2018). Nevertheless, some researchers offer critique of actigraphy as a superficial measure owing to the limited channels of measurement. Blood et al. (1997) notes that actigraphy is inherently less accurate than some other measure of sleep quality (such as Polysomnography, or Behavioural Response Monitoring), as limb movement equating to sleep quality will overlook the lack of limb movement during peaceful wakefulness. While such a limitation of actigraphy is often recognised in sleep research (Blood et al., 1997; Conley et al., 2019; Marino et al., 2013), actigraphy has consistently been found to be equally as sensitive to sleep-wake patterns and distinct components of sleep (Blood et al., 1997; Conley et al., 2019; Kushida et al., 2001; Marino et al., 2013; Meltzer et al., 2012; Yavuz-Kodat et al., 2019) when compared to polysomnography (often referred to as the “gold standard” of sleep quality measurement, Krystal & Edinger, 2008; Yavuz-Kodat et al., 2019).

Typically, actigraphy is used as a measure of objective sleep quality in clinical settings, in examinations of sleep (Sadeh et al., 1995; Sadeh 2011) or psychological (Ancoli-Israel et al., 2015; Walia & Mehra, 2019) disorders. In social psychology, little research has explored the link between objective sleep quality and self-constructs. Actigraphy has been implemented in studies of self-control, although the actigraphy in most of these studies has been used to measure limb-movement during waking hours to measure motor activity in self-control tasks (Patros et al., 2017) and sleeping behaviours have been neglected. However, a recent doctoral thesis tested the influence of sleep quality on self-control over a two-week diary study using actigraphy alongside subjective self-report diary entries (Hisler et al, 2019). Greater state self-control was significantly predicted by nights of greater objective quality of sleep. Self-esteem has been tested primarily as a covariate in actigraphy research. One study used actigraphy to test the relationship between sleep quality and cognitive functioning in children over a seven-night longitudinal study, with the addition of self-esteem as a moderator of this relationship (Saini et al., 2020). Self-esteem moderated the relationship between sleep and cognitive function, as far as higher cognitive functioning was evident in children with greater objective sleep quality and higher self-esteem. Further, a meta-analysis of sleep quality and self-compassion yielded associations between sleep quality and self-compassion across a range of metrics and measures, but did not use actigraphy (Brown et al., 2020). Here, I used actigraphy to examine the link between sleep quality and self-compassion, self-esteem, and self-continuity over six nights. Participants also completed measures of subjective sleep quality, self-compassion, self-control, self-esteem, and self-continuity over the seven days.

4.2 Hypotheses

4.2.1 Subjective Sleep Quality

As per Study 2, I hypothesise that, when participants have higher subjective sleep quality than usual, they will experience a subsequent increase in self-compassion (Hypothesis 1A), self-control (Hypothesis 1B), self-esteem (Hypothesis 1C) and self-continuity (Hypothesis 1D) at short (12-hour) but not long (36-hour) lags.

4.2.2 Objective Sleep Quality

I hypothesise two possibilities. The first is that cross-lagged associations between objective sleep quality and self-constructs will be similar to the previously (Study 2) obtained cross-lagged associations for subjective sleep quality. Thus, when participants have higher objective sleep quality than usual, they will experience a subsequent increase in self-compassion (Hypothesis 2A), self-control (Hypothesis 2B), self-esteem (Hypothesis 2C) and self-continuity (Hypothesis 2D) at both short (12-hour) and long (36-hour) lags. This would also be replicated in the reverse direction, where self-compassion (Hypothesis 3A), self-control (Hypothesis 3B), self-esteem (Hypothesis 3C) and self-continuity (Hypothesis 3D) will not predict objective sleep quality at the short or long lag.

Alternatively, if subjective and objective sleep quality track distinct aspects of sleep, then the results for objective and subjective sleep quality will be opposite. In other words, whereas cross-lagged associations from self to sleep were null for subjective sleep quality in Study 2, they will be significant here. Thus, my second hypothesis for objective sleep quality is that, when self-compassion (Hypothesis 4A), self-control (Hypothesis 4B), self-esteem (Hypothesis 4C) or self-continuity (Hypothesis 4D) are higher than usual, participants will experience a subsequent increase in objective sleep quality. By extension, when participants show greater objective sleep quality, there will be no subsequent change in self-compassion (Hypothesis 5A), self-control (Hypothesis 5B), self-esteem (Hypothesis 5C) or self-continuity (Hypothesis 5D).

4.3 Method

4.3.1 Participants and Sample Size Determination

The average sample size for actigraphy studies testing individuals without sleep disorders is 42 (Kushida et al., 2001; Sadeh et al., 1995). Thus, I sought to have data from at least that many participants for the final sample of Study 3. In anticipation of attrition over a 7-day longitudinal study, my data collection goal was at least 60 participants.

Participants were 63 University of Southampton students. I reduced the number of days from 14 (Study 2) to 7, because only 5-6 nights of actigraphy are needed to obtain reliable readings (Acebo et al., 1999; Aili, 2017; Knutson et al., 2007). I remunerated participants with a maximum of 23 course credits (depending on completion progress) for completing the laboratory session on Day 1 and each succeeding day's 5-minute online survey. I excluded participants if they did not complete at least 5 days of the longitude phase ($N = 0$) or due to actigraphy watch malfunctions ($N = 23$). This left 40 participants for the analyses reported below. Participants in the final sample were 18 to 34 years old ($M = 19.45$, $SD = 2.99$). Most were women ($N = 34$, 85%) and the remaining were men ($N = 6$, 15%). Also, most participants were White ($N = 31$, 77.5%) with additional participants reporting being Black ($N = 2$, 5%) or Asian ($N = 9$, 22.5%). Two participants responded twice, following incomplete first responses, so their first responses were excluded and their second responses were included.

4.3.2 Procedure

On Day 1 participants visited the laboratory where they completed the same trait and demographic measures as in Study 2 (Appendix A). Then a Micro Mini-Motionlogger actigraph watch was fastened to their wrist, and they were instructed not to remove it until the end of the study (7 days later). The Micro Mini-Motionlogger actigraph has no user interface and therefore requires no skill to use. Beginning the evening of Day 1, participants completed the same brief (5 minute) online survey every day for 7 days as in Study 2. The only difference was that both trait and state measures were recorded on Day 1. The survey was distributed at 5pm (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). After seven days (168 hours), participants returned the Micro Mini-Motionlogger actigraph to the laboratory and were debriefed.

4.3.3 Actigraphy

I measure objective 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) for the duration of the 7 days. The Micro Mini-Motionlogger provides an objective 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 subject, which is generated through a precision piezoelectric bimorph-ceramic cantilevered beam. This voltage is then transferred to the analogue circuitry, where the original signal is amplified and filtered according to the 2-3 Hz bandpass filter. Bodily movement has been well validated as an accurate measure of sleep quality (Ancoli-Israel et al., 2003; Blackwell, 2011; Mendonça et al., 2019; Spielmanns et al., 2019) and has been reliably established as a good alternative (comparable incremental predictive validity) to other objective measures of sleep quality (Acebo & LeBourgeois. 2006), such as polysomnography (Spielmanns et al., 2019), cyclic alternating pattern (Krystal & Edinger, 2008; Hartmann & Baumert, 2020), or electroencephalography (EEG; Fietze et al., 2015; Krystal & Edinger, 2008).

The Micro Mini-Motionlogger uses movement to generate 19 components of sleep quality. I focused on the component of sleep efficiency, because sleep efficiency is the most commonly used measure of objective of sleep quality (Åkerstedt et al., 1994; Bruyneel et al., 2011; Jung et al., 2016) and is recommended as a good indicator of sleep quality across the lifespan by the National Sleep Foundation (Ohayon et al., 2017). Sleep efficiency is defined by the amount of time spent asleep, relative to the amount of time in bed, therefore accounts for duration of effort trying to sleep and sleep disturbances during the night. Sleep efficiency is therefore indicative of the *quality* of actual sleep, as opposed to duration of sleep or mood upon waking. Additionally, some research suggests that actigraphy might be an unreliable measure of alternative sleep quality metrics but is a reliable measure of sleep efficiency (Tworoger et al., 2005). Furthermore, research by Rosipal et al. (2013) compared a series of objective sleep quality components against subjective sleep quality and found that subjective sleep quality correlated strongest with sleep-efficiency. Actigraphy is further validated as a measure of sleep quality (via sleep efficiency) and has been widely used in sleep studies (Ancoli-Israel, 2003; Bender et al. 2003; Winzeler et al., 2014). Sleep efficiency is calculated by dividing the amount of time scored as sleep by the full duration of the sleep epoch. A sleep epoch is defined by limb movement, where the epoch onset is the moment limb movement significantly drops and ends when limb movement significantly increases. Epoch onset is 60 seconds of persistent sleep (minimal limb movement), and all epochs are verified by the researcher to excluded short / mislabelled epochs. The outcome is the amount of time one spends actually asleep relative to the time spent trying to sleep. The Micro Mini-Motionlogger is a non-invasive and non-interactive actigraph, which promotes a more natural sleep, compared to the aforementioned physiological measures, and continues to be effectively used in prominent research (Bellone et al., 2016; Schoch et al., 2020), providing a reliable and valid objective measure of sleep quality.

4.3.4 Statistical Analysis

4.3.4.1 Subjective Sleep Quality.

I used bivariate correlations and multiple regression analyses of the Day 1 trait data via SPSS 28 to test the replicability of the results of Study 1-2. As in Study 2, I used a series of RI-CLPM(in SAS to examine bidirectional relationships between subjective sleep quality and self-related constructs. This approach allowed testing for: (1) Prospective effects of temporary deviations from the trait level of each self construct on change in the temporary deviation from the trait level of Sleep Quality (self → subjective 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 construct (subjective sleep → self cross-lagged path). I ran separate sets of models for self-esteem, self-control, self-compassion, and self-continuity as well as a composite of the four self-constructs. See Figures 2ai and 2aii.

4.3.4.2 Objective Sleep Quality.

I also used a series of RI-CLPMs to examine bidirectional relationships between objective sleep quality (i.e., sleep efficiency) and self-related constructs. This approach allowed testing for: (1) Prospective effects of temporary deviations from the trait level of each self construct on change in the temporary deviation from the trait level of sleep efficiency (self → objective sleep cross-lagged path), and (2) Prospective effects of temporary deviations from the trait level of Sleep Efficiency on change in the temporary deviation from the trait level of each self construct (objective sleep → self cross-lagged path). I ran separate sets of models for self-esteem, self-control, self-compassion, and self-continuity as well as a composite of the four self-constructs. See Figures 2ai and 2aii.

As before, in the RI-CLPMs reported below, I specified time equality constraints placed on the auto-regressive and cross-lagged paths. Here, structural coefficients (autoregressive and cross-lagged effects) are assessed at equally separated time points for consistency across models and within-model response times. This is a common approach that improves the statistical power, precision of parameter estimates, and interpretability (Orth et al., 2021). I used the following criteria to evaluate model fit: Comparative Fit Index (CFI) > .90, Root Mean Square Error of Approximation (RMSEA) < .08 and Standardized Root Mean Square Residual (SRMR) < .08 (Hu & Bentler, 1999; Kline, 2011).

4.3.4.3 Actigraphy Pre-Processing

Actigraphy devices can implement a number of methods to process movement-based activity signals when measuring sleep activity. I opted to calculate and process this activity using the zero-crossing method. Zero-crossing is the most popular mode of operation due to it being the recommended method which estimates sleep activity with the highest accuracy, compared to other modes (such as Proportional Integrating Measure). The zero-crossing 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 retrieval of data, this data is presented as a histogram, with movement activity presented on the y-axis. Sleep is interpreted as a movement which does not cross the signal threshold. In lighter sleep, movement can still occur, so 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. I follow the guidelines set by the manufacturer of this device (Ambulatory Monitoring Inc.) and corroborated in prior research (Jean-Louis et al., 2001).

4.3.4.4 Sleep Efficiency

Sleep efficiency is scored as a percentage. This is calculated by dividing the sleep duration by the full sleep epoch duration (sleep epoch duration includes small movement-activity before, during and after activity scored as sleep), multiplied by 100. Sleep duration is defined as the total minutes of activity scored as sleep. All sleep epochs were cross-referenced with participants self-report sleep measures. In the PSQD, participants report the time they went to bed, the time they think they fell asleep, and the time the woke up. In cases where these reports did not match (generally due to participant interference with the actigraphy devices), the sleep epochs were manually adjusted to correspond with participant self-report data. Examples of participant interference are the participant removed the actigraph for an extended period of time (e.g., washing, or extreme physical sport), or the actigraph broke (e.g., ran out of battery or broken watch strap). In these instances, participants were required to note and report the time of the actigraph removal so that the researcher could cross-reference interference with anomalous data.

4.4 Results

4.4.1 Associations Between Subjective and Objective Sleep Quality

I report associations between daily reports of subjective sleep quality and actigraphy-based sleep efficiency in Table 3a. Same day associations between subjective and objective reports ranged from

-.07 to .44. Associations between earlier subjective reports and the next day's objective reports ranged from -.19 to .36. Associations between earlier objective reports and the next day's subjective reports ranged from -.01 to .25. Only two of the 16 associations were significant.

4.4.2 Longitudinal Analyses: Subjective sleep quality RI-CLPMs

I tested the casual effects of subjective state sleep quality on each of the four state subjective self-constructs, and vice versa. Each day's reported state subjective sleep quality and state self-constructs were inputted into separate RI-CLPM. I generated two models to examine how self-compassion, self-control, self-esteem, and self-continuity predicted succeeding night's sleep quality at the short (12-hour) and long (36-hour) lag across consecutive 7 days. Then, I examined the reverse direction of how each night's subjective sleep quality predicted self-compassion, self-control, self-esteem, and self-continuity at the short (12-hour) and long (36-hour) lag across 7 consecutive days. The first model (Model 1) shows short self → sleep and long sleep → self lagged effects. The second model (Model 2) shows short sleep → self and long self → sleep lagged effects.

Model 1

Self-Composite. I fit the self-composite and subjective sleep quality to a RI-CLPM. The model fit the data poorly, *X2* (77) = 104.02, *p* = .022 (CFI = .87, RMSEA = .09, 90% CI [.037, .137], SRMR = .129). The between-subjects covariation (μ) between subjective sleep quality and the self-composite was significant, *B* = 0.26, *SE* = .13, (*t*(77) = 2.03, *p* = .042. The autoregressive path from earlier self-composite to later self-composite scores (ζ) was not significant, *B* = 0.15, *SE* = .10, (*t*(77) = 1.52, *p* = .128. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B* = 0.09, *SE* = .10, (*t*(77) = 0.91, *p* = .365. The cross-lagged path from earlier sleep to later self-composite (κ) was not significant, *B* = 0.06, *SE* = .04, (*t*(77) = 1.34, *p* = .182. The cross-lagged path from earlier self-composite to later sleep (ε) was not significant, *B* = 0.16, *SE* = .19, (*t*(77) = 0.87, *p* = .385.

Self-Compassion. Second, I fit self-compassion and subjective sleep quality to a RI-CLPM. The model fit the data poorly, *X2* (77) = 100.36, *p* = .038 (CFI = .82, RMSEA = .08, 90% CI [.022, .132], SRMR = .127). The between-subjects covariation (μ) between subjective sleep quality and the 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 (ζ) 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 (δ) was not significant, *B* = 0.14, *SE* = .10, (*t*(77) = 1.40, *p* = .162. The cross-lagged path from earlier sleep to later self-compassion (κ) 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 (ε) was not significant, *B* = -0.12, *SE* = .17, t (77) = - 0.71, *p* = .478.

Self-Control. Third, I fit self-control and subjective sleep quality to a RI-CLPM. The model did not fit the data well *X2* (77) = 98.61, *p* = .049 (CFI = .85, RMSEA = .08, 90% CI [.005, .129], SRMR = .139). The between-subjects covariation (μ) between subjective 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 (ζ) was not significant, *B* = 0.14, *SE* = .09, (*t*(77) = 1.63, *p* = .103. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B* = 0.04, *SE* = .11, (*t*(77) = 0.42, *p* = .676. The cross-lagged path from earlier sleep to later self-control (κ) was not significant, *B* = 0.01, *SE* = .06, (*t*(77) = 0.24, *p* = .812. The cross-lagged path from earlier self-control to later sleep (ε) was not significant, *B* = 0.20, *SE* = .13, (*t*(77) = 1.55, *p* = .122.

Self-Esteem. Fourth, I fit self-esteem and subjective sleep quality to a RI-CLPM. The model fit the data well, with the exception of SRMR, *X2* (77) = 96.68, *p* = .064 (CFI = .91, RMSEA = .08, 90% CI [.000, .126], SRMR = .122). The between-subjects covariation (μ) between subjective sleep quality and self-esteem was significant, *B* = 0.24, *SE* = .19, (*t*(77) = 1.25, *p* = .211. The autoregressive path from earlier self-esteem to later self-esteem (ζ) was not significant, *B* = 0.18, *SE* = .08, (*t*(77) = 2.10, *p* = .036. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B* = 0.09, *SE* = .09, (*t*(77) = 0.95, *p* = .340. The cross-lagged path from earlier sleep to later self-esteem (κ) 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 (ε) was not significant, *B* = 0.12, *SE* = .11, t (77) = 1.06, *p* = .287.

Self-Continuity. Finally, I fit self-continuity and subjective sleep quality to a RI-CLPM. The model fit the data poorly, *X2* (77) = 122.02, *p* < .001 (CFI = .77, RMSEA = .12, 90% CI [.078, .160], SRMR = .165). The between-subjects covariation (μ) between subjective 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 (ζ) was significant, *B* = 0.17, *SE* = .09, (*t*(77) = 1.99, *p* = .047. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B* = 0.15, *SE* = .10, (*t*(77) = 1.52, *p* = .131. The cross-lagged path from earlier sleep to later self-continuity (κ) was not significant, *B* = 0.10, *SE* = .06, (*t*(77) = 1.72, *p* = .085. The cross-lagged path from earlier self-continuity to later sleep (ε) was not significant, *B* = -0.04, *SE* = .12, t (77) = -0.34, *p* = .728.

See Figure 3ai for applied example of the conceptual model.

Model 2

Self-Composite. I fit the self-composite and subjective sleep quality to a RI-CLPM. The model fit the data well with the exception of SRMR, *X2* (53) = 67.55, *p* = .086 (CFI = .91, RMSEA = .08, 90% CI [.000, .137], SRMR = .121). The between-subjects covariation (μ) between subjective sleep quality and the self-composite was significant, *B =* 0.34, *SE* = .13, (*t*(53) = 2.67, *p* = .008. The autoregressive path from earlier self-composite to later self-composite scores (ζ) was not significant, *B =* 0.13, *SE* = .09, (*t*(53) = 1.41, *p* = .159, but the pattern is consistent with Study 2. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B =* 0.10, *SE* = .11, (*t*(53) = 0.87, *p* = .382, though the pattern is consistent with Study 2. The cross-lagged path from earlier sleep to later self-composite (κ) was significant, *B =* 0.16, *SE* = .04, (*t*(53) = 3.97, *p* < .001. However, the cross-lagged path from earlier self-composite to later sleep (ε) was not significant, *B =* -0.38, *SE* = .20, (*t*(53) = -1.84, *p* = .065.

Self-Compassion. I fit self-compassion and subjective sleep quality to a RI-CLPM. The model fit the data well, with the exception of SRMR, *X2* (53) = 56.92, *p* = .332 (CFI = .97, RMSEA = .04, 90% CI [.000, .111], SRMR = .119). The between-subjects covariation (μ) between subjective 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 (ζ) was not significant, *B =* 0.15, *SE* = .09, (*t*(53) = 1.57, *p* = .116. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B =* 0.10, *SE* = .10, (*t*(53) = 0.99, *p* = .320. The cross-lagged path from earlier sleep to later self-compassion (κ) was not significant, *B =* 0.06, *SE* = .04, t (53) = 1.40, *p* = .161. The cross-lagged path from earlier self-compassion to later sleep (ε) was not significant, *B =* -0.20, *SE* = .18, (*t*(53) = - 1.10, *p* = .273.

Self-Control. I fit self-control and subjective sleep quality to a RI-CLPM. The model did not fit the data well *X2* (53) = 68.57, *p* = .074 (CFI = .87, RMSEA = .09, 90% CI [.000, .139], SRMR = .135). The between-subjects covariation (μ) between subjective 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 (ζ) was not significant, *B =* 0.04, *SE* = .08, (*t*(53) = 0.55, *p* = .573. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B =* 0.14, *SE* = .11, (*t*(53) = 1.25, *p* = .211. The cross-lagged path from earlier sleep to later self-control (κ) was significant, *B =* 0.32, *SE* = .05, t (53) = 6.09 *p* < .001. The cross-lagged path from earlier self-control to later sleep (ε) was not significant, *B =* -0.18, *SE* = .14, (*t*(53) = -1.28, *p* = .200.

Self-Esteem. I fit self-esteem and subjective sleep quality to a RI-CLPM. The model fit the data well, with the exception of SRMR, *X2* (53) = 41.81, *p* = .866 (CFI = .99, RMSEA = .00, 90% CI [.000, .055], SRMR = .102). The between-subjects covariation (μ) between subjective 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 (ζ) was not significant, *B =* 0.09, *SE* = .09, (*t*(53) = 1.01, *p* = .312. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B =* 0.12, *SE* = .10, (*t*(53) = 1.14, *p* = .253. The cross-lagged path from earlier sleep to later self-esteem (κ) was marginally significant, *B =* 0.10, *SE* = .06, (*t*(53) = 1.84 *p* = .066. The cross-lagged path from earlier self-esteem to later sleep (ε) was significant, *B =* -0.33, *SE* = .14, (*t*(53) = 2.40, *p* = .016.

Self-Continuity. I fit self-continuity and subjective sleep quality to a RI-CLPM. The model fit the data well, with the exception of SRMR, *X2* (53) = 64.87, *p* = .127 (CFI = .91, RMSEA = .07, 90% CI [.000, .131], SRMR = .151). The between-subjects covariation (μ) between subjective 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 (ζ) was significant, *B =* 0.31, *SE* = .11, (*t*(53) = 2.96, *p* = .003. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B =* 0.15, *SE* = .11, (*t*(53) = 1.33, *p* = .184. The cross-lagged path from earlier sleep to later self-continuity (κ) was significant, *B =* 0.15, *SE* = .06, t (53) = 2.37, *p* = .018. The cross-lagged path from earlier self-continuity to later sleep (ε) was not significant, *B =* -0.07, *SE* = .13, (*t*(53) = -0.57, *p* = .572.

See Figure 3aii for applied example of the conceptual model.

4.4.3 Longitudinal Analyses: Objective Sleep Quality RI-CLPMs

Next, I ran a series of RI-CLPMs to examine lagged associations between objective markers of sleep (i.e., sleep efficiency) and self-related measures. Given that these variables cannot be assessed simultaneously, the same temporal lags as above and in Study 2 apply here. The first model (Model 3) shows short self → sleep and long sleep → self lagged effects. The second model (Model 4) shows short sleep → self and long self → sleep lagged effects.

Model 3

Self-Composite. I fit the self-composite and sleep efficiency to a RI-CLPM. The model fit the data well with the exception of SRMR, *X2* (53) = 49.00, *p* = .631 (CFI = .99, RMSEA = .00, 90% CI [.000, .867], SRMR = .117). The between-subjects covariation (μ) between sleep efficiency and the self-composite was not significant, *B =* -0.06, *SE* = .08, (*t*(53) = -0.80, *p* = .425. The autoregressive path from earlier self-composite to later self-composite scores (ζ) was significant, *B =* 0.44, *SE* = .10, (*t*(53) = 4.40, *p*

< .001. The autoregressive path from earlier sleep efficiency to later sleep efficiency (δ) was not significant, B = 0.16, SE = .10, (t(53) = 1.51, p = .130. The cross-lagged path from earlier sleep efficiency to later self-composite (κ) was not significant, B = 0.05, SE = .09, (t(53) = 0.53, p = .596. The cross-lagged path from earlier self-composite to later sleep efficiency (ε) was significant, B = 0.29, SE = .10, (t(53) = 2.91, p = .004.

Self-Compassion. I fit self-compassion and sleep efficiency to a RI-CLPM. The model did fit the data well with the exception of SRMR, $X2$ (53) = 57.82, p = .302 (CFI = .96, RMSEA = .05, 90% CI [.000, .114], SRMR = .141). The between-subjects covariation (μ) between sleep efficiency and self-compassion was not significant, B = -0.15, SE = .09, (t(53) = -1.65, p = .098. The autoregressive path from earlier self-compassion to later self-compassion (ζ) was significant, B = 0.11, SE = .11, (t(53) = 1.01, p = .311. The autoregressive path from earlier sleep efficiency to later sleep efficiency (δ) was significant, B = 0.20, SE = .15, (t(53) = 1.34, p = .181. The cross-lagged path from earlier sleep efficiency to later self-compassion (κ) was not significant, B = 0.08, SE = .11, (t(53) = 0.74, p = .553. The cross-lagged path from earlier self-compassion to later sleep efficiency (ε) was significant, B = 0.21, SE = .09, (t(53) = 2.39, p = .017.

Self-Control. I fit self-control and sleep efficiency to a RI-CLPM. The model fit the data well with the exception of SRMR, $X2$ (53) = 55.79, p = .371 (CFI = .96, RMSEA = .04, 90% CI [.000, .108], SRMR = .131). The between-subjects covariation (μ) between sleep efficiency 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 (ζ) scores was significant, B = 0.17, SE = .09, (t(53) = 1.95, p = .051. The autoregressive path from earlier sleep efficiency to later sleep efficiency (δ) was significant, B = 0.07, SE = .10, (t(53) = 0.73, p = .466. The cross-lagged path from earlier sleep efficiency to later self-control (κ) 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 efficiency (ε) was not significant, B = -0.01, SE = .07, (t(53) = -0.11, p = .912.

Self-Esteem. I fit self-esteem and subjective sleep quality to a RI-CLPM. The model fit the data well with the exception of SRMR, $X2$ (53) = 52.44, p = .496 (CFI = .99, RMSEA = .02, 90% CI [.000, .098], SRMR = .118). The between-subjects covariation (μ) between sleep efficiency 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 (ζ) scores was significant, B = 0.21, SE = .11, (t(53) = 1.94, p = .052. The autoregressive path from earlier sleep efficiency to later sleep efficiency (δ) was not significant, B = 0.08, SE = .09, (t(53) = 0.91, p = .364. The cross-lagged path from earlier sleep efficiency to later self-esteem (κ) 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 efficiency (*ε*) was not significant, *B* = 0.09, *SE* = .07, (*t*(53) = 1.23, *p* = .217.

Self-Continuity. I fit self-continuity and subjective sleep quality to a RI-CLPM. The model fit the data well with the exception of SRMR, *X2* (53) = 59.56, *p* = .249 (CFI = .96, RMSEA = .06, 90% CI [.000, .118], SRMR = .121). The between-subjects covariation (*μ*) between sleep efficiency 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 (*ζ*) was significant, *B* = 0.33, *SE* = .16, (*t*(53) = 2.06, *p* = .039. The autoregressive path from earlier sleep efficiency to later sleep efficiency (*δ*) was not significant, *B* = 0.11, *SE* = .09, (*t*(53) = 1.18, *p* = .238. The cross-lagged path from earlier sleep efficiency to later self-continuity (*κ*) was not significant, *B* = -0.07, *SE* = .14, (*t*(53) = -0.53, *p* = .597. The cross-lagged path from earlier self-continuity to later sleep efficiency (*ε*) was significant, *B* = 0.16, *SE* = .07, t (53) = 2.33, *p* = .020.

See Figure 3ai for applied example of the conceptual model.

Model 4

Self-Composite. I fit the self-composite and sleep efficiency to a RI-CLPM. The model fit the data poorly, *X2* (77) = 104.02, *p* = .022 (CFI = .87, RMSEA = .08, 90% CI [.000, .122], SRMR = .129). The between-subjects covariation (*μ*) between sleep efficiency and the self-composite was significant, *B* = 0.26, *SE* = .13, (*t*(77) = 2.03, *p* = .042. The autoregressive path from earlier self-composite to later self-composite scores (*ζ*) was not significant, *B* = 0.15, *SE* = .10, (*t*(77) = 1.52, *p* = .128. The autoregressive path from earlier sleep efficiency to later sleep efficiency (*δ*) was marginally significant, *B* = 0.14, *SE* = .08, t (77) = 1.80, *p* = .073. The cross-lagged path from earlier sleep efficiency to later self-composite (*κ*) was not significant, *B* = -0.06, *SE* = .07, (*t*(77) = -0.82, *p* = .412. The cross-lagged path from earlier self-composite to later sleep efficiency (*ε*) was not significant, *B* = 0.04, *SE* = .09, (*t*(77) = 0.44, *p* = .661.

Self-Compassion. I fit self-compassion and sleep efficiency to a RI-CLPM. The model did not fit the data well, *X2* (77) = 94.71, *p* = .083 (CFI = .89, RMSEA = .08, 90% CI [.000, .123], SRMR = .158). The between-subjects covariation (*μ*) between sleep efficiency 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 (*ζ*) was significant, *B* = 0.10, *SE* = .09, (*t*(77) = 1.08, *p* = .281. The autoregressive path from earlier sleep efficiency to later sleep efficiency (*δ*) was significant, *B* = 0.17, *SE* = .08, (*t*(77) = 1.99, *p* = .046. The cross-lagged path from earlier sleep efficiency to later self-compassion (*κ*) was not significant, *B* = -0.05, *SE* = .08, (*t*(77) = -0.60, *p* = .553. The cross-lagged path from earlier self-compassion to later sleep efficiency (*ε*) was not significant, *B* = -0.08, *SE* = .09, t (77) = -0.90, *p* = .369.

Self-Control. I fit self-control and sleep efficiency to a RI-CLPM. The model fit the data well with the exception of SRMR, *X2* (77) = 84.83, *p* = .253 (CFI = .93, RMSEA = .05, 90% CI [.000, .106], SRMR = .139). The between-subjects covariation (*μ*) between sleep efficiency 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 (*ζ*) scores was not significant, *B* = 0.13, *SE* = .08, (*t*(77) = 1.54, *p* = .124. The autoregressive path from earlier sleep efficiency to later sleep efficiency (*δ*) was significant, *B* = 0.16, *SE* = .08, (*t*(77) = 1.97, *p* = .049. The cross-lagged path from earlier sleep efficiency to later self-control (*κ*) was not significant, *B* = -0.08, *SE* = .09, (*t*(77) = -0.88, *p* = .380. The cross-lagged path from earlier self-control to later sleep efficiency (*ε*) was not significant, *B* = -0.06, *SE* = .06, t (77) = -1.01, *p* = .313.

Self-Esteem. I fit self-esteem and subjective sleep quality to a RI-CLPM. The model fit the data well with the exception of SRMR, *X2* (77) = 77.85, *p* = .451 (CFI = .99, RMSEA = .02, 90% CI [.000, .092], SRMR = .122). The between-subjects covariation (*μ*) between sleep efficiency 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 (*ζ*) scores was significant, *B* = 0.19, *SE* = .09, (*t*(77) = 2.26, *p* = .024. The autoregressive path from earlier sleep efficiency to later sleep efficiency (*δ*) was significant, *B* = 0.16, *SE* = .08, (*t*(77) = 1.93, *p* = .053. The cross-lagged path from earlier sleep efficiency to later self-esteem (*κ*) was not significant, *B* = -0.12, *SE* = .10, (*t*(77) = -1.25, *p* = .212. The cross-lagged path from earlier self-esteem to later sleep efficiency (*ε*) was not significant, *B* = 0.06, *SE* = .08, (*t*(77) = 1.10, *p* = .273.

Self-Continuity. I fit self-continuity and subjective sleep quality to a RI-CLPM. The model fit the data well with the exception of SRMR, *X2* (77) = 90.38, *p* = .141 (CFI = .93, RMSEA = .07, 90% CI [.000, .116], SRMR = .122). The between-subjects covariation (*μ*) between sleep efficiency 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 (*ζ*) was significant, *B* = 0.22, *SE* = .09, (*t*(77) = 2.43, *p* = .015. The autoregressive path from earlier sleep efficiency to later sleep efficiency (*δ*) was not significant, *B* = 0.12, *SE* = .08, (*t*(77) = 1.56, *p* = .118. The cross-lagged path from earlier sleep efficiency to later self-continuity (*κ*) was not significant, *B* = -0.03, *SE* = .10, (*t*(77) = -0.36, *p* = .720. The cross-lagged path from earlier self-continuity to later sleep efficiency (*ε*) was not significant, *B* = 0.08, *SE* = .05, (*t*(77) = 1.47, *p* = .143. See Figure 3aii for applied example of the conceptual model.

4.5 Discussion

Despite some model fit issues in the subjective sleep quality RI-CLPMs (likely due to a lower sample size), I generally replicated the subjective sleep → self pattern of cross-lagged effects that I observed in Study 2 at short lags. In other words, Hypotheses 1B, 1C, and 1D were supported, but Hypothesis 1A was not. At longer lags, the models fit the data poorly and no cross-lagged effects from sleep to self were observed, again replicating the findings of study 2.

Regarding objective sleep quality, I offered two possible patterns of cross-lagged associations. First, objective sleep → self associations (Hypotheses 2A-D) and self → sleep associations (Hypotheses 3A-D) would replicate those of subjective sleep quality. This would provide strong support for a direction of effect, regardless of measure, suggesting that sleep quality predicts all self-constructs, but self-constructs do not predict sleep quality. The second possible outcome was that self → sleep associations (Hypotheses 4A-D) and objective sleep → self associations (Hypotheses 5A-D) would contrast those of subjective sleep quality. This would indicate that objective measures of sleep quality track alternative components of sleep quality than self-report subjective measures and therefore self-constructs may influence objectively measured sleep in a way they did not for subjective sleep quality. Results support the latter hypotheses, as objective sleep quality predicted none of the self-constructs, but self-compassion, self-continuity, and the composite self score predicted objective sleep quality, at short but not long lags. These findings generally oppose the findings of prior literature (Hisler et al., 2019; Saini et al., 2020). However, given the support for the reliability and validity of actigraphy-measured sleep efficiency (Ancoli-Israel, 2003; Bender et al. 2003; Ohayon et al., 2017; Tworoger et al., 2005; Winzeler et al., 2014) and the clear lack of research using actigraphy in studies of self-constructs, there is little grounds to reject the findings of my research and thus we must acknowledge these findings with some credence. Additionally, it should be noted prior research has found results concurring with the sentiment that subjective and objective measure of sleep quality do not produce parallel findings (Lee and Lawson, 2021).

Another finding of interest is the semi-frequent non-significant autoregression from self → self and sleep → sleep. This would suggest a lack of stability in the state (within-person) variables over time, or, that the state fluctuations of the variable are less pronounced relative to the controlled-for trait (between-person) variable. This may be apparent if the time points are too close together (Mund et al., 2021). However, Hamaker (2020) argues that it is common to see non-significant autoregressive paths in RI-CLPM, because RI-CLPM separate trait from state variation, which restricts the comparable deviation of state from stable trait variables. Nonetheless, this may influence the output of the RI-CLPM and subsequent conclusion.

Taken together with the results of Study 2, the results of Study 3 suggest that subjective (but not objective) sleep predicts self-related measures at short (12-hour) lags and objective (but not subjective) sleep predicts some aspects of the self (composite, compassion, continuity) at short (12-hour) lags. In a final study, I took an interventionist approach and tried to amplify self-compassion, self-control, and self-esteem to see whether such an intervention may produce any stronger, more consistent self to sleep effects.

See Figure 3b for a cumulative graphic of associations between sleep quality and the self.

Chapter 5 Study 4

“A ruffled mind makes a restless pillow.”

- Charlotte Bronte (*The Professor*, 1857)

Studies 2 and 3 showed a consistent pattern of cross-lagged effects of subjective sleep quality on self-constructs. When participants self-reported better than average sleep, they reported increases in self-compassion, self-control, self-esteem, and self-continuity. However, when participants’ self-compassion, self-control, self-esteem, or self-continuity were higher than average, they did not show corresponding increases in subjective sleep quality but some increases in objective sleep quality were observed. My cross sectional (Study 1) and diary studies (Studies 2-3) as well as the wider literature link better sleep to increased self-compassion, self-control, and self-esteem. However, consideration of self to sleep pathways is limited. In a daily diary study, Hu et al. (2018) found that increased self-compassion led to better sleep. Building on this, Butz and Stahlberg (2018) found that a self-compassion intervention (vs. control) increased subjective sleep quality. Alongside reliable self-compassion interventions (Ferarri et al., 2019) are reliable interventions to boost both self-esteem (Niveau et al., 2021) and self-control (de Ridder et al., 2020). Thus far, my own research (Studies 2-3) has not identified a predictive effect of any self-construct on subjective sleep quality, which contradicts theory and empirical evidence. Therefore, Study 4 was conducted for two reasons.

First, I argue that my null findings are due to a distinction in measurement of self-constructs: namely, explicit compared to implicit self-constructs. Specifically, research suggests that explicit and implicit self-constructs are distinct (The Dual Attitude Model; Wilson et al., 2000) and may have differing effects on behaviour and personality (Dijksterhuis, 2004; Grumm et al., 2009; Huntjens et al., 2013; Keatley et al., 2017). By definition, implicit self-constructs are less controllable, with unknown origin, where the individual applies less cognitive effort to consider the construct and therefore require less cognitive effort to express. Explicit self-constructs are more controlled and rationally processed reflections of the self. In the context of the present research, implicit self-esteem is defined as the product of automatic processing of affective experiences, whereas explicit self-esteem is defined as a conscious and rational processing of self-relevant information (Grumm et al., 2009). Similar definitions can be applied to self-control (Huntjens et al., 2013) and self-compassion (Koop, 2024). Studies 2-3 failed to show the expected effect of self-constructs on the sleep quality, but then only questionnaires have been used. I propose that the effect on sleep may be driven by explicit (rather than implicit) self-constructs. Such a suggestion is supported by research, where a self-compassion intervention targeting explicit self-compassion has improved sleep quality (Sheng et al., 2023). Although, no prior research has examined the effect of an explicit self-esteem or self-control manipulation on sleep quality. Here, rejecting the null hypothesis may suggest that cognitive effort does indeed play a role in the self-sleep relationship.

The second rationale for Study 4 is that of rigor. Given the null hypotheses accepted in Studies 2 and 3, the findings so far contradict those of prior literature. Such unexpected outcomes encourage replication, for the sake of reliability. Plenty of prior research does support a self-sleep effect when using questionnaires. Study 4, then, allows a final chance for the effects of self-constructs on sleep quality to show. Although, accepting the null hypothesis in Study 4 would add value and reliability to the consistent findings of Studies 2 – 3. The application of an experimental manipulation adds further rigor through increased empirical control. An alternative route was to instead manipulate sleep via sleep deprivation methods, to provide further evidence for the sleep-self effect. However, this would have ignored potential self-sleep effects. Given the earlier discussed ethical and empirical concerns with sleep deprivation methods (1.1.3), the former approach was more logistically and ethically feasible.

Studies 2 and 3 concur that self-constructs do not predict subjective sleep, although there is some evidence for an effect on objective sleep quality (supported by prior literature). Therefore, Study 4 targets subjective sleep quality (rather than objective sleep quality) to examine whether self-constructs effect subjective sleep quality if cognitive effort is applied.

5.1 Hypothesis

In Study 4, I took an interventionist approach. I attempted to experimentally enhance self-constructs and examine their impact on subjective sleep quality in a 10-day longitudinal study. I assessed the effectiveness of self-compassion, self-control, and self-esteem manipulations, against a control condition (no manipulation). An important distinction with Study 4 is that self-continuity was not tested. This was due to methodological challenges which are discussed in depth later in this chapter (5.2.3). In line with Butz and Stahlberg (2018), I hypothesised that greater engagement with each self-construct manipulation would independently increase subjective sleep quality.

5.2 Method

5.2.1 Participants

I tested 258 UK Prolific workers, who agreed to participate in a 10-day longitudinal study. I renumerated them with £1.00 for completing a 10-minute survey the first day and £0.50 for a 5-minute survey on each subsequent day. I excluded participants if they completed Day 1 only (*N* = 27), had missing data on three or more intervention days (*N* = 81), or reported not attempting the intervention despite participating on eight or more days (*N* = 2). The final sample comprised 148 participants. I randomly assigned them to a self-compassion (*N* = 35), self-control (*N* = 40), self-esteem (*N* = 31) intervention, or control (*N* = 42) condition.

Participants were 18 to 73 years old (*M* = 36.88, *SD* = 12.71). Most of them were women (*N* = 115, 77.70%), and the remaining were men (*N* = 29, 19.59%), nonbinary (*N* =1, 0.68%) or did not report their gender (*N* = 3, 2.03%). Participants were also predominantly White (*N* = 124, 83.78%) with additional participants reporting being Black (*N* = 2, 1.35%), Asian (*N* = 9, 6.08%), Other (*N* = 2, 1.35%), Multi-Racial (*N* = 4, 2.70%), or not reporting their race (*N* = 7, 4.73%).

5.2.2 Procedure

The procedure for Study 4 was nearly identical to Study 2. Participants completed a brief (5 minute) online survey every day for 10 days. The survey was distributed at 5pm (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). This was checked by observing time stamps of questionnaire completion. Also, each questionnaire included a final question of “should we use your data?” with instruction and reference to full compliance with procedure. Day 1 consisted of trait measures and demographics as in Studies 1-2. Following this, participants entered the longitudinal phase (Days 2-10), where they reported on their self-esteem, self-control, self-compassion, and how well they slept the night before (Appendix A). Measures were presented in a separate randomized order each day.

5.2.3 Experimental Manipulation

The intervention was inspired by a self-administered exercise, recommended by Neff (2021). These exercises are well validated and effective (Neff, 2013; Smeets et al., 2014) in improving self-compassion. The exercise is a non-invasive self-awareness exercise. Participants are instructed simply to be aware of and try to engage with their assigned self-construct (self-compassion, self-control, or self-esteem). A control group did not engage with any exercise. I altered the instructions of Neff (20121) minimally across each condition to relate to concepts appropriate for self-control and self-esteem, without creating significant differences between groups. The instructions were altered to be applicable daily, without the necessity for physical intervention (although examples of physical behaviours are suggested, in order to maintain consistency with the original exercises; Neff, 2021). Participants were randomly assigned to 1 of 4 conditions: the three experimental conditions, and a control group. Instructions for each condition are as follows:

Self-Compassion. Participants in the self-compassion condition read the following instructions on each study day:

> In addition to this, we ask that you make a conscious effort to show self-compassion throughout your day. This could be forgiving yourself for being rude to a waitress; reciting some kind words to yourself; or making extra time in the day for yourself. You may find it useful to keep a "self-compassion journal" in which you spend a few minutes every day expressing kindness, common humanity, and understanding towards yourself. You may choose to find somewhere quiet and write a paragraph in a personal diary or close your eyes and reflect on these behaviours, or regularly remind yourself to be forgiving and supportive towards yourself.

Self-Control. Participants in the self-control condition read the following instructions on each study day:

> In addition to this, we ask you to make a conscious effort to show self-control as you go about your day. This could be denying yourself unnecessary luxuries (e.g., an indulgent dessert), reducing bad habits (e.g., biting your nails), or promoting healthier habits (e.g., daily exercise). You may find it useful to keep a "control diary" in which you spend a few minutes every day noting the ways in which you showed self-control. You may choose to find somewhere quiet and write a paragraph in a personal diary or close your eyes and reflect on these behaviours, or regularly remind yourself to show restraint and control.

Self-Esteem. Participants in the self-esteem condition read the following instructions on each study day:

> In addition to this, we ask you to make a conscious effort to show high self-esteem as you go about your day. This could be recognizing your strengths as a competent and likeable person; explaining that a failure was not entirely your fault and interpreting the event in a way that makes you feel better about yourself; or clarifying why your friendly behaviours and attitudes reflect who you are. You may find it useful to keep a “self-esteem journal” in which you spend a few minutes every day noting the behaviours that reflect your positive characteristics. You may choose to find somewhere quiet and write a paragraph in a personal diary or close your eyes and reflect on these behaviours, or regularly remind yourself to recognize your positive attributes.

An important distinction with Study 4, compared to Studies 1-3, is that self-continuity was omitted from the study. This is due to several methodological challenges. First, the manipulation that was applied to each self-construct in order induce greater cognitive effort did not transfer well to self-continuity. The exercise involves implementing cognitive effort to induce the self-construct, without any forced behavioural or attitudinal change that differs from habitual routine. Given the familiarity to the lay person, it is much easier to engage in daily behaviours and attitudes for self-compassion (e.g. forgiving oneself for an outburst), self-control (e.g. not eating unhealthy food), and self-esteem (e.g. a proud achievement). Self-continuity, on the other hand, neither has such lay-familiarity nor does it recognisably manifest in one’s daily routine. Rather, connection to one’s past and future self is much more conceptually vague. In order to sufficiently induce greater self-continuity by means of manipulation, a study would require much more rigorous intervention. Relevant to the present research, such an intervention would subtract from the focus on natural daily behaviours.

Along similar lines, there is no existing intervention that increases self-continuity. The only existing research that successfully increased self-continuity manipulated either nostalgia (Sedikides et al., 2016) or holistic thinking tasks (Hong et al., 2020). Therefore, there is no empirical grounds to suggest that applying a non-invasive exercise (such as Neff, 2021) would have any effect. By extension, implementing an effective manipulation to induce self-continuity would require that the intervention be specifically tailored. This would subsequently require that all self-constructs use a manipulation that is equally tailored, in order to maintain control and consistency. However, such a method would thus decrease the similarities between manipulations subsequently introducing uncontrolled-for confounding variables, restricting the reliability of this research.

Finally, the relatively small sample size risked Study 4 being somewhat underpowered. Generally, it is recommended that a sample group size should contain at least 50 participants in order to achieve 80% power (Baayen, 2009; Brysbaert, 2019). Here, logistical restrictions permitted a maximum sample size of 250 participants. Given the expected attrition rates, I opted to prioritise four conditions with maximum power, rather than five conditions with unacceptable power.

Ultimately, due to the limited empirical rationale for a self-continuity intervention, problematic application of the proposed manipulation, alongside the notable concern of low power from a higher number of conditions, self-continuity was not included in Study 4. The focus of Study 4 thus lies on identifying an effect of self-compassion, self-control, and self-esteem on subjective sleep quality.

Successful Random Assignment. Experimental conditions did not differ as a function of participant's age, (F(3, 142) =1.02, p = 3.88, gender, $X2$ (9) = .471, or race, $X2$ (12) = .491. Conditions also did not vary as a function of sleep quality over the prior month, (F(3, 121) = 1.69, p = .173, partial $\eta2$ =.040, trait self-compassion, (F(3, 127) = .691, p = .559, $\eta2$ =.017, trait self-control, (F(3, 114) = .312, p = .817, $\eta2$ =.008, or trait self-esteem, (F(3, 104) = .457, p = .769, $\eta2$ =.011. Randomisation was successful.

5.2.4 Manipulation Checks

Given the transparency of this research in explicitly stating the variables being measured and manipulated, there is the heightened risk of demand characteristics. Participants may inaccurately report their engagement with the study to align with assumed researcher expectations. Therefore, alongside the use of a control group, manipulation checks were implemented to mitigate such bias. Although it is worth noting that demand characteristics are difficult to eliminate entirely, especially in experimental studies such as this, and this strategy is fallible. I return to this issue in the Discussion section of this thesis (6.3.2).

Participants in the three intervention conditions completed several manipulation checks. First, I included an open-ended question asking participants to "briefly describe the way(s)in which [they] showed self-[construct]". No such question was asked in the control condition. Answers were not analysed beyond checking that participants had engaged with the assigned self-construct. Example participant responses include: "Tried not to be so hard on myself about things and to have more patience" (self-compassion); "I stopped myself buying items impulsively" (self-control); "I was talking to a friend about what I'd say when asking for a promotion at work" (self-esteem). Participants were also asked about several indices of their engagement with the allocated self-construct manipulation.

Engagement. The first manipulation check concerned engagement, "Today, did you attempt to show self-[construct] throughout your day?" Participants responded on a binary scale (Yes, No). I summated the number of days participants engaged with the manipulation and responses ranged from 1 to 9 (*M* = 6.13, *SD* = 2.31d).

Time. The second manipulation check concerned time, “Roughly how long did you spend consciously showing self-[construct]?” Participants responded on a 4-point scale (1 = less than 10 minutes, 2 = 10-30 minutes, 3 = 30-60 minutes, 4 = more than an hour). I averaged scores across the longitudinal period and responses ranged from 1.00 to 4.00 (*M* = 2.04, *SD* = 0.81)

Perceived Success. The third manipulation check was perceived success. Participants responded to the question “How successful do you feel you were at showing self-[construct]?” on a 10-point scale from 1 (not at all) to 10 (very much). I averaged responses across the longitudinal period and responses ranged from 3.00 to 10.00 (*M* = 6.98, *SD* = 1.61).

5.3 Results

5.3.1 Trait Correlations

I examined correlations across my trait variables to test for any baseline relationship between the variables. The results replicate the findings of my prior research in so far as trait self-compassion positively correlates with self-control (r = .470, p < .001), self-esteem (r = .683, p < .001), and sleep quality (r = .232, p = .003). Self-control positively correlates with self-esteem (r = .539, p < .001), and sleep quality (r = .198, p = .020). Self-esteem positively correlates with sleep quality (r = .342, p < .001). Bivariate correlation matrix for trait associations can be found in Table 4a.

5.3.2 Manipulation check

Participants in the three experimental conditions did not differ in the number of days they engaged with the manipulation, (F(2, 102) = 1.50, p = .228, $\eta 2$ = .028. However, participants differed in the length of time they engaged with the manipulation, (F(2, 102) = 11.58, p < .001, $\eta 2$ = .185. Participants spent more time engaged with the self-control manipulation (*M* = 2.46, *SD* = 0.87) than they did with either the self-compassion (*M* = 1.65, *SD* = 0.55, p < .001) or self-esteem (*M* = 1.94, *SD* = 0.74, p = .012) manipulation. The self-compassion and self-esteem manipulations did not differ, p = .337. Also, participants differed across experimental conditions as a function of perceived success, (F(2, 103) = 3.85, p =.024. Specifically, they perceived that they were more successful in the self-control condition (*M* = 7.52, *SD* = 1.61) than either in the self-compassion (*M* = 6.73, *SD* = 1.54, p = .033) or self-esteem (*M* = 6.57, *SD* = 1.53, p = .013) condition. The self-compassion and self-esteem manipulations did not differ, p = .999. Thus, participants engaged more with the self-control manipulation both in terms of time and perceived success, which were positively related, r = .22, p = .027, respectively. I report results of the tests comparing the manipulation checks across conditions in Table 4b.

5.3.3 The Effects of the Manipulation on Self-Constructs

Self-Compassion. I conducted a Condition × Day interaction mixed-model Analysis of Variance (ANOVA) to examine the effects of condition, day, and their interaction on self-compassion. Results reveal no main effect of condition on self-compassion, (F(3, 92) = .258, p = .856, $\eta2$ =.008. There was a significant main effect of day on self-compassion, (F(8,736) = 2.97, p = .003, $\eta2$ =.031. However, none of the pairwise comparisons between days were significant, ps > .144. There was also no significant Condition × Day interaction, (F(24, 736) = 1.11, p = .324, $\eta2$ =.035 (Table 4c).

Self-Control. I conducted a Condition × Day interaction mixed-model ANOVA to examine the effects of condition, day, and their interaction on self-control. Results reveal no main effect of condition on self-control, (F(3, 92) = 1.47, p = .229, $\eta2$ =.046. There was a significant main effect of day on self-control, (F(8, 736) = 2.36, p = .016, $\eta2$ =.025. However, none of the pairwise comparisons between days were significant, ps > .106. There was also no significant Condition × Day interaction, (F(24, 736) = 0.904, p = .597, $\eta2$ =.029 (Table 4c).

Self-Esteem. I conducted a Condition × Day interaction mixed-model ANOVA to examine the effects of condition, day, and their interaction on self-esteem. Results reveal no main effect of condition on self-esteem, (F(3, 92) = 0.18, p = .907, $\eta2$ =.006. There was a significant main effect of day on self-esteem, (F(8, 736) = 7.39, p = < .001, $\eta2$ =.074. Self-esteem was lowest on the first day of the longitudinal period relative to all other days, p < .01. This pattern did not vary as a function of condition, (F(24, 736) = 1.31, p = .145, $\eta2$ =.041 (Table 4c).

Since there were no condition × day interactions, and the sample size of the mixed-model ANOVAs above is attenuated due to listwise deletion, I conducted a series of one-way between-subjects ANOVAs where I separately averaged self-compassion, self-control, and self-esteem across the longitudinal phase. These ANOVAs produced equivalent results to those above. There was no effect of condition on self-compassion, (F(3, 144) = 0.44, p = .723, self-control, (F(3, 144) = 2.20, p = .090, or self-esteem, (F(3, 144) = 0.09, p = .965. In summary, the manipulation did not increase self-compassion, self-control, or self-compassion (Table 4d).

5.3.4 The Effects of the Manipulation on Subjective Sleep Quality

I conducted a Condition × Day interaction mixed-model ANOVA to examine the effects of condition, day, and their interaction on subjective sleep quality (Table 4e). There was a main effect of condition, ($F(3, 93) = 2.97$, $p = .036$, $\eta 2$ =.087. Relative to the self-control condition, the self-esteem condition decreased subjective sleep quality across the longitudinal phase, $p = .041$. No other conditions varied from one another, $p > .140$. There was no main effect of day on subjective sleep quality through the longitudinal phase, ($F(8, 744) = 1.86$, $p = .063$, $\eta 2$ =.020. The interaction was not significant, ($F(24, 744) = 0.77$, $p = .772$, $\eta 2$ =.024. Given that the condition × day interaction was not significant and the sample size of the mixed-model ANOVAs above is attenuated due to listwise deletion, I conducted a follow-up one-way between-subjects ANOVA where I averaged subjective sleep quality across the longitudinal phase. This produced equivalent results to the analyses above, ($F(3, 144) = 2.70$, $p = .048$, $\eta 2$ =.053. In these analyses sleep quality in the self-esteem condition was reduced across the longitudinal phase relative to all the other conditions (ps < 05). However, these effects were small as they did not survive Bonferroni corrections for multiple comparisons.

5.3.5 Within Condition Correlations.

I next examined number of days, amount of time spent on the manipulation, and perceived success at engaging with the manipulation were associated with subjective sleep quality, self-compassion, self-control, and self-esteem within conditions (Table 4f).

Self-Compassion Condition. Results revealed no relation between days engaged and any self-construct (self-compassion: $r = -.090$, $p = .605$; self-control: $r = -.301$, $p = .079$; self-esteem: $r = -.323$, $p = .058$) or subjective sleep quality ($r = -.261$, $p = .130$). Perceived success was related to subjective sleep quality ($r = .355$, $p = .036$), but manipulation time was not ($r = -.073$, $p = .681$). There was no relation between any self-constructs and perceived success (self-compassion: $r = .028$, $p = .875$; self-control: $r = .271$, $p = .115$; self-esteem: $r = .077$, $p = .659$). Manipulation time was unrelated to self-esteem ($r = -.088$, $p = .623$), but was related to self-compassion ($r = -.397$, $p = .020$) and self-control ($r = -.339$, $p = .050$). Perceived success and time were not significantly correlated ($r = -.026$, $p = .885$].

Self-Control Condition. Results revealed no relation between days engaged with manipulation and any self-construct (self-compassion: $r = .107$, $p = .509$; self-control: $r = -.013$, $p = .937$; self-esteem: $r = -.183$, $p = .257$) or subjective sleep quality ($r = .012$, $p = .940$). Perceived success was related to subjective sleep quality ($r = .475$, $p = .002$), but time spent on manipulation was not ($r = -.061$, $p = .710$). Perceived success related with self-compassion ($r = .423$, $p = .007$), and self-control ($r = .400$, *p* = .011), but not self-esteem (*r* = -.183, *p* = .257). Time spent on manipulation was unrelate to any self-construct (self-compassion: *r* = -.065, *p* = .692; self-control: *r* = -.254, *p* = .113; self-esteem: *r* = -.232, *p* = .149). Perceived success and time were unrelated (*r* = -.045, *p* = .782).

Self-Esteem Condition. In the self-esteem condition, the number of days engaged with the manipulation was positively related to self-esteem over the week (*r* = .492, *p* = .005), but not self-compassion (*r* = .275, *p* = .135), self-control (*r* = .184, *p* = .321), or subjective sleep quality (*r* = .163, *p* = .381). Time spent on the manipulation and perceived success were unrelated to self-esteem over the week (rs = .050 and .104 respectively, ps = .789 and .578 respectively). Within the self-esteem condition, perceived success and time were highly related (*r* = .573, *p* < .001).

In summary, there are inconsistencies between condition on how measures of sleep quality and self-constructs correlated with condition-specific manipulation. Participants in the self-esteem condition showed increasing self-esteem the more days they engaged with the manipulation, but self-esteem did not correlate with the amount of time or perceived success of engagement. Sleep quality was unaffected by the manipulation. In the self-compassion and self-control condition, perceived success of engagement positively strongly correlated with all measure of sleep quality, suggesting that the more successful the participants believed they were at engaging with the manipulation, the higher their sleep quality.

5.3.6 Longitudinal Analyses: Random Intercept Cross-Lagged Panel Models

Given that the manipulation did not influence sleep quality or any of the self-constructs I next collapsed across condition and examined the lagged effects of changes in sleep quality on self-constructs and vice versa as in Study 2. The first model (Model 1) shows short self → sleep and long sleep → self lagged effects. The second model (Model 2) shows short sleep → self and long self → sleep lagged effects. See Figure 2ai for conceptual Model 1 and Figure 2aii for conceptual Model 2.

Model 1

Self-Composite. First, I fit the self-composite and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (137) = 240.20, *p* < .001 (CFI = .92, RMSEA = .06, 90% CI [.045, .069], SRMR = .089). The between-subjects covariation (μ) between subjective sleep quality and the self-composite was significant, *B* = 0.33, *SE* = .07, (*t*(137) = 6.19, *p* < .001. The autoregressive path from earlier self-composite to later self-composite scores (ζ) were significant, *B* = 0.36, *SE* = .04, (*t*(137) = 8.55, *p* < .001. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B* = 0.01, *SE* = .04, (*t*(137) = 0.41, *p* = .685. The cross-lagged path from earlier sleep to later self-composite (*κ*) was significant and in the opposite direction I predicted, *B* = -0.04, *SE* = .01, (*t*(137) = -2.74, *p* = .006. The cross-lagged path from earlier self-composite to later sleep (*ε*) was significant, *B* = 0.27, *SE* = .04, (*t*(137) = 3.11, *p* = .002.

Self-Compassion. Second, I fit self-compassion and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (105) = 153.97, *p* < .001 (CFI = .94, RMSEA = .05, 90% CI [.029, .060], SRMR = .084). The between-subjects covariation (*μ*) between subjective sleep quality and the self-compassion was significant, *B* = 0.30, *SE* = .07, (*t*(105) = 4.41, *p* < .001. The autoregressive path from earlier self-compassion to later self-compassion (*ζ*) was significant, *B* = 0.24, *SE* = .04, (*t*(105) = 5.71, *p* < .001. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (*δ*) was not significant, *B* = 0.00, *SE* = .04, (*t*(105) = 0.01, *p* = .995. The cross-lagged path from earlier sleep to later self-compassion (*κ*) was significant and in the opposite direction, *B* = -0.04, *SE* = .02, (*t*(105) = -2.30, *p* = .022. The cross-lagged path from earlier self-compassion to later sleep (*ε*) was significant, *B* = 0.16, *SE* = .07, (*t*(105) = 2.13, *p* = .033.

Self-Control. Third, I fit self-control and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (105) = 149.73, *p* = .003 (CFI = .95, RMSEA = .04, 90% CI [.029, .052], SRMR = .079). The between-subjects covariation (*μ*) between subjective sleep quality and self-control was significant, *B* = 0.46, *SE* = .09, (*t*(105) = 5.34, *p* < .001. The autoregressive path from earlier self-control to later self-control (*ζ*) was significant, *B* = 0.12, *SE* = .04, (*t*(105) = 2.72, *p* = .007. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (*δ*) was not significant, *B* = 0.01, *SE* = .04, (*t*(105) = 0.19, *p* = .852. The cross-lagged path from earlier sleep to later self-control (*κ*) was not significant, *B* = -0.02, *SE* = .03, (*t*(105) = -0.74, *p* = .460. The cross-lagged path from earlier self-control to later sleep (*ε*) was not significant, *B* = 0.05, *SE* = .06, (*t*(105) = 0.87, *p* = .383.

Self-Esteem. Fourth, I fit self-esteem and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (105) = 196.82, *p* < .001 (CFI = .93, RMSEA = .06, 90% CI [.048, .075], SRMR = .079). The between-subjects covariation (*μ*) between subjective sleep quality and self-esteem was significant, *B* = 0.26, *SE* = .07, (*t*(105) = 3.65, *p* < .001. The autoregressive path from earlier self-esteem to later self-esteem (*ζ*) was significant, *B* = 0.38, *SE* = .04, (*t*(105) = 8.75, *p* < .001. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (*δ*) was not significant, *B* = -0.00, *SE* = .04, (*t*(105) = -0.03, *p* = .979. The cross-lagged path from earlier sleep to later self-esteem (*κ*) was not significant, *B* = -0.02, *SE* = .01, (*t*(105) = -1.10, *p* = .269. The cross-lagged path from earlier self-esteem to later sleep (*ε*) was significant, *B* = 0.32, *SE* = .10, (*t*(105) = 3.21, *p* = .001.

See Figure 4ai for applied example of the conceptual model.

Model 2

Self-Composite. First, I fit the self-composite and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (105) = 177.16, $p < .001$ (CFI = .94, RMSEA = .05, 90% CI [.040, .068], SRMR = .081). The between-subjects covariation (μ) between subjective sleep quality and the self-composite was significant, *B =* 0.64, *SE* = .12, (*t*(105) = 5.40, $p < .001$. The autoregressive path from earlier self-composite to later self-composite scores (ζ) were significant, *B =* 0.21, *SE* = .04, (*t*(105) = 5.77, $p < .001$. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B =* 0.05, *SE* = .03, (*t*(105) = 1.56, *p* = .118. The cross-lagged path from earlier subjective sleep quality to later self-composite (κ) was significant, *B =* 0.39, *SE* = .03, (*t*(105) = 11.11, $p < .001$. The cross-lagged path from earlier self-composite to later subjective sleep quality (ε) was significant, *B =* 0.10, *SE* = .03, (*t*(105) = 3.02, *p* = .003.

Self-Compassion. Second, I fit self-compassion and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (105) = 157.99, $p < .001$ (CFI = .93, RMSEA = .05, 90% CI [.031, .061], SRMR = .081). The between-subjects covariation (μ) between subjective sleep quality and the self-compassion was significant, *B =* 0.67, *SE* = .12, (*t*(105) = 5.62, $p < .001$. The autoregressive path from earlier self-compassion to later self-compassion (ζ) was significant, *B =* 0.20, *SE* = .04, (*t*(105) = 5.10, $p < .001$. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was significant, *B =* 0.05, *SE* = .04, (*t*(105) = 1.22, *p* = .221. The cross-lagged path from earlier subjective sleep quality to later self-compassion (κ) was significant, *B =* 0.16, *SE* = .02, (*t*(105) = 10.07, $p < .001$. The cross-lagged path from earlier self-compassion to later subjective sleep quality (ε) was significant, *B =* 0.22, *SE* = .04, (*t*(105) = 3.03, *p* = .003.

Self-Control. Third, I fit self-control and subjective sleep quality to a RI-CLPM. The model fit the data well, *X2* (105) = 148.49, *p* = .003 (CFI = .95, RMSEA = .04, 90% CI [.025, .057], SRMR = .092). The between-subjects covariation (μ) between subjective sleep quality and self-control was significant, *B* = 0.38, *SE* = .08, (*t*(105) = 4.54, $p < .001$. The autoregressive path from earlier self-control to later self-control (ζ) was significant, *B =* 0.11, *SE* = .03, (*t*(105) = 3.09, *p* = .002. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, *B =* 0.07, *SE* = .04, (*t*(105) = 1.83, *p* = .067. The cross-lagged path from earlier subjective sleep quality to later self-control (κ) was significant, *B =* 0.31, *SE* = .02, (*t*(105) = 15.60 $p < .001$. The cross-lagged path from earlier self-control to later subjective sleep quality (ε) was not significant, *B =* 0.10, *SE* = .06, (*t*(105) = 1.77, *p* = .076.

Self-Esteem. Fourth, I fit self-esteem and subjective sleep quality to a RI-CLPM. The model fit the data well *X2* (105) = 186.52, $p < .001$ (CFI = .94, RMSEA = .06, 90% CI [.044, .071], SRMR = .073). The between-subjects covariation (μ) between subjective sleep quality and self-esteem was significant, $B = 0.24$, $SE = .07$, ($t(105) = 3.33$, $p < .001$. The autoregressive path from earlier self-esteem to later self-esteem (ζ) was significant, $B = 0.37$, $SE = .04$, ($t(105) = 8.71$, $p < .001$. The autoregressive path from earlier subjective sleep quality to later subjective sleep quality (δ) was not significant, $B = 0.04$, $SE = .04$, ($t(105) = 1.15$, $p = .251$. The cross-lagged path from earlier subjective sleep quality to later self-esteem (κ) was significant, $B = 0.08$, $SE = .01$, ($t(105) = 7.13$, $p < .001$. The cross-lagged path from earlier self-esteem to later subjective sleep quality (ε) was significant, $B = 0.26$, $SE = .10$, ($t(105) = 2.57$, $p = .010$.

See Figure 4aii for applied example of the conceptual model.

5.4 Discussion

Study 4 is the first to attempt to strengthen multiple self-constructs using a natural behavioural manipulation to examine the subsequent effects on subjective sleep quality. Self-compassion, self-control, and self-esteem were not strengthened as a function of their condition-specific manipulations, suggesting that the manipulation itself did not have the desired effect. However, self-compassion and self-esteem (and self-control, trendingly) did predict subjective sleep quality across conditions. Specifically, when participants reported days of increased self-compassion, self-esteem, and (arguably) self-control, they also reported better sleep quality that following night. However, this effect is not due to the self-construct-specific manipulations. These findings contrast the findings of Study 2 and 3, which did not show any predictive effect of the self on subjective sleep quality. Together, these findings suggest that these self-constructs do predict subjective sleep quality, but only when individuals employ cognitive effort to boost self-compassion, self-control, or self-esteem.

Study 4 replicates the findings of study 2 and 3 as far as subjective sleep quality predicted self-compassion, self-control, and self-esteem at the short lag. Furthermore, the results of study 4 show that the predictive effect of subjective sleep quality on self-compassion (and the self-composite) is stronger at the longer lag. This would imply that the effect of greater subjective sleep quality on self-compassion extends beyond the succeeding day. Given the context of Study 4 compared to study 2 and 3, this may indicate a moderating role effortful self-compassion, self-control, and self-esteem.

Additional findings suggest that perceived success at engaging in the self-compassion and self-control manipulation has a positive effect on subjective sleep quality, and more frequent engagements with positive self-esteem manipulations boosts self-esteem. This implies that some form of engagement with the condition-specific manipulations does improve sleep quality, although this is not mediated by the self-construct itself.

Collectively, study 4 identifies a bidirectional relationship between subjective sleep quality and the self. Consistent with Study 2 and 3, subjective sleep quality predicted self-compassion, self-control, and self-esteem on the following day. Contrasting Study 2 and 3, self-compassion and self-esteem (and self-control, trendingly) predicted subjective sleep quality the following night. However, results show that engaging in self-constructs specific manipulations did not improve subjective sleep quality. Nonetheless, the methodological distinctions and respective results of Study 2 – 4 suggest a promising mediating role of effortful self-compassion, self-control, and self-esteem in improving subjective sleep quality.

See Figure 4b for a cumulative graphic of associations between sleep quality and the self.

Chapter 6 Discussion

"Sleep is not the absence of wakefulness. It is far more than that."

- Mathew Walker (*Why We Sleep*, 2018)

6.1 Summary

Sleep quality and the self are two of the most widely studied phenomena and are evidently inter-related. Sleep plays a substantial part in the waking social self (Jabar et al., 2022; Lenneis et al, 2021; Pilcher et al., 1997; Sella et al., 2020; Soehner et al., 2007; Stephan et al., 2018; Zhang et al., 2020). Also, sleep serves several functions: (1) sleep consolidates self-relevant memories (Stickgold, 2005), facilitating self-understanding (Conway & Pleydell-Pearce, 2000; Conway 2005; Klein & Loftus 1988; Ray et al. 2009); (2) sleep has restorative abilities on both psychological and physical states (Steptoe et al., 2008); and (3) dreams may maintain psychological balance between social and natural motivations (Mullen, 2006). However, researchers have only focused on a relatively restricted number of self-constructs (and in an isolated fashion) with regard to sleep quality.

In this PhD thesis, I expand upon the range of self-constructs linked to sleep quality. Across four studies I implemented complementary methods that establish a holistic perspective of the relationship between sleep quality and the self, and the distinct associations between specific measures of sleep quality and individual self-constructs. Study 1 used a cross sectional self-report method to test trait relationships between subjective sleep quality and seven self-constructs. Study 2 extracted the four self-constructs that significantly correlated with sleep quality in Study 1 (self-compassion, self-control, self-esteem, and self-continuity), and implemented a longitudinal self-report daily diary method to examine how these self-constructs relate to subjective sleep quality on a state basis. Study 3 replicated Study 2 with the addition of actigraphy, an objective measure of sleep quality. Finally, Study 4 implemented a final longitudinal self-report daily diary method, with the addition of a condition-dependent experimental manipulation, designed to improve either their self-compassion, self-control, or self-esteem.

See Figure 5a for a summative graphic of associations between sleep quality and the self.

6.2 Interpretation of Results

6.2.1 Trait Associations

In Study 1, I examined the trait association between sleep quality and a multidimensional model self which includes six core dimensions. I tested seven self-constructs as representations of these six dimensions. After correcting for multiple analysis, four self-constructs were positively associated with sleep quality: self-compassion, self-control, self-esteem, self-continuity. The exceptions were self-concept clarity, self-expression, and self-enhancement. Put otherwise, sleep quality was positively linked to the executive self, affective self, and temporal self, but not representational self, interpersonal self, or motivational self. The discrepancy is hard to sort out, but future research can build on these findings in taking the relation between sleep and the self forward. Also, the strength of the relation between the four self-constructs and the self varied marginally (from strongest to weakest): self-esteem, self-compassion, self-continuity, self-control. Self-concept clarity marginally correlated with sleep quality, although this did not survive post hoc correction; it should be noted that this could be indicative of a type II error, whereby I rejected a true result. In any case, future research should strive to replicate and extend these findings.

6.2.2 State Effects

In Studies 2-4, I implemented longitudinal diary methods to dive deeper into the relationship between sleep quality and the self. I conducted a series of RI-CLPM(analyses on the state variables. In all studies, subjective sleep quality positively predicted all four self-constructs on immediately succeeding days. I ran these RI-CLPM both within and between subjects and found consistent concurring results. This means that on any given day, better subjective quality of sleep predicts heightened self-compassion, self-control, self-esteem, and self-continuity. The findings add to the literature, concurring that nightly sleep quality predicts succeeding days self-compassion (Hu et al., 2018; Rakhimov et al., 2023; Semenchuk, 2021), self-control, (Diestel et al., 2015; Przepiorka, Blachnio, & Siu, 2019; van Eerde & Venus, 2018), and self-esteem (Lee & Sibley, 2019; Lemola et al., 2013; Saini et al., 2020; Yip, 2015; Wang & Yip, 2020). Only one study (Brotkin, 2015) has assessed self-continuity and sleep quality concurrently, although this was not its primary aim and no directional inference was possible. No prior research has addressed the state relationship between sleep quality and self-continuity, therefore my research breaks ground in establishing the state effects of subjective sleep quality on self-continuity. This novel contribution of my thesis also highlights the importance of this variable for well-being (Sedikides et al., 2023).

Generally, my findings demonstrate that an individual will likely experience greater self-compassion, self-control, self-esteem, and self-continuity on days following nights of better subjective sleep quality. By extension, this would imply that sleep quality and these four self-constructs have a direct causal relationship. Yet, this effect of sleep on the self was consistently evident at a short lag (12 hours), but not consistently at long lag (36 hours). Rather, the effect of sleep quality on the self does not necessarily extend beyond the succeeding day. As such, the influence of sleep quality on the self is relatively short-lived and does not last beyond the next sleep cycle (perhaps indicative of the cognitive restoration function of sleep). However, study 4 did reveal a significant effect of subjective sleep quality on self-compassion at the long lag; given the methodology of Study 4 compared to study 2 and 3, one might infer that the effect of sleep on self-compassion may be extended if one engages with effortful self-construct exercises. Although, my research does not consider lagged effects sooner or later than 12 (short) and 36 (long) hours post-wake, so future research should consider shorter (1 hour) and longer (48 hour) lags to gain a more complete overview of the restorative effect of sleep quality on self-constructs.

I also examined whether changes in daily self-constructs influence the succeeding night's sleep quality. Prior literature has revealed an effect of self-compassion (Bian et al., 2020; Butz & Stahlberg, 2018; Kemper et al., 2015; Kim and Ko, 2018), self-control (van Eerde & Venus, 2018; Przepiorka et al., 2019), and self-esteem (Adams, & Kisler, 2014; Conti, Kutenaee et al. 2020; Lemola et al. 2013) on sleep quality. Therefore, I hypothesized that the relationship between sleep quality and the self would be bidirectional, as far as sleep quality predicts succeeding days self-constructs, and in turn these self-constructs would influence sleep quality. Study 2 and 3 accepted the null hypothesis, revealing no significant statistical support for a predictive effect of any self-construct on subjective sleep quality. However, In Study 4, self-esteem, and (trendingly) self-control predicted subjective sleep quality at the short lag, and self-compassion predicted subjective sleep quality at both lags. Also, Study 3 revealed a significant effect of self-compassion and self-continuity on objective sleep quality at the short lag. These findings support my hypothesis, alongside concurring evidence that sleep quality may be improved by self-compassion (Bian et al., 2020; Butz & Stahlberg, 2018; Kemper et al., 2015; Kim and Ko, 2018; Semenchuk et al.,2021), self-control (van Eerde & Venus, 2018; Przepiorka et al., 2019), and self-esteem (Adams, & Kisler, 2014; Conti, Kutenaee et al. 2020; Lemola et al. 2013). Although, some of this research has targeted samples with depressive symptoms (Bian, 2020; Butz & Stahlberg, 2018). Therefore, the expected effects of self-compassion on sleep quality may be mediated by symptoms of depression, which were not recorded in my research. In the case of self-control, studies of sleep hygiene show that individuals who delay going to sleep in an attempt to obtain immediate pleasure will ultimately experience poorer sleep quality (Dorrian, et al., 2019;

Kroese et al. 2014; Massar & Chee, 2019). Studies such as these suggest that self-constructs may yet affect sleep quality, but perhaps with necessary mediation of confounding variables not explored in this thesis. Despite some clear significance, my results do not show a consistently significant predictive effect of any self-construct on sleep quality. Thus, further research is required to deepen our understanding of this relationship.

6.2.3 Subjective Versus Objective findings

In Studies 2, 3 and 4, I found a predictive relationship between subjective sleep quality and four self-constructs, whereby these four self-constructs are heightened in days following better sleep quality. In Study 3, I used actigraphy over 7 days to gain an objective measure of sleep quality, but the results did not concur with my findings of subjective sleep quality. First, subjective sleep quality predicted all four self-constructs (consistent with Study 2 and 4), but objective sleep quality did not predict any self-construct. Also, no self-construct predicted subjective sleep quality (consistent with study 2). However, at the short (but not long) lag, self-compassion, self-continuity, and the composite self (all four self-constructs taken together) predicted objective sleep quality. This would suggest that there are some components of the self that do indeed influence sleep-efficiency, but only when sleep efficiency is measured objectively.

Indeed, subjective and objective sleep quality were uncorrelated in Study 3 and are weakly related in the literature (Aili et al., 2017; Buysse et al., 2008; Girschik et al., 2012; Iwasaki et al., 2010; Jackowska et al., 2011; Landry et al., 2015; Lemola et al., 2013; Tworoger et al., 2005; Van Den Berg et al., 2008). Therefore, my findings may be justified by a prominent theoretical explanation: subjective and objective measures of sleep quality measure separate sleep components. Many self-report measures of sleep quality include the items of "mood upon waking" and "alertness upon waking" as determinants of sleep quality (PSQI, Buysse et al., 1989; Consensus Sleep Diary, Carney et al., 2012). These subjective measures of sleep quality cannot be measured by actigraphy. People can accurately self-report how they feel in the morning, with better alertness and feelings of restoration indicating a better night's sleep. It is plausible that participants were therefore using their mood and alertness upon waking as their self-reported measure of how well they slept. Research has identified mood and alertness upon waking as two of the strongest correlates of subjective sleep quality (Monk et al., 1993), and some self-report measures of state subjective sleep quality primarily use these three measures (subjective sleep quality, mood and alertness upon waking) instead of other measures, such as sleep disturbance or sleep efficiency (PSQI, Buysse et al., 1989; Consensus Sleep Diary, Carney et al., 2012). Whereas actigraphy measures the frequency of movement during the night to determine sleep efficiency, self-reporting such components is unreliable due to sleep being a subconscious experience.

Nonetheless, a second plausible interpretation of the findings of Study 3 may simply be explained through methodological limitations. Limited sample size, the condition of actigraphy device, participant interferences, and potential issues with statistical model fit, might explain the unparalleled findings between subjective and objective sleep quality. It is also plausible that the method of decomposing actigraphy data for analysis may have influenced the outcome. In other words, I opted to measure objective sleep quality via the parameter of sleep-efficiency, when other parameters were available. Although the sleep-efficiency parameter has a large backing from empirical literature as the most common and most appropriate measure of sleep quality (Åkerstedt et al., 1994; Bruyneel et al., 2011; Jung et al., 2016; Ohayon et al., 2017; Tworoger et al., 2005), it should be noted that other variables (such as sleep duration, onset latency, epoch length) could have been used in this research, although they may be less closely associated with subjective sleep quality compared to sleep-efficiency (Åkerstedt et al., 1994; Rosipal et al., 2013). In addition, in the absence of other objective methods, sleep-efficiency has been established as a strong associate of slow-wave-sleep (Keklund & Åkerstedt, 2005). Yet, given the numerous parameters of objective sleep quality, it is important to accept these results with some caution.

6.2.4 Experimental Manipulation

Studies 2-3 demonstrated that sleep quality predicts four self-constructs but with no bidirectional effect; rather, thus far I had not identified a predictive effect of any self-construct on subjective sleep quality. However, this contradicted expectations. Therefore, the final study of my thesis was designed to further explore how self-compassion, self-control, and self-esteem may influence sleep quality, in a longitudinal diary over 10 days. I used experimental manipulations in an attempt to amplify the effect of self-compassion, self-control, and self-esteem on subsequent sleep quality. Of note, self-continuity was omitted from study 4 due to methodological inconsistencies. Specifically, Study 4 implemented an experimental manipulation designed to amplify each self-construct in a way that was minimally invasive, allowing participants to behave in as close to a typical daily routine as possible, while keeping the distinct manipulations for each self-construct as similar to each other as possible. The strive to improve sleep quality via this route of minimally invasive self manipulations is especially important given that new research proposes sleep enhancing drugs to be ineffective and an unhealthy long-term intervention (Fitzgerald & Vietri, 2015; Qaseem et al., 2016). The manipulations were closely adapted from a validated exercise of self-compassion (Neff, 2021). This exercise applied well to self-compassion, self-esteem, and self-control, but not self-continuity. This is due to self-continuity being a more abstract concept, with less accessible behaviours. Therefore, exercises of self-continuity would encourage the participant to deviate from their natural or typical daily behaviours much more than the other self-constructs. As no validated manipulation met the criteria for all four self-constructs, self-continuity was omitted from Study 4.

Participants were randomly assigned to one of four conditions (self-compassion, self-control, self-esteem, or a control condition) where they received daily instruction to make a conscious effort to heighten their assigned self-construct. I hypothesized that making a conscious effort to implement self-compassion, self-control, and self-esteem would result in improved sleep quality, relative to the control condition. Participants in the control condition engaged with no manipulation, and instead simply reported their state self-constructs and subjective sleep quality in the same daily-diary style procedure.

First, participants in the self-control condition reported the most intense engagement with the manipulation. This might be due to the differences in the way that self-control is more easily operationalised compared to self-esteem and self-compassion. Behaviours and attitudes of self-control may be more accessible as they commonly manifest as conscious decisions to do or not to do an activity. Self-compassion and self-esteem are more commonly affective responses that require more effort and perhaps more desire to execute. Similarly, opportunities to implement self-control may occur more frequently than self-esteem and self-compassion. Therefore, these findings are likely accurate representations of typical engagement with these self-constructs. However, despite differences in engage with the manipulation, results reveal that none of the condition-specific self-constructs were significantly influenced by their respective condition manipulations. This finding would indicate the manipulations did not have an effect on the behaviour or attitudes of participants. Given the validation of prior research (Neff, 2021), this contradicts expectation.

Second, I observed a significant difference in subjective sleep quality between conditions. Participants in the self-esteem condition reported having worse subjective sleep quality than those in the control condition, self-compassion, and self-control conditions. Engaging in the self-esteem manipulation, then, has a negative effect on sleep quality contrary to hypotheses. Given the theoretical and empirically establish connections between the tested self-constructs (Brown & Marshall, 2001; Caprara et al., 2013; Leary et al., 2007; Neff, 2003a; Neff et al., 2008; Wilson & Ross, 2000), the effect of one self-construct should be somewhat consistent with all self-constructs. The lack of significant difference between the self-control and self-compassion conditions, adds some reasonable doubt to this self-esteem finding. Further doubt is cast upon this finding as additional analysis of state effects reveal that self-esteem positively predicts sleep quality at the between subjects' level. Therefore, the outcome of this analysis, which implies a negative effect of self-esteem on sleep quality, may be due to methodological limitations. Further research is required to clarify this relationship.

Finally, I examined the relationship between multiple measures of sleep quality, each of the self-constructs, and engagement with the condition-specific manipulations. Results show inconsistencies between conditions. Participants in the self-esteem condition reported greater self-esteem positively correlating with the number of days they engaged in the manipulation; however, self-esteem did not increase as a function of time or success of engagement. Also, there was no clear relationship with sleep quality in this condition. These findings would imply that self-esteem is most strongly related with the number of times one attempts to engage in tasks that boost self-esteem, but self-esteem is not determined by how well the engage or how much time they spend engaging in these tasks. By extension, engagement with these tasks does not influence sleep quality on any level. In the self-compassion and self-control conditions, participants who reported higher success of engagement reported better sleep quality. Here, perceived successful engagement with self-compassion and self-control tasks positively influenced sleep quality, albeit indirectly. Moreover, although participants in the self-esteem condition reported the largest number of attempts at engaging with the condition-specific task, there was no significant relationship between number of days engaged and level of self-esteem. Similarly, participants in the self-control condition reported the highest perceived success with their condition-specific manipulation, but the relationship between perceived success and sleep quality was significant in this condition, but not in the self-esteem condition. Therefore, it is plausible that we might see a significant relationship between all measures of engagement with the manipulations, but there is threshold (magnitude of engagement) which must be crossed in order to see such a relationship.

6.2.5 The Multidimensional Self

In Chapter 1, I outlined a multidimensional model of the self which presents the self as holistic structure made up of six core components. The findings of my research present some interesting implications and interpretations for this model.

First, I demonstrate evidence that self-compassion and self-esteem fall neatly into the component of the affective self. This is evident via a pattern of consistently similar outcomes in all studies. Unlike self-control and self-continuity, which displayed unique patterns across the 3 longitudinal studies, self-compassion and self-esteem matched almost exactly. They were also the only self-constructs to reveal non-significant predictive effects on subjective sleep quality in Study 3, and the only self-constructs to show a predictive effect of subjective sleep quality in study 4. Given their theoretical inclusion into the Affective component of the multidimensional model, this infers that sleep quality has a distinct relationship with emotional responses. This is compared to other components of the self, which have less of an emotional basis, such as the temporal self (self-continuity) or the executive self (self-control).

Another inference is that that components of the self may be differentiated by physical properties. Executive self (self-control) is commonly operationalised in physical behaviours and activities, compared to the Affective self (self-compassion and self-esteem) which are more meta-physical (beliefs, attitudes, cognitions). In Study 4, participants reported greater success at engaging in the self-control compared to the self-compassion and self-esteem conditions. This may be because engagement is more accessible or easier to recognise due to the physical properties of the activities (such as rejecting unhealthy food or partaking in health beneficial activities).

In Study 1, sleep quality was associated with the affective, executive, and temporal, but not the interpersonal, motivational, or representational. One suggestion for this disparity is that sleep quality is more closely related to the more implicit personal components of the self, rather than explicit social components. For example, self-control (executive self) regards personal goals and desires, compared to self-enhancement (motivational self) which is operationalized as a comparison to social achievements and criteria; self-esteem and self-compassion (affective self) are defined by emotional responses to protect and maintain psychological wellbeing, compared to self-expression (the interpersonal self), which is manifested in behaviours and attitudes that maintain social wellbeing and prevent ostracism; and we can compare self-continuity (temporal self) to self-concept clarity (representational self) by separating implicit beliefs of personal change over time, to personal understandings of the self within the context of wider society and effect on others' existence. These latter components of the self are embedded in memory and are defined by our relationship with ourselves. Although, there is a key difference in that self-continuity is connection to one's past and future self, whereas self-concept clarity uses our understanding of others to recognize our own identity. Therefore, it is plausible that the six components of the multidimensional self can be selected into personal and social categories. As such, the results of my research would indicate that sleep quality has a strong relationship with the implicit components of the self, but not the explicit social components.

It is important to recognise that this multidimensional model of the self is a novel and as-yet empirically unexamined approach to understanding the self. Therefore, my discussion and acknowledgement of the relationship between self-constructs and sleep quality, in relation to this multidimensional model of the self, is speculative with some theoretical support. It is imperative that future research consider empirical research and analyses to support this innovative approach.

6.3 Limitations and Methodological Considerations

There were many distinct strengths to the present research. First and foremost, this research is the first to directly explore the explicit relationship between sleep quality and multiple dimensions of the self on a state basis. The findings of this research provide novel and invaluable insight into this relationship, adding considerable understanding to a growing body of literature. Also, another key strength lies in the complimentary methods used between studies. Using cross-sectional and longitudinal methods, subjective and objective methods, and controlled and natural methods, allows us to consider a range of potential confounding variables, and to establish the greatest influences of sleep quality. Furthermore, the findings of this study can be interpreted with considerable reliability due to the consistency across the complete research. Plus, in total, this research recruited a large number of participants from diverse backgrounds, making the findings more generalizable.

6.3.1 Sample

Nevertheless, the present study was not without its flaws. First, this research is hindered by some of the more common limitations that many other studies have been hindered by. Specifically, some of the sample sizes in these studies may be considered relatively small, and therefore the cumulative sample size may be deemed somewhat low. In total, 686 participants took part in this research, although the balance is skewed across studies, as the overall sample was distributed between Study 1 (43.59%), Study 2 (29.01%), Study 3 (5.83%), and Study 4 (21.57%). In each study, the original sample size was large enough to provide moderate effect sizes while also accounting for attrition rates, and the final sample sizes were no smaller than those of published articles using similar methodologies. Nevertheless, more high-powered studies would help consolidate the findings.

6.3.2 Common Method Bias

Susceptibility to the common method bias was another limitation. Responses to one self-report measure may have carried over to another self-report measure, when measured in the same occurrence, which leads to a form of priming in which participants attribute (and sometimes misattribute) subjective reports of one variable to another (Podsakoff et al., 2003; Zhou & Long, 2004). Participants responded to scales measuring the self-construct at the state level and then responded to the quality of their previous night's sleep. However, they completed all of these measures at the same time, in the evening of each day. Testing the predictor and outcome variables at the same time can inflate or deflate the effect of one variable on another, leading to either type I or type II errors (Kline et al., 2000). Future research could implement a split-survey, whereby measures of sleep quality are recorded immediately following waking, and separate measures of self-constructs are recorded later in the day. This would differentiate the concepts from each other, minimizing the possibility of carry-over effects.

Another bias likely in this research is demand characteristics. Specifically, each study was clear and transparent regarding the true aims of the research. No deception or misleading information was present in this research. As such, it is plausible that participants would manipulate their responses to align with their subjective interpretation of desired responses. This may skew the data and subsequently bias the overall findings and conclusions. The present research took action to limit these effects, such as manipulation checks and explicit requests for honesty. Still, demand characteristics may be present. Future research can further restrict the influence of demand characteristics by including measures of social desirability. This will allow for statistical control over such biases.

6.3.3 Retrospective Sleep Quality

Along similar lines, there is a lack of reliability to retrospective reports. Participants reported their sleep quality many hours after waking, leaving an almost-full day for individual to subconsciously distort the memory of their sleep, due to misattribution, personal biases, suggestibility, or simply forgetting (Loftus, 1996; Schacter, 1999; Schacter, 2001; Schacter & Slotnick, 2004), resulting in potentially inaccurate recall of sleep quality. It is plausible that participants may have reported their sleep quality differently, and perhaps more accurately, if they reported this immediately after waking. The original *PSD* (Monk et al., 1993) is applied in two parts, an evening and a waketime. The waketime questionnaire asks questions about the participants quality of sleep whereas the bedtime asks questions about the behaviours during the day (e.g., caffeine intake, exercise). This would suggest that subjective sleep data should be recorded when the participant wake up, not before they go to bed. Such a notion is support by Fabbri et al. (2021), who explicitly state the importance of recording subjective sleep quality as soon as the participant wakes up, for successful data collection. However, such a proposition is falsified by a meta-analysis by Guarana et al. (2021) testing the relationship between sleep and self-control. This relationship was stronger in time-lagged studies in comparison to cross-sectional studies, suggesting that measuring sleep quality and self-control at the same time attenuates the correlation. Despite some support for the use of retrospective reports in my research, reliability could have been improved by use of immediate reports.

6.3.4 Absent Self-Constructs

A key rationale for this research is the lack of self-constructs and dimensions of the self that have not been previously explored in relation to sleep quality. It was an aim of this research to widen the field and establish how sleep quality is related to a larger range of self-constructs than those already established. In Study 1, I tested 6 core components of the multidimensional self (operationalised by 7 self-constructs), several of which had not been tested before alongside sleep. This cross-sectional study revealed that 3 of these self-constructs (all novel in sleep quality research) were unrelated to sleep quality. Therefore, Studies 2-4 did not consider these unrelated self-constructs longitudinally. It is Important to recognize that a single cross-sectional self-report study is not enough to conclude that there is no relationship between these uncorrelated variables, and further research is certainly warranted. These variables were not considered throughout the remainder of this project for two connected reasons. First, the lack of trait significance limited the rationale for further follow-up, compared to the four self-constructs that showed significant correlation with sleep quality. Hence, given that Studies 2-4 required effortful commitment and engagement from the participants, the second reason is that inclusion in state-based research, when there is no established trait relationship, was deemed superfluous.

Running parallel to those novel self-constructs omitted from follow-up investigation, there are numerous self-constructs that were not examined at all. To select the original 7 self-constructs (representing the 6 core components of the self), I explored a vast array of literature to find any self-constructs that had theoretical, logical, or empirical grounds for investigation alongside sleep quality, but this does not mean that the list of measures is exhaustive. Rather, it is very possible that there are more self-constructs not explored in this research that show strong associations with sleep quality. It is therefore advised that future replicas of the present research should consider expanding their criteria to review more self-related concepts that may provide further insight into these research aims.

6.3.5 Memory and Rumination

A final limitation of my research is the lack of regard for confounding variables. Prior research that examines sleep quality and self-constructs has frequently done so with consideration for mediating or moderating variables. Two of the most prominent confounding variables examined in prior research are memory and rumination. Rumination has been well established as detrimental to sleep quality (Liu et al., 2018; Ferrari et al., 2019; Bian et al., 2020), and research has shown that sleep quality is improved when rumination is buffered by self-compassion (Liu et al., 2018; Bian et al., 2020), self-esteem (Palmer et al., 2018; Liu et al., 2018), and self-control (Liu et al., 2018). Rumination is the conscious process of revisiting memories of past experiences that caused psychological distress (Watkins & Roberts, 2020), and this psychological distress is revived when we ruminate (Nolen-Hoeksema et al., 2008; Watkins & Roberts, 2020). The present study did not explore ruminations as a mediator or moderator of the relationship between sleep quality and self-constructs.

No research has examined the relationship between self-continuity and rumination, but due to the theoretical link between self-continuity and memory, it is not unreasonable to expect an association. This manuscript has frequently referred to the fundamental role of memory consolidation in sleep and the theoretical association between sleep quality and self-continuity via this route of memory. With the additional consideration for the effects of rumination as memory access, it is logical to propose that memory capacity might play a confounding role in the relationship between sleep quality and self-continuity, and perhaps all self-constructs. Given that past and future self-continuity are highly correlated (Ji et al., 2018; Sedikides et al., 2013), perhaps a greater memory capacity, as determined by sleep quality, yields a more vivid connection to the past self. By extension, if one feels more connected to their future self, then they should be more inclined to exert behavioural regulation (self-control) and emotion regulation (self-compassion and self-esteem) to better benefit their future self. Thus, memory may be a significant confounding variable in the relationship between sleep quality and the self holistically. Alas, this thesis did not examine memory, which constrains such theoretical associations.

6.4 Future Directions

6.4.1 Sleep Deprivation

Sleep deprivation studies have been utilized in psychological research for many years (Block et al., 1981; Bennington & Frank, 2003; Ellenbogen, et al., 2006; Grosvenor & Lack, 1984; McCoy & Strecker, 2011; Meldrum et al., 2015) and have successfully demonstrated the detrimental effects on behaviour, emotion, and cognition when sleep is deprived. While experimental sleep deprivation does not approximate poor sleep in daily life, it can provide insights into the effects of extreme or minor sleep loss on self-related processes. Research has shown that sleep deprivation (reduced sleep or complete loss of sleep) conduces to lower self-control (Dorrian et al., 2019; Meldrum et al., 2015; Vohs et al., 2010), and self-esteem (Greene et al., 2007; Haack & Mullington, 2005; Kahn-Roberts et al., 2009; Killgore, 2010). No research has examined the influence of sleep deprivation on self-compassion or self-continuity.

In this thesis, I have conducted four studies which employ complementary methods which explore the relationship between sleep quality and self-constructs on trait and state basis, objectively and subjectively, and with a manipulation designed to control self-constructs. The missing link is a manipulation of sleep quality. In line with literature that highlights the negative impact of sleep deprivation on self-control and self-esteem, it is hypothesised that sleep deprivation also induces lower self-compassion, and self-continuity. Empirical research examining the effects of sleep deprivation on the multidimensional self is necessary to provide innovative insight into the relationship between sleep quality and the self.

6.4.2 Subjective vs Objective Sleep Quality

The predictors of subjective and objective sleep quality differed. Multiple self-constructs significantly predicted objective sleep quality, but these self-constructs did not predictive subjective sleep quality in Studies 2-4. Actigraphy and self-reported sleep quality might not measure the same processes. Actigraphy (and likely other measures of objective sleep quality, such as polysomnography) measures sleep behaviours and activities of which one is not consciously aware and therefore cannot report accurately. Although actigraphy is a valid and reliable method of measuring sleep quality (Chae, et al., 2009; Jean-Louis et al., 2001; Martin & Hakim, 2011; Sadeh, 2011; van Hees et al., 2018), it does not frequently well correlate with subjective sleep quality (Aili et al., 2017; Buysse et al., 2008; Girschik et al., 2012; Iwasaki et al., 2010; Jackowska et al., 2011; Landry et al., 2015; Lemola et al., 2013; Tworoger et al., 2005; Van Den Berg et al., 2008), and the relationship between the two is not clear (Zhang & Zhao, 2007). Similarly, self-report measures regard sleep behaviours of which one is not conscious for (such as the time the person fell asleep), and so the reliability of these measures must be questioned. Self-report measures also include items that consider conscious activities, such as mood and alertness upon waking. People can accurately self report these, but actigraphy cannot. Thus, it is likely that objective and subjective measures of sleep quality target different sleep components. There is a literature gap for research to better understand this disparity.

6.5 Conclusion

I tested the relationship between sleep quality and the multidimensional self. To gain a holistic perspective of this relationship, I decompose the self into multiple core components, as represented by tangible self-constructs. I hypothesised a bidirectional synergetic relationship, whereby sleep quality is a determinant of the self, but also that the self is a determinant of sleep quality. I conducted four diversely methodological studies, which focused on four self-constructs: self-compassion, self-control, self-esteem, and self-continuity. At the trait level (Studies 1-4), subjective sleep quality was consistently positively associated with each of the four self-constructs. The longitudinal results were more nuanced. Across three methodologically distinct daily diary studies (Studies 2-4), better subjective sleep quality consistently predicted increased self-compassion, self-control, self-esteem, and self-continuity on the following day. In turn, subjective sleep quality was not predicted by these self-constructs, except when these self-constructs were experimentally manipulated (Study 4). In this instance, self-compassion and self-esteem predicted subjective sleep quality. When sleep quality was measured objectively (Study 3), I found reverse effects. Objective sleep quality did not predict fluctuations in any self-construct but increased objective sleep quality was predicted by increases in self-compassion and self-continuity. This suggests a discrepancy between subjective and objective measures of sleep quality.

In conclusion, the present research breaks ground as the first empirical research to simultaneously examine the bi-directional relationship between sleep quality and multiple self-constructs. This research identifies night-time sleep quality as a significantly predictive factor of daily self-compassion, self-control, self-esteem, and self-continuity, on both a trait and state basis. In the reverse direction, the predictive effect of these self-constructs on sleep quality was inconsistent but promising. Ultimately, I provide novel and invaluable insight into the relationship between sleep quality and the multidimensional self.

Appendix A Scales and Measures

A.1 Trait Measures

The following list of measures are exact copies of those given to participants in Studies 1-4. First presented are the trait measures, which were given to participants on Day 1 of Studies 2-4, and on the single completion time of Study 1 (being a cross-sectional study). All measures are presented with the scale used for participant response. The scales are presented directly beneath the related questions.

Pittsburgh Sleep Quality Index (PSQI)

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.

1. During the past month, what time have you usually gone to bed at night?
2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?
3. During the past month, what time have you usually gotten up in the morning?
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)
5. During the past month, how often have you had trouble sleeping because you…
    a. Cannot get to sleep within 30 minutes
    b. Wake up in the middle of the night or early morning
    c. Have to get up to use the bathroom
    d. Cannot breath comfortably
    e. Cough or snore loudly
    f. Feel too cold
    g. Feel too hot
    h. Have bad dreams
    i. Have pain
    j. Have other reasons
6. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
0	1	2	3

8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No problem at all	Only a very slight problem	Somewhat of a problem	A very big problem
0	1	2	3

9. During the past month, how would you rate your sleep quality overall?

Very good	Fairly good	Fairly bad	Very bad
0	1	2	3

Self-Esteem Scale

For each item, please select the response to indicate how strongly you agree or disagree with each statement.

1. I feel that I am a person of worth, at least on an equal plane with others.
2. I feel that I have a number of good qualities.
3. All in all, I am inclined to feel that I am a failure.
4. I am able to do things as well as most other people.
5. I feel I do not have much to be proud of.
6. I take a positive attitude toward myself.
7. On the whole, I am satisfied with myself.
8. I wish I could have more respect for myself.
9. I certainly feel useless at times.
10. At times I think I am no good at all.

Strongly Agree	Mostly Agree	Slightly Agree	Slightly Disagree	Mostly Disagree	Strongly Disagree
1	2	3	4	5	6

Self-Compassion Scale

Please read each statement carefully before answering. Using the following scale, indicate how often you behave in the stated manner:

1. When I fail at something important to me I become consumed by feelings of inadequacy.
2. I try to be understanding and patient towards those aspects of my personality I don't like.
3. When something painful happens I try to take a balanced view of the situation
4. When I'm feeling down, I tend to feel like most other people are probably happier than I am.
5. I try to see my failings as part of the human condition.
6. When I'm going through a very hard time, I give myself the caring and tenderness I need.
7. When something upsets me I try to keep my emotions in balance.
8. When I fail at something that's important to me, I tend to feel alone in my failure.
9. When I'm feeling down I tend to obsess and fixate on everything that's wrong.
10. When I feel inadequate in some way, I try to remind myself that feelings of inadequacy are shared by most people.
11. I'm disapproving and judgmental about my own flaws and inadequacies.
12. I'm intolerant and impatient towards those aspects of my personality I don't like.

Almost Never				Almost Always
1	2	3	4	5

Self-Control Scale

Using the scale provided, please indicate how much each of the following statements reflects how you typically are.

1. I am good at resisting temptation.
2. I have a hard time breaking bad habits.
3. I am lazy.
4. I say inappropriate things.
5. I do certain things that are bad for me, if they are fun
6. I refuse things that are bad for me.
7. I wish I had more self-discipline.
8. People would say that I have iron self- discipline.
9. Pleasure and fun sometimes keep me from getting work done.
10. I have trouble concentrating.
11. I am able to work effectively toward long-term goals.
12. Sometimes I can't stop myself from doing something, even if I know it is wrong.
13. I often act without thinking through all the alternatives.

Not at all like me				Very much like me
1	2	3	4	5

Self-Continuity Scale

Please indicate the extent to which you agree or disagree with each of the statements below.

1. I feel disconnected with my future self.
2. My sense of self as continuous feels disturbed.
3. I feel disconnected to my future self.
4. I feel disconnected to who I will be in the future.
5. There is continuity in my life – from present to future.
6. I feel connected to my future self.
7. I feel connected to who I will be in the future.
8. Important aspects of my personality will remain the same in the future.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

Self-Concept Clarity Scale

Please respond to the following statements.

1. My beliefs about myself often conflict with one another.
2. On one day I might have one opinion of myself and on another day I might have a different opinion.
3. I spend a lot of time wondering about what kind of person I really am.
4. Sometimes I feel that I am not really the person that I appear to be.
5. When I think about the kind of person I have been in the past, ’'m not sure what I was really like.
6. I seldom experience conflict between the different aspects of my personality.
7. Sometimes I think I know other people better than I know myself.
8. My beliefs about myself seem to change very frequently.
9. If I were asked to describe my personality, my description might end up being different from one day to another day.
10. Even if I wanted to, I don’t think that I could tell someone what ’'m really like.
11. In general, I have a clear sense of who I am and what I am
12. It is often hard for me to make up my mind about things because I don’t really know what I want.

Disagree very much	Disagree pretty much	Disagree a little	Agree a little	Agree pretty much	Agree very much
1	2	3	4	5	6

Self-Enhancement Scale

For each item, please select the response to indicate how strongly you agree or disagree with each statement.

1. In general, I LIKE to hear that I am a GREAT person.
2. In general, I WANT to discover that I have EXCELLENT qualities.

Strongly Agree	Mostly Agree	Slightly Agree	Slightly Disagree	Mostly Disagree	Strongly Disagree
1	2	3	4	5	6

Self-Expression Scale

How much do you agree with each of the following statements? Please respond using the scale provided.

1. People place too much value on the expression of ideas.
2. I express my feelings publicly, regardless of what others say.
3. I do not like to talk about my thoughts to others.
4. The freedom of speech is the most important right.
5. I generally like talking about my thoughts whenever I can.
6. I generally keep my opinions to myself because I do not wish to offend others who may disagree with me.
7. My thoughts are the most important thing about myself.
8. Those who are close to me know my preferences and opinions on many issues.
9. I know preferences and opinions of those who are close to me.
10. Being able to make my own choice is important to me.
11. My opinions and preferences tell who I really am.

Strongly Disagree							Strongly Agree
1	2	3	4	5	6	7	8

A.2 State Measures

The following list of measures are exact copies of those given to participants in Studies 2–- 4. No state measures were given to participants in Study 1. Here, I present the state measures which were given to participants every day from Day 2 until the end of the longitudinal study. All measures are presented alongside the scale used for participant response.

Pittsburgh Sleep Diary – combined *Waketime* and *Bedtime* diaries

1. What time did you go to bed last night? In other words, at what time did you get into your bed in order to sleep?
2. Last night, what time do you think you fell asleep?
3. What time did you wake up this morning?
4. After falling asleep, how many times did you wake up during the night?

0	1	2	3	4	5 or more

5. After first falling asleep, how much time did you spend awake during the night?

[Using the scale below]

6. How would you rate your sleep quality last night?
7. How would you rate your mood upon waking this morning?
8. How would you rate your alertness upon waking this morning?

Very bad	Moderately bad	Slightly bad	Neither good nor bad	Slightly good	Moderately good	Very good
1	2	3	4	5	6	7

Single-Item Self-Esteem Scale

Please read the following statement carefully before answering. Using the following scale, indicate how much you agree with the statement RIGHT NOW:

1. I have high self-esteem.

Not very true of me						Very true of me
1	2	3	4	5	6	7

6-Item State Self-Compassion Scale

Please read each statement carefully before answering. Using the following scale, indicate how much you agree with each statement TODAY:

1. Today, I was tolerant of my own flaws and inadequacies.
2. Today, when I saw aspects of myself that I don't like, I got down on myself.
3. Today, when I felt inadequate in some way, I tried to remind myself that feelings of inadequacies are shared by most people.
4. Today, when I thought about my inadequacies, it tended to make me feel more separate and cut off from the rest of the world.
5. Today, when something upset me, I tried to keep my emotions in balance.
6. Today, when I felt down, I tended to obsess and fixate on everything that was wrong.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly Agree
1	2	3	4	5	6	7

Brief Self-Control Capacity Scale

Please reply spontaneously to the following statements about how you feel at the moment. Please tick one box between 1 ‘not true’ and 7 ‘very true’ in each line to express which statement applies to you at the moment.

1. I feel drained.
2. I feel calm and rational.
3. I feel lazy.
4. I feel sharp and focused.
5. I feel like my willpower is gone.

Not true						Very true
1	2	3	4	5	6	7

Single-Item Self-Continuity Scale

Please read the following statement carefully before answering. Using the following scale, indicate how much you agree with the statement RIGHT NOW:

1. I feel connected to my future self.

Not true						Very true
1	2	3	4	5	6	7

Demographics

1. What is your age? (Numbers only)
2. Many people feel older or younger than they actually are. What age do you *feel* most of the time? (years)
3. What is your gender?
4. Please select the race that you consider yourself to be:
    a. White: British
    b. White: Irish
    c. White: Gypsy or Irish Traveller
    d. Mixed: White and Black Caribbean
    e. Mixed: White and Black African
    f. Mixed: White and Asian
    g. Asian: Indian
    h. Asian: Pakistani
    i. Asian: Bangladeshi
    j. Asian: Chinese
    k. Black: African
    l. Black: Caribbean
    m. Other
        i. Please describe.
5. One hears about "morning" and "evening" types of people. Which one of these types do you consider yourself to be?
    a. Definitely an“"evening”" type
    b. More an "evening" type than a "morning" type
    c. More a "morning" type than an "evening" type
    d. Definitely a "morning" type

Manipulation Check [Study 4 only]

1. Today, did you attempt to show self-compassion throughout your day?

Yes	No

2. Roughly how long did you spend consciously showing self-compassion?

Less than 10 minutes	10–- 30 minutes	30–- 60 minutes	More than 1 hour

3. Please briefly describe the way(s) in which you showed self-compassion.
[TEXT ENTRY]

4. How successful do you feel you were at showing self-compassion?

Not at all successful										Very successful
0	1	2	3	4	5	6	7	8	9	10

Appendix B Statistical Analyses [Tables and Figures]

B.1 Study 1

Table 1a

Self-Constructs Used to Measure Each Dimension of the Multidimensional Self

Dimension	Self-Construct
Affective Self	Self-Compassion
Affective Self	Self-Esteem
Motivational Self	Self-Enhancement Motive
Executive Self	Self-Control
Temporal Self	Self-Continuity
Interpersonal Self	Self-Expression
Representational Self	Self-Concept Clarity

Note. Grid that displays the six (6) dimensions of the Multidimensional Self Model and the associated self-constructs which operationalise these dimensions. Two (2) self-constructs were used to measure the affective self.

Table 1b

Bivariate Correlations for all self-constructs and sleep quality

		1	2	3	4	5	6	7	8
1	Sleep Quality	--							
2	Self-Control	-.199**	--						
3	Self-Compassion	-.229**	.437**	--					
4	Self-Esteem	-.233**	.462**	.655**	--				
5	Self-Continuity	-.221**	.384**	.542**	.598**	--			
6	Self Concept-Clarity	-.143*	.439**	.612**	.582**	.628**	--		
7	Self-Expression	-.047	.159**	.241**	.308**	.219**	.181**	--	
8	Self-Enhancement	.014	-.051	-.031	.056	.065	.005	.164**	--

**$p < .01$; *$p < .05$

Note. Correlation matrix used to establish an association between sleep quality and seven [7] self-constructs.

Table 1c

Multiple Regression of all self-constructs as predictors of sleep quality

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.29[a]	0.08	0.06	2.15

a. Predictors: (Constant), Self-Enhancement, Self-Concept Clarity, Self-Expression, Self-Control, Future Self-Continuity, Self-Compassion, Self-Esteem

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	*p*
1	Regression	123.94	7	17.701	3.83	<.001[b]
	Residual	1344.16	291	4.61		
	Total	1468.10	298			

a. Dependent Variable: Sleep Quality

b. Predictors: (Constant), Self-Enhancement, Self-Concept Clarity, Self-Expression, Self-Control, Future Self-Continuity, Self-Compassion, Self-Esteem

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	*p*
1	(Constant)	7.70	1.21		6.36	<0.001
	Self-Compassion	-0.39	0.26	-0.12	-1.49	0.136
	Self-Control	-0.37	0.24	-0.10	-1.54	0.125
	Self-Esteem	-0.21	0.16	-0.11	-1.26	0.210
	Self-Continuity	-0.22	0.13	-0.13	-1.72	0.086
	Self-Concept Clarity	0.24	0.17	0.12	1.42	0.155
	Self-Expression	0.12	0.18	0.04	0.63	0.528
	Self-Enhancement	0.03	0.13	0.01	0.23	0.817

a. Dependent Variable: Sleep Quality

Note. Statistical output from a multiple regression where sleep quality is the dependent variable, and all seven self-constructs are the independent variables. Output shows the predictive relationship between self-construct and sleep quality when controlling for the other self-constructs.

Table 1d

Comparison of means and standard deviations for all self-constructs and sleep quality.

Group Statistics

Sleep Group		N	Mean	Std. Deviation	Std. Error Mean
Self-Compassion	Good Sleeper	166	2.95	0.68	0.05
	Bad Sleeper	133	2.66	0.68	0.06
Self-Control	Good Sleeper	166	3.28	0.61	0.05
	Bad Sleeper	133	3.05	0.59	0.05
Self-Esteem	Good Sleeper	166	4.14	1.08	0.08
	Bad Sleeper	133	3.63	1.15	0.10
Self-Continuity	Good Sleeper	166	4.65	1.29	0.10
	Bad Sleeper	133	4.05	1.37	0.12
Self-Concept Clarity	Good Sleeper	166	3.77	1.08	0.08
	Bad Sleeper	133	3.50	1.05	0.09
Self-Expression	Good Sleeper	166	5.22	0.71	0.06
	Bad Sleeper	133	5.19	0.74	0.06
Self-Enhancement	Good Sleeper	166	5.31	1.05	0.08
	Bad Sleeper	133	5.36	0.92	0.08

Independent Samples Test

	t	df	p	Mean Difference	Std. Error Difference	95% CI Lower	95% CI Upper
Self-Compassion	3.64	297	<.001	0.29	0.08	0.13	0.44
Self-Control	3.25	297	<.001	0.23	0.07	0.09	0.36
Self-Esteem	3.97	297	<.001	0.51	0.13	0.26	0.77
Self-Continuity	3.87	297	<.001	0.60	0.15	0.29	0.90
Self-Concept Clarity	2.17	297	.031	0.27	0.12	0.02	0.51
Self-Expression	0.36	297	.717	0.03	0.08	-0.14	0.20
Self-Enhancement	-0.44	297	.657	-0.05	0.12	-0.28	0.18

Independent Samples Effect Sizes

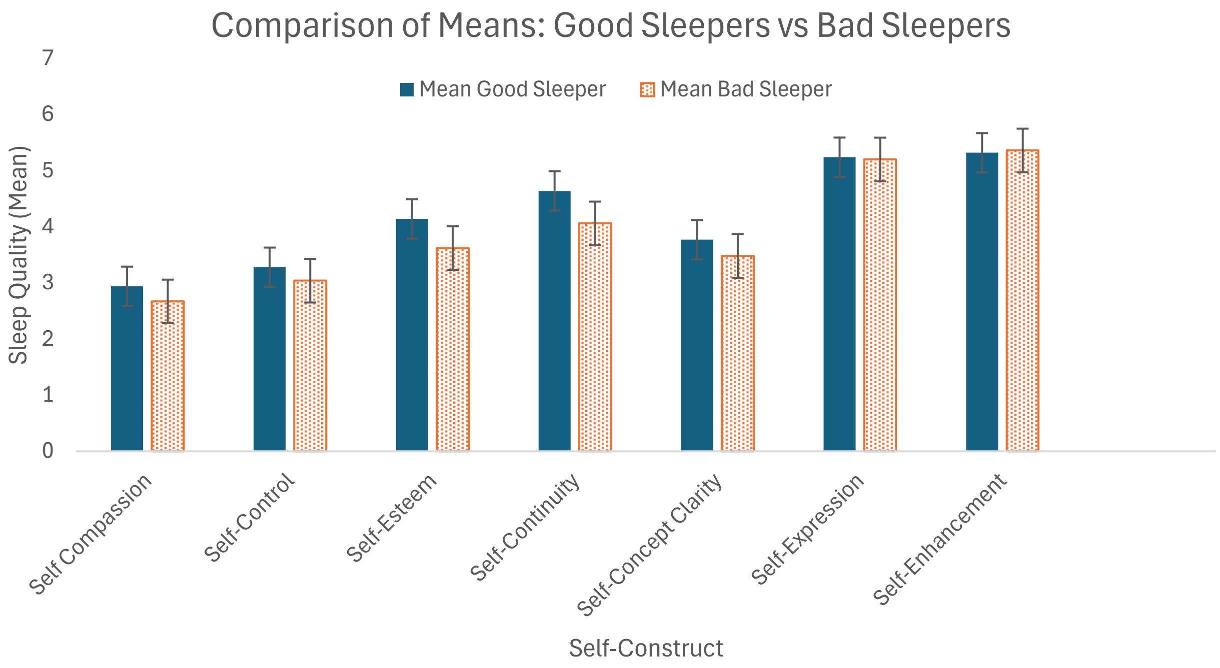
		Standardizer[a]	Point Estimate	95% CI Lower	95% CI Upper
Self-Compassion	Cohen's d	0.68	0.42	0.19	0.65
Self-Control	Cohen's d	0.60	0.38	0.15	0.61
Self-Esteem	Cohen's d	1.11	0.46	0.23	0.69
Self-Continuity	Cohen's d	1.33	0.45	0.22	0.68
Self-Concept Clarity	Cohen's d	1.06	0.25	0.02	0.48
Self-Expression	Cohen's d	0.72	0.04	-0.19	0.27
Self-Enhancement	Cohen's d	0.99	-0.05	-0.28	0.18

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.

Note. Statistical output comparing the means of all self-constructs across good sleepers and bad sleepers. Good sleepers are those with a global PSQI score of <6.

Figure 1a

Comparison of all self-construct means. Clustered by sleep quality (good vs bad sleepers).



Note. A bar chart which displays the comparison of means of all self-constructs across good sleepers (Blue, Solid) and bad sleepers (Orange, Textured) in graphic format.

Table 1e

Communities for the exploratory factor analysis.

Communalities[a]	Initial	Extraction
Self-Compassion	0.53	0.58
Self-Control	0.27	0.30
Self-Esteem	0.56	0.80
Self-Continuity	0.49	0.53
Self-Concept Clarity	0.52	0.84
Self-Enhancement	0.05	0.01
Self-Expression	0.12	0.13

Extraction Method: Maximum Likelihood.

a. One or more communality estimates greater than 1 were encountered during iterations. The resulting solution should be interpreted with caution.

Note. Communities for the exploratory factor analysis. This table shows the variance of each self construct explained by all factors together (Initial) and following extraction (Extraction). Communities are not affected by rotation.

Table 1f

Total Initial Eigenvalues for each component from exploratory factor analysis

Total Variance Explained

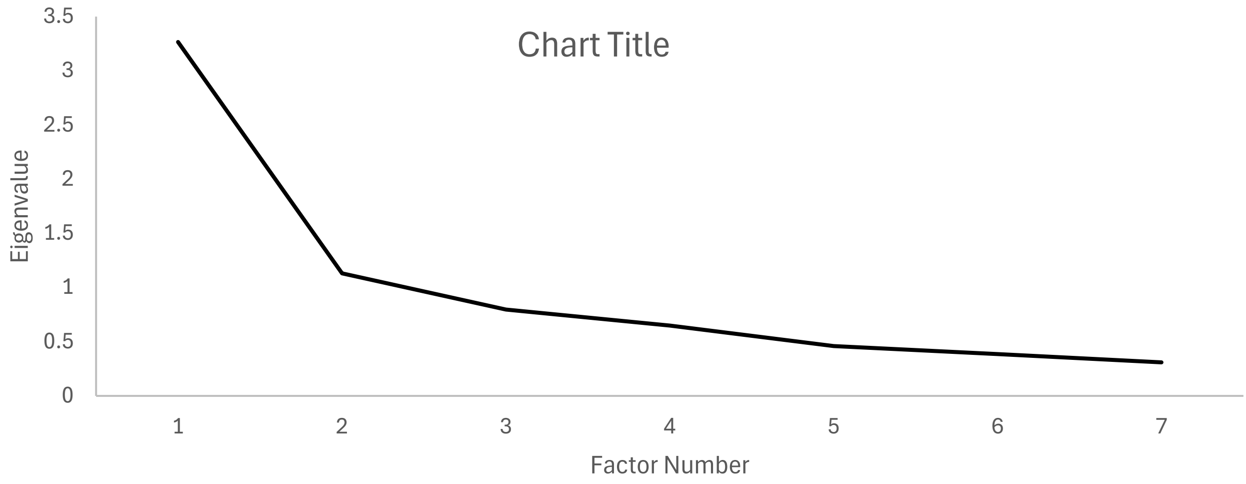
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.27	46.65	46.65	2.88	41.14	41.14	2.88
2	1.13	16.14	62.80	0.30	4.31	45.45	0.73
3	0.80	11.40	74.20				
4	0.65	9.28	83.48				
5	0.46	6.59	90.07				
6	0.39	5.51	95.58				
7	0.31	4.42	100.00				

Extraction Method: Maximum Likelihood.
a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Note. Total initial eigenvalues for each component. Only components that have a total initial eigenvalue greater than 1 are accepted as significant components. Two components explain 62.95% of the total variance.

Figure 1b

Scree plot of Total Initial Eigenvalues from exploratory factor analysis



Note*.* A scree plot which displays the total initial eigenvalues of each component in graphic format.

Table 1g

Pattern Matrix for exploratory factor analysis.

Pattern Matrix[a]		
	Factor	
	1	2
Self-Compassion	0.71	0.12
Self-Control	0.52	0.07
Self-Esteem	0.68	0.39
Self-Continuity	0.73	0.01
Self-Concept Clarity	0.97	-0.34
Self-Enhancement	0.00	0.09
Self-Expression	0.21	0.23

Extraction Method: Maximum Likelihood.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 6 iterations.

Note. Regression coefficients for each self-construct factored into two components. A stronger factor loading is indicated by a larger coefficient.

Table 1h

Structure Matrix for exploratory factor analysis.

Structure Matrix	Factor	
	1	2
Self-Compassion	0.754	0.356
Self-Control	0.539	0.243
Self-Esteem	0.813	0.617
Self-Continuity	0.730	0.251
Self-Concept Clarity	0.860	-0.013
Self-Enhancement	0.028	0.089
Self-Expression	0.287	0.298

Extraction Method: Maximum Likelihood.
Rotation Method: Oblimin with Kaiser Normalization.

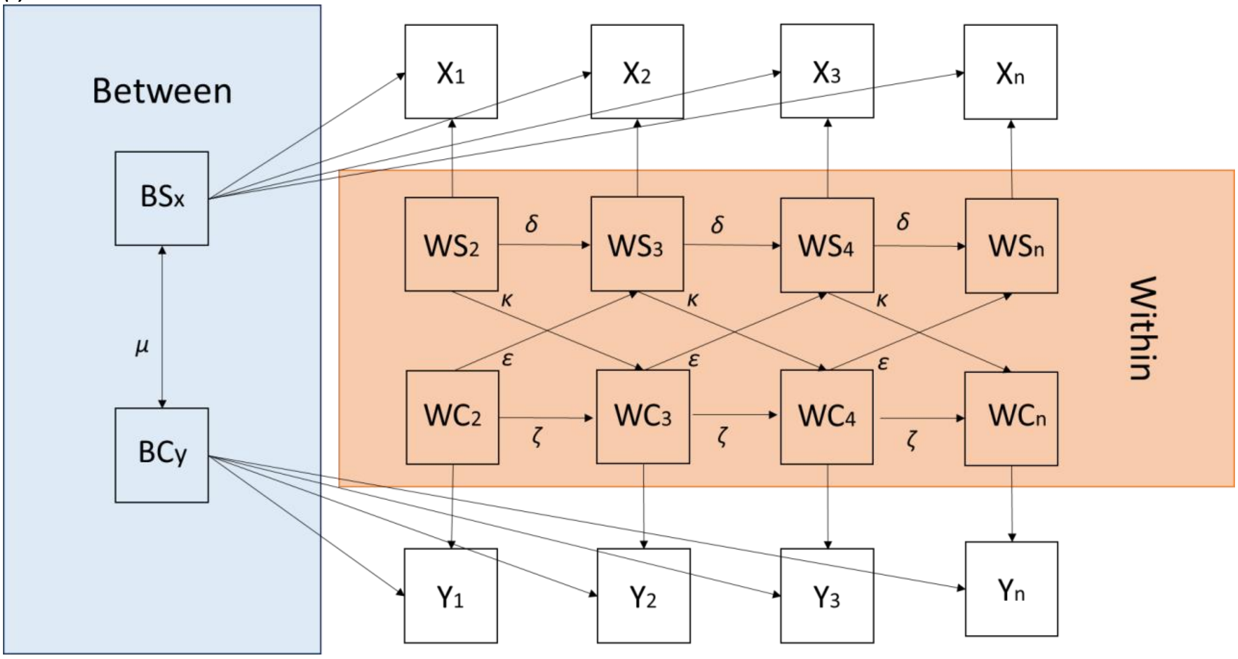
Note. Correlations between rotated factors and each self-construct. The larger correlations suggest a stronger factor loading.

B.2 Study 2

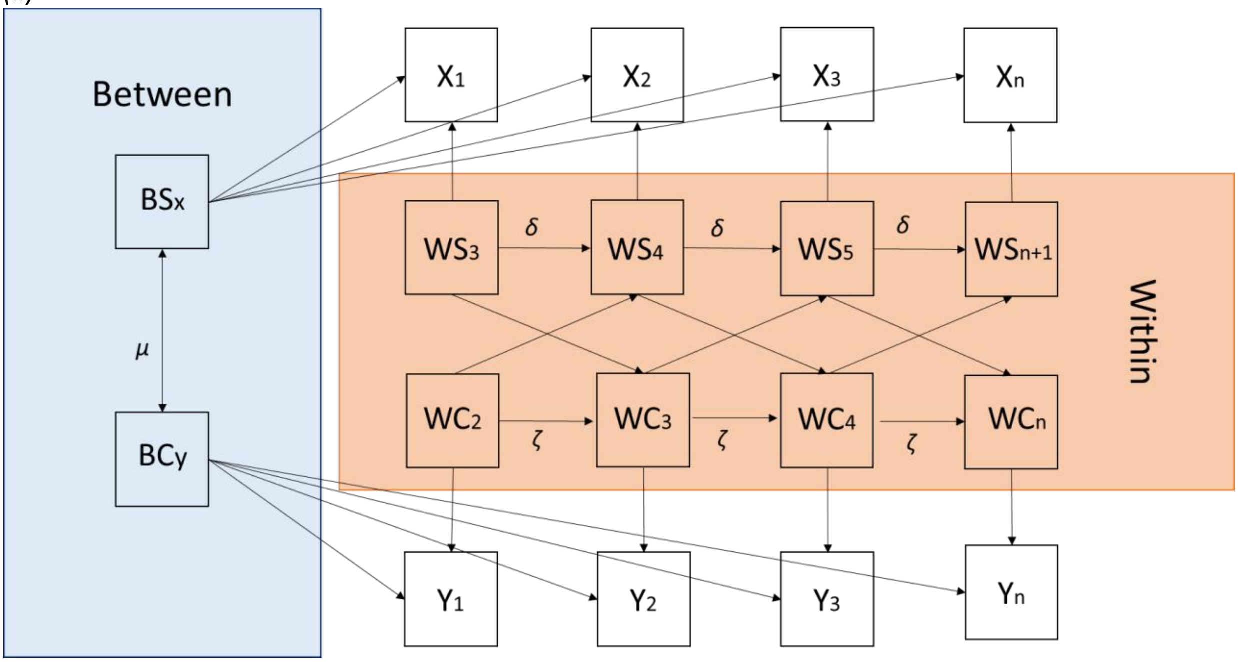
Figure 2a

Applied conceptual model of RI-CLPM for (i) coupled data and (ii) uncoupled data.

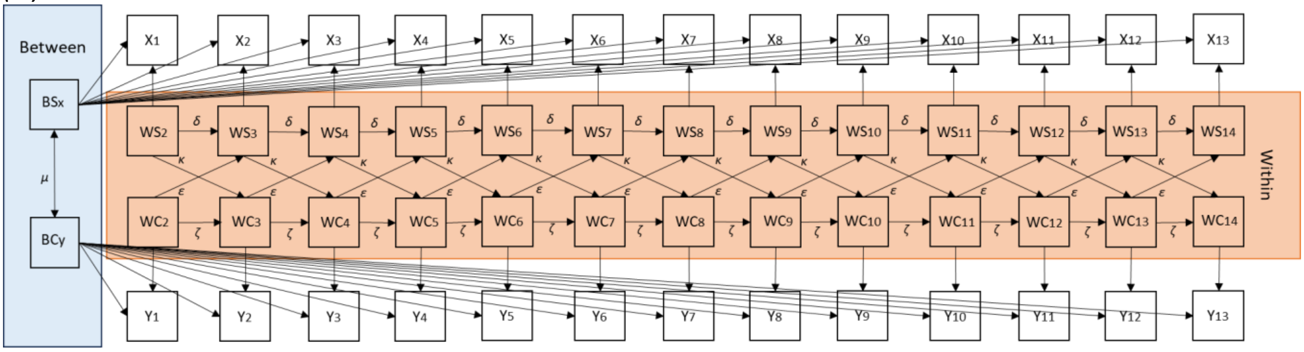
(i)



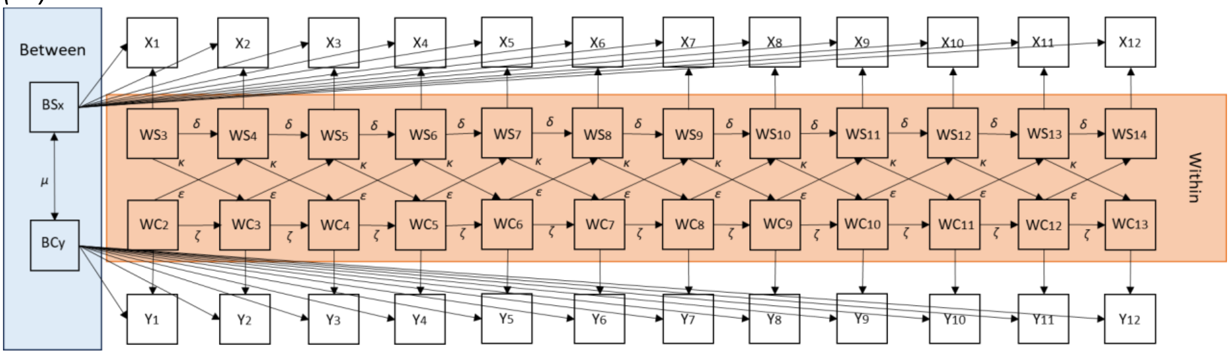
(ii)



(iii)



(iiii)



Note. RI-CLPM for Study 2. The models are constrained, so I assume that the autoregressive and cross-lagged effects are the same for each interaction. For example, the autoregressive effect from day 2 – day3 is the same as the autoregressive effect from day 5 - day 6. δ and ζ are autoregressive regression coefficients, κ and ε are cross-lagged regression coefficients, and μ is between-person correlation. B/WS is Between/Within Sleep Quality. B/WC is Between/Within Construct. In the Within component, days are nested with individuals. Day count starts on n=2, as no state data was collected on day 1. Figure based on Hamaker, et al. (2015) and van Genugten et al. (2021).

5. Conceptual Figure of Model 1. 4 days representative of any given day within this study. Coupled variables. Short self → sleep lags (12 hours) and long sleep → self lags (36 hours).
6. Conceptual Figure of Model 2. 4 days representative of any given day within this study. Uncoupled variables. Long self → sleep lags (36 hours) and short sleep → self lags (12 hours).
7. Model 1 (coupled variables) for Study 2. 13 interactions are derived from 13 days that collected state data. State data collection began on day 2.
8. Model 2 (uncoupled variables) for Study 2. 12 interactions are derived from 13 days that collected state data, but I shifted state sleep quality 24 hours earlier to couple with previous data self-constructs data. This means day 2 sleep quality and day 14 self-construct data are sacrificed. State data collection began on day 2.

Table 2a

Bivariate correlations for trait self-constructs and sleep quality

		1	2	3	4	5
1	Sleep Quality	--				
2	Self-Comparison	-.344**	--			
3	Self-Control	-.318**	.392**	--		
4	Self-Esteem	-.379**	.816**	.437**	--	
5	Self-Continuity	-.423**	.608**	.369**	.709**	--

**. Correlation is significant at the 0.01 level (2-tailed).

Note. Correlation matrix used to establish an association between sleep quality and the four [4] measured self-constructs.

Figure 2b

A summative graphic of associations between sleep quality and the self.

(*i) Sleep Quality →Self-Constructs*

	Self-Composite	Self-compassion	Self-esteem	Self-control	Self-continuity
Study 2	Yes	Yes	Yes	Yes	Yes

(*ii) Self-Constructs →Sleep Quality*

	Self-composite	Self-compassion	Self-esteem	Self-control	Self-continuity
Study 2	No	No	No	No	No

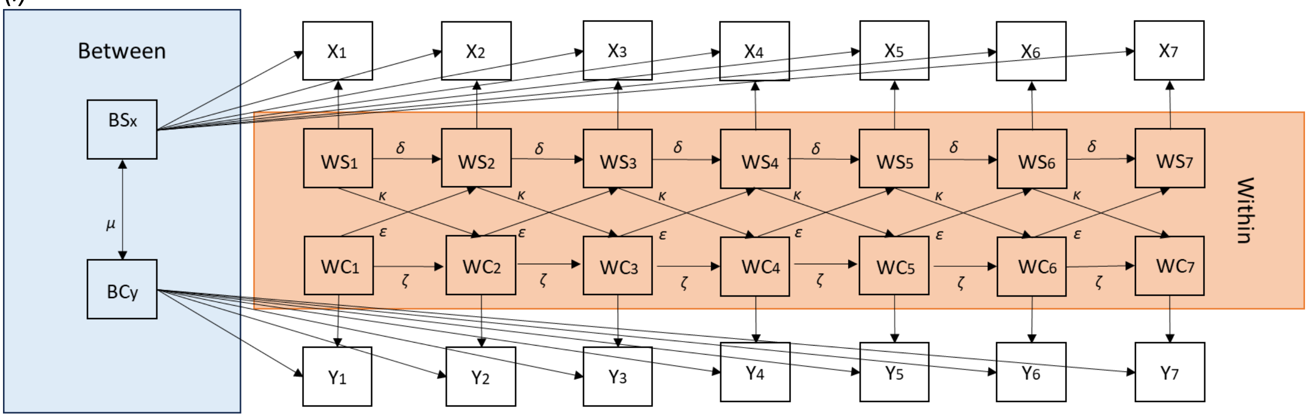
Note. Cumulative graphic that displays the predictive associations between (i) sleep quality → self-constructs, and (ii) self-constructs → sleep quality, at the short (12 hour) lag, in Study 2.

B.3 Study 3

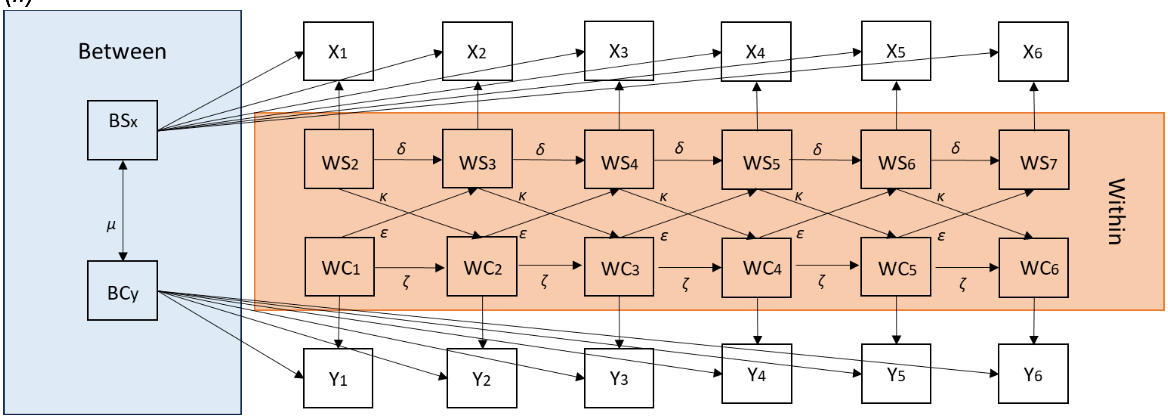
Figure 3a

Applied conceptual model of RI-CLPM for subjective sleep quality for (*i*) *coupled data and* (*ii*) *uncoupled data.*

(*i*)



(*ii*)



Note. RI-CLPM for Study 3. The models are constrained, so I assume that the autoregressive and cross-lagged effects are the same for each interaction. For example, the autoregressive effect from day 2 – day3 is the same as the autoregressive effect from day 5 - day 6. δ and ζ are autoregressive regression coefficients, κ and ε are cross-lagged regression coefficients, and μ is between-person correlation. B/WS is Between/Within Sleep Quality. B/WC is Between/Within Construct. In the Within component, days are nested with individuals. Day count starts on n=1. Figure based on Hamaker, et al. (2015) and van Genugten et al. (2021).

3. Model 1 (coupled variables) for Study 3. 7 interactions are derived from 7 days that collected state data.
4. Model 2 (uncoupled variables) for Study 3. 6 interactions are derived from 7 days that collected state data, but I shifted state sleep quality 24 hours earlier to couple with previous data self-constructs data. This means day 1 sleep quality and day 7 self-construct data are sacrificed.

Table 3a

Bivariate Correlations between subjective and objective sleep quality

		1	2	3	4	5	6	7
1	ASE2	--						
2	ASE3	.347*	--					
3	ASE4	.407*	.513**	--				
4	ASE5	0.102	0.064	.475**	--			
5	ASE6	0.277	0.314	.661**	.559**	--		
6	ASE7	.329*	0.294	.511**	.566**	.554**	--	
7	ASE8	.358*	.384*	.422*	.604**	.460**	.609**	--
8	SSQ1	0.085	-0.227	-0.165	-.341*	0.044	-.427*	-0.337
9	SSQ2	0.186	.355*	-0.069	-0.185	0.058	-0.146	-0.165
10	SSQ3	0.024	0.198	-0.185	-0.034	-0.114	-0.209	-0.229
11	SSQ4	-0.046	0.075	0.027	0.259	.334*	0.162	0.100
12	SSQ5	0.100	0.172	0.120	-0.068	0.045	0.061	0.033
13	SSQ6	-0.007	-0.055	0.024	0.254	.441**	0.136	0.235
14	SSQ7	-0.258	0.125	0.049	0.191	-0.005	0.113	0.145

		8	9	10	11	12	13	14
1	ASE2							
2	ASE3							
3	ASE4							
4	ASE5							
5	ASE6							
6	ASE7							
7	ASE8							
8	SSQ1	--						
9	SSQ2	0.103	--					
10	SSQ3	-0.060	.507**	--				
11	SSQ4	0.241	0.151	0.118	--			
12	SSQ5	0.127	0.189	0.212	.330*	--		
13	SSQ6	0.160	0.179	0.231	0.301	0.318	--	
14	SSQ7	-0.253	0.071	0.156	.367*	0.117	.328*	--

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Note. Correlation matrix used to establish an association between subjective sleep quality (SSQ) and actigraphy sleep efficiency (ASE) on each day of data collection. ASE starts on Day 2 and SSQ starts on day 1. This is because on Day 1 participants received their actigraphy watch, so they could self-report their previous night's sleep quality but did not have actigraph data. Similarly, ASE ends on Day 8 and SSQ ends on Day 7because participants returned their actigraph watch on Day 8 before the time they were due to complete self-report measures.

Figure 3b

A summative graphic of associations between sleep quality and the self.

(*i) Sleep Quality → Self-Constructs*

	Self-Composite	Self-compassion	Self-esteem	Self-control	Self-continuity
Study 2	Yes	Yes	Yes	Yes	Yes
Study 3 *Subj	Yes	Yes	Marginal	No	Yes
Study 3 *Obj	No	No	No	No	No

(*ii) Self-Constructs → Sleep Quality*

	Self-composite	Self-compassion	Self-esteem	Self-control	Self-continuity
Study 2	No	No	No	No	No
Study 3 *Subj	No	No	No	No	No
Study 3 *Obj	Yes	Yes	No	No	Yes

Note. Cumulative graphic that displays the predictive associations between (i) sleep quality → self-constructs, and (ii) self-constructs → sleep quality, at the short (12 hour) lag, including Study 2 and Study 3.

B.4 Study 4

Table 4a

Bivariate Correlations for all trait self-constructs and sleep quality

		1	2	3	4
1	Sleep Quality	--			
2	Self-Compassion	.232**	--		
3	Self-Control	.198*	.470**	--	
4	Self-Esteem	.342**	.683**	.539**	--

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Note. Correlation matrix used to establish an association between trait subjective sleep quality and all self-constructs.

Table 4b

Table of results. Comparison of manipulation effects between conditions

(*i) Number of days engaged with the experimental manipulation.*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	15.85[a]	2	7.93	1.50	.228	.01
Intercept	3994.66	1	3994.66	755.92	<.001	.88
Condition	15.85	2	7.93	1.50	.228	.03
Error	544.30	103	5.28			
Total	4546.00	106				
Corrected Total	560.15	105				
a. R Squared = .028 (Adjusted R Squared = .009)						

(*ii) Amount of time spent engaging with the experimental manipulation.*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12.69[a]	2	6.35	11.58	<.001	.19
Intercept	423.18	1	423.178	772.37	<.001	.883
Condition	12.69	2	6.35	11.58	<.001	.19
Error	55.89	102	.55			
Total	508.26	105				
Corrected Total	68.578	104				
a. R Squared = .185 (Adjusted R Squared = .169)						

Condition	Mean	Std. Deviation	N
Self-Esteem	1.94	0.74	31
Self-Compassion	1.65	0.55	34
Self-Control	2.46	0.87	40
Total	2.05	0.81	105

(iii) Perceived success of engaging with the manipulation.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	18.92[a]	2	9.46	3.85	.024	0.07
Intercept	5049.59	1	5049.59	2054.90	<.001	0.95
Condition	18.92	2	9.46	3.85	.024	0.07
Error	253.11	103	2.46			
Total	5437.50	106				
Corrected Total	272.03	105				

a. R Squared = .070 (Adjusted R Squared = .051)

Condition	Mean	Std. Deviation	N
Self-Esteem	6.57	1.53	31
Self-Compassion	6.73	1.55	35
Self-Control	7.52	1.61	40
Total	6.98	1.61	106

Note. Statistical output of a mixed model ANOVA. This analysis tests whether each experimental condition differed in any of the manipulation checks: number of days engaged with the manipulation; amount of time engaged with the manipulation; perceived success of engaging with the manipulation.

Table 4c

Table of results. Effect of manipulation on self-constructs (*mixed model ANOVA)*

(*i)*

Test of Between-Subjects Effects

Transformed Variable Average

Source	Measure	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	Self-Compassion	19155.39	1	19155.39	3053.27	<.001	0.971
	Self-Control	17635.23	1	17635.23	2315.30	<.001	0.961
	Self-Esteem	13614.85	1	13614.85	1805.80	<.001	0.952
Condition	Self-Compassion	4.85	3	1.62	0.26	.856	0.008
	Self-Control	37.28	3	12.43	1.63	.187	0.05
	Self-Esteem	4.16	3	1.39	0.18	.907	0.006
Error	Self-Compassion	577.18	92	6.27			
	Self-Control	708.37	93	7.62			
	Self-Esteem	693.64	92	7.54			

(ii)

Univariate Tests								
Source	Measure		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Day	Self-Compassion	Sphericity Assumed	13.29	8.00	1.66	2.97	0.003	0.03
		Greenhouse-Geisser	13.29	6.09	2.18	2.97	0.007	0.03
		Huynh-Feldt	13.29	6.78	1.96	2.97	0.005	0.03
		Lower-bound	13.29	1.00	13.29	2.97	0.088	0.03
	Self-Control	Sphericity Assumed	20.78	8.00	2.60	2.36	0.016	0.03
		Greenhouse-Geisser	20.78	6.47	3.21	2.36	0.025	0.03
		Huynh-Feldt	20.78	7.24	2.87	2.36	0.020	0.03
		Lower-bound	20.78	1.00	20.78	2.36	0.128	0.03
	Self-Esteem	Sphericity Assumed	16.93	8.00	2.12	7.39	<.001	0.07
		Greenhouse-Geisser	16.93	5.07	3.34	7.39	<.001	0.07
		Huynh-Feldt	16.93	5.58	3.04	7.39	<.001	0.07
		Lower-bound	16.93	1.00	16.93	7.39	0.008	0.07
Day* Condition	Self-Compassion	Sphericity Assumed	14.91	24.00	0.62	1.11	0.324	0.04
		Greenhouse-Geisser	14.91	18.27	0.82	1.11	0.336	0.04
		Huynh-Feldt	14.91	20.34	0.73	1.11	0.332	0.04
		Lower-bound	14.91	3.00	4.97	1.11	0.349	0.04
	Self-Control	Sphericity Assumed	23.87	24.00	1.00	0.90	0.597	0.03
		Greenhouse-Geisser	23.87	19.41	1.23	0.90	0.579	0.03
		Huynh-Feldt	23.87	21.71	1.10	0.90	0.588	0.03
		Lower-bound	23.87	3.00	7.96	0.90	0.442	0.03
	Self-Esteem	Sphericity Assumed	9.02	24.00	0.38	1.31	0.145	0.04
		Greenhouse-Geisser	9.02	15.21	0.59	1.31	0.189	0.04
		Huynh-Feldt	9.02	16.73	0.54	1.31	0.180	0.04
		Lower-bound	9.02	3.00	3.01	1.31	0.275	0.04

Error (Day)	Self-Compassion	Sphericity Assumed	411.57	736.00	0.56
		Greenhouse-Geisser	411.57	560.12	0.74
		Huynh-Feldt	411.57	623.75	0.66
		Lower-bound	411.57	92.00	4.47
	Self-Control	Sphericity Assumed	809.54	736.00	1.10
		Greenhouse-Geisser	809.54	595.19	1.36
		Huynh-Feldt	809.54	665.90	1.22
		Lower-bound	809.54	92.00	8.80
	Self-Esteem	Sphericity Assumed	210.87	736.00	0.29
		Greenhouse-Geisser	210.87	466.53	0.45
		Huynh-Feldt	210.87	513.10	0.41
		Lower-bound	210.87	92.00	2.29

Note. Statistical output of a mixed model ANOVA, testing the effect of each condition, day, and their interaction on each self-construct.

Table 4d

Table of results. Effect of manipulation on self-constructs (*one-way ANOVAs)*

(*i)*

Tests of Between-Subjects Effects					
Dependent Variable: Self-Compassion					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.91a	3	0.30	0.44	0.723
Intercept	3258.83	1	3258.83	4755.28	<.001
Condition	0.91	3	0.30	0.44	0.723
Error	98.68	144	0.69		
Total	3399.75	148			
Corrected Total	99.59	147			
a. R Squared = .009 (Adjusted R Squared .012)					

(*ii)*

Tests of Between-Subjects Effects					
Dependent Variable: Self-Control					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5.45a	3	1.82	2.20	0.090
Intercept	2946.50	1	2946.50	3574.18	<.001
Condition	5.45	3	1.82	2.20	0.090
Error	118.71	144	0.82		
Total	3122.08	148			
Corrected Total	124.16	147			
a. R Squared = .044 (Adjusted R Squared .024)					

(*iii)*

Tests of Between-Subjects Effects					
Dependent Variable: Self-Esteem					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.21	3	0.07	0.09	0.965
Intercept	2283.81	1	2283.81	2938.38	<.001
Condition	0.21	3	0.07	0.09	0.965
Error	111.92	144	0.78		
Total	2430.98	148			
Corrected Total	112.13	147			
a. R Squared = .002 (Adjusted R Squared .019)					

Note. Statistical output of 3 individual one-way ANOVAs, testing the effect of each condition, day, and their interaction on each self-construct: (i) self-compassion; (ii) self-control; (iii) self-esteem.

Table 4e

Table of results. Effect of manipulation on subjective sleep quality

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	19007.82	1	19007.82	2442.75	<.001	.96
Condition	69.34	3	23.11	2.97	.036	.09
Error	723.66	93	7.78			

(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence
					Lower Bound
Control Condition	Self-Esteem	.63	.27	.140	-.11
	Self-Compassion	.03	.27	1.000	-.69
	Self-Control	-.12	.26	1.000	-.82
Self-Esteem	Control Condition	-.63	.27	.140	-1.36
	Self-Compassion	-.60	.27	.187	-1.34
	Self-Control	-.75*	.27	.041	-1.47
Self-Compassion	Control Condition	-.03	.27	1.000	-.7
	Self-Esteem	.60	.27	.187	-.14
	Self-Control	-.15	.26	1.000	-.86
Self-Control	Control Condition	.12	.26	1.000	-.58
	Self-Esteem	.75*	.27	.041	.02
	Self-Compassion	.15	.26	1.000	-.57

Note. Statistical output of a mixed model ANOVA. This analysis tests the effect of each condition, day, and their interaction on subjective sleep quality.

Table 4f

Bivariate Correlations between manipulation and self-constructs within conditions

(*i) Self-Compassion*

	Correlations							
		1	2	3	4	5	6	7
1	Sleep Quality	--						
2	Self-Compassion	.392*	--					
3	Self-Control	.607**	.554**	--				
4	Self-Esteem	.478**	.490**	.702**	--			
5	Days	-0.261	-0.09	-0.301	-0.323	--		
6	Success	.355*	0.028	0.271	0.077	-0.164	--	
7	Time	-0.073	-0.397	-0.339	-0.088	0.255	-0.026	--

* Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

(*ii) Self-Control*

	Correlations							
		1	2	3	4	5	6	7
1	Sleep Quality	--						
2	Self-Compassion	.536**	--					
3	Self-Control	.633**	.835**	--				
4	Self-Esteem	.433**	.792**	.828**	--			
5	Days	0.012	0.107	-0.013	-0.183	--		
6	Success	.475**	.423**	.400*	0.308	-0.166	--	
7	Time	-0.061	-0.065	-0.254	-0.232	0.146	-0.045	--

* Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

(*iii) Self-Esteem*

	Correlations							
		1	2	3	4	5	6	7
1	Sleep Quality	--						
2	Self-Compassion	.404*	--					
3	Self-Control	.689**	.709**	--				
4	Self-Esteem	.218	.663**	.451*	--			
5	Days	.163	.275	.184	.492**	--		
6	Success	.129	.226	.316	.104	.177	--	
7	Time	.327	.236	.438*	.050	.066	.573**	--

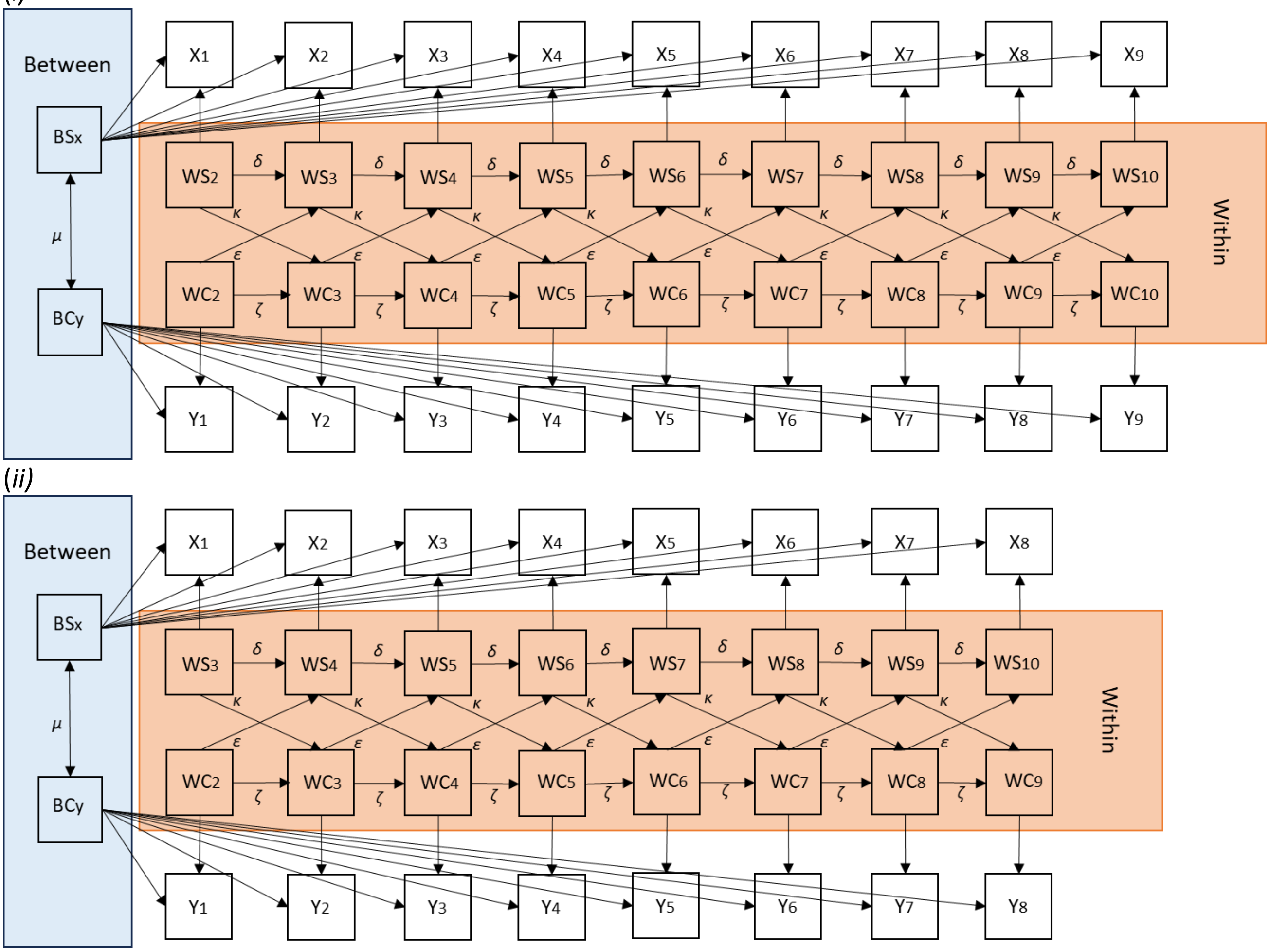
* Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

Note. Correlation matrices used to establish an association between each of the three manipulation checks (number of days engaged with the manipulation; perceived success at engaging with the manipulation; amount of time spent engaging with the manipulation) and subjective sleep quality and all self-constructs (self-compassion; self-control; self-esteem) across each of the experimental conditions.

Figure 4a

Applied conceptual model of RI-CLPM for subjective sleep quality for (i) coupled data and (ii) uncoupled data.

(*i*)



Note. RI-CLPM for Study 4. The models are constrained, so I assume that the autoregressive and cross-lagged effects are the same for each interaction. For example, the autoregressive effect from day 2 – day3 is the same as the autoregressive effect from day 5 - day 6. δ and ζ are autoregressive regression coefficients, κ and ε are cross-lagged regression coefficients, and μ is between-person correlation. B/WS is Between/Within Sleep Quality. B/WC is Between/Within Construct. In the Within component, days are nested with individuals. Day count starts on n=2, as no state data was collected on day 1. Figure based on Hamaker, et al. (2015) and van Genugten et al. (2021).

3. Model 1 (coupled variables) for Study 4. 9 interactions are derived from 9 days that collected state data.
4. Model 2 (uncoupled variables) for Study 4. 8 interactions are derived from 9 days that collected state data, but I shifted state sleep quality 24 hours earlier to couple with previous data self-constructs data. This means day 2 sleep quality and day 10 self-construct data are sacrificed.

Figure 4b

A summative graphic of associations between sleep quality and the self.
(*i) Sleep Quality → Self-Constructs*

	Self-Composite	Self-compassion	Self-esteem	Self-control	Self-continuity
Study 2	Yes	Yes	Yes	Yes	Yes
Study 3 *Subj	Yes	Yes	Marginal	No	Yes
Study 3 *Obj	No	No	No	No	No
Study 4	Yes	Yes	Yes	Yes	X

(*ii) Self-Constructs → Sleep Quality*

	Self-composite	Self-compassion	Self-esteem	Self-control	Self-continuity
Study 2	No	No	No	No	No
Study 3 *Subj	No	No	No	No	No
Study 3 *Obj	Yes	Yes	No	No	Yes
Study 4	Yes	Yes	Yes	No	X

Note. Cumulative graphic that displays the predictive associations between (i) sleep quality → self-constructs, and (ii) self-constructs → sleep quality, at the short (12 hour) lag. Figure includes Study 2, Study 3, and Study 4.

Glossary of Terms

Actigraphy .... Objective measure of sleep quality. Uses movement to determine duration of sleep processes.

Autoregressive Path .... Describes the predictive effect of the same variable measured at consecutive moments in time.

Bidirectional .... The effect of one variable on another that flows in both directions, where variable A effects variable B and variable B effects variable A.

Circadian Rhythms .... A natural and repetitive oscillation of biological processes that respond to environmental stimuli.

Chronotype .... A biological mechanism that is based on one's personal circadian rhythms, refers to individual differences in sleep-wake cycles; or, over a 24-hour period, the individual differences in start, end, and duration of circadian rhythms.

Cognition .... Mental processes involved in psychological events, such as memory, attention, and information processing.

Composite Score .... A global score of a measure, averaging all sub-scores derived from sub-components of the measure.

Cross-Lagged Path .... Describes the predictive effect of one variable on a different variable measured at consecutive moments in time.

Cross Sectional .... A method of data collection that gathers and compares variables across a single time point.

COVID .... The Coronavirus Disease.

Empirical .... Verified by published research, rather than theory.

Longitudinal .... A method of data collection that gathers and compares variables across multiple time points.

Self-Compassion .... The act, physical or mental, of minimizing one's own mental pain or suffering by managing positive and negative emotions.

Self-Concept Clarity .... The degree to which one can maintain and define self-beliefs.

Self-Construct .... A term used to describe self-related variables. In the present research, all variables with the prefix "self-," for example, self-compassion and self-control, are self-constructs.

Self-Continuity ....The subjective sense of connection to one's own past and future self.

Self-Control ....The act, physical or mental, of regulating behaviours and emotions that are motivated by desires, temptations, or impulses.

Self-Enhancement................The act, physical or mental, of heightening positive feelings and perceptions of oneself.

Self-Esteem ....The individual positive perception and value one places on themself, including self-worth and self-respect.

Self-Expression.....................The act, physical or mental, of expressing one's views or beliefs, or those which present the individual in a socially acceptable way.

Sleep Deprivation.................The total or partial removal of sleep from one's typical sleep process.

Sleep Duration ....The length of time an individual spends asleep. Often used as a measurement of sleep quality.

Sleep Efficiency ....The length of time one spends asleep, relative to the time they spend trying to sleep. Often used as a measurement of sleep quality.

Sleep Hygiene.......................The behaviours and cognitions one engages in that are related to sleep. This does not include the act of sleep. Typically includes habitual behaviours active prior to sleep (such as brushing teeth or reading in bed).

Sleep Latency ....The length of time it takes for one to fall asleep, after they begin the process of trying to sleep. Often used as a measurement of sleep quality.

Sleep Quality ....The measurement of how well one sleeps, be it positive or negative.

Unidirectional.......................The effect of one variable on another follows a single linear path, where variable A effects variable B, but variable B does not affect variable A.

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