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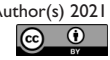

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The role of regulatory, affective, and motivational resources in the adverse spillover of sleep in the home domain to employee effectiveness in the work domain

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Abstract

How does sleep affect employee effectiveness and what can employees do to remain effective on days with a lack of sleep? Drawing on the conservation of resources theory, our research expands on the cognitive (regulatory resources), affective (positive affect), and motivational (subjective vitality) mechanisms that link sleep and employee effectiveness. Furthermore, considering the crucial role of individuals' beliefs in the spillover of sleep to work, we examine implicit theories about willpower – a mindset about the resource-draining nature of self-regulation – as a moderator of the positive relationship between sleep duration and employee effectiveness through regulatory resources availability. Two daily diary studies with a combined sample of N_{total} = 214

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employees (N_{total} = 1317 workdays) demonstrate the predominant role of cognitive- and affective resources in the day-specific relations between sleep at home to engagement, in-role, and extra-role performance at work. Moreover, the spillover of sleep to employee effectiveness via cognitive resources is stronger for individuals holding a limited as compared with a non-limited resource theory. This research not only expands our theoretical understanding of the psychological mechanisms that link sleep to employee effectiveness but also offers practical implications by highlighting the protective role of holding a non-limited resource theory on days with a lack of sleep.

Keywords
conservation of resource theory, in- and extra-role performance, self-regulation, subjective vitality, theories about willpower, work engagement

Sleep is a crucial recovery experience, which can make or break a workday (Barnes, 2012). Whereas good sleep can facilitate employee effectiveness, having slept poorly can be highly detrimental to one's work (for reviews see Harrison and Horne, 2000; Henderson and Horan, 2021; Litwiller et al., 2017; Pilcher and Huffcutt, 1996; Siegel, 2005). To understand the role of sleep for employee effectiveness, scholars have predominantly sought out self-regulation theory for explanations (Barnes, 2012; Muraven and Baumeister, 2000). This theory suggests that self-regulation, which refers to controlling one's impulses, desires, and emotions to achieve long-term goals, relies on the availability of limited regulatory resources (Muraven and Baumeister, 2000). Sleep restores regulatory resources (Barnes, 2012) and thereby facilitates employee effectiveness (Lian et al., 2017). That is, good sleep allows employees to successfully resist distractions and focus on their work tasks or to persist when work tasks become more demanding (Schmidt and Neubach, 2007). However, alternative psychological mechanisms have been scarcely considered in the relation between sleep and work (Lian et al., 2017). This not only prevents painting a more comprehensive picture of the relevant psychological mechanisms that link sleep to employee effectiveness but also limits our understanding of the unique role of self-regulation identified in previous studies (Henderson and Horan, 2021; Litwiller et al., 2017).

Furthermore, in light of a steep increase of sleep difficulties among the working population (Kessler et al., 2011), and based on theoretical propositions and empirical findings that self-regulation constitutes an important mechanism in the relation between sleep and employee effectiveness (Barnes, 2012), scholars have explored individual and organizational contingencies that can alleviate the harmful effects of a lack of sleep. Most studies, however, have focused on relatively stable contingencies (i.e., self-control capacity, chronotype; job control; Diestel et al., 2015; Kühnel et al., 2016; Lanaj et al., 2014), which are not very malleable. Whereas some studies have identified more malleable protective factors such as caffeine consumption (Welsh et al., 2014), having a sense of power, and contemplation (Welsh et al., 2018), their beneficial role may be more relevant for some individuals compared with others. For instance, consuming caffeinated beverages

is less useful for individuals who do not like such beverages or are concerned about the potential side effects of caffeine (Pray et al., 2014). Moreover, whereas a sense of power and contemplation can reduce unethical conduct following a lower sleep duration (Welsh et al., 2018), their relevance for broader indicators of employee effectiveness such as work engagement and task performance remains unexplored. Thus, it is important to identify additional malleable contingencies that can help employees to successfully self-regulate at work and thereby protect their effectiveness from fluctuations in sleep duration.

Considering that for the most part sleep occurs in the home domain, our research introduces a spillover lens (i.e., experiences being transferred intact between domains; Edwards and Rothbard, 2000) to examine the home-to-work spillover of sleep to employee effectiveness. To fully explain this spillover, we draw on the distinction between cognitive-, affective-, and motivational processes (Inzlicht and Schmeichel, 2012; Lazarus, 1991; O'Shea et al., 2017) and hence test the mediating role of regulatory resource availability, positive affect, and subjective vitality in the relation between sleep and employee effectiveness. Furthermore, to identify a viable way to prevent the harmful consequences of a lack of sleep, we examine theories about willpower as a malleable mindset that can attenuate the harmful spillover of sleep to employee effectiveness via self-regulation.

We delineate our conceptual model building on notions about sleep as a recovery process and the Conservation of Resources Theory (CoR; Hobfoll et al., 2018), which focuses on the role of resources, defined as 'anything perceived by the individual to help attain his or her goals' (Halbesleben et al., 2014: 1338), for individual functioning. More specifically, CoR theory suggests that the loss of resources triggers a defensive state to protect one's remaining resources and prevent further resource loss. This state is characterized by the aim to conserve and protect an individual's remaining resources – for example, by refraining from activities that may further drain one's resources. Based on this theoretical argument, we propose regulatory resource availability (an indicator of cognitive resources; Baumeister et al., 1998), positive affect (an indicator of affective resources; Watson et al., 1988), and subjective vitality (an indicator of motivational resources; Ryan and Deci, 2008; Ryan and Frederick, 1997) as unique mediating mechanisms of the home-to-work spillover of sleep duration to employee effectiveness as these resources have been identified as crucial for employee effectiveness (Quinn et al., 2012). Furthermore, we propose theories about willpower – a mindset whether willpower relies on resources that are easily depleted and take time to recover (i.e., limited theory of willpower) or are *not* easily drained and can quickly refuel themselves (i.e., non-limited theory of willpower) – as a moderator of the relation between sleep and employee effectiveness. More specifically, we argue that individuals who hold a limited resource theory rely more strongly on sleep as a recovery process for successful self-regulation because these individuals are more sensitive to fluctuations in the availability of their regulatory resources (Job et al., 2013). As sleep and the examined psychological resources considerably fluctuate across days (Henderson and Horan, 2021; Litwiller et al., 2017), our hypothesized model is tested in two daily diary studies. As outcomes, we focus on indicators of employee effectiveness, which have been strongly linked to organizational effectiveness (Call and Ployhart, 2021; Christian et al., 2011). Besides work engagement

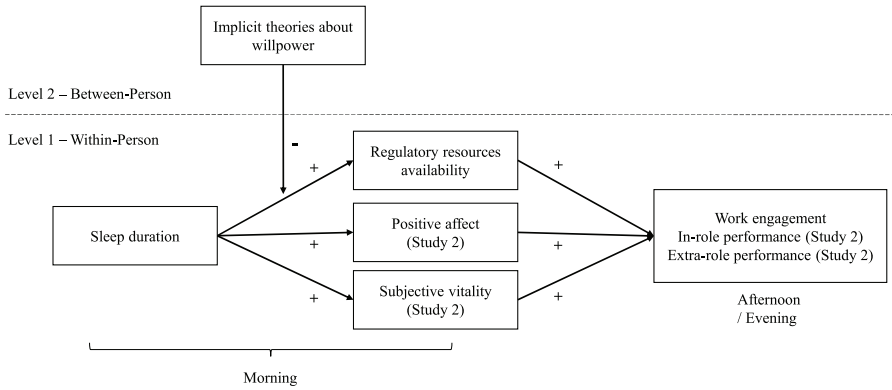

Figure 1. Theoretical model.
Control variables were omitted for clarity.

(i.e., a positive state characterized by feelings of vigor, dedication, and absorption at work), we examine in- (i.e., the effective fulfillment of job duties) and extra-role performance (i.e., discretionary acts that go beyond job duties) as indicators of employee effectiveness (see Figure 1 for the depiction of our model).

Our study offers several contributions to the literature on sleep and employee effectiveness. First, beyond the well-established insights into the beneficial effects of sleep on self-regulatory functioning, our research highlights the crucial but so far overlooked role of positive affect and subjective vitality as alternative psychological mechanisms that link sleep in the home domain to employee effectiveness in the work domain. This is crucial because examining different processes that underlie the harmful effects of a lack of sleep for work can help us to disentangle the unique role of each psychological process and thus allows us to paint a more comprehensive picture of how sleep affects work. Second, we seek to expand scholarly understanding of how sleep as a recovery process interacts with theories about willpower as a mindset about self-regulation. More specifically, we examine whether holding a limited resource theory makes employees' self-regulation and associated effectiveness more dependent on sleep as a recovery experience. Identifying the moderating role of theories about willpower also holds practical implications in the form of interventions to change one's mindset towards a non-limited theory, which can alleviate the detrimental consequences of day-to-day fluctuations in sleep duration. Finally, whereas research has strongly focused on the work-to-home spillover of how work affects sleep as an indicator of well-being (Litwiller et al., 2017), our research focuses on the mechanisms and contingencies of the home-to-work spillover of sleep to employee effectiveness (ten Brummelhuis and Bakker, 2012). We do this by addressing Litwiller et al.'s (2017) call to go beyond work engagement and unethical conduct as consequences of sleep and focus on in- and extra-role performance as behavioral indicators of employee effectiveness, which have been strongly linked to organizational effectiveness (Call and Ployhart, 2021).

The cognitive, affective, and motivational mechanisms of the home-to-work spillover of sleep to employee effectiveness

Sleep is a dynamic recovery process, which has received increasing attention from organizational scholars (Barnes, 2012; Barnes and Watson, 2019; Litwiller et al., 2017). Research on the relationship between sleep and work has foremost focused on two distinct conceptualizations of sleep (Harvey et al., 2008; Pilcher et al., 1997). Whereas sleep quality refers to a more experiential indicator of how people evaluate their sleep, sleep duration as the number of hours spent sleeping constitutes a more objective indicator (Pilcher et al., 1997). Departing from an initial interest in how work affects employees' sleep as an indicator of employee well-being, more recent research has emphasized that sleep is an important determinant of employee effectiveness (Litwiller et al., 2017). The dominant theoretical explanation for the work-related consequences of sleep is based on self-regulation theory (Muraven and Baumeister, 2000). More specifically, scholars have argued that maintaining high work engagement or abstaining from unethical or counterproductive work behaviors requires self-regulation to control one's impulses, emotions, and desires, which requires the availability of regulatory resources (Lian et al., 2017). Furthermore, sleep is a recovery process that restores regulatory resources (Barnes, 2012). By now, several meta-analyses have provided convincing support for this theoretical proposition (Harrison and Horne, 2000; Henderson and Horan, 2021; Litwiller et al., 2017; Pilcher and Huffcutt, 1996; Siegel, 2005).

However, besides focusing on self-regulation research on the within-person psychological processes that link sleep to employee effectiveness has largely neglected alternative mechanisms (Henderson and Horan, 2021; Litwiller et al., 2017). As sleep mostly occurs in the home domain the present research adopts a home-to-work spillover lens (Edwards and Rothbard, 2000) to investigate how sleep affects employee effectiveness. Theoretically, we explain this spillover through the CoR theory (Hobfoll et al., 2018), which is based on the assumption that individuals strive to obtain, retain, foster, and protect their resources, defined as anything that facilitates goal attainment (Halbesleben et al., 2014). This theory suggests that resource loss is a salient experience, which triggers the tendency to conserve and protect one's remaining resources. Based on these theoretical arguments, we propose regulatory resource availability (a specific resource for self-regulation; Baumeister et al., 2000), positive affect (an affective resource reflected by pleasant states of high activation; Watson et al., 1988), and subjective vitality (a motivational resource reflected by feelings of aliveness and energy; Ryan and Frederick, 1997), as mediators of the relation between sleep and employee effectiveness. Our decision to focus on these three resources is based on the widely established distinction between cognitive-, affective-, and motivational processes and their unique role for individual states and behaviors (Inzlicht and Schmeichel, 2012; Lazarus, 1991; O'Shea et al., 2017). In addition to providing a comprehensive understanding of the psychological mechanisms of the spillover of sleep to work, the conceptual differences between the examined resources can also disentangle the unique role of each resource and associated psychological mechanisms in linking sleep to employee effectiveness. Despite some

conceptual overlap given that all three resources represent forms of human energy (Quinn et al., 2012), we draw on previous research suggesting that each of the examined resources has unique characteristics (Gombert et al., 2020; Muraven et al., 2008; Ryan and Frederick, 1997; Tice et al., 2007). Specifically, regulatory resource availability represents a cognitive resource, which is solely required for acts of self-regulation or willpower (Baumeister et al., 2000). It is distinct from positive affect because positive affect is not inevitably tied to one's capacity for self-regulation as is the case with regulatory resources availability. For example, after making a successful sale to a difficult customer a salesperson may feel enthusiastic, excited, and proud but at the same time have fewer regulatory resources because engaging with the customer required self-regulation. However, if the customer interaction was not challenging in nature, the salesperson may still experience positive affect without their regulatory resources having been taxed. In line with this proposition, a meta-analysis of experimental research on self-regulation suggests that there is no significant relationship between self-regulation and positive affect (Hagger et al., 2010). We further argue that regulatory resource availability is distinct from subjective vitality, which represents a 'salient and functionally significant indicator of health and motivation' (Ryan and Deci, 2008: 730). Accordingly, subjective vitality is proposed as a comprehensive organismic state, which goes beyond regulatory resources availability (Ryan and Deci, 2008). Furthermore, compared with regulatory resources, high subjective vitality represents a surplus of energy, which facilitates the motivation to further expand one's energy. Finally, positive affect and subjective vitality are also conceptually distinct because positive affect incorporates states of low and high activation whereas subjective vitality only reflects high activation (Ryan and Deci, 2008). In line with these theoretical arguments, previous research demonstrates that the correlations between these resources range between $r = 0.36$ and 0.64, suggesting that the proportions of variance shared between these constructs range between 13% and 41% (Gombert et al., 2020; Ryan and Frederick, 1997).

In line with our goal to disentangle the roles of cognitive-, affective-, and motivational resources, we focus on sleep duration rather than sleep quality as sleep duration should be less confounded by momentary states (Henderson and Horan, 2021; Litwiller et al., 2017). Whereas states of high regulatory resource availability, positive affect, or subjective vitality in the morning may affect how employees retrospectively evaluate their sleep quality, this is less likely to be the case for sleep duration (Bower et al., 2010). This proposition is also supported by the higher correlations between self-reported and objectively measured indicators of sleep duration as compared with sleep quality (Litwiller et al., 2017). Besides methodological considerations, our focus on sleep duration is also guided by practical considerations because employees have more influence on the duration rather than the quality of their sleep – for example, by going to bed earlier (Sayre et al., 2021). Rather than examining it as a focal predictor, we control for sleep quality, which also allows us to disentangle the unique effects of sleep duration for employee effectiveness. In the following, we will elaborate on each spillover mechanism that links sleep duration to employee effectiveness.

Starting with the role of self-regulation, we propose that regulatory resources mediate the positive relationship between sleep duration and employee effectiveness. Drawing on previous research, which suggests that sleep affects neurobiological processes involving

the prefrontal cortex – an area of the brain that has been identified as relevant for self-regulation (Gruber and Cassoff, 2014; Mullins et al., 2014; Schnyer et al., 2009) – we argue that on days with a lower sleep duration employees experience internal signs of lower availability of regulatory resources, such as feeling tired and not being able to concentrate, as well as being more irritable or impulsive. These feelings are also associated with the desire for more sleep, which needs to be suppressed to achieve one's daily goals (Kotabe and Hofmann, 2015). To illustrate, imagine the sound of your wake-up alarm on a day where you have slept regular hours and compare that with a day where you have slept less. Getting out of bed and ready for work on the latter day is likely to require more willpower to overcome the urge to stay in bed and to sleep longer, which consumes regulatory resources. In support of this proposition, an experience sampling study of daily desires demonstrates that the desire for sleep on workdays is more prevalent than on non-workdays (Hofmann et al., 2012). The authors explain this finding by suggesting that on workdays employees' sleep duration is much more constrained. In contrast, on days with more sleep employees are less likely to experience any cues that may indicate a lack of regulatory resources and the associated desire for more sleep, which in turn reduces the self-regulation requirements when engaging in morning activities. Based on these arguments, we propose that sleep duration is positively related to employees' regulatory resources availability in the morning.

Consistent with CoR theory, we further argue that after experiencing a lower daily availability of regulatory resources owing to a lack of sleep employees enter a defensive state, during which they try to refrain from further self-regulation to protect their remaining regulatory resources. This is because for reasons of self-preservation individuals conserve at least some of their regulatory resources for critical situations, which may require self-regulation and may result in major aversive consequences if individuals are unable to self-regulate. For example, owing to the lower availability of regulatory resources an individual may be caught speeding when commuting home after work (Clinton et al., 2021). If the individual then does not self-regulate and insults the police officer this will result in an even more severe punishment than the speeding ticket. This defensive state in turn spills over to the work domain and reduces employee effectiveness (Chong et al., 2020; Gerpott et al., 2021). In the present study, we focus on work engagement, as well as in- and extra-role performance as work behaviors, which contribute to organizational effectiveness (Goodman and Svyantek, 1999). In line with previous research, we argue that sleep in the home domain spills over to these indicators of effectiveness in the work domain through a lower availability of regulatory resources in their essential role for self-regulation at work. That is, maintaining a high level of work engagement, which involves being vigorous, dedicated, and absorbed at work, requires self-regulation and associated regulatory resources (Diestel et al., 2015; Lanaj et al., 2014). More specifically, vigor at work most likely emerges during challenging tasks that require basic cognitive functions such as reasoning and problem solving, which rely on self-regulation (Stjernfelt, 2021). Moreover, dedication and absorption are also dependent on one's regulatory resource availability as both require individuals to remain focused on a particular work task for extended periods and overcome difficulties when working (Schmidt and Neubach, 2007).

In addition to this, to effectively complete work tasks (i.e., in-role performance), employees must invest regulatory resources to resist distractions and stay focused even

when working on potentially uninteresting tasks (Gerpott et al., 2021). Finally, engaging in extra-role performance requires regulatory resources to suppress the desire to be selfish and instead support a co-worker (DeWall et al., 2008; Lanaj et al., 2016).

Hypothesis 1: Regulatory resources availability mediates the day-specific positive relation between sleep duration and (a) work engagement, (b) in-, and (c) extra-role performance.

Notwithstanding evidence for the association between sleep and employees' positive affect (Bower et al., 2010; Pilcher and Huffcutt, 1996; Scott and Judge, 2006; Sonnentag et al., 2008; Totterdell et al., 1994) as well as the role of positive affect for employee effectiveness (Kaplan et al., 2009; Shockley et al., 2012), to our knowledge only one study directly tested the mediating role of positive affect in this relationship, and the findings were inconclusive (Sayre et al., 2021). To further elucidate the role of affective processes in linking sleep to employee effectiveness, we examine positive affect as an alternative mechanism underlying this relationship. Based on evidence that sleep is associated with overall brain activity (Ma et al., 2015), we argue that sleep duration is positively related to positive affect. More specifically, given that positive affect reflects a state of positive activation (Watson et al., 1988), a reduction in brain activity owing to a lack of sleep should be associated with a lower overall level of activation, which manifests in lower levels of positive affect. Moreover, because employees anticipate difficulties in attaining their daily goals owing to reductions in sleep duration, they will have to invest more effort to adequately fulfill their work and non-work duties, which should also reduce positive affect (Scott and Judge, 2006; Sonnentag et al., 2008).

In turn, and consistent with CoR theory, we argue that morning positive affect will be positively associated with daily effectiveness as it focuses employees' attention on positive outcomes, which reduces tendencies to protect and conserve affective resources and instead facilitates the investment of these resources when engaging in work tasks (Bledow et al., 2013; Ilies and Judge, 2005). Accordingly, experiencing high morning positive affect makes it more likely that employees tackle challenging work tasks, which not only increases work engagement but also in-role performance when investing more effort at work. Moreover, morning positive affect also improves extra-role performance because it increases the likelihood to approach rather than avoid others at work (Spector and Fox, 2002). Furthermore, in line with the proposition that to gain resources employees must invest resources (Hobfoll et al., 2018), we argue that when in states of high positive affect employees are more willing to invest their resources to help others, which can help to maintain and further enhance their affective resources through positive experiences associated with helping others (Koopman et al., 2016).

Hypothesis 2: Positive affect mediates the day-specific positive relation between sleep duration and (a) work engagement, (b) in-, and (c) extra-role performance.

Akin to affective processes, our literature review also indicates only one study that examined subjective vitality as a motivational resource of the home-to-work spillover of sleep to employee effectiveness (Schmitt et al., 2017). The results of this study

support the mediating effect of subjective vitality in the relation between sleep quality and proactivity contingent on employees' self-efficacy. However, this same mediating effect was not observed for sleep duration. To further extend these initial findings, we examine subjective vitality as a motivational mechanism that links sleep duration to employee effectiveness. Subjective vitality reflects a motivational resource that is more likely to emerge 'when basic bodily functions are robust and able to be effectively exercised' (Ryan and Frederick, 1997: 531). We thus propose that sleep duration as a somatic factor is positively associated with subjective vitality. This is because on days with a lack of sleep employees become more constrained by experienced aversive somatic states such as having a headache, irritable bowel syndrome, limb pain (Schlarb et al., 2017), which should reduce their feelings of subjective vitality because individuals realize their limitations when experiencing aversive somatic states (Liu et al., 2020; Schmitt et al., 2017).

We further argue that lower levels of subjective vitality owing to a lower daily sleep duration will impair employee effectiveness. This proposition corresponds with CoR, in that employees will withhold their motivation to invest resources at work on days with lower as compared with higher levels of subjective vitality as they try to conserve their remaining resources. This in turn will inhibit employees' work engagement, which requires mustering the initial motivation to engage in a work task (Bakker and Oerlemans, 2019). Lower subjective vitality will also inhibit in-role performance because employees will not be motivated to invest any more energy than the bare minimum to complete work tasks. Finally, on days with lower subjective vitality employees will be less motivated to invest their remaining energy in supporting their colleagues, which should manifest in lower extra-role behaviors (Lanaj et al., 2016).

Hypothesis 3: Subjective vitality mediates the day-specific positive relation between sleep duration and (a) work engagement, (b) in-, and (c) extra-role performance.

Theories about willpower and the regulatory resources spillover of sleep to employee effectiveness

Research on implicit theories about willpower has offered novel perspectives on how mindsets can affect self-regulation processes (Francis and Job, 2018; Job, 2016) by demonstrating that having a mindset that regulatory resources are scarce and easily depleted, which is referred to as holding a limited resource theory, compared with a mindset that regulatory resources are abundant and cannot be easily drained (i.e., holding a non-limited resource theory), can impair one's ability to self-regulate (Job et al., 2010). Drawing on these findings, a growing body of research has demonstrated that holding a limited resource theory is negatively related to various positive outcomes associated with self-regulation such as well-being (Bernecker et al., 2017; Job et al., 2010) and psychological adjustment (Bernecker and Job, 2015). Furthermore, considering the crucial role of self-regulation at work (Lian et al., 2017), an initial study (Konze et al., 2019) demonstrated that holding a limited resource theory strengthens the adverse effects of emotional dissonance – a work demand which requires self-regulation to display emotions which are not genuinely felt.

Going beyond these relevant findings, initial research on theories about willpower has also contributed to our understanding of how physiological processes can facilitate successful self-regulation (Gailliot et al., 2007). Based on studies on the role of glucose for successful self-regulation, scholars have proposed that glucose represents the physiological manifestation of regulatory resources availability (Gailliot et al., 2007). Job et al. (2013) have questioned this proposition and suggested that rather than through the physiological process of regulatory resource recovery, the benefits of glucose for self-regulation can be accounted for by psychological mechanisms, which are determined by the extent to which the availability of resources for self-regulation is of concern for individuals. Accordingly, these authors propose that the intake of glucose will be more likely to support self-regulation for individuals holding a limited resource theory and thus believe that regulatory resources are easily consumed. This is because believing that regulatory resources are limited makes individuals more sensitive to internal cues associated with the availability of regulatory resources. In contrast, individuals who hold a non-limited resource theory are less sensitive to internal cues associated with regulatory resource availability and thus should be less likely affected by the consumption of glucose for successful self-regulation. Three experiments support this proposition by demonstrating that after a self-regulation task the consumption of a sugar drink as compared with a sugar substitute drink improves subsequent self-regulation only for those participants who believed or were led to believe in a limited as compared with a non-limited resource theory (Job et al., 2013).

The present study aims to extend these initial findings by examining whether theories about willpower moderate the self-regulatory consequences of sleep duration as another recovery process relevant for self-regulatory functioning (Barnes, 2012). More specifically, we integrate theories about willpower and the CoR theory to propose that holding a limited resource theory strengthens the relation between sleep duration and employees' regulatory resource availability because to successfully self-regulate, these individuals rely more strongly on sleep as a recovery process. Drawing on the proposition that individuals who hold a limited resource theory are more sensitive to internal cues associated with one's availability of regulatory resources (Job et al., 2013), we argue that this sensitivity strengthens the tendency to conserve and protect regulatory resources associated with daily fluctuations in sleep duration. This is because daily fluctuations in sleep duration trigger internal cues, such as feeling refreshed and recovered when sleep duration is high or tired and more irritable when sleep duration is low, which are more likely to be felt by individuals holding a limited as compared with a non-limited resource theory. The heightened awareness of these internal cues triggers the tendency to conserve and protect one's regulatory resources and thus makes individuals who hold a limited resource theory more dependent on daily sleep duration for successful self-regulation. Furthermore, for individuals holding a limited resource theory this psychological process occurs even on days with minor fluctuations in sleep duration as their heightened sensitivity allows them to perceive internal cues associated with even minor daily changes in sleep, which are less likely to be noticed by individuals holding a non-limited resource theory. In turn, we argue that on days with a lower sleep duration those holding a limited resource theory will experience a lower regulatory resource availability than individuals who hold a non-limited resource theory. This is because individuals with a limited resource theory tend

to conserve and protect their remaining resources after a night with a lower sleep duration. This tendency becomes manifest in high inner motivational resistances, when engaging in morning activities, thereby requiring additional self-regulation. In contrast, on days with a higher sleep duration we do not expect major differences in regulatory resource availability between individuals holding a limited and a non-limited resource theory because on those days individuals do not experience any tendencies to conserve and protect their regulatory resources.

Hypothesis 4: Implicit theories about willpower moderate the positive day-specific relation of sleep duration and regulatory resource availability. The relation will be stronger for individuals holding a limited as compared with non-limited resource theory.

Integrating Hypothesis 1 that regulatory resources mediate the relation between sleep duration and employee effectiveness and the moderating effect of theories about willpower proposed in Hypothesis 4, we argue that implicit theories about willpower will moderate the indirect effect of sleep duration on employee effectiveness through regulatory resources.

Hypothesis 5: Implicit theories about willpower moderate the indirect effects of sleep duration on (a) work engagement, (b) in-, and (c) extra-role performance via regulatory resource availability. The indirect effects will be stronger for individuals holding a limited as compared with a non-limited resource theory.

To demonstrate the unique moderating role of theories about willpower in the relation between sleep duration end employee effectiveness through regulatory resources, we also control for self-control capacity as a crucial individual factor for successful self-regulation (de Ridder et al., 2012). Self-control capacity reflects an interindividual difference in the ability to volitionally regulate behavior, emotions, and motivational tendencies (Tangney et al., 2004). Previous research has suggested that the beneficial role of self-control capacity for self-regulation results from individuals having, on the one hand, generally higher availability of regulatory resources (Hagger et al., 2010) and on the other hand more effective strategies for self-regulation (de Ridder and Gillebaart, 2017). Thus, to strengthen the evidence for our theoretical proposition that the moderating effect of theories about willpower is owing to an increased sensitivity to cues associated with the availability of regulatory resources, which are affected by daily sleep duration rather than an individual's overall capability for self-regulation, we thoroughly test alternative explanations by considering direct and moderating effects of self-control capacity when examining theories about willpower as a moderator.

It should be noted that although most research has focused on between-person differences in theories about willpower (Francis and Job, 2018), there is mounting evidence supporting the malleability of such theories (Francis and Job, 2018). This malleability derives from the notion that individuals' theories about willpower are influenced by previous experiences of effort exertion associated with willpower (Klinger et al., 2018) and external information such as cultural views on willpower (Savani and Job, 2017). As

both one's experienced effort when exerting willpower and external information about willpower (i.e., cultural beliefs) can change, we argue that theories about willpower are malleable. Whereas we acknowledge that individuals will not actively challenge their theories about willpower on a daily basis, previous evidence suggests that providing external information can reliably change an individual's theories about willpower (Job et al., 2010, 2013). Such malleability in turn ascribes important practical value to this moderator.

Studies

We examine the proposed hypotheses in two studies. In Study 1, we test a moderated mediation model in which regulatory resource availability mediates the day-specific relations of sleep duration on work engagement, and this indirect effect is moderated by theories about willpower. In Study 2, we replicate and extend Study 1's findings by (a) examining positive affect, and subjective vitality as additional mechanisms that link sleep duration to employee effectiveness, (b) going beyond work engagement by testing in- and extra-role performance as outcomes, and (c) controlling for self-control capacity to substantiate evidence for the proposed mechanisms underlying the moderating role of theories about willpower.

Study 1

Method

Participants. The data for Study 1 were collected through snowball sampling involving students taking a methods module at a university in Germany. Each student was asked to recruit three participants from their networks. To take part in the study, participants had to be in employment on a full-time contract. Once consent was given, each participant received a pre-survey, which measured demographic characteristics as well as stable variables such as theories about willpower. After that, participants indicated two consecutive weeks (10 workdays) during the following month to receive daily surveys. Subsequently, for each workday (Monday–Friday) during the selected period, participants indicated their estimated time at which they finished work. Each participant received three surveys per day: A morning survey at 8 am, an afternoon survey one hour before the end of work, and an evening survey two hours after the end of work. The data collection was part of a larger project; the present study only focuses on the first- and last daily measurements. If participants did not respond within the first hour after receiving a survey, a reminder was sent. The surveys were automatically deactivated if participants did not respond within four hours after they received a survey. There was no compensation awarded for participation.

The initial sample of participants who completed the pre-survey consisted of $N = 67$ individuals. After that, we excluded participants who did not complete any daily surveys, which resulted in a sample of $N = 58$ (person-level response rate 87%) who completed 428 daily surveys (day-level response rate 74%). These person- and day-level response rates are in line with previously published daily diary studies (Fisher and To, 2012). The

average completion times for daily surveys were 10.49 am and 6.17 pm. Participants were employed in different sectors (19% teaching and education, 12% health, 10% public administration, 9% finance and insurance, 5% manufacturing, 5% hospitality, and 40% in other sectors), their age ranged from 20 to 60 years ($M = 40.31$; SD = 12.57), and the rate of female participants was 55%. Out of all participants, 41% indicated that they had flexible time arrangements and that their main tasks at work were interacting with customers (indicated by 48%), followed by knowledge work (indicated by 33%) and manual labor (indicated by 12%; selection of more than one activity was possible).

Measures. In the pre-survey, we assessed *theories about willpower* with five items of the strenuous mental activity scale developed by Job et al. (2010). The scale was introduced by the following statement:

> The following questions investigate your ideas about willpower. Willpower is what you use to resist temptations, stick to your intentions, and remain vigilant during strenuous mental activities. There are no right or wrong answers. We are interested in your ideas. Please indicate how much you agree or disagree with each of the following statements.

A sample item is: 'When you have been working on a strenuous mental task, you feel energized and you are able to immediately start with another demanding activity' (1 = 'strongly disagree' to 6 = 'strongly agree'). The original scale consists of six items; our MCFAs indicated a high correlation ($r = 0.78$, $p < 0.01$) between two items of this scale, which negatively affected the overall fit of the measurement model. Therefore, we removed the item 'Strenuous mental activities exhaust resources, which need to be refueled afterward (e.g., through taking breaks, doing nothing, watching television).' Theories about willpower were coded so that high levels indicate the agreement with a non-limited rather than a limited resource theory.

In the morning, we measured *sleep duration* with the following item from the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989): 'During the last night, how many hours of actual sleep did you get?' This measure is widely used to assess sleep duration in organizational research (Guarana et al., 2021; Liu et al., 2020; Sayre et al., 2021). *Regulatory resources availability* was also assessed in the morning with five items (Bertrams et al., 2011) related to the participant's current experiences (e.g., 'Right now, I have no mental energy left'; 1 = 'not at all' to 4 = 'a great deal'). We reversed the items so that higher values represent higher perceived regulatory resource availability (see also Yam et al., 2016).

In the evening, we assessed day-specific *work engagement* with the nine-item version of the Utrecht Work Engagement Scale (Breevaart et al., 2012; Schaufeli et al., 2006), which involves three facets: vigor (e.g., 'Today, I felt strong and vigorous at work'), dedication (e.g., 'Today, I was enthusiastic about my work'), and absorption (e.g., 'Today, I was immersed in my work'; 1 = 'strongly disagree' to 7 = 'strongly agree').

Data analysis. Because of the nested structure of our data (Level 1: Sleep duration, regulatory resource availability, and work engagement; Level 2: Theories about willpower), we used multilevel structure equation modeling (MSEM) to examine our hypotheses. This method allows for analyses on multiple levels and has advantages compared with traditional approaches to multilevel mediation analysis (e.g., multilevel modeling;

Preacher et al., 2010). The analyses were conducted with Mplus 8.2 (Muthén and Muthén, 1998–2017) using maximum likelihood estimation with robust standard errors.

We test the proposed hypotheses by specifying a 1-1-1 moderated-mediation mediation model (Preacher et al., 2010). In this model on the within-person level, we specified the relation between sleep duration and perceived regulatory resource availability as a random slope. To examine the cross-level moderator, in the between-person level part of our model implicit theories about willpower predicted this random slope as well as the mediator regulatory resource availability. Finally, on the within-person level sleep duration was specified to predict work engagement. Following the suggestions of Ohly et al. (2010), we centered all exogenous day-level variables around each person's mean ('group-mean centering') and grand-mean-centered implicit theories about willpower.

Because the conventional bootstrapping method of re-sampling cannot be applied to multilevel analyses (Preacher and Selig, 2012), we utilized a Monte Carlo approach of re-sampling to estimate the confidence intervals for the moderated mediation model (Preacher and Selig, 2012). Specifically, we computed bias-corrected 95% confidence intervals (CIs) for the indirect effects based on 20,000 re-samples using the software provided by Selig and Preacher (2008). For testing moderated indirect effects, we followed Hayes and Preacher's (2010) recommendation and computed conditional indirect effects, at lower (−1 SD) and higher (+1 SD) levels of our moderators. Moreover, following Koopman et al. (2016) we also computed 95% CIs to test whether the indirect effects differ between high and low levels of theories about willpower. An indirect effect or a difference in indirect effects is indicated by the respective 95% CI, not including zero (Preacher et al., 2007).

Measurement models. We conducted multilevel confirmatory factor analyses (MCFAs) to assess the psychometrical distinctiveness of our day-level measures. In line with our research model, we specified a model with implicit theories about willpower on the between- and perceived regulatory resource availability and work engagement on the within-person level. Accordingly, a 1-factor model on the between- and a 2-factor model on the within-person level provided an acceptable data fit: $\chi^2(81) = 233.06$, $p < 0.01$, root mean square error of approximation (RMSEA) = 0.066, confirmatory fit index (CFI) = 0.937, standardized root mean square residual within-person/between-person (SRMRw/b) = 0.048/0.042. A 1-factor model on the between- and a 1-factor model on the within-person level that integrated perceived regulatory resource availability and work engagement into one factor performed worse ($\chi^2[82] = 1262.59$, $p < 0.01$, RMSEA = 0.183, CFI = 0.731, SRMRw/b = 0.156/0.042; S-B [Satorra-Bentler] scaled $\Delta\chi^2(1) = 102.34$, $p < 0.01$).

Results

The high proportions of within-person variance of sleep duration (68%), perceived regulatory resource availability (54%), and work engagement (33%) justify the application of multilevel modeling. Table 1 provides an overview of the descriptive statistics, internal consistencies, and correlations.

Table 1. Means, standard deviations, internal consistencies (Cronbach's alpha), and intercorrelations (Study 1).

Variable		1	2	3	4	5	6
1.	Sleep duration – morning	–	**0.30**	**0.25**			
2.	Regulatory resources availability – morning	0.26	*.92–.96*	**0.24**			
3.	Work engagement – evening	0.26	**0.71**	*.96–.98*			
4.	*Implicit theories about willpower*	−0.03	**0.27**	0.22	*.71*		
5.	*Age*	−0.14	0.25	**0.31**	−0.16	–	
6.	*Gender*	−0.05	0.12	0.06	0.23	0.05	–
	M	6.35	3.26	4.04	2.84	40.31	1.45
	SD	1.10	0.75	1.44	0.79	12.57	0.50

Cronbach's alpha for day-level variables represents the lowest and highest values across all measurement days. Correlations below the diagonal are person-level correlations ($N = 58$). Correlations above the diagonal are day-level correlations ($N = 428$). Numbers in bold, $p < 0.05$. Between-person level variables in italic.

In support of Hypothesis 1, which predicts that perceived regulatory resource availability mediates the relation between sleep duration and work engagement, we found direct relations of sleep duration and perceived regulatory resource availability as well as between perceived regulatory resource availability and work engagement with signs corresponding to expectations. Furthermore, there was an indirect effect of sleep duration on work engagement via perceived regulatory resource availability (95% CI = 0.022−0.096).

Hypothesis 2 predicts a moderating (strengthening) effect of holding a limited resource theory on the relation between sleep duration and regulatory resource availability. The significant effect of implicit theories about willpower on the random slope between sleep duration and perceived regulatory resource availability ($\gamma = -0.11$, $p = 0.012$) supports this hypothesis. We plotted the relationship between sleep duration and perceived regulatory resource availability at conditional values of implicit theories about willpower (+1 SD: non-limited resource theory and −1 SD: limited resource theory; Cohen et al., 2003). In line with our predictions, Figure 2 demonstrates that for individuals holding a limited resource theory, the positive relation between sleep duration and perceived regulatory resource availability was stronger than for individuals holding a non-limited resource theory.

Hypothesis 3 proposes that person-specific implicit theories about willpower moderate the indirect relation between sleep duration and work engagement via perceived regulatory resource availability. Our results support the proposition that the indirect effect of sleep duration on work engagement via regulatory resource availability is weaker for individuals holding a non-limited as compared with a limited resource theory, which is indicated by the 95% CI of the difference in indirect effects between individuals holding a limited and a non-limited resource theory not including zero (95% CI = −0.007

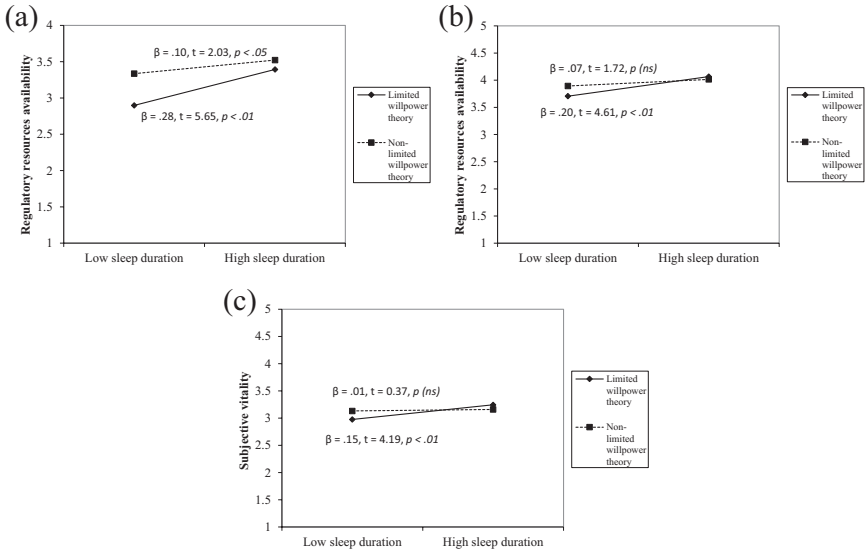

Figure 2. Cross-level moderating effect of implicit theories about willpower on the relations between sleep duration and (a) perceived regulatory resources availability – Study 1, (b) perceived regulatory resources availability – Study 2, and (c) subjective vitality – Study 2.

to −0.107; cf. Table 2). This implies that the indirect effect of sleep duration on work engagement through regulatory resource availability is considerably stronger for individuals holding a limited as compared with a non-limited resource theory.

Finally, we calculated the amounts of variance in our endogenous variables explained by the proposed predictors. As traditional R^2 values are not available for MSEM, we followed recommendations by Snijders and Bosker (2011) and computed pseudo R^2 values for all endogenous variables (see also LaHuis et al., 2014). For perceived regulatory resource availability and work engagement, the amounts of explained variance were 11.1% and 18.1%, respectively. These proportions of explained variance not only support the theoretical but also the practical relevance of our findings.

Study 2

Method

Participants. Data for Study 2 were collected by students of a university in the UK. Each student was asked to recruit 20 participants as part of their master's dissertation project. The recruitment criteria were that employees were English speakers and employed on a full-time contract. The design of this study was similar to that of Study 1. We adapted the times of measurement to account for participants' work schedules. More specifically, in the pre-survey, we asked participants when they started and finished work. The first daily survey was distributed two hours after the start of work, whereas the second survey was

Table 2. Unstandardized coefficients from an MSEM predicting perceived regulatory resource availability, work engagement, and conditional indirect effects (Study 1).

	Regulatory resources availability – morning			Work engagement – evening		
	Estimate	SE	*z*	Estimate	SE	*z*
Between-level						
Intercept	3.286	0.072	45.910**	4.319	0.166	26.062**
Implicit theories about willpower	0.174	0.099	1.764+			
Residual variance	0.247	0.052	4.718*			
Residual variance of RS[a]	0.024	0.014	1.742+			
Within-level						
Sleep duration – morning[a]	0.193	0.037	5.284**	0.164	0.084	1.965*
Regulatory resources availability – morning				0.292	0.088	3.328**
Sleep duration × Implicit theories about willpower[a]	−0.098	0.041	−2.365*			
Residual variance	0.253	0.034	7.401**	0.645	0.099	6.490**
Indirect effects						
Moderator: Implicit theories about willpower	95% CI indirect effect			Difference of the conditional indirect effect to low theories about willpower		
	LL 95% CI		UL 95% CI	LL 95% CI		UL 95% CI
High (non-limited resource theory)	**0.006**		**0.073**	**−0.098**		**−0.006**
Low (limited resource theory)	**0.030**		**0.135**			

+$p < 0.10$. *$p < 0.05$. **$p < 0.01$. [a]Estimates refer to the random slope (RS) of sleep duration and regulatory resource availability, which was specified at the between-level part of the statistical model and predicted by theories about willpower to test the cross-level interaction. All estimates are unstandardized, resulting from one overall analysis including the prediction of all outcomes and RS in one model. CI = Confidence interval. LL = Lower limit. UL = Upper limit. Confidence intervals that do not include zero in bold. Controlling for previous day endogenous variables, as well as a linear and a quadratic trend across days, did not affect the results.

sent one hour before the end of work. A timeframe of 4 hours was given to complete each survey, after which the surveys were automatically deactivated.

The initial sample of participants who completed the pre-survey consisted of $N = 224$ individuals. Again, we excluded participants who did not complete any daily survey throughout the study period, which resulted in a sample of $N = 156$ (person-level response rate 70%) who completed 889 daily surveys (daily response rate 57%). Though both person- and day-level response rates are lower than in Study 1, the sample size on

the person- and day-level conforms with recommendations for daily diary studies (Gabriel et al., 2019). The average completion times for each daily survey were 12.09 pm for the first survey and 6.10 pm for the second survey. Participants worked in different countries: 63% in the UK, 13% in Italy, 12% in Saudi Arabia, and 12% in other countries. They were employed in different sectors (30% health, 8% energy and water supply, 6% education, 6% retail and wholesale, 6% finance and insurance, 6% IT and communications, and 38% in other sectors), their age ranged from 20 to 65 years ($M = 32.16$; SD = 10.15), and the rate of female participants was 56%. Out of all participants, 37% indicated that they had flexible time arrangements and that their main tasks at work involved interacting with customers (indicated by 72%), followed by knowledge work (69%) and manual labor (12%).

Measures. We used the same measures as in Study 1 for implicit theories about willpower (pre-survey), sleep duration, regulatory resources availability (morning; changed to a 5-point scale), and work engagement (afternoon).

In the morning, we assessed *positive affect* – a state of high positive activation – with six items (see Sonnentag et al., 2008) that were based on the Positive and Negative Affect Schedule (Watson et al., 1988; i.e., 'Right now, I feel strong; 1 = 'very slightly/not at all'; 5 = 'extremely'). Moreover, s*ubjective vitality*, which reflects feelings of energy and aliveness, was measured in the morning with four items from the subjective vitality scale (Rivkin et al., 2018; Ryan and Frederick, 1997; i.e., 'Right now, I have energy and spirit'; 1 = 'strongly disagree'; 5 = 'strongly agree').

In the afternoon, we measured day-specific *in-role performance* with two items (Demerouti et al., 2015; Goodman and Svyantek, 1999; i.e., 'Today, I performed tasks that were expected of me'; 1 = 'not at all' to 7 = 'a great deal') and *extra-role performance* (i.e., individual-focused organizational citizenship behavior) with four items (Lee and Allen, 2002; i.e., 'Today, I willingly gave my time to help others who had work-related problems'; 1 = 'not at all' to 7 = 'a great deal').

Control variables. We included several control variables to substantiate the robustness of our findings. First, because sleep quality is considered a determinant of sleep duration (Barnes et al., 2011), we controlled for its influence. *Sleep quality* was assessed with the following item from the PSQI (Buysse et al., 1989): 'How would you rate the quality of your previous night's sleep?' (0 = 'very bad' to 3 = 'very good').

We also controlled for the direct and moderating effects of *self-control capacity* when examining the moderating effect of theories about willpower. Self-control capacity was measured in the pre-survey with a 17-item scale (Tangney et al., 2004; i.e., 'I am good at resisting temptations'; 1 = 'strongly disagree'; 5 = 'strongly agree')

Data analysis. Based on the model specified in Study 1, we added in- and extra-role performance as additional endogenous variables. Moreover, we extended our model by adding random slopes for the relation between sleep duration and positive affect as well as subjective vitality. Both alternative mechanisms were also specified to predict all outcomes. In the between-person part of our model, all random slopes, as well as each mediator (perceived regulatory resource availability, subjective vitality, and positive

affect) were predicted by theories about willpower as well as self-control capacity to account for the proposed moderating effects. As in Study 1, all exogenous day-level variables were person-mean centered whereas exogenous person-level variables were group mean-centered.

Measurement models. As in Study 1, we assessed the psychometrical distinctiveness of our day-level measures through MCFAs. We specified a model with the Level 2 variables (implicit theories about willpower and self-control capacity) on the between- and the Level 1 variables (perceived regulatory resource availability, subjective vitality, positive affect, work engagement, in- and extra-role performance on the within-person-level). Accordingly, a 2-factor model on the between- and a 6-factor model on the within-person level provided a good data fit: $\chi^2(607) = 1812.30$, $p < 0.01$, RMSEA = 0.047, CFI = 0.927, SRMRw/b = 0.052/0.080. A 2-factor model on the between- and a 4-factor model that integrated perceived regulatory resource availability, positive affect, and subjective vitality into a single factor performed worse ($\chi^2[616] = 4649.27$, $p < 0.01$, RMSEA = 0.085, CFI = 0.756, SRMRw/b = 0.137/0.080) compared with the theoretically proposed factor model (S-B scaled $\Delta\chi^2(9) = 3594.79$, $p < 0.01$). Finally, a 2-factor model on the between and a 4-factor model on the within level that integrated all outcomes into a single factor also performed worse ($\chi^2[616] = 4451.95$, $p < 0.01$, RMSEA = 0.083, CFI = 0.768, SRMRw/b = 0.088/0.080) compared with the theoretically proposed model (S-B [Satorra-Bentler] scaled $\Delta\chi^2$ (9) = 1745.05, $p < 0.01$). Thus, MCFAs support the proposed factor structure of our variables in Study 2.

Results

As in Study 1, our day-level variables exhibited a high proportion of within-person variation: sleep duration 57%, sleep quality 67%, regulatory resource availability 62%, positive affect 50%, subjective vitality 60%, work engagement 54%, and in- 53%, and extra-role performance 54%. The descriptive statistics, internal consistencies, and correlations among all study variables are presented in Table 3.

Hypothesis 1 (a)–(c) proposes that regulatory resource availability mediates the relations between sleep duration and (a) work engagement, (b) in-, and (c) extra-role performance. Our results support this hypothesis as the corresponding 95% CIs for the indirect effects of sleep duration on work engagement, and in- and extra-role performance do not include zero (cf. Table 4) at average levels of theories about willpower. Hypothesis 2 (a)–(c) predicts positive affect as a mediator of the relation between sleep duration and employee effectiveness. Our data lend support for this hypothesis as the 95% CIs for the indirect effects of sleep duration on work engagement, in-, and extra-role performance via positive affect did not include zero (cf. Table 4). Hypothesis 3 (a)–(c) suggests that subjective vitality also mediates the relation between sleep duration and employee effectiveness. The proposed mediating role of subjective vitality linking sleep duration to work engagement (3a) was supported by our data. However, the indirect effects on in- (3b) and extra-role (3c) performance were not supported (cf. Table 4).

Hypothesis 4 proposes that person-level theories about willpower moderate the relation between sleep duration and regulatory resource availability. As indicated by the

Table 3. Means, standard deviations, internal consistencies (Cronbach's alpha), and intercorrelations (Study 2).

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Sleep duration – morning	–	**0.34**	**0.27**	**0.28**	0.03	0.00	−0.04	**0.41**				
2. Regulatory resources availability – morning	0.01	*.94–.97*	**0.51**	**0.58**	**0.35**	**0.27**	**0.11**	**0.45**				
3. Positive affect – morning	0.13	**0.39**	*.86–.93*	**0.70**	**0.32**	**0.27**	**0.12**	**0.38**				
4. Subjective vitality – morning	**0.21**	**0.48**	**0.81**	*.84–.91*	**0.33**	**0.26**	**0.10**	**0.41**				
5. Work engagement – afternoon	0.09	**0.45**	**0.60**	**0.59**	*.93–.96*	**0.67**	**0.50**	**0.14**				
6. In-role performance – afternoon	**0.16**	**0.49**	**0.30**	**0.39**	**0.67**	*.87–.96*	**0.46**	**0.13**				
7. Extra-role performance – afternoon	−0.06	**0.16**	**0.36**	**0.33**	**0.54**	**0.50**	*.89–.97*	0.02				
8. Sleep quality – morning	**0.35**	**0.30**	**0.40**	**0.43**	**0.18**	0.15	0.11	–				
9. *Implicit theories about willpower*	0.03	0.08	0.15	0.05	0.08	−0.01	0.02	0.02	*.81*			
10. *Trait self-control*	0.03	**0.30**	0.12	0.13	**0.16**	**0.23**	0.01	0.07	0.01	*.75*		
11. *Age*	0.08	0.13	0.06	−0.03	−0.08	−0.11	−0.01	0.04	0.08	0.14	–	
12. *Gender*	−0.15	0.07	0.07	0.08	0.07	−0.08	0.03	0.00	−0.08	**−0.18**	−0.13	–
M	6.70	3.90	3.19	3.13	3.72	3.85	4.32	2.07	3.04	3.37	32.16	1.44
SD	1.29	0.88	0.74	0.78	0.96	0.86	1.35	0.75	0.77	0.48	10.15	0.50

Cronbach's alpha for day-level variables represents the lowest and highest values across all measurement days. Correlations below the diagonal are person-level correlations ($N = 156$). Correlations above the diagonal are day-level correlations ($N = 889$). Numbers in bold, $p < 0.05$. Between-person level variables in italic.

Table 4. Unstandardized coefficients of an MSEM predicting sleep duration perceived regulatory resource availability, -subjective vitality, -positive affect, work engagement, in-role performance, and indirect effects (Study 2).

	Sleep duration – morning			Regulatory resources availability – morning			Positive affect – morning			Subjective vitality – morning			Work engagement – afternoon			In-role performance – afternoon			Extra-role performance – afternoon		
	Estimate	SE	z	Estimate	SE	z	Estimate	SE	z	Estimate	SE	z	Estimate	SE	z	Estimate	SE	z	Estimate	SE	z
Between-level																					
Intercept				3.919	0.049	79.573 **	3.164	0.050	62.721 **	3.128	0.048	64.941 **	3.647	0.065	56.175 **	3.755	0.060	62.579 **	4.127	0.096	42.865 **
Implicit theories about willpower				0.044	0.058	0.760	0.111	0.066	1.677 +	0.023	0.058	0.402									
Self-control capacity				0.425	0.109	3.900 **	0.123	0.110	1.116	0.154	0.104	1.475									
Residual variance				0.247	0.042	5.944 **	0.289	0.047	6.110 **	0.239	0.037	6.450 **	0.311	0.062	4.981 **	0.294	0.045	6.586 **	0.876	0.143	6.108 **
Residual variance RS[a]				0.002	0.008	0.318	0.001	0.003	0.389	0.009	0.010	0.904									
Within-level																					
Sleep quality – morning	0.662	0.071	9.295**	0.425	0.049	8.669 **	0.292	0.037	7.910 **	0.371	0.046	8.013 **	−0.066	0.054	−1.229	−0.009	0.052	−0.178	−0.100	0.085	−1.176
Sleep duration[a] – morninig				0.130	0.031	4.228 **	0.080	0.024	3.309 **	0.080	0.030	2.656 *	−0.103	0.037	−2.779 *	−0.102	0.035	−2.896 **	−0.109	0.063	−1.744 +
Regulatory resources availability – morning													0.308	0.059	5.209 **	0.207	0.047	4.392 **	0.200	0.088	2.282 *
Positive affect – morning													0.224	0.085	2.634 *	0.208	0.080	2.614*	0.244	0.116	2.098 *
Subjective vitality – morning													0.175	0.077	2.269 *	0.109	0.063	1.734 +	0.042	0.115	0.367
Sleep duration × Implicit theories about willpower[a]				−0.084	0.034	−2.517 *	−0.012	0.026	−0.445	−0.085	0.028	−2.982 **									
Sleep duration × Self-control capacity[a]				−0.029	0.060	−0.475	0.004	0.047	0.074	−0.004	0.052	−0.072									
Residual variance	0.711	0.079	9.045 **	0.417	0.038	11.109 **	0.288	0.023	12.448 **	0.346	0.027	12.896 **	0.518	0.058	9.004 **	0.459	0.043	10.743 **	1.363	0.137	9.957 **

(Continued)

Table 4. (Continued)

Indirect effects			
Outcome	Mediator	95% CI indirect effect: LL 95% CI	UL 95% CI
Work engagement	Regulatory resources availability	**0.021**	**0.061**
	Positive affect	**0.003**	**0.039**
	Subjective vitality	**0.001**	**0.033**
In-role performance	Regulatory resources availability	**0.013**	**0.042**
	Positive affect	**0.003**	**0.037**
	Subjective vitality	−0.001	0.023
Extra-role performance	Regulatory resources availability	**0.004**	**0.047**
	Positive affect	**0.001**	**0.048**
	Subjective vitality	−0.016	0.024

*$p < 0.05$. **$p < 0.01$ [a]Estimates refer to random slopes (RS) of sleep duration and each mediator (regulatory resource availability, positive affect, and subjective vitality), which were specified at the between-level part of the statistical model and predicted by theories about willpower and self-control capacity to test the cross-level interactions. Estimates are unstandardized, resulting from one overall analysis including the prediction of all outcomes and RSs in one model. CI = Confidence interval. LL = Lower limit. UL = Upper limit. Controlling for previous day endogenous variables, as well as a linear and a quadratic trend across days, did affect the results. The effect of positive affect on extra-role performance became marginally significant ($p = 0.068$).

significant effect of theories about willpower on the random slope linking sleep duration and perceived regulatory resource availability (i.e., the interaction term in Table 4), our data support a moderating effect of theories about willpower. Corresponding with our hypothesis and Study 1's findings, the plot of the interaction effect suggests that the relation between sleep duration and perceived regulatory resource availability is weaker for individuals holding a non-limited as compared with a limited resource theory (cf. Figure 2). Moreover, simple slope tests indicate that for individuals holding a non-limited resource theory the relationship between sleep duration and regulatory resource availability is non-significant whereas this relationship is significant for individuals holding a limited resource theory.

Hypothesis 5 suggests that person-specific implicit theories about willpower moderate the indirect relation between sleep duration and all indicators of employee effectiveness via perceived regulatory resource availability. Our data support the proposed moderated mediation model, as the indirect effects of sleep duration on (a) work engagement (95% CI = 0.034 to 0.103), (b) in- (95% CI = 0.022 to 0.071), and (c) extra-role performance (95% CI = 0.006 to 0.080) via perceived regulatory resource availability were only present for individuals holding a limited resource theory. In contrast, the 95% CIs for these indirect effects were not present for individuals holding a non-limited resource theory on work engagement (−0.013 to 0.039), in- (−0.009 to 0.028), and extra-role performance (−0.009 to 0.029). Accordingly, comparisons of the indirect effects reveal a significant difference between the indirect effects for individuals holding a limited as compared with a non-limited resource theory on work engagement (−0.103 to −0.011), in- (−0.069 to −0.007), and extra-role performance (−0.079 to −0.002). These results indicate that regulatory resource availability mediates the relation between sleep duration and employee effectiveness for individuals holding a limited resource theory, whereas our data suggest no such mediating effect for individuals holding a non-limited resource theory.

Another interesting finding was that theories about willpower also moderate the relation between sleep duration and subjective vitality as indicated by the significant effect of theories about willpower on the sleep duration/subjective vitality random slope (represented by the interaction term in Table 4). The interaction plots and simple slope tests indicate a similar pattern of the interaction as for regulatory resources availability (cf. Figure 2c). More specifically, sleep duration significantly affects subjective vitality only for those individuals who hold a limited as compared with a non-limited resource theory.

The amounts of explained variance for our endogenous variables were: sleep duration 18.4%, perceived regulatory resource availability 18.3%, positive affect 7.3%, subjective vitality 10.9%, work engagement 29.6%, in- 17.5%, and extra-role performance 6.5%. These proportions of explained variance again support the practical relevance of our results.

Finally, our results suggest that self-control capacity neither moderated the link between sleep duration and perceived regulatory resource availability nor the relations between sleep duration and alternative mediating pathways. Also, controlling for self-control capacity did not affect the moderating effect of theories about willpower on the relation between sleep duration and perceived regulatory resource availability (cf. Table 4).

Discussion

To provide a more comprehensive understanding of the psychological mechanisms that underlie the home-to-work spillover of sleep to employee effectiveness, our research examined regulatory resource availability, positive affect, and subjective vitality as mediators of the daily relation between sleep duration and employee effectiveness. Furthermore, to identify an additional malleable factor that can prevent the harmful consequences of less sleep for employee effectiveness, we tested the moderating role of theories about willpower in the relation between sleep duration and employee effectiveness through self-regulation. The results of two daily diary studies support most of the hypothesized relations. First, our research affirms the relevance of all three examined psychological mechanisms in linking sleep to employee effectiveness. Our studies support the substantial role of regulatory resources in linking sleep duration to work engagement, in-, and extra-role performance. Moreover, our data suggest that positive affect also constitutes a relevant psychological mechanism which links sleep duration to employee effectiveness. Finally, subjective vitality only mediated the relation between sleep duration and work engagement. Furthermore, both studies consistently demonstrate that holding a limited as compared with a non-limited resource theory strengthens the relation between sleep duration and regulatory resource availability. In addition, we found preliminary evidence suggesting that theories about willpower also moderate the relation between sleep duration and subjective vitality.

The present research offers several contributions to research on the work-to-home spillover of sleep to employee effectiveness. First, by integrating sleep as a recovery experience with CoR, our study expands on the cognitive-, affective-, and motivational mechanisms that underly the spillover of sleep to employee effectiveness. More specifically, our study suggests that regulatory resource availability, positive affect, and subjective vitality each represent a distinct cognitive-, affective-, and motivational resource, which exhibits unique relationships with employee effectiveness. On the one hand, our findings complement previous research showing that self-regulation links sleep to indicators of employee effectiveness such as unethical conduct and work engagement (Barnes, 2012; Litwiller et al., 2017) by demonstrating the relevance of regulatory resource availability for the link between sleep and employees' daily in- and extra-role performance. On the other hand, our research sheds light on the role of affective and motivational resources that link sleep and employee effectiveness. More specifically, by highlighting positive affect as an important mechanism that explains how sleep relates to work outcomes, our study identifies the crucial but so far largely neglected role of affective processes in linking sleep duration to employee effectiveness. Moreover, beyond cognitive and affective processes, our results suggest that subjective vitality as a motivational resource represents yet another linchpin that connects sleep to work engagement. Taken together, our research supports the theoretical propositions for the unique role of cognitive-, affective-, and motivational mechanisms in the relation between sleep and employee effectiveness. That is, whereas the mediating role of regulatory resources implies that sleep duration affects employee effectiveness through employees' ability to control impulses, emotions, and desires, the mediating role of positive affect indicates that sleep duration spills over to employee effectiveness through a more positive outlook

towards task completion. Last, but not least, the mediating role of subjective vitality suggests that sleep duration also facilitates employee effectiveness through increasing employees' motivation to invest their energetic resources at work. It is also noteworthy that the results of Study 1 indicate a positive relationship between sleep duration and work engagement even after controlling for the mediating effect of regulatory resource availability. This highlights the added value of examining the proposed additional mechanisms in Study 2 as there we do not find a positive relationship between sleep duration and employee effectiveness after including all proposed mediators. Taken together, results of both studies imply that the examined mechanisms comprehensively explain the positive relation between sleep duration and employee effectiveness.

Second, by examining the interplay between sleep duration and theories about willpower in predicting regulatory resource availability and associated effectiveness, we not only expand our understanding of sleep and theories about willpower as determinants of self-regulation but also identify an important malleable moderator, which can protect employee effectiveness from daily fluctuations in sleep duration. Akin to being more reliant on consuming glucose drinks for self-regulation, we find that holding a limited resource theory also makes individuals more dependent on sleep duration for successful self-regulation. Accordingly, our findings support Job et al.'s (2013) proposition that employees' current ability to self-regulate is at least partially influenced by theories about willpower, which determines the extent to which employees are sensitive to internal cues associated with the availability of regulatory resources. Though we do not argue that holding a non-limited resource theory makes employees immune to sleep deprivation, our findings indicate that believing that regulatory resources are abundant can stabilize employee effectiveness on days with a lack of sleep. Furthermore, demonstrating that the moderating effect of theories about willpower remains stable even when controlling for self-control capacity supports the theoretical propositions that the beneficial effects of self-control capacity, which reflect the general ability to self-regulate, and theories about willpower, which represent a mindset about the nature of self-regulation, rely on distinct psychological mechanisms. Last, but not least, replicating the moderating effect of theories about willpower across two samples from different cultural contexts further supports the relevance of this moderator.

Finally, we also expand the literature on spillover effects between the home- and the work domain (Edwards and Rothbard, 2000). More specifically, we go beyond the previous focus on work engagement and unethical conduct (Harrison and Horne, 2000; Litwiller et al., 2017) by examining in- and extra-role performance as behavioral indicators of work effectiveness. Interestingly, whereas our findings highlight the relevance of all three psychological mechanisms in the relation between sleep duration and work engagement, regulatory resources availability and positive affect constitute the most relevant mediators in the relation of sleep duration to in- and extra-role performance. This indicates that after, accounting for cognitive- and affective mechanisms, there is no significant relation of motivational resources in the form of subjective vitality to in- and extra-role performance. One reason for this finding may be that subjective vitality reflects a surplus of motivational energy (Ryan and Deci, 2008). However, as in-role performance constitutes the core part of one's work, it still has to be delivered even if

employees feel less motivated. In sum, our research highlights the relevance of different psychological mechanisms for linking sleep to different indicators of employee effectiveness.

Practical implications

Our research also offers some practical implications on how to prevent the adverse consequences of a lack of sleep. First, in line with previous research (Barnes et al., 2011; Lanaj et al., 2014), our studies further highlight the importance of day-specific sleep for employee effectiveness. Accordingly, interventions to improve day-to-day sleep at home can facilitate employee effectiveness at work. For example, Hülsheger et al. (2015) demonstrate that a guided mindfulness meditation combined with informal mindfulness exercises can improve sleep duration. Moreover, by identifying different mechanisms that link sleep to employee effectiveness, practitioners may focus on these psychological mechanisms to alleviate the aversive consequences of a lack of sleep. Organizations may, for example, offer employees the autonomy to engage in micro-breaks, which can replenish regulatory resources (Kim et al., 2021). Furthermore, to improve employees' positive affect on days with poor sleep, interventions such as watching a humorous video, picture, or text may serve to alleviate negative sleep-related consequences (Ferrer et al., 2015). Also, to enhance subjective vitality, managers may focus on the satisfaction of employees' basic needs (van den Broeck et al., 2016).

Furthermore, considering the crucial role of self-regulation in linking sleep to employee effectiveness, our findings highlight that holding a non-limited as compared with a limited resource theory attenuates the adverse spillover effects of a lack of sleep on regulatory resource availability and in turn stabilizes employees' effectiveness in the work domain. As such theories can be malleable (Job et al., 2010; Klinger et al., 2018; Sieber et al., 2019), individuals could adapt their implicit theories about willpower towards holding a non-limited resource theory. This may in turn help in overcoming the adverse consequences of short-term fluctuations in sleep duration and stabilize their effectiveness. Furthermore, organizational interventions informing individuals about the role of malleable mindsets when engaging in self-regulation may also support employee effectiveness (Dweck, 2017).

Limitations and suggestions for future research

Despite positive contributions, our work also has some limitations that should be discussed. First, though previous research suggests that implicit theories about willpower are malleable and can be affected through manipulations as well as recent experiences of self-regulation (Job et al., 2010; Klinger et al., 2018; Sieber et al., 2019), the malleability of such theories in everyday contexts needs to be further explored (Francis and Job, 2018). In light of the beneficial impact of holding a non-limited resource theory on self-regulation processes and associated outcomes, future studies could integrate an experimental manipulation with an experience sampling study to examine the impact of an intervention to change employees' implicit theories about willpower towards adapting a non-limited resource theory.

Second, aligned with previous research, our measure for theories about willpower focused on engaging in strenuous mental activities as a form of self-regulation (Job, 2016). Considering that self-regulation can occur in different domains such as resisting temptations, controlling impulses, or regulating emotions (Diestel and Schmidt, 2011), domain-specific theories about willpower could be even more effective in facilitating domain-specific self-regulation. Accordingly, future research may explore differences between general and domain-specific theories about willpower. In addition, the indicated role of theories about willpower in the relation between sleep duration and subjective vitality provides initial evidence that theories about willpower also affect motivational processes, which could be further explored in the future.

Third, though our research provides initial evidence on the unique role of different psychological resources, there may be further mechanisms that are relevant in the spillover of sleep to employee effectiveness. For example, the conceptual differences and similarities between perceived regulatory resources availability and fatigue are not yet well understood (Baumeister et al., 2006; Evans et al., 2016; Lian et al., 2017). Accordingly, shedding light on the similarities and differences of fatigue and regulatory resources availability could help to expand our understanding of the role of self-regulation in the relation of sleep and work.

Fourth, our studies were based on self-reported data, which are susceptible to common method bias (Podsakoff et al., 2003). However, the occurrence of moderating effects of theories about willpower in both studies as well as the differential mediating effects of different psychological processes in Study 2 is highly unlikely under the assumption of common method bias. Also, though external performance assessments may increase the validity of our research, they may also be deficient in experience sampling studies because supervisors and colleagues may not be comprehensively aware of an employee's day-specific in- and extra-role performance (Gabriel et al., 2019). Accordingly, future research may use more objective assessments of sleep (Lauderdale et al., 2008) or collect more objective assessments of employee effectiveness to validate the findings of our research.

Conclusion

In sum, our studies highlight the relevance of cognitive-, affective-, and motivational processes in the daily home-to-work spillover of sleep duration to employee effectiveness. Furthermore, we identify that holding a limited resources theory makes employees' self-regulation and associated effectiveness more dependent on sleep duration as a process of regulatory resource recovery.

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