"Fully Recharged" Evenings? The Effect of Evening Cyber Leisure on Next-Day Vitality and Performance through Sleep Quantity and Quality, Bedtime Procrastination, and Psychological Detachment, and the Moderating Role of Mindfulness

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Abstract

Aligning with the recovery perspective, we propose a dual-path model to illustrate the effects of employees' evening cyber leisure on next-day work outcomes, namely, psychological vitality and performance. We argue that evening cyber leisure has contradicting effects on next-day performance and vitality through its effects on bedtime procrastination and psychological detachment, and in turn, sleep quantity and sleep quality. We also propose that trait mindfulness acts as an important boundary condition of the indirect effects of evening cyber leisure. We used an experience sampling methodology to collect three surveys per day for 10 days from 155 R&D employees of a biotech company. Our findings suggest that cyber leisure has a negative indirect effect on sleep quantity and sleep quality via bedtime procrastination, and a positive indirect effect on sleep quantity and sleep quality via evening psychological detachment. Additionally, sleep quantity was positively associated with performance, and sleep quality was positively associated with psychological vitality. Lastly, as trait mindfulness increased, the negative impact of cyber leisure on bedtime procrastination was mitigated, and the positive impact of cyber leisure on psychological detachment was enhanced. Theoretical and practical implications specific to the use of cyber devices for workplace recovery are discussed.

Keywords: Evening cyber leisure, sleep, psychological vitality, performance, trait mindfulness, recovery

In 2019, over 95% of North America's population used cyber devices such as laptops, tablets, and mobile phones (Internet World Stats, 2019). The popularity of cyber devices has revolutionized the way employees work, increasing their access to work platforms and resources as well as their ability to immediately respond to colleagues and customers when outside the office (Derks & Bakker, 2014). This research highlights that business-related cyber-device usage during employees' post-work time can be beneficial (e.g., productivity) or detrimental (e.g., work-home interference), and that the effect depends on organizational context and employee preference (e.g., Derks & Bakker, 2014; Lanaj, Johnson, & Barnes, 2014).

We build on this literature by highlighting that cyber devices are not just for business purposes, but non-work activities as well, and that such usage may have work-related implications. Indeed, cyber leisure—seeking relaxation, recreation, and entertainment by using electronic devices via the internet (Bae, 2013)—is an increasingly popular evening activity (Sintas, De Francisco, & Álvarez, 2015). Thus, in this study, we investigate the impact of evening cyber leisure on work-specific phenomena, namely, employees' next-day vitality and performance. Considering the time interval between evening cyber leisure and next-day work outcomes, we also consider activities that happen in between as possible mechanisms. In research outside of organizational contexts, the relationship between cyber leisure and sleep has received a great deal of attention (e.g., Brunborg et al., 2011; Perlow, 2012; Twenge, Krizan, & Hisler, 2017). Additionally, sleep is commonly associated with recovery in the workplace (Barnes & Watson, 2019). We, therefore, focus on sleep as a mediating mechanism between cyber leisure and next-day work outcomes.

Sleep is defined as "a recurring, reversible neurobehavioral state of relative perceptual disengagement from and unresponsiveness to the environment" (Carskadon & Dement, 2011, p.

16). Sleep is critical to properly function on a daily basis, because it restores cellular components, conserves and replenishes energy reserves, and allows for neural reorganization (Mignot, 2008). In our study, we focus on sleep *quantity* and sleep *quality* as operationalizations of the construct of sleep. Sleep quantity is a measure of duration, and entails the total amount of time a person has slept (Buyssé, 2014). Sleep quality is a subjective evaluation of how well a person feels he or she has slept (Buyssé, 2014). It is important to study both sleep quantity and sleep quality because the two are conceptually and empirically distinct, and both are necessary for optimal functioning (i.e., they are not substitutes for one another) (Barnes, Schaubroeck, Huth, & Ghumman, 2011). More importantly, the separation of the two is especially meaningful for our research. Specifically, the separation of the two can help us understand the effect of evening cyber leisure on sleep, as well as the effect of sleep on next-day work outcomes in a deeper manner.

Research, so far, illustrates that evening cyber-device usage for work purposes is negatively associated with next-day work engagement through reduced sleep quantity (Lanaj et al., 2014). These findings align with the overarching assumption regarding the negative impact of evening cyber-device usage for work on employee productivity (e.g., work-related exhaustion: Derks & Bakker, 2014). However, prior work overlooks an important element of cyber-device usage, namely, its potential as a leisure activity that facilitates recovery. Research illustrates that evening leisure activities facilitate recovery through increased sleep quantity and higher levels of sleep quality (Rook & Zijlstra, 2006), which in turn replenishes energy for next-day work (Hülsheger, Feinholdt, & Nubold, 2015). Thus, an interesting paradox appears to exist in the cyber device literature. On the one hand, evening cyber-device usage is typically associated with reduced sleep quantity (Brunborg et al., 2011; Perlow, 2012; Twenge et al., 2017), and in turn, detrimental work-related outcomes (Lanaj et al., 2014). On the other hand, evening leisure activities are typically associated with a higher level of sleep quality (Rook & Zijlstra, 2006), and in turn, beneficial work-related outcomes (Hülsheger et al., 2015).

In an attempt to understand the processes underlying these opposing perspectives, we evaluate two mechanisms— one detrimental and one beneficial—through which cyber leisure relates to employees' sleep quantity and sleep quality, and in turn, next-day work outcomes. For the purposes of this study, evening cyber leisure entails the amount of time an individual uses any form of cyber device for leisure (i.e., non-work) in the evenings (i.e., post-work but before bedtime). We fist suggest that evening cyber leisure negatively impacts sleep and next-day productivity through *bedtime procrastination*, defined as going to bed later than intended, without having external reasons for doing so (Kroese, De Ridder, Evers, & Aiaanse, 2014). Stopping engagement in cyber leisure can be difficult because it is a highly stimulating and pleasurable form of entertainment (Brunborg et al., 2011), which tends to disrupt appropriate sleep patterns (Twenge et al., 2017). We also suggest that evening cyber leisure has a positive impact on sleep and next-day productivity through *psychological detachment*, which entails disconnecting from work-related activities, feelings, and thoughts during non-work time (Querstret & Cropley, 2012). As individuals engage in evening cyber leisure, it should minimize thinking and worrying about work, allowing them to unwind and get higher levels of sleep quality (Hülsheger et al., 2015).

Our model speaks to recovery research (Sonnentag, 2003) that suggests post-work recovery has a positive influence on employees' next-day well-being and performance (e.g., Demerouti, Bakker, Geurts, & Taris, 2009; Sonnentag & Fritz, 2007). This area of research commonly draws from the effort-recovery model (Meijman & Mulder, 1998), which suggests that on a daily basis, employees expend effort and energy to perform effectively. Such expenditures are taxing, and without replenishment, can be associated with next-day reductions in well-being and performance (Meijman & Mulder, 1998; Sonnentag, 2003). In keeping with the recovery literature, we evaluate next-day psychological vitality (i.e., a positive feeling of aliveness and of possessing personal energy; Ryan & Frederick, 1997) and next-day performance (i.e., effectively fulfilling job roles and functions to achieve organizational goals; Binnewies, Sonnentag, & Mojza, 2009) as outcome variables. Indeed, next-day psychological vitality and next-day performance are commonly positioned as theoretically relevant outcome variables within recovery studies in general (Binnewies et al., 2009), and sleep studies in particular (Schmitt, Belschak, & Den Hartog, 2017).

Recovery research suggests that the extent to which evening leisure activities translate into next-day recovery is dependent upon the intentions and motivations of the individual (e.g., Ten Brummelhuis & Trougakos, 2014). Along these lines, we sought to investigate an individual characteristic that might dictate whether evening cyber leisure is associated with psychological detachment and/or bedtime procrastination and subsequent sleep quantity and sleep quality. Specifically, we evaluate the moderating role of trait mindfulness, defined as consistently being attentive to and aware of what is taking place in the present (Brown & Ryan, 2003, p. 822). At lower levels of mindfulness, individuals pay less attention to the present and fail to consider or question why they are doing what they are doing (Hülsheger et al., 2015). At higher levels of mindfulness, individuals acknowledge their internal dialogue with clarity, allowing them to engage activities in ways that are more conscious and self-determined (Brown & Ryan, 2003). Thus, the self-regulatory capacities inherent in higher levels of trait mindfulness (Good et al., 2016) may mitigate the potential for cyber leisure to be detrimental in the form of bedtime procrastination and ensure that cyber leisure is beneficial in the form of psychological detachment. Indeed, the role of mindfulness in recovery research in general (Hulsheger et al., 2014; Hülsheger et al., 2015), and sleep research in particular (Hülsheger, Walkowiak, & Thommes, 2018), has generated a great deal of scholarly interest. We extend this line of inquiry by integrating cyber leisure as a form of recovery.

To summarize, we hypothesize (a) a negative, sequential indirect effect of evening cyber leisure on next-day psychological vitality and performance through evening bedtime procrastination and that night's sleep quantity and sleep quality; (b) a positive, sequential indirect effect of evening cyber leisure on next-day psychological vitality and performance through evening psychological detachment and that night's sleep quantity and sleep quality; and (c) a moderating effect such that higher levels of trait mindfulness mitigate the relationship between evening cyber leisure and evening bedtime procrastination, and enhance the relationship between evening cyber leisure and evening psychological detachment (see Figure 1).

This work contributes to the recovery, sleep, and mindfulness literatures. First, incorporating cyber leisure into a recovery framework is important given its popularity (Bae, 2013; Internet World Stats, 2019), and it's potential to have effects that are different from traditional forms of leisure (Sintas et al., 2015). Second, prior work focuses on the negative impact of cyber devices on sleep and work productivity (Lanaj et al., 2014), yet recovery research suggests evening leisure activities have a positive impact (Sonnentag, 2003). To understand why these competing effects exist we offer a dual-path model whereby evening cyber leisure differentially affects sleep through evening bedtime procrastination and psychological detachment. Third, we investigate the role of trait mindfulness on our dual-path model of evening cyber leisure and sleep. By investigating trait mindfulness, we illustrate that evening cyber leisure has the potential to be a beneficial recovery activity, but only when done with present moment attention and awareness. We, therefore, highlight a novel means through which trait mindfulness facilitates or diminishes workplace productivity.

Hypothesis Development

Evening Cyber Leisure, Bedtime Procrastination, Psychological Detachment, and Sleep

Procrastination is defined as a "voluntary delay of an intended course of action despite expecting to be worse off for the delay" (Steel, 2007, p. 66). Bedtime procrastination is a context-specific version of procrastination, such that individuals delay going to bed, even though they know they should (Kroese et al., 2014). Individuals procrastinate because they do not want to stop doing something more interesting or exciting than what they should be doing (Steel, 2007). Evening cyber leisure aligns with this "preferred distraction." Cyber leisure is an immersive activity, such that users feel a higher sense of involvement in the activity, can escape reality, and lose track of time (Wood, Griffiths, & Parke, 2007). Thus, the enjoyable and immersive experience of evening cyber leisure makes beginning the process of getting ready to go to sleep harder for individuals (Hofmann, Vohs, & Baumeister, 2012). In support, prior research illustrates that device-based entertainment, whether it be gaming, watching shows, social media, or browsing the internet, is positively associated with bedtime procrastination (Exelmans & Van den Bulck, 2017a),

Research also suggests cyber leisure is negatively associated with sleep quantity (Barber & Jenkins, 2014; Brunborg et al., 2011; Exelmans & Van den Bulck, 2017a). We suggest evening bedtime procrastination may help explain this relationship. The time that individuals go to bed is relatively self-determined. However, working adults cannot necessarily delay their wake-up time to accommodate their later bedtime, because they still need to attend to life's responsibility (e.g., getting to work on time, getting children to school on time). Thus, the more individuals delay their bedtime, the less sleep quantity they are likely to obtain. Indeed, several studies illustrate a negative association between evening bedtime procrastination and that night's sleep quantity (e.g., Kroese et al., 2014).

Research also suggests cyber leisure not only pushes back bedtime but disrupts sleep quality (Barber & Jenkins, 2012; Brunborg et al., 2011; Exelmans & Van den Bulck, 2017a). Bedtime procrastination may help explain this relationship. Using cyber devices as a form of procrastination elicits negative self-appraisals in the form of self-defeating thoughts (Carney, Harris, Moss, & Edinger, 2010). These negative appraisals manifest as stress (Meier, Reinecke, & Meltzer, 2016), guilt (Reinecke, Hartmann, & Eden, 2014), and self-condemnation (Stainton, Lay, & Flett, 2000), which in turn make it harder to sleep well (Carney et al., 2010). Indeed, the relationship between stress and sleep quality has been widely documented, with evidence suggesting that stress disrupts sleep-wake regulation, decreases the amount of deep sleep (e.g., slow-wave and rapid eye movement) and sleep efficiency, and increases awakenings throughout the night (Kim & Dimsdale, 2007; Van Reeth et al., 2002). There is also evidence suggesting that bedtime procrastination is positively associated with stress (Sirois & Pychyl, 2013) and that trait procrastination is indirectly related to sleep quality via stress (Sirois, Van Eerde, & Argiropoulou, 2015). In summary, we expect that evening cyber leisure indirectly affects that night's sleep quantity and sleep quality via evening bedtime procrastination, and offer the formal hypothesis below.

H1: Increased evening cyber leisure is negatively and indirectly related to that night's (a) sleep quantity and (b) sleep quality via evening bedtime procrastination.

According to the effort-recovery model (Meijman & Mulder, 1998), recovery occurs when the psychophysiological systems being activated by work demands are no longer being called upon. Thus, recovery entails the ability to replenish the functional systems being drained through work activities (Sonnentag & Fritz, 2007). One such replenishing mechanism is psychological detachment, which entails an individual's sense of being away from the demands of work (Etzion, Eden, & Lapidot, 1998, p. 579). Importantly, psychological detachment is more than being physically away from work; it entails feeling mentally disconnected from work by refraining from work-related thoughts and activities (Querstret & Cropley, 2012).

Recovery activities can be work-related (e.g., preparing for the next workday), physical (e.g., recreational sports), social (e.g., visiting with friends), or lower-effort (e.g., watching television) (Sonnentag, Mojza, Demerouti, & Bakker, 2012). Cyber leisure is a form of lower-effort recovery because it is relatively passive and requires limited physical exertion (Sonnentag, 2003). Cyber leisure is a relaxing activity that entails using cyber devices for fun activities (e.g., gaming, interacting with apps), or seeking out entertaining content (e.g., browsing websites or social media). Thus, engaging in cyber leisure places fewer demands on the functional systems that are typically used while engaging in work, and in turn, these functional systems can return to their baseline levels (Sonnentag, 2003). Several studies illustrate that lower-effort leisure activities are related to recovery experiences (Demerouti et al., 2009; Sonnentag, 2003). Aligning with this prior work, we expect that evening cyber leisure is associated with the recovery experience of evening psychological detachment.

We also suggest that psychological detachment might help explain the relationship between evening cyber leisure and sleep quantity. When individuals cannot psychologically detach from work, they ruminate about work-related demands (Querstret & Cropley, 2012). This preoccupation with work entails worrying about uncompleted work or unresolved problems, obsessing about relationship issues or negative events, or anticipating future demands and challenges (Cropley & Zijlstra, 2011). Rumination is problematic for getting to sleep because rumination causes individuals to continuously attach to the stimulating cognitive processes associated with those ruminative thoughts (Harvey & Payne, 2002). Indeed, several studies illustrate that the inability to stop thinking about work is negatively associated with sleep quantity (e.g., Querstret & Cropley, 2012).

We also suggest that evening cyber leisure is associated with higher quality sleep through evening psychological detachment. Insufficient detachment from work during non-work time causes a mental continuation of work demands and thereby impedes successful recovery (Querstret & Cropley, 2012; Sonnentag et al., 2012). This results in continued psychophysiological activation during non-work time that hinders sleep quality (Querstret & Cropley, 2012). More specifically, work demands trigger neuroendocrine systems (e.g., catecholamines, adrenaline) (Stojanovich & Marisavljevich, 2008). These systems “wake-up” our bodies, preparing us for action (e.g., fight-or-flight responses). Prior work suggests catecholamine levels are highest during workday evenings, presumably because employees accumulate work-related demands throughout their workday (Sonnentag & Fritz, 2006). Engaging in leisure helps individuals stop thinking about work demands, which helps them relax and enables their psychophysiological systems to return to baseline levels. Thus, individuals who psychologically detach from work have less active psychophysiological systems (Hall et al., 2004), which facilitates stable circadian rhythms and reduces sleep disruptions during the night (Kim & Dimsdale, 2007; Van Reeth et al., 2002). As a result, individuals may have a higher subjective feeling that they slept well.

Several studies draw upon the aforementioned rationale and illustrate that psychological detachment is positively associated with sleep quantity (Barber & Jenkins, 2014) and sleep quality (e.g., Hülsheger et al., 2014; Sonnentag & Fritz, 2007). We connect these findings with the findings of the recovery literature and suggest evening cyber leisure indirectly relates to that night's sleep quantity and sleep quality through enhanced evening psychological detachment. We, therefore, hypothesize the following:

H2: Increased evening cyber leisure in the evening is positively and indirectly related to that night's (a) sleep quantity and (b) sleep quality via evening psychological detachment.

Trait Mindfulness as a Boundary Condition

Trait mindfulness, the tendency to be attentive to and aware of what is taking place in the present (Brown & Ryan, 2003), entails the self-regulatory capacity to bring our attentional state back to the present moment (Smallwood & Schooler, 2015). As previously discussed, using a cyber device is a highly immersive form of leisure (Wood et al., 2007), making it challenging to put away the "preferred distraction" to begin bedtime (Hofmann et al., 2012). Thus, this capacity for more consistent present-moment attention is likely to play an important role in the evening cyber leisure to bedtime procrastination relationship.

When the mindfulness construct was developed, it was theorized as a trait-based, self-regulatory characteristic with the capacity to enlist more self-determined behaviors, which in turn would lead to beneficial outcomes (Brown & Ryan, 2003). At lower levels of mindfulness, employees tend to pay less attention to the present, potentially making them less likely to consider or question why they should discontinue engaging in cyber leisure. Alternatively, as mindfulness increases, employees are more likely to acknowledge their circumstances with clarity (Siegel, 2005), potentially making them less likely to allow the immersive activity of evening cyber leisure to disrupt their plans to go to sleep. In total, employees higher in mindfulness may be more conscious of their situation and act with intention (Shapiro et al., 2006), potentially making them more likely to engage in self-determined actions that align with their goals and needs (Brown & Ryan, 2003). In this case, the appropriate self-determined behavior is putting away their cyber devices to get more sleep quantity and better sleep quality.

As previously discussed, we expect that evening cyber leisure is negatively related to sleep quantity and sleep quality via bedtime procrastination. Connecting these prior arguments with our suggestion that mindfulness should mitigate the negative relationship between evening cyber leisure and bedtime procrastination, we further hypothesize that mindfulness will conditionally affect the indirect relationships between evening cyber leisure and sleep quantity and sleep quality through bedtime procrastination. As mindfulness increases, evening cyber leisure will have a weaker negative association with bedtime procrastination, and in turn, reduce its negative association with sleep quantity and sleep quality.

H3: Trait mindfulness moderates the negative indirect effect of evening cyber leisure on that night's (a) sleep quantity and (b) sleep quality via evening bedtime procrastination, such that the negative effect will be weaker for individuals higher in mindfulness.

Drawing from the effort-recovery model, we suggest that evening cyber leisure has a positive impact on evening psychological detachment because it allows individuals to rejuvenate psychophysiological systems that were depleted during work. This process might be stunted if individuals are not fully present while engaging in cyber leisure. At lower levels of mindfulness, individuals may be less likely to be fully attentive to the enjoyable experience stemming from cyber leisure (Brown & Ryan, 2003). Instead of solely paying attention to the relaxing activity, they are more likely to be randomly jumping back-and-forth from thoughts about the leisure activity to alternative worries or concerns (about work or non-work) (Smallwood & Schooler, 2015). In such circumstances, individuals are not fully experiencing the detachment benefits stemming from cyber leisure. Alternatively, at higher levels of mindfulness, individuals may be more capable of controlling their attention such that they stay focused on the cyber leisure, as well as stabilizing their attention such that they bring their attention back to the cyber leisure if they become distracted (Good et al., 2016). Thus, individuals higher in mindfulness may be more likely to garner the benefits associated with relaxing and disengaging from work through cyber leisure.

As previously discussed, we expect that evening cyber leisure is positively related to sleep quantity and sleep quality via psychological detachment. Connecting these prior arguments with our suggestion that mindfulness should enhance the positive relationship between evening cyber leisure and psychological detachment, we further hypothesize that mindfulness will conditionally affect the indirect relationships between evening cyber leisure and sleep quantity and sleep quality through psychological detachment. As mindfulness increases, evening cyber leisure will have a stronger positive association with psychological detachment, and in turn, will heighten its positive association with sleep quantity and sleep quality.

H4: Trait mindfulness moderates the positive indirect effect of evening cyber leisure on that night's (a) sleep quantity and (b) sleep quality via evening psychological detachment, such that the positive effect will be stronger for individuals higher in mindfulness.

Implications for Daily Work States and Behaviors

Psychological vitality—the positive feelings associated with having energy (Ryan & Frederick, 1997)—acts as a marker of well-being (Nix, Ryan, Manly, & Deci, 1999). Individuals experiencing psychological vitality feel activated, alert, and alive (Nix et al., 1999). More specifically, the experience of psychological vitality is facilitated “when basic bodily functions are robust and able to be effectively exercised” (Ryan & Frederick, 1997, p. 531). Along these lines, somatic factors that affect energy levels, such as sleep, should affect expressions of psychological vitality (Schmitt et al., 2017).

Prior research illustrates that a lower level of sleep quantity and quality disrupt functions of the prefrontal cortex, which regulates attention and also activates emotions such as enthusiasm (Chee & Choo, 2004; Ochsner & Gross, 2005), both of which are related to expressions of vitality. Research also suggests that lower levels of sleep quantity and quality are associated with reduced energy and alertness (Christian & Ellis, 2011; Querstret & Cropley, 2012) and increased fatigue (Sonnentag & Fritz, 2007), which are also related to vitality. Indeed, Schmitt and colleagues (2017) illustrate that both sleep quantity and sleep quality are associated with next-day psychological vitality.

Building on these findings, we also expect that sleep quantity and sleep quality affect next-day performance. When individuals sleep poorly (i.e., reduced sleep quantity and quality), they miss out on its restorative benefits, which hampers the functional systems underlying emotional stability and cognitive processing (Barnes et al., 2011; Christian & Ellis, 2011). These functional system failures stemming from a lower level of sleep quantity and quality relate to a host of next-day, performance-related issues (see Barnes & Watson, 2019 for a review). For example, a lower level of sleep quantity and quality are associated with impaired memory, learning (Frenda & Fenn, 2016), and attention management (Bratzke, Rolke, Steinborn, &

Ulrich, 2009); impulsive decision making (Barnes, 2012) and a propensity to make errors (Hsieh, Li, & Tsai, 2010); and reduced overall cognitive performance (Elmenhorst et al., 2009). Interpersonal processes are also affected, such that a lower level of sleep quantity and quality are positively associated with social loafing (Hoeksema-van Orden, Gaillard, & Buunk, 1998) and engaging in hostility toward others (Barnes, 2012), and negatively associated with helping behaviors (Barnes, Ghumman, & Scott, 2013). Overall, these findings align with recovery research that illustrates recovery is associated with next-day performance (Binnewies et al., 2009; Demerouti et al., 2009).

As previously outlined, we suggest evening cyber leisure positively relates to that night's sleep quantity and sleep quality through evening psychological detachment, and negatively relates to that night's sleep quantity and sleep quality through evening bedtime procrastination. Connecting these prior arguments with our expectations regarding the effect of sleep quantity and sleep quality on next-day psychological vitality and performance, we further suggest evening cyber leisure positively relates to next-day psychological vitality and performance through evening psychological detachment and that night's sleep quantity and sleep quality, and negatively relates to next-day psychological vitality and performance through evening bedtime procrastination and that night's sleep quantity and sleep quality. These hypotheses are formalized below:

H5: Evening cyber leisure has a positive sequential indirect effect on psychological vitality via bedtime procrastination and then (a) sleep quantity and (b) sleep quality.

H6: Evening cyber leisure has a negative sequential indirect effect on psychological vitality via psychological detachment and then (a) sleep quantity and (b) sleep quality.

H7: Evening cyber leisure has a positive sequential indirect effect on daily performance via bedtime procrastination and then (a) sleep quantity and (b) sleep quality.

H8: Evening cyber leisure has a negative sequential indirect effect on daily performance via psychological detachment and then (a) sleep quantity and (b) sleep quality.

Method

Sample and Procedure

Participants lived in eastern China and were full-time employees in the research and development department of a large biotech company. Common job type descriptions included biological research, drug development, and data analysis. The focus of their day-to-day tasks was on research and development, with an emphasis on creativity, teamwork, and responsibility. Given the nature of their work, they were familiar with cyber technologies (i.e., tablets, devices, personal computers, and the internet). The employees worked on a fixed, eight-hour schedule (average working hours per day = 8.03 during the daily-survey period). With the permission of the CEO, and with the help of the company's human resource department, we contacted 180 employees and explained the procedures of the study. In the communication, we requested permission to send them daily surveys, explained the nature of the study (e.g., general purpose, format/length of surveys, timeline of surveys), and clearly stated that they could withdraw from the study at any time. The research team provided participants with their contact information in case they had any questions or concerns. We also clearly explained that their responses would be anonymous. Participants were instructed to create a unique identification number using the last six digits of a friend's phone number. The prompt reminded participants that their organization would not have access to their unique identification number. This number was used to match the daily surveys by participants. A total of 171 employees agreed to participate in the study (initial response rate = 95%).

One week before the daily survey, participants reported their demographic information and trait mindfulness by completing a paper-and-pencil questionnaire. After one week, participants were asked to complete paper-and-pencil surveys three times a day—at bedtime, the following morning, and the following afternoon—for 10 consecutive workdays. We started our daily data collection with the bedtime survey on a Sunday night. We instructed the participants to complete the bedtime survey before going to sleep, which was at 9 PM or later for all participants. In this bedtime survey, we assessed participants' evening cyber leisure, evening usage of cyber devices for work, bedtime procrastination, and psychological detachment. In the morning survey, which was completed at 8 AM the following morning, participants reported the previous night's sleep quantity and sleep quality. The afternoon survey, which followed the morning survey on the same day, was completed at 4 PM every day. In this afternoon survey, participants reported their psychological vitality and performance for that day. Each day, after the afternoon surveys were completed, employees put their three surveys in a sealed envelope and gave it to human resource department personnel. This personnel then collected all of the daily surveys and delivered them to the researchers. We employed three research assistants who were not affiliated with the company to encourage participants to complete each survey at the appropriate time. The research assistants used an instant messaging app to send the participants a prompt to complete each survey. This prompt asked participants to reply with a confirmation once they had completed their survey. After 2 hours, if we did not receive a confirmation, we sent a final reminder to complete the survey. We received a total of 1,510 matched data from 155 employees (86% of initially contacted participants). We did not find any significant patterns (e.g., time of day, specific items, specific measures, etc.) for missing surveys. Most of the participants were male (57%) and their average age was 39.37 (*SD* = 6.15) years old.[1]

Measures

All measures were originally written in English. These measures were translated to Mandarin using the translation and back translation procedure (Brislin, 1980). First, the items were translated from English to Mandarin by a bilingual research assistant. Second, a few words and phrases were modified by the second author. Third, the first author, who did not participate in the English-to-Mandarin translation, translated the Mandarin version back to English. Fourth, the research team collaborated to compare the original and back-translated versions and confirmed that the two were semantically equivalent.

Trait mindfulness (pre-daily survey). We assessed employees' trait mindfulness using Van Dam, Earleywine, and Borders' (2010) five-item scale. Van Dam and colleagues (2010) conducted item response theory analyses to create a reduced-item version of Brown and Ryan's (2003) 15-item mindfulness attention and awareness scale (MAAS). The range of the item parameter estimates for the final five items was between 2.00 and 2.45 (mean = 2.37) compared to the remaining ten items with a range between 0.67 and 1.47 (mean = 1.08). These five items account for approximately 2/3 of the information (i.e., the ability to discriminate between individuals at lower and higher levels of the trait). Additionally, including the remaining ten

[1] The second author collected this data in China, where IRB approval is neither required nor common. However, the second author's school department has similar ethical policies that align with U.S. IRB standards and APA ethical guidelines regarding data collection on human subjects. Before collecting data, the second author gained approval from the department and conducted the data collection procedures in line with the department's ethical policies.

items did not improve scale reliability, and decreased item-total correlations (Van Dam et al., 2010). The five items included: “It seems I am ‘running on automatic,’ without much awareness of what I’m doing,” “I rush through activities without being really attentive to them,” “I get so focused on the goal I want to achieve that I lose touch with what I’m doing right now to get there,” “I do jobs or tasks automatically, without being aware of what I’m doing,” and “I find myself doing things without paying attention” (1 = *not at all*, 7 = *always*). Van Dam and colleagues (2010) suggest that these five items are ideal predictors of the MAAS conceptualization because they are (a) more general (e.g., compared to items about driving or snacking), making it easier to self-report about states of which one is unaware, and (b) more directly align with Brown and Ryan’s (2003) proposition that MAAS addresses the core definition of trait mindfulness which is “consistently being attentive to and aware of what is taking place in the present” (p. 822). Items were reverse coded so that higher scores represent higher levels of mindfulness. Cronbach's α for this measure was .96.

Evening cyber leisure (bedtime survey). We assessed employees’ evening cyber leisure using similar wording to Lanaj et al. (2014). The question asked, “How many minutes did you use cyber devices (e.g., smartphones, laptops, tablets, etc.) for leisure this evening?”

Bedtime procrastination (bedtime survey). We measured employees’ bedtime procrastination using Kroese et al.’s (2014) nine-item scale. Sample items included “This evening, I wanted to go to bed on time but I just did not do it” and “This evening, I was still doing other things when it was time to go to bed” (1 = *fully disagree*, 7 = *fully agree*). To increase readability in Mandarin, during the translation procedure, we modified one item. The item “If it is time to turn off the lights at night, I do it immediately,” was modified to state “If it is time to turn off the lights at night (to sleep), I do it immediately". Cronbach's α was .96 at the within level and .98 at the between level.

Psychological detachment (bedtime survey). We measured employees' psychological detachment using Sonnentag and Fritz's (2007) four-item scale. A sample item is "This evening, I got a break from the demands of work" (1 = *fully disagree*, 7 = *fully agree*). Cronbach's α for this scale was .96 at the within level and .98 at the between level.

Sleep quantity and sleep quality (morning survey). We used two items from the Pittsburgh Sleep Quality Index (PSQI: Buyssé, Reynolds, Monk, Berman, & Kupfer, 1989) to measure sleep quantity and sleep quality. For sleep quantity, participants were asked to report how many minutes they had slept the night before completing the survey. To increase the accuracy of the response, participants were reminded that they should exclude any amount of time that they were awake between when they first fell asleep and when they started their day. For sleep quality, participants were asked, "How would you rate the quality of your previous night's sleep" (0 = *very bad*, 3 = *very good*). The correlation between sleep quantity and sleep quality was .30 ($p < .01$) at the daily (within-subjects) level. The PSQI includes several other questions that can be used to formulate equations that represent alternative sleep quality indices such as sleep efficiency, sleep onset, and sleep disturbances (Buyssé et al., 1989). Our one-item, self-report approach is commonly used in organizational research for both sleep quantity (e.g., Barnes et al., 2011; Guarana & Barnes, 2017; Lanaj et al., 2014; Hülsheger et al., 2015) and sleep quality (e.g., Hülsheger et al., 2014; Hülsheger et al., 2018; Hahn, Binnewies, Sonnentag, & Mojza, 2011; Liu, Song, Koopmann, Wang, Chang, & Shi, 2017; Patrick, Griffin, Huntley, & Maggs, 2018). Further, these one-item, self-report indices appropriately correlate with polysomnography metrics obtained during clinical sleep studies (Buyssé, 2014).

Daily psychological vitality (afternoon survey). We measured employees' psychological vitality using Ryan and Frederick's (1997) seven-item scale. Sample items included "Today, I feel alive and vital during work" and "I feel energized at work today" (1 = *fully disagree*, 7 = *fully agree*). Cronbach's α was .95 at the within level and .97 at the between level.

Daily performance (afternoon survey). We measured employees' daily job performance using Liden, Wayne, and Stilwell's (1993) three-item scale. An example item is "Today, I am highly effective at completing my work successfully (1 = *fully disagree*, 7 = *fully agree*). Cronbach's α for this scale was .84 at the within level and .91 at the between level.

Control variables. We controlled for cyber-device usage for work because prior research illustrates it is associated with sleep and recovery (Lanaj et al., 2014). We measured the evening usage of cyber devices for work by asking, "How many minutes did you use cyber devices (e.g., smartphones, laptops, tablets, etc.) for work this evening?" (Lanaj et al., 2014). Finally, we controlled for the day of the week and day of the study because sleep loss could accumulate across the week and the study (Beebe, 2016). Each of the hypothesized direct, indirect, interaction, and moderated mediated effects remains statistically significant when excluding these controls.

Analytical Strategy

Because the data had a nested structure, we employed multilevel modeling to our hypotheses using Mplus 7 software (Muthén & Muthén, 1998-2018). In addition, we specified cross-level moderating effects to test the two-way interaction hypothesis (i.e., H3-H4) by adopting random-slope techniques (Raudenbush & Bryk, 2002). We group-mean centered all within-person-level predictors (Hofmann & Gavin, 1998), and grand-mean centered the between-person-level moderator to obtain unbiased estimates of the within-person main effects and the cross-level interaction effects (Hofmann & Gavin, 1998). In testing the significance of the indirect effects (i.e., H5–H7) and the implied conditional indirect effects, we adopted the Monte Carlo simulation procedure (20,000 replications) and computed the 95% bias-corrected confidence intervals (Preacher & Selig, 2012). Lastly, we used the formulas of Kreft and De Leeuw (1998) to calculate a *pseudo*-R^2 for effect sizes.

Results

Confirmatory Factor Analysis

To evaluate construct validity, we conducted a confirmatory factor analysis (CFA) for the daily measures at the within-person level (i.e., bedtime procrastination, psychological detachment, psychological vitality, and performance), excluding single-item measures. The four-factor model fit was adequate (χ^2 [244] = 3411.28, $p < .01$; CFI = .92, TLI = .91, SRMR = .04, RMSEA = .09). This model was superior to several alternative models, including a three-factor model with bedtime procrastination and psychological detachment combined (χ^2 [227] = 17817.81, $p < .01$; CFI = .57, TLI = .52, SRMR = .26, RMSEA = .22; $\Delta\chi^2$ [17] = 13766.33, $p < .01$), a three-factor model with performance and psychological vitality combined (χ^2 [227] = 5296.18, $p < .01$; CFI = .88, TLI = .86, SRMR = .08, RSMEA = .12; $\Delta\chi^2$ [17] =1884.90, $p < .01$), and a three-factor model with bedtime procrastination and psychological vitality combined (χ^2 [227] = 17156.27, $p < .01$; CFI = .59, TLI = .54, SRMR = .24, RSMEA = .22; $\Delta\chi^2$ [17] = 13744.99, $p < .01$).

Preliminary Analyses

Before testing the hypotheses, we investigated whether the outcome variables varied at both the within-person (daily) and between-person levels via random intercept-only models. We found sufficient variances at both levels, providing support for using multilevel modeling to analyze the data: For bedtime procrastination, 63% of total variance was at the within-person (daily) level (ICC [1] = .37); for psychological detachment, 55% of total variance was at the within-person (daily) level (ICC [1] = .45); for sleep quantity, 68% of total variance was at the within-person (daily) level (ICC [1] = .32); for sleep quality, 69% of total variance was at the within-person (daily) level (ICC [1] = .31); for psychological vitality, 40% of total variance was at the within-person (daily) level (ICC [1] = .60); and for performance, 61% of total variance was at the within-person (daily) level (ICC [1] = .39).

Table 1 presents the means, standard deviations, and bivariate correlations for all variables. At the within-individual (daily) level, evening cyber leisure was positively correlated with evening bedtime procrastination ($r = .12$, $p < .01$) and evening psychological detachment ($r = .12$, $p < .01$). Additionally, evening bedtime procrastination was negatively related to that night's sleep quantity ($r = -.49$, $p < .01$) and sleep quality ($r = -.40$, $p < .01$), whereas evening psychological detachment was positively related to that night's sleep quantity ($r = .13$, $p < .01$) and sleep quality ($r = .26$, $p < .01$). In turn, sleep quantity was positively related to next-day psychological vitality ($r = .13$, $p < .01$) and next-day performance ($r = .16$, $p < .01$), whereas sleep quality was positively related to next-day psychological vitality ($r = .27$, $p < .01$) and next-day performance ($r = .14$, $p < .01$).

Multilevel Modeling

Table 2 presents the multilevel path modeling results for our hypothesized dual-path model, and Figure 2 depicts the results in a simplified path model. At the daily level, evening cyber leisure was positively related to that evening's bedtime procrastination ($b = .004$, $p < .05$) and psychological detachment ($b = .003$, $p < .05$). At the same time, bedtime procrastination that evening was negatively associated with that night's sleep quantity (b = -26.58, p < .01) and sleep quality (b = -.24, p < .01), whereas psychological detachment in the evening was positively associated with that night's sleep quantity (b = 7.47, p < .01) and sleep quality (b = .20, p < .01). We also conducted the Monte Carlo method with 20,000 replications to test for mediation. The results suggest negative effects on that night's sleep quantity (*indirect effect* = -.11; 95% *CI* = [-.21, -.01]) and sleep quality (*indirect effect* = -.001; 95% *CI* = [-.002, -.0001]) via that evening's bedtime procrastination. Alternatively, the results suggest positive and statistically significant indirect effects of evening cyber leisure on that night's sleep quantity (*indirect effect* = .02; 95% *CI* = [.003, .05]) and sleep quality (*indirect effect* = .001; 95% *CI* = [.0001, .001]) via that evening's psychological detachment. These results support Hypotheses 1 and 2.

Hypotheses 3 and 4 suggest trait mindfulness moderates the indirect relationship between evening cyber leisure and that night's sleep quantity and sleep quality via that evening's bedtime procrastination and psychological detachment. We began with an evaluation of first-stage moderation. As shown in Table 2, the interactions between trait mindfulness and evening cyber leisure on that evening's bedtime procrastination (b = -.004, p < .01) and psychological detachment (b = .003, p < .01) were statistically significant, but with different signs. The interaction patterns are depicted in Figures 3a and 3b. Figure 3a illustrates that when trait mindfulness was lower (*M* -1 *SD*), the simple slope of evening cyber leisure on that evening's bedtime procrastination was positive and statistically significant (b = .01, p < .01); but when trait mindfulness was higher (*M* +1 *SD*), the simple slope was not statistically significant (b = .00, *ns*). This pattern suggests that higher levels of trait mindfulness neutralized the negative effect of evening cyber leisure on bedtime procrastination. These findings provide initial support for the first-stage moderation implied in Hypothesis 3. Figure 3b illustrates that when trait mindfulness was lower (*M* -1 *SD*), the simple slope of evening cyber leisure on that evening's psychological detachment was not statistically significant ($b = -.001$, *ns*), but when trait mindfulness was higher (*M* +1 *SD*), the simple slope became positive and statistically significant ($b = .01$, $p < .01$). This pattern suggests that trait mindfulness moderated the positive effect of evening cyber leisure on psychological detachment, such that the effect was stronger when individuals were higher in mindfulness, providing initial support for the first-stage moderation implied in Hypothesis 4.

We then investigated the conditional indirect effects by computing the moderated-mediation index using Monte Carlo procedures with 20,000 replications. For bedtime procrastination, when trait mindfulness was lower (*M* -1 *SD*), the indirect effects of evening cyber leisure on that night's sleep quantity (*indirect effect* = -.21; 95% *CI* = [-.37, -.06]) and sleep quality (*indirect effect* = -.002; 95% *CI* = [-.004, -.001]) were negative and statistically significant, but when trait mindfulness was higher (*M* +1 *SD*), the indirect effects of evening cyber leisure on that night's sleep quantity (*indirect effect* = .00; 95% *CI* = [-.11, .10]) and sleep quality (*indirect effect* = -.00; 95% *CI* = [-.001, .001]) were not statistically significant. Additionally, the moderated-mediation indexes excluded zero, suggesting that moderated mediation was statistically significant (sleep quantity: *difference index* = .21; 95% *CI* = [.04, .39]; sleep quality: *difference index* = .002; 95% *CI* = [.0003, .004]). Thus, Hypotheses 3a and 3b were supported.

For psychological detachment, when trait mindfulness was lower (*M* -1 *SD*), the indirect effects of evening cyber leisure on that night's sleep quantity (*indirect effect* = .00; 95% *CI* = [-.03, .03]) and sleep quality (*indirect effect* = .00; 95% *CI* = [-.001, .001]) were not statistically significant; but when trait mindfulness was higher (*M* +1 *SD*), the indirect effects of evening cyber leisure on that night's sleep quantity (*indirect effect* = .04; 95% *CI* = [.02, .08]) and sleep quality (*indirect effect* = .001; 95% *CI* = [.001, .002]) were statistically significant. The moderated-mediation indexes for psychological detachment also excluded zero (sleep quantity: *difference index* = .04; 95% *CI* = [.01, .09]; sleep quality: *difference index* = .001; 95% *CI* = [.0004, .002]), suggesting statistical significance. Thus, Hypotheses 4a and 4b were supported.

Hypotheses 5 through 8 hypothesize serial mediation effects of evening cyber leisure on next-day psychological vitality and next-day performance. Evaluating the final stage of the path model (see Table 2), we found that sleep quantity was not significantly associated with next-day psychological vitality ($b = .00$, *ns*), but it was significantly associated with next-day performance ($b = .0013, p < .05$). Alternatively, sleep quality was significantly associated with next-day psychological vitality ($b = .11, p < .01$), but it was not significantly associated with next-day performance ($b = .06$, *ns*). Based on these results, we continued to investigate multiple, sequential mediation of Hypothesis 5b, 6b, 7a, and 8a, but excluded Hypothesis 5a, 6a, 7b, and 8b from further examination.

We again adopted Monte Carlo procedures to investigate the serial indirect effects with 20,000 replications. Specific to next-day psychological vitality, the serial indirect effects of evening cyber leisure were significant for both the bedtime procrastination to sleep quality path (Hypothesis 5b; *indirect effect* = -.0001; 95% *CI* = [-.0002, -.00001]) and the psychological detachment to sleep quality path (Hypothesis 6b; *indirect effect* = .0001; 95% *CI* = [.0001, .0002]). As such, Hypotheses 5b and 6b were supported.

We also tested for moderated serial mediation. Specific to the bedtime procrastination path (i.e., Hypothesis 5b), the indirect effect was not statistically significant when trait mindfulness was higher (M +1 SD) (*indirect effect* = -.00; 95% *CI* = [-.0001, .0001]), but remained negative and statistically significant when trait mindfulness was lower (M -1 SD) (*indirect effect* = -.0002; 95% *CI* = [-.0004, -.00004]). Specific to the psychological detachment path (i.e., Hypothesis 6b), when trait mindfulness was higher (*M* +1 *SD*), the indirect effect was positive and statistically significant (*indirect effect* = .0001; 95% *CI* = [.00003, .0003]). Alternatively, when trait mindfulness was lower (M -1 SD), the path was not statistically significant (*indirect effect* = .00; 95% *CI* = [-.0001, .0001]). The difference indices for those two scenarios were also statistically significant (bedtime procrastination path: *difference index* = .0002; 95% *CI* = [.00002, .0005]; psychological detachment path: *difference index* = .0001; 95% *CI* = [.00002, .0003]). These results support moderated serial mediation, such that higher levels of mindfulness (a) neutralize the detrimental effects of evening cyber leisure on next-day psychological vitality through evening bedtime procrastination and that night’s sleep quality, and (b) retain the beneficial effects of evening cyber leisure on next-day psychological vitality through evening psychological detachment and that night’s sleep quality.

Moving to next-day performance, the serial indirect effects of evening cyber leisure on next-day performance were significant for both the bedtime procrastination to sleep quantity path (Hypothesis 7a; *indirect effect* = -.0001; 95% *CI* = [-.0003, -.00001]) and the psychological detachment to sleep quantity path (Hypothesis 8a; *indirect effect* = .00003; 95% *CI* = [.00003, .0001]). As such, Hypotheses 7a and 8a were supported.

We again evaluated moderated serial mediation but for next-day performance. Specific to the bedtime procrastination path (i.e., Hypothesis 7a), the indirect effect was not statistically significant when trait mindfulness was higher (M +1 SD) (*indirect effect* = .00; 95% *CI* = [-.0002, .0001]), but remained negative and statistically significant when trait mindfulness was lower (M -1 SD) (*indirect effect* = –.0003; 95% *CI* = [-.001, -.0001]). Specific to the psychological detachment path (i.e., Hypothesis 8a), when trait mindfulness was higher (*M* +1 *SD*), the indirect effect was positive and statistically significant (*indirect effect* = .0001; 95% *CI* = [.00001, .0001]). Alternatively, when trait mindfulness was lower (M -1 SD), the path was not statistically significant (*indirect effect* = .00; 95% *CI* = [-.00004, .00004]). The difference indices for those two scenarios were also statistically significant (bedtime procrastination path: *difference index* = .0003; 95% *CI* = [.0001, .001]; psychological detachment path: *difference index* = .0001; 95% *CI* = [.00001, .0001]). These results again support moderated serial mediation, such that higher levels of mindfulness (a) neutralize the detrimental effects of evening cyber leisure on next-day performance through evening bedtime procrastination and that night's sleep quantity, and (b) retain the beneficial effects of evening cyber leisure on next-day performance through evening psychological detachment and that night's sleep quantity.

Discussion

The findings of this study suggest that evening cyber leisure negatively relates to sleep quantity and sleep quality through bedtime procrastination, and positively relates to sleep quantity and sleep quality through psychological detachment. The findings also suggest that sleep quantity positively relates to psychological vitality, but not performance, and that sleep quality positively relates to performance, but not psychological vitality. This pattern of non-significant findings highlights that more work can be done to better understand the differences between sleep quantity and sleep quality.

There is a plethora of clinically-focused sleep research evaluating antecedents of sleep and/or potential interventions to improve sleep for specific populations (e.g., adolescents, chronically ill). These studies repeatedly illustrate that sleep quantity and sleep quality are conceptually and empirically distinct (Buyssé, 2014), which aligns with our findings (i.e., sleep quantity and sleep quality are correlated at $r = .30$, $p < .01$). However, to the best of our knowledge, no work to date—in work-related settings—has attempted to understand how sleep quantity and sleep quality differ with respect to their consequences. Self-rated psychological vitality captures whether one feels alive, awake, and energized. Self-rated performance is an estimation of the degree to which one was able to engage in effective and productive work behaviors throughout the day. Thus, psychological vitality addresses one's psychological state, while performance addresses one's behavior given the circumstances of the day. Perhaps, then, perceptual evaluations of whether one obtained poor or good sleep (i.e., sleep quality) carries over into our perceptions of our energy, regardless of whether our underlying, functional systems are fully restored through enough hours of sleep. Alternatively, perhaps hours slept (i.e., sleep quantity) is more directly linked to the restorative benefits of functional systems (i.e., proper self-regulation and cognitive processing), which are critical to performance.

Our findings also suggest that trait mindfulness acts as a conditional moderator of several indirect models. Specifically, mindfulness mitigates the negative indirect effect of evening cyber leisure on psychological vitality through bedtime procrastination and sleep quantity, and enhances the positive indirect effect of evening cyber leisure on psychological vitality through psychological detachment and sleep quantity. Additionally, mindfulness mitigates the negative indirect effect of evening cyber leisure on performance through bedtime procrastination and sleep quality, and enhances the positive indirect effect of evening cyber leisure on performance through psychological detachment and sleep quality.

Theoretical Implications

This study contributes to the recovery literature in several ways, one of which is highlighting that cyber leisure is qualitatively different than other forms of leisure. Cyber leisure is similar to other lower-effort recovery activities (e.g., watching television, reading a book, taking a bath, lounging on the couch, doing nothing) in that it is relatively passive and takes limited physical exertion. However, cyber leisure is different in that it offers—on-demand—a wide variety of entertaining content, making it inevitable that users will easily and quickly find something of interest (Lavoie & Pychyl, 2001). Cyber leisure is also unique in the degree to which it stimulates the senses, making it a highly engaging experience (Geng, Han, Gao, Jou, & Huang, 2018). Its closest lower-effort comparator is television, given that users commonly report feeling engrossed in the experience (e.g., Exelmans & Van den Bulck, 2017a). However, cyber devices offer a more continuous experience; for example, they are portable and commonly taken to the bedroom, and used while lying in bed immediately before going to sleep (Bayer, Dal Cin, Campbell, & Panek, 2016). More research attention to cyber leisure is warranted, as it is the only lower-effort activity experiencing explosive growth (Internet World Stats, 2019), and for many, it has become the preferred form of leisure (Bae, 2013).

The vast majority of research suggests that recovery activities are beneficial. Our study contributes to this literature by illustrating that at least one recovery activity—cyber leisure—can be both beneficial (i.e., via psychological detachment) and detrimental (i.e., via bedtime procrastination). This highlights the importance of evaluating recovery activities more holistically. In particular, time is a fixed quantity; thus, spending time engaging in a recovery activity (e.g., cyber leisure) might take away from alternative, beneficial activities (e.g., sleep). Relatedly, what we perceive to be a productive recovery activity might depend upon its placement in time. For example, cyber leisure might only help in terms of sleep quantity or sleep quality via psychological detachment when done earlier in the evening, and in turn, less likely to affect the time one tries to go to sleep.

There are a few studies to date that take a similar perspective on the hidden costs associated with recovery activities. For example, Reinecke and colleagues (2014) illustrate that for some individuals, using entertainment media for recovery is associated with feelings of guilt, which then leads to detrimental recovery outcomes. Relatedly, Fritz, Yankelevich, Zarubin, and Barger (2010) found that there was a curvilinear relationship between self-rated psychological detachment and colleague-rated job performance, such that performance began to decrease when moving from moderate to higher levels. The rationale was that employees with the highest level of psychological detachment were not closing out unfinished work or getting prepared and organized for the upcoming day during their evenings. Our findings align with this broader conversation regarding the need to understand how to optimize recovery. Perhaps cyber leisure is beneficial when it just barely satiates our need for detachment without taking away from alternative, productive activities. Further, perhaps cyber leisure is a false reality in that we think it is a restorative activity, but in comparison to alternative lower-effort activities, its costs counteract its benefits, at least as it pertains to sleep.

Our investigation of bedtime procrastination also adds to this conversation regarding the need to evaluate recovery more holistically. Compared to alternative lower-effort leisure activities, cyber leisure is particularly well-suited as a form of bedtime procrastination. The primary driver of procrastination is mood optimization (Sirois & Pychyl, 2013). This makes cyber leisure problematic because research suggests that it is easily accessible and highly immersive (Bayer et al., 2016) and that it is strongly associated with immediate increases in pleasure and positive affect (Reinecke et al., 2014). To understand whether the connection between cyber leisure and bedtime procrastination can be broken, recovery research should consider integrating prior research on generalized, trait-based procrastination (i.e., not specific to bedtime). For example, procrastination can either be deliberate or mindless (Nauts, Kamphorst, Stut, De Ridder, & Anderson, 2019). Perhaps the downstream effect of cyber leisure on sleep through bedtime procrastination is disrupted when the procrastinator recognizes what they are doing and has considered the implications of their actions so that they can estimate whether it will have a negative impact.

Related to this last point, research suggests that trait-based self-control is negatively related (Exelmans & Van den Bulck, 2017b), and impulsivity is positively related (Steel, 2007; Van Eerde, 2003) to procrastination. These findings align with our evaluation of mindfulness. More specifically, our work highlights that the self-regulatory capacities associated with trait-based mindfulness can mitigate the negative impact of cyber leisure on bedtime procrastination (and enhance the positive impact of cyber leisure on psychological detachment). Prior research also illustrates that perceptions of engaging in preferred activities act as boundary conditions of whether or not recovery activities relate to recovery experiences (Ragsdale, Hoover, & Wood, 2016). These findings highlight that not everyone will experience the counteracting effect of bedtime procrastination while garnering psychological detachment. Perhaps, then, there are alternative individual characteristics, such as self-control, impulsivity, or the degree to which one prefers cyber leisure over alternative recovery activities, that dictate whether cyber leisure has a beneficial and/or detrimental impact on sleep and next-day work outcomes.

The comprehensive and longitudinal nature of this study also has implications for applied psychology audiences interested in sleep. A few studies to date suggest psychological detachment and bedtime procrastination are related to lower levels of sleep quantity and quality (Sonnentag & Fritz, 2007). We build on these findings and highlight how evening cyber leisure—an emerging lower-effort recovery activity—indirectly affects these variables. Our evaluation of sleep quality and sleep quantity on next-day performance using a field study is also important. To date, the majority of research focuses on cognitive performance (e.g., Elmenhorst et al., 2009), not task performance in workplace settings. Additionally, studies focusing on the sleep-performance relationship focus on extreme sleep deprivation (e.g., 24 hours or longer) in experimental settings (Hsieh et al., 2010) or extreme settings such as military combat (e.g. Krueger, 1991). To the best of our knowledge, the closest that prior work comes to investigating the relationship between sleep and next-day performance conceptualizes performance as helping behaviors (Barnes et al., 2013) or personal initiative (Sonnentag, 2003), and investigates these effects through the mechanisms of job satisfaction and engagement, respectively. The findings of our research specific to sleep and its impact on work are therefore relatively more generalizable to the masses.

Practical Implications

A number of practical implications also stem from the findings of this research. Although lower-effort activities have always been a staple of evening recovery, the newest and fastest-growing type of lower-effort recovery—cyber leisure—should be used with caution. Individuals must acknowledge the trade-offs associated with cyber leisure as it relates to sleep. There is nothing wrong with engaging in cyber leisure if it facilitates psychological detachment but allowing it to manifest as bedtime procrastination can counteract its restorative benefits. Our findings suggest that one way to optimize recovery is to mindfully engage in cyber leisure. The extent to which individuals can remain present while engaging in cyber leisure ensures they are fully realizing the benefits associated with psychological detachment. Further, mindfully engaging with cyber devices for leisure decreases the likelihood that they become so transfixed on the recovery activity that they cannot put the device away and go to sleep.

Enhancing the capacity to remain mindful while engaging in cyber leisure can happen in several different ways. Our findings are specific to trait-based mindfulness. Along these lines, research suggests that over time, regular meditation (i.e., the practice of bringing one's attention back to the present) can enhance mindful dispositions and behaviors (Kiken, Garland, Bluth, Palsson, & Gaylord, 2015). Thus, regular mindfulness practices may help ensure that evening leisure time is spent wisely. If higher levels of trait-based mindfulness (i.e., the self-regulatory capacity to ensure one comes back to a state of mindfulness) are unobtainable, it might help to prime oneself with state-based mindfulness using an intervention approach immediately preceding cyber leisure. For example, a short mindfulness breathing exercise might facilitate a mindful session of cyber leisure (e.g., Hafenbrack, Kinias, & Barsade, 2014).

Another angle for minimizing the detriments associated with cyber leisure, namely, bedtime procrastination, is to be realistic and thoughtful about one's leisure time. The amount of time between the conclusion of work and bedtime is relatively short. This window of time becomes increasingly shorter as one attends to higher-duty activities such as cooking, cleaning, or childcare. Perhaps, then, it would be beneficial for individuals to plan out in advance when and for how long they will engage in cyber leisure. Individuals could also use the cyber device itself to monitor and track how long it is being used and/or set a timer that alerts them when their pre-determined allowance is up. In total, regardless of the method, the goal is to cultivate opportunities for more intentional engagement in cyber leisure. Doing so should help facilitate next-day vitality and performance through reduced bedtime procrastination, and in turn, better sleep.

The findings of this research should also be helpful to employees in that they clarify the work-related benefits of mindfully engaging in cyber leisure. Vitality and performance fluctuate from day-to-day. Thus, it is important to cultivate evening recovery practices that positively contribute to these next-day outcomes. It is widely acknowledged that getting enough, higher-quality sleep is beneficial. It is therefore also important to acknowledge how we approach recovery (i.e., mindful or mindless) and the choice of the recovery activity (i.e., cyber leisure) because these factors will dictate whether better sleep, and in turn, productive outcomes are realized.

Future Directions and Limitations

This study has several limitations that future research should address. First, similar to prior work employing a daily-diary study approach, all variables were self-rated, making common method bias (CMB) a potential concern (Podsakoff, MacKenzie, & Podsakoff, 2012). To address this issue, we employed several strategies recommended by Podsakoff et al. (2012). For one, the variables were collected at different points in time throughout the day. Additionally, we employed multi-level modeling, and daily variables were group-mean centered, both of which reduce the potential confounding effects stemming from between-person factors (Song, Liu, Wang, Lanaj, Johnson, & Shi, 2018). The model also incorporates a self-reported individual-differences characteristic (trait-based mindfulness), which may statistically control the artificial inflation from self-reported measures (Song et al., 2018). Lastly, our model includes several moderation and moderated mediation hypotheses, and interaction effects are less likely to be influenced by CMB (Siemsen, Roth, & Oliveira, 2010).

Nonetheless, future research should consider alternative measurement options for minimizing same-source bias. Sleep quantity and sleep quality could be measured using sleep-monitoring devices. For example, actigraphs have been used in sleep and recovery research (e.g., Barnes et al., 2013). Specific to performance, self-reporting is common practice in daily-diary studies (e.g., Binnewies et al., 2009). However, future research could evaluate daily performance using supervisor or peer ratings, and for some jobs, objective evaluations may be suitable (e.g., number of calls made, number of units produced). Alternative ratings of performance are particularly important because they not only mitigate same-source bias but also inflation bias (Krueger & Mueller, 2002). We continuously reminded participants that their responses were anonymous, which should help minimize inflation bias (Krueger & Mueller, 2002). Additionally, daily reports of performance may be less susceptible to inflation bias, because respondents feel more comfortable reporting a bad day as opposed to overall and/or consistent poor performance.

Several opportunities for future research are available to build upon the findings of our study by offering more granular investigations of the phenomenon of interest. We operationalized cyber leisure as the number of minutes individuals use cyber devices for leisure. Future research could ask respondents to report the number of minutes they spend on each type of cyber-leisure activity (e.g., internet browsing, social media, gaming, etc.) or type of device (e.g., smartphone, tablet) to evaluate whether the effects are similar or different. Relatedly, perhaps certain types of cyber leisure not only relate to psychological detachment, but also to alternative recovery experiences such as relaxation (i.e., a state of lower activation and higher positive affect) and/or control (i.e., a person's ability to choose an action from two or more options) (Sonnentag & Fritz, 2007). Another suggestion is for future research to take a temporal perspective and investigate the extent to which cyber-device users have one uninterrupted cyber-leisure experience or accumulate intermittent cyber-device leisure throughout the evening. For example, perhaps individuals toggle back and forth between work and non-work cyber activities, or between more active forms of leisure (e.g., household chores) and lower-effort cyber-device leisure. Finally, another interesting avenue to explore is whether the effects of evening cyber leisure differ when alone, in the presence of others, or when engaging in leisure with others.

A similar point should be made regarding measurements of sleep. In this study, we hypothesize and test both sleep quantity and sleep quality. Examining both is important because prior work illustrates that the two are conceptually and empirically distinct (Barnes et al., 2011). Similar to prior work (e.g., Barnes et al., 2011; Doane, Gress-Smith, & Breitenstein, 2015), the correlation between these variables in our study was relatively low ($r = .30$, $p < .01$). The one-item sleep quantity and sleep quality scales come from the Pittsburgh Sleep Quality Index (PSQI: Buyssé et al., 1989). Notably, this scale also includes sleep efficiency, sleep latency, and restfulness. From a construct-validity standpoint, how these additional items are conceptually and empirically related to sleep quantity and sleep quality is relatively unclear. This issue is beyond the focus of this manuscript, and we instead build upon influential sleep and recovery studies in applied psychology by using the same one-item scales of sleep quantity (e.g., Barnes et al., 2011; Guarana & Barnes, 2017; Lanaj et al., 2014; Hülsheger et al., 2015) and sleep quality (e.g., Hülsheger et al., 2015; Hülsheger et al., 2018; Hahn et al., 2011; Liu et al., 2017; Patrick et al., 2018). We did conduct supplemental analyses combining the one-item sleep quantity and one-item sleep quality scales as well as using the full PSQI. When using these combined operationalizations, the findings illustrate that sleep continues to predict next-day psychological vitality and performance, and that cyber leisure continues to indirectly affect next-day outcomes via bedtime procrastination, psychological detachment, sleep quantity, and sleep quality. Importantly, we also note that single-item measures can be overly simplistic and cannot access reliability (Wanous, Reichers, & Hudy, 1997). Although the measure of sleep quantity is relatively straightforward, sleep quality may be multi-faceted, thus warranting future work assessing construct validity.

Future research should also consider evaluating our hypotheses using a variety of samples. The average age of our sample was 39.37 years (SD = 6.15) and 86.7% of the respondents had at least one child under 18 years old, which may explain the relatively modest average amount of time spent on evening cyber leisure. Future investigations may reveal that alternative samples with younger or older participants without childcare responsibilities report more cyber leisure. Our participants were also from one large biotech entity in China. Mindfulness is rooted in Buddhist culture (Brown, Ryan, & Creswell, 2007), which is central to the cultural background of China. Chinese respondents may, therefore, have relatively higher baseline levels of mindful dispositions (Birnbaum, 2003). Although our findings for a moderating effect of mindfulness were significant, the sample characteristics may have caused range restriction, thereby underestimating the effect sizes of the relationships. Future research should consider capturing the degree to which respondents feel the need for recovery given the demands of their work environment, as well as the degree to which they feel as if their organization encourages non-work leisure and/or healthy sleeping habits. This additional information would add more context to our interpretations of the study findings. With respect to the interpretation of findings, we also note that the effect sizes are relatively small for some relationships, which is common in daily studies (e.g., Lanaj et al., 2014). Within-person fluctuations inevitably coalesce around between-person levels, making it relatively unlikely to see substantial within-person fluctuations across time. Furthermore, small effect sizes are still practically important, particularly when considering the potential impact of changes in human performance (Cascio & Boudreau, 2010).

Conclusion

The goal of this study was to integrate research on the usage of cyber devices for leisure and recovery, specifically as it relates to sleep and next-day work outcomes. Our dual-path model helps clarify the downstream impact of evening cyber leisure. Indeed, cyber leisure can be beneficial and/or detrimental through psychological detachment and bedtime procrastination, respectively, and trait-based mindfulness can help determine the extent to which these effects are realized. Our hope is that this study helps spark additional conversations regarding the complex impact of cyber leisure on recovery processes.

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Table 1

Means, Standard Deviations, and Correlations among Studied Variables

Variable	M	Between-person *SD*	Within-person *SD*	1	2	3	4	5	6	7	8
Level 2 (between-person level)											
1. Gender	57	.50		—							
2. Age	39.37	6.15		-.24**	—						
3. Trait mindfulness	5.10	.99		.08	-.01	(.96)					
Level 1 (daily level)											
1. Evening cyber leisure	17.95	22.86	32.01	—							
2. Evening usage of cyber devices for work	13.69	17.95	39.44	.19**	—						
3. Bedtime procrastination	3.67	.84	1.10	.12**	.06*	(.96/.98)					
4. Psychological detachment	4.92	.76	.84	.12**	.01	-.07**	(.96/.98)				
5. Night sleep quantity	480.51	42.42	61.67	-.14**	-.10**	-.49**	.13**	—			
6. Night sleep quality	2.67	.46	.69	-.04	-.05*	-.40**	.26**	.30**	—		
7. Next-day psychological vitality	4.78	.81	.65	.09**	-.01	-.15**	.54**	.13**	.27**	(.95/.97)	
8. Next-day daily performance	4.65	.77	.95	-.002	.003	-.17**	.14**	.16**	.14**	.14**	(.84/.91)

Note. N =1,510 at the daily level; N =155 at the individual level. Gender: Male = 1, and Female = 0. Correlations among studied variables were reported at each corresponding level. Cronbach's alpha coefficients are presented in the parentheses (for Level 1 variables, the coefficients are presented in the following order: within-person reliability/between-person reliability).

* p <.05, ** p < .01.

Table 2

Multilevel Path Modeling Results

	Bedtime procrastination	Psychological detachment	Night sleep quantity	Night sleep quality	Next-day Psychological vitality	Next-day performance
	b (SE)	*b (SE)*	*b (SE)*	*b (SE)*	*b (SE)*	*b (SE)*
Level 1: Within-person (daily) level						
Control variable						
Evening usage of cyber devices for work	.002(.002)	-.001(.00)	-.10(.08)	.00(.001)	.00(.001)	.00(.001)
Day of study	$-.03^{*}$(.01)	$-.04^{**}$(.01)	-1.30(.69)	.01(.01)	-.01(.01)	.01(.01)
Day of week	-.01(.02)	.01(.02)	-.97(1.15)	.01(.01)	$.03^{*}$(.01)	-.01(.02)
Predictors						
Evening cyber leisure	$.004^{*}$(.002)	$.003^{*}$(.001)	$-.19^{**}$(.04)	.00(.001)	.001(.001)	.00(.001)
Bedtime procrastination			-26.58^{**}(1.89)	$-.24^{**}$(.02)	-.04(.02)	$-.09^{*}$(.04)
Psychological detachment			7.47^{**}(2.05)	$.20^{**}$(.03)	$.39^{**}$(.04)	$.12^{*}$(.05)
Night sleep quantity					.00(.00)	$.0013^{*}$(.0006)
Night sleep quality					$.11^{**}$(.04)	.06 (.06)
Level 2: Between-person level						
Intercept	3.83^{**}(.10)	5.08^{**}(.09)	487.39^{**}(5.50)	2.61^{**}(.06)	4.79^{**}(.08)	4.67^{*}(.09)
Predictor						
Trait mindfulness	-.004(.08)	$.20^{**}$(.07)	2.84(3.52)	.05 (.04)	$.21^{**}$(.08)	.03(.09)
Level 2: Moderating effect of trait mindfulness						
On the random slope of the cyber leisure	$-.004^{**}$(.002)	$.003^{**}$(.001)				
pseudo-R^2	.05	.07	.18	.15	.17	.03

Note. N =1,510 at the daily level; N =155 at the individual level. Unstandardized coefficients are reported in the table.

$^{*}p$ <.05, $^{**}p$ < .01.

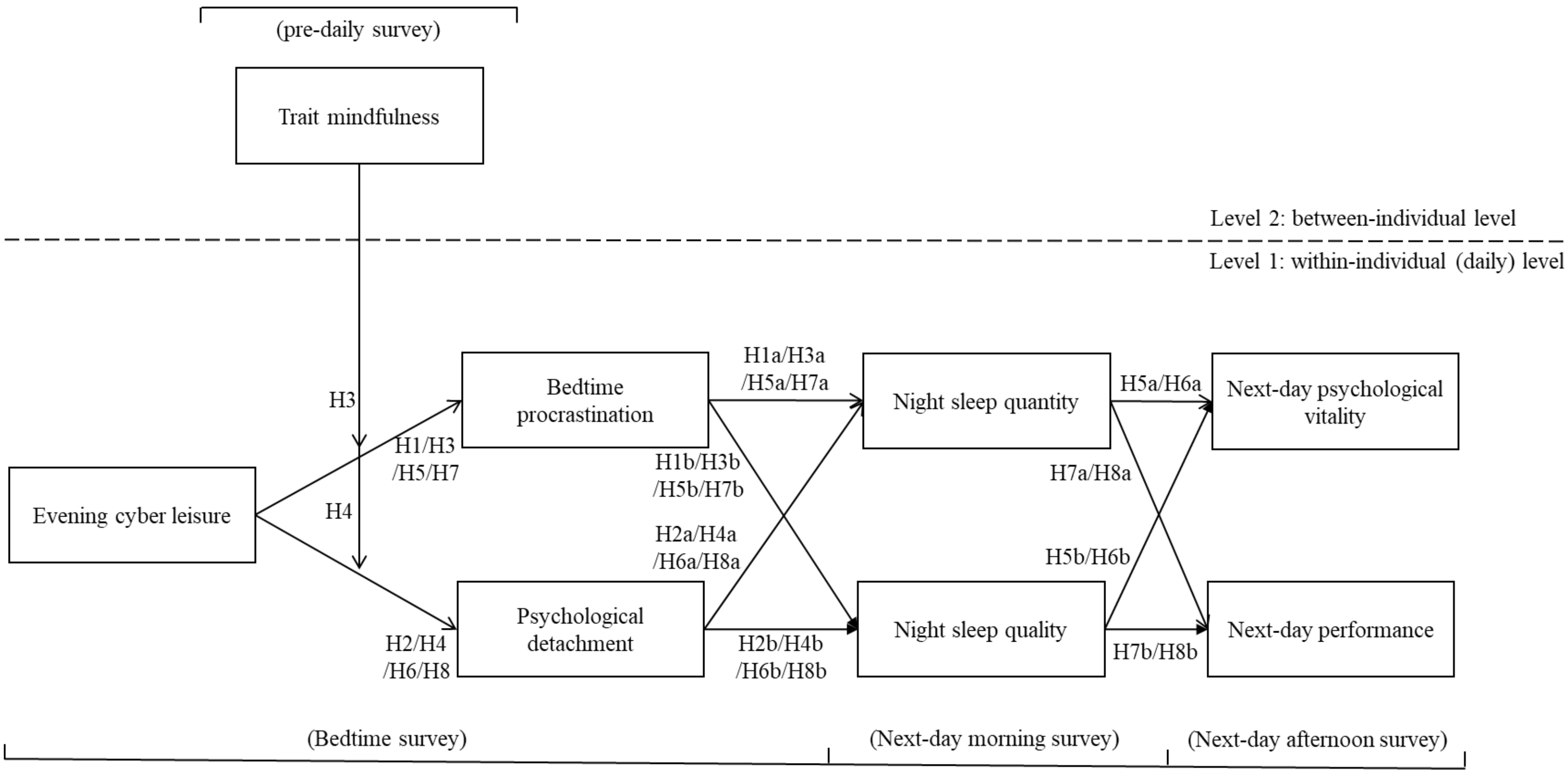

Figure 1. Hypothesized Model and Measurement Points.

Note. H1, H2, H5, H6, H7, and H8 refer to mediation hypotheses. For simplification purposes, controls are not displayed in the figure.

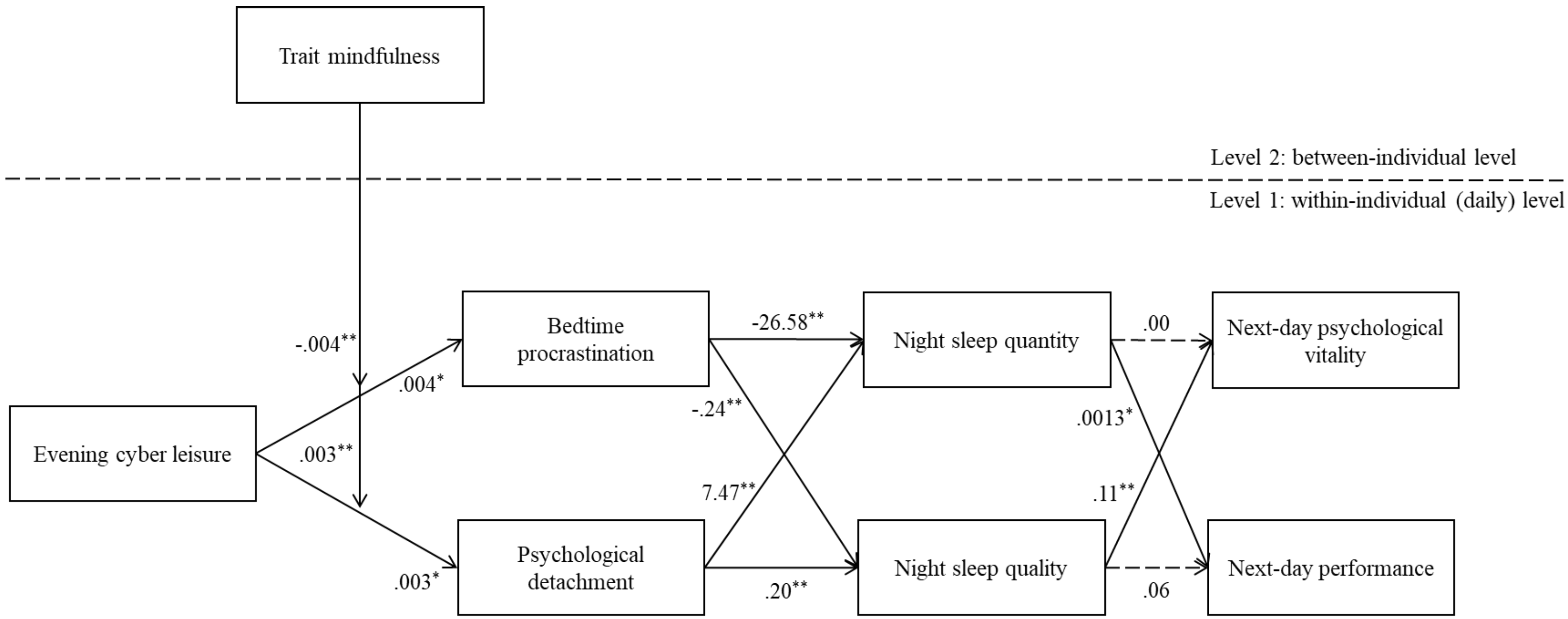

Figure 2. Model Results.

Notes. Hypothesized coefficients are illustrated in the figure. The full model is reported in Table 2. Dashed lines mean the coefficient of the path is not significant.

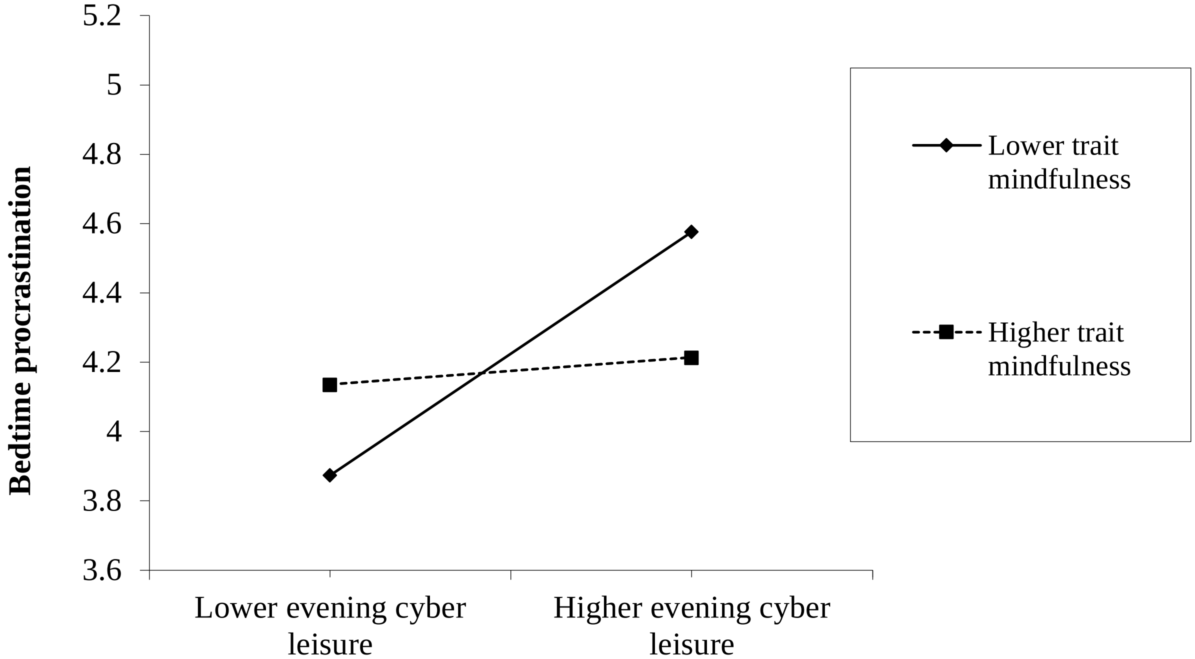

Figure 3a. The moderating effects of trait mindfulness on the relationship between evening cyber leisure and bedtime procrastination.

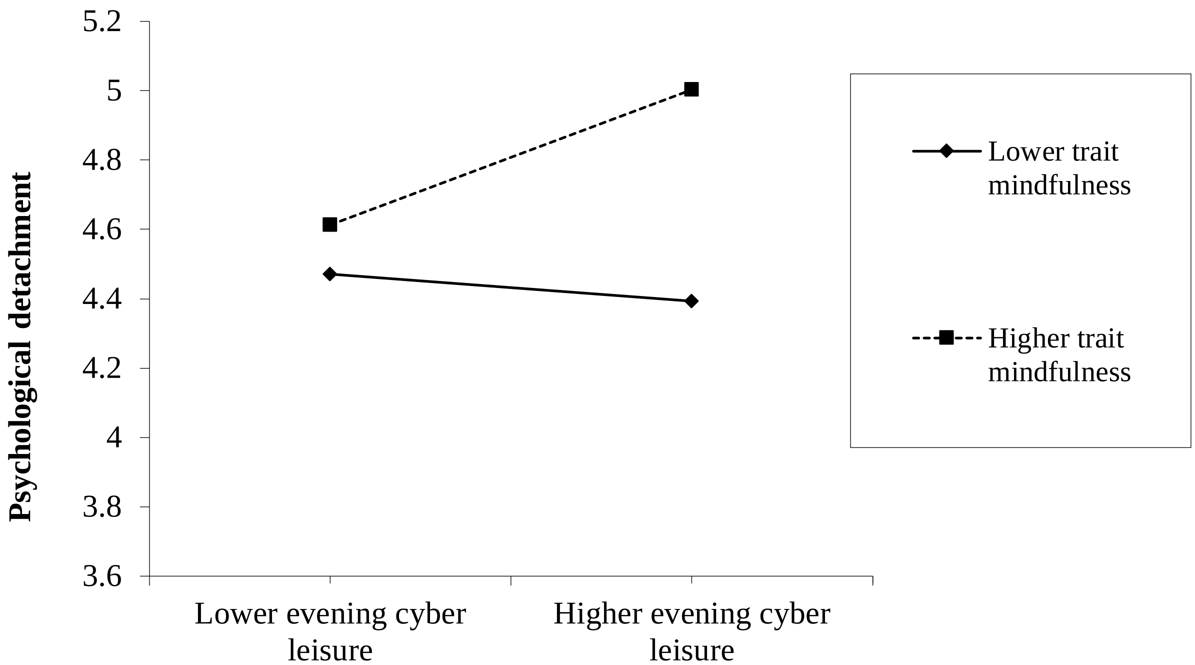

Figure 3b. The moderating effects of trait mindfulness on the relationship between evening cyber leisure and psychological detachment.