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Rest, Zest and My Innovative Best: Sleep and Mood as Drivers of Entrepreneurs' Innovative Behavior

Amanda J. Williamson
University of Sheffield
Sheffield, S10 2TN, United Kingdom
a.j.williamson@sheffield.ac.uk

Martina Battisti
University of Portsmouth
Portsmouth PO1 3DE, United Kingdom

Michael Leatherbee
Pontificia Universidad Católica de Chile
Av. Vicuña Mackenna 4860, Macul, Santiago, Chile

J. Jeffrey Gish
University of Oregon
Eugene, OR 97403, United States

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REST, ZEST AND MY INNOVATIVE BEST: SLEEP AND MOOD AS DRIVERS OF ENTREPRENEURS' INNOVATIVE BEHAVIOR

Amanda J. Williamson, Martina Battisti, Michael Leatherbee & J. Jeffrey Gish

This study investigates the antecedents of an entrepreneur's day-level innovative behavior. Drawing on 2,420 data points from a 10-day experience sampling study with 121 entrepreneurs, we find that sleep quality is a precursor to an entrepreneur's subsequent innovative behavior, in accordance with the effort-recovery model. Moreover, sleep quality is positively related to high-activation positive moods (e.g., enthusiastic, inspired) and negatively related to high-activation negative moods (e.g., tension, anxiety). Our multilevel structural equation model indicates that high-activation positive moods mediate the relationship between sleep quality and innovative behavior on a given day. These results are relevant for managing entrepreneurial performance.

INTRODUCTION

Innovative behavior, defined as the generation, exploration, championing, and implementation of innovative ideas (De Jong & Den Hartog, 2010; Janssen, 2000; Scott & Bruce, 1994), is at the heart of the enterprise creation process. However, an individual's ability to behave innovatively fluctuates on a daily basis (Orth & Volmer, 2017). To understand how innovative behavior unfolds, scholarly focus needs to shift from exploring innovative behavior from a static between-person perspective to one that accounts for individual variation. To date, however, limited attention has been given to understanding the dynamic and temporal nature of innovative behavior within an individual entrepreneur from one day to the next. This study investigates the drivers behind an entrepreneur's fluctuating *day-level* innovative behavior.

Innovative behavior at the day-level is essential for entrepreneurs, because they operate in unfamiliar territory (Casson, 2000; Lichtenstein, Dooley, & Lumpkin, 2006). However, on a given day, an entrepreneur may not always feel able to approach entrepreneurial work activities in an innovative manner due to a lack of physiological and psychological resources (e.g., feeling cognitively, emotionally and physically depleted). The Effort-Recovery Model (ERM) indicates that work depletes such physiological and psychological resources, leading to a reduction in performance during subsequent tasks (Meijman & Mulder, 1998). This reduction is particularly evident for performance in complex, unpredictable, cognitively-demanding activities (Meijman &

Mulder, 1998) such as innovative behavior. Notwithstanding, ERM suggests that resources can be restored.

Quality sleep is one particularly effective form of restoring physiological and psychological resources. Poor sleep quality impacts cognitive functions (Durmer & Dinges, 2005) and brain activity (Thomas, 2003). Poor sleep can be especially detrimental for adapting to new situations and thinking flexibly (Harrison & Horne, 1999). In the workplace, recent studies suggest that sleep quality may explain a significant portion of variance in performance outcomes (Barnes, 2012; Budnick & Barber, 2015; Litwiller, Snyder, Taylor, & Steele, 2017; Mullins, Cortina, & Drake, 2014). For instance, studies utilizing samples of employees show that with impaired sleep and the resulting inadequate restoration of resources, the level of proactive and engaged work behavior the following day tends to decline (Kühnel, Zacher, de Bloom, & Bledow, 2016; Nägel & Sonnentag, 2013) and the time spent procrastinating increases (Kühnel, Bledow, & Feuerhahn, 2016). Sleep has received little attention within the field of entrepreneurship even though fluctuations in sleep quality may have a particularly pronounced effect on an entrepreneur's ability to operate at his or her innovative best.

In addition, sleep impacts how one *feels* (Gish & Wagner, 2016). Better sleep quality relates to experiencing more positive and less negative moods in contrast to poor sleep quality which produces less positive and more negative frames of mind (Bouwmans, Bos, Hoenders, Oldehinkel, & de Jonge, 2016; Kamphuis, Meerlo, Koolhaas, & Lancel, 2012). Moreover, entrepreneurship scholars have demonstrated that an entrepreneur's positive and negative feelings (their moods, emotions and affectivity[1]) are linked to entrepreneurial cognition and behaviors

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[1] While these constructs have significant conceptual overlap, emotions tend to be more short-lived and intense than moods. Moods are more generally experienced, lingering affective states not as easily attributable to a particular emotion-eliciting event (Frijda, 1986). Moreover, moods can last "for hours, sometimes for days" (Ekman, 1994, p. 56).'Affect,' on the other hand, is an umbrella term that can be used interchangeably with *emotion, mood, and trait affectivity*. The latter relates to an individual's tendency for affective experiences.

(Delgado-García, De Quevedo Puente, & Blanco Mazagatos, 2015). Indeed, some report that an individual's high activation positive mood directly predicts their dedication and absorption in work tasks (Ouweneel, Le Blanc, Schaufeli, & van Wijhe, 2012) and employees' weekly innovative workplace behavior (Madrid Cabezas, Patterson, Birdi, Leiva, & Kausel, 2014). Contrarily, these correlations have not been found when studying high-activation negative moods[2] (Madrid Cabezas et al., 2014). Regardless of the centrality of mood to sleep and innovative behavior, mood as a potential mediator between sleep and workplace outcomes scarcely has been examined (Cai, Mednick, Harrison, Kanady, & Mednick, 2009; Harrison & Horne, 1999; Nelson, Dell'Angela, Jellish, Brown, & Skaredoff, 1995; Wagner, Gais, Haider, Vergeler, Born, 2004).

To reverse that trend and to explain the role of mood as mediator between sleep and innovative behavior, we draw on Broaden and Build Theory (Fredrickson, 2001). This approach postulates that positive moods broaden and negative moods narrow thought-action repertoires which, in turn, affect scopes of attention, cognition and action (Fredrickson & Branigan, 2005). The implication is that a pleasant mood influences motivation positively (Bandura, 1989), allows for more exploratory thoughts and engenders creative fluency and flexibility which lead to enduring positive effects for the individual. However, a negative mood largely has the opposite effect on cognition and attention (Fredrickson & Branigan, 2005). To test this theory in relation to an entrepreneur's day-level innovative behavior, we focus on positive and negative moods high in activation. High-activation moods are associated with an immediate readiness for action (Russell, 2003) that otherwise can obscure the effect of a mood's positive or negative tone (Warr, Bindl, Parker, & Inceoglu, 2014). A high-activation focus thus allows for richer conceptual clarity (De

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[2] Some scholars propose that negative moods may play a more interactive and dynamic role in affecting proactive and creative outcomes (e.g., Bledow, Rosing, & Frese, 2013; Bledow, Schmitt, Frese, & Kühnel, 2011; George & Zhou, 2002, 2007; To et al., 2015). We account for high-activation negative mood's potentially dynamic role in our robustness checks (the affective shift model).

Dreu, Baas, & Nijstad, 2008; Parker, Bindl, & Strauss, 2010) when examining the mediating role of mood in an entrepreneur's day-level innovative behavior.

In this paper we developed a multi-level structural equation model to test the direct link between sleep quality and subsequent innovative behavior, including the mediating functions of high-activation positive and negative moods. Building on the aforementioned ERM (Meijman & Mulder, 1998) and Broaden and Build Theory (Fredrickson, 2001) while also focusing on high-activation moods (Warr et al., 2014; Yik, Russell, & Steiger, 2011), we make several contributions to entrepreneurship literature. First, we explore fluctuations in sleep, mood and innovative behavior at the day-level of analysis by drawing on a twice-per day experience sample with 121 entrepreneurs over a period of ten days. This within-person and state-like process perspective affords greater granularity in understanding the unfolding of innovative behavior in the context of early stage ventures. This is important as the exploration of within-person fluctuations from one day to the next is still scarce (Orth & Volmer, 2017) yet opens opportunities for identifying the situational determinants that drive an entrepreneur's inclination to innovate on a given day. Consequently, our study potentially provides empirical guidance on how to improve an entrepreneur's daily innovative behavior. Therefore, within-person fluctuations of innovative behavior warrant closer investigation to better understand the role of individual agency for entrepreneurial outcomes (McMullen, 2015; McMullen & Dimov, 2013).

Second, this study offers rare empirical evidence in support of the idea that sleep is particularly important for entrepreneurship (Gunia, 2017). We demonstrate that when an entrepreneur's sleep quality is high, innovative behavior the next day is high. When sleep quality is poor, innovative behavior may be impaired. Moreover, our research provides an important contribution to entrepreneurship theory and practice. In particular, it reinforces Gunia's (2017) theoretical argument that poor sleep quality has the potential to undermine an entrepreneur's ability to develop a venture successfully. Our study challenges popular rhetoric that celebrates poor sleep patterns and sleep deprivation among entrepreneurs (Miller, 2016; Surden, 2017) by highlighting the importance of sleep for the emotional well-being of entrepreneurs.

Third, we identify high-activation positive mood as an influential mediator between sleep and innovative behavior. This contribution is particularly valuable as it advances our understanding of the complex mechanisms through which entrepreneurs can achieve their innovative best. More specifically, our findings confirm that high-activation positive mood mediates the relationship between sleep quality and innovative behavior. At the same time, we find no support for the mediating role of high-activation negative mood. By focusing on moods that are similar in activation, but differ in valence, we advance our understanding on mood (Baas, De Dreu, & Nijstad, 2008; Foo, Uy, & Murnieks, 2015; Warr et al., 2014) and, more precisely, the specific role valence plays in explaining entrepreneurial outcomes.

EFFORT-RECOVERY AND INNOVATIVE BEHAVIOR

According to ERM, engaging in work tasks expends physiological and psychological resources (Meijman & Mulder, 1998). Innovative behavior is a complex work activity that draws intensively on such mental and physical resources. Innovative behavior contains a creative component and requires proactivity in initiating the generation, exploration, championing, and application of innovative ideas (Amabile, 1988; Scott & Bruce, 1994). Moreover, innovative tasks are unproven, uncertain and risky in nature and, therefore, highly cognitively demanding (Janssen, Van de Vliert, & West, 2004). In order to replenish these resources, ERM stresses that individuals need a break from stressors. Sleep provides a highly effective respite. In fact, for the restoration of physiological and psychological processes, empirical studies show that sleep remains imperative.

Sleep and innovative behavior

Sleep is a central resource renewal activity (de Jonge, Spoor, Sonnentag, Dormann, & van den Tooren, 2012; Nägel & Sonnentag, 2013). It entails a physical, cognitive and emotional separation from work and daily stressors (Barber, Grawitch, & Munz, 2012). In addition, sleep provides a restorative function to the body and parts of the brain (Schmidt, 2014). In fact, impaired sleep negatively affects psychology, physiology and brain function, particularly attention, divergent thinking (Harrison & Horne, 1999) and the regulation of behavior and mood. Without adequate sleep, individuals are less able to employ the effort necessary to act in harmony with their ideals (Barnes, 2012; Budnick & Barber, 2015; Litwiller et al., 2017; Mullins et al., 2014) nor to perform creative tasks (Weinberger, Wach, Stephan, & Wegge, 2018). Additional organizational studies demonstrate that sleep-impaired workers engage less in their work tasks (Lanaj, Johnson, & Barnes, 2014), are more likely to be distracted by non-productive pursuits (Kühnel, Bledow, et al., 2016; Wagner, Barnes, Lim, & Ferris, 2012) and are less likely to transmit ideas in a charismatic manner (Barnes, Guarana, Nauman, & Kong, 2016).

While sleep impairment admittedly can increase risk-taking behavior (Killgore, 2010), it also negatively influences creative performance in a broader manner (Wagner et al., 2004). For example, creative problem solving (Cai et al., 2009) and innovative idea-generating performance (Harrison & Horne, 1999) are shown to decline with inadequate sleep. In fact, the negative correlation between sleep impairment and cognitive performance is more apparent for tasks related to innovation than for other workday activities (May & Kline, 1987; Nelson et al., 1995). Therefore, sleep helps restore resources that are lost during the day, and, therefore, acts as a critical antecedent to entrepreneurs' day-level innovative behavior.

In summary, these findings attest to the important role of sleep as a restorative activity. We argue that innovative behavior arises as a function of energetic and computational processes supported by sleep. Sleep helps to renew resources, resulting in greater cognitive performance and effort investment in innovative behavior. Consistent with this position, we propose:

Hypothesis 1: *At the within-person level, sleep quality is positively related to an entrepreneur's innovative behavior.*

THE MEDIATING ROLE OF MOOD

ERM scholars acknowledge that reduced physiological and psychological resources may influence “changes in mood” (Meijman & Mulder, 1998, p. 24) such that poor quality sleep increases negative and decreases positive mood propensity (Feuerhahn, Sonnentag, & Woll, 2014). Yet, few organizational studies have accounted for the mediating potential of mood in the link between sleep and workplace behaviors (Cai et al., 2009; Harrison & Horne, 1999; Nelson et al., 1995; Wagner et al., 2004). To explain the mediating role of moods, we draw on Broaden and Build Theory which suggests positive moods broaden and negative moods narrow thought-action repertoires which then affect scopes of attention, cognition and action (Fredrickson, 2001; Fredrickson & Branigan, 2005). Because positive moods indicate that the environment is safe, they affirmatively influence perception, and allow for more exploratory thoughts, creative fluency and flexibility. On the other hand, negative moods largely have the opposite effect (Fredrickson & Branigan, 2005). Positive moods, in turn, help ‘build’ resources for sustained individual performance, contributing to longer-term effort-recovery and well-being (Fredrickson, 2001).

We apply Broaden and Build Theory specifically in the context of high-activation moods. High activation moods, such as enthusiastic, inspired (positive), anxious and tense (negative), tend to activate the body and mind (Russell, 2003). This is not necessarily the case with low-activation moods such as relaxed, calm (positive), depressed and dejected (negative). Scholars recently have demonstrated that activation can confound the interpretation of relationships between positive/negative mood and behavior (c.f., Baas et al., 2008; Foo et al., 2015). Positive moods tend to be inadvertently operationalized with scales reflecting high-activation positive moods while negative moods are generally represented with low-activation negative moods (Warr et al., 2014). Thus, the role of valence (mood’s intrinsic positive or negative tone) may be confused with the influence of activation. We seek to address this issue by focusing on moods that are similar in activation but differ in valence (Warr et al., 2014; Yik et al., 2011). We specifically focus on high-activation moods since they are closely tied to work behavior (Warr et al., 2014). A high-activation focus allows us to explore the role of valence over and above that of activation.

High-activation positive moods

High-activation positive moods are beneficial for creative and proactive pursuits (Madrid Cabezas & Patterson, 2018), and thus are likely to drive innovative behavior. The broadening function of positive moods promote expansive thought-action repertoires that lead to more novel thoughts and creative behavior. Moreover, a high-activation positive mood encourages variety-seeking behavior (Kahn & Isen, 1993) and a more positive perception of one's own capabilities (Janssen, 2003; Laguna, Razmus, & Żaliński, 2017). Consequently, in this context, it follows that entrepreneurs will engage in more innovative behavior due to greater ease in forming novel ideas (Baas et al., 2008) as well as an enhanced ability and desire to construct and implement creative solutions.

Indeed, evidence shows that the correlates of day-level innovative behavior generally benefit from a high-activation positive mood. This state of mind has been found to predict engaged work behavior (Ouweneel, Le Blanc, Schaufeli, & van Wijhe, 2012) and risk-taking (Mittal & Ross, 1998). Moreover, at a cognitive level, positive moods, particularly *high*-activation ones (Baas et al., 2008), have been shown to engender modes of thinking that are useful for idea-generation activities (Förster, 2012; Fredrickson, 2001; Isen, 2001). In fact, research at the weekly level of analysis found that when employees noted experiencing enthusiasm, joy and inspiration in the previous week, they were more likely to report higher innovative workplace behavior the subsequent week (Madrid Cabezas et al., 2014).

Based on this evidence, we argue that positive moods that are *high in activation*, produce modes of thinking and a propensity for action particularly beneficial for innovative behavior. As such, we expect that high-activation positive moods will lead to higher innovative behavior.

***Hypothesis 2a**: At the within-person level, high-activation positive mood is positively related to an entrepreneur's innovative behavior.*

We suspect that the proposed relationship between sleep and innovative behavior may be partially explained by the role of moods. High-quality sleep relates to feeling recovered upon waking, and is thus inherently linked to pleasant moods. A wealth of literature indicates that sleep quality closely ties to emotional experiences and, specifically, the propensity for high-activation positive moods (Bouwmans et al., 2016; Scott & Judge, 2006). Correspondingly, evidence suggests that high-activation positive moods will, in turn, drive effort investment towards innovative behavior (Madrid Cabezas et al., 2014). Considered in unison, these findings indicate that high-sleep quality may drive innovative behavior. In other words, sleep helps replenish resources and thus assists entrepreneurs in feeling more energized as well as excited and inspired to engage in innovative tasks. Therefore, we postulate that these high-activation positive moods will mediate the relationship between sleep and innovative behavior.

***Hypothesis 2b**. At the within-person level, high-activation positive mood mediates the relationship between sleep and an entrepreneur's innovative behavior.*

High-activation negative moods

High-activation negative and positive moods impact cognitive processes in many opposing ways, and, as such, may have opposite effects on innovative behavior (Fredrickson, 2001). High-activation negative moods narrow thought-action repertoires by reducing the "scopes of attention, cognition and action" (Fredrickson & Branigan, 2005, p. 315). This influences what information is noticed and how it is recombined, resulting in diminished fluency and flexibility which particularly affects creative performance (Fredrickson & Branigan, 2005). Moreover, high-activation negative moods can lead to distracting ruminative thought (Martin & Tesser, 1996; Thompson, Webber, & Montgomery, 2002) and can redirect attention towards the circumstance that elicited the mood (Easterbrook, 1959). Furthermore, high-activation negative moods can reduce an individual's information processing abilities (Kahneman, 1973). Not surprisingly, therefore, high-activation negative mood has been linked negatively to entrepreneurial behavior and cognition (Grichnik, Smeja, & Welpe, 2010; Welpe, Spörrle, Grichnik, Michl, & Audretsch, 2012).

While narrowed thought-action repertoires' common to high-activation negative moods contain some creative benefits, they mainly are limited to the incubation stages of creative tasks (De Dreu et al., 2008; Nijstad, De Dreu, Rietzschel, & Baas, 2010) such as issue identification (Sonnentag & Starzyk, 2015). Reduced creative fluency and flexibility limits an individual's range of novel solutions for the generation, exploration, championing, and implementation of innovative ideas (De Jong & Den Hartog, 2010; Janssen, 2000; Scott & Bruce, 1994). Therefore, the cognitive effects of high-activation negative moods run contrary to the dominant creative demands of innovative behavior.

Moreover, high-activation negative moods may influence innovative behavior negatively through its role on perception. Subjective interpretations impact an individual's understanding of their ideas and abilities. As such, in a high-activation negative mood, entrepreneurs may undervalue their current capacity (Chang, Algoe, & Chen, 2017; Martin, Ward, Achee, & Wyer, 1993) and, in turn, feel they have less to invest into the effort-intensive activities required for innovative behavior. Accordingly, high-activation negative moods ultimately may erode an entrepreneur's motivation for taking action in innovative tasks (Bandura, 1989), and thereby influence innovative behavior negatively through a perception pathway.

In summary, high-activation negative moods drive a narrow scope of attention and cognition which is ill-suited to the majority of innovative behavior activities. High-activation negative moods, moreover, impact judgment which may influence the motivation an entrepreneur needs to take action on an idea. In accordance with this reasoning, we propose that high-activation negative moods will hamper the innovative behavior of entrepreneurs.

Hypothesis 3a*. At the within-person level, high-activation negative mood is negatively related to an entrepreneur's innovative behavior.*

High-activation negative moods may partially account for a negative relationship between sleep quality and innovative behavior. Research indicates that poor sleep tends to beget negative moods. In fact, experiencing a poor night's sleep can produce feelings of frustration and tension, i.e., high-activation negative moods (Sonnentag, Binnewies, & Mojza, 2008). In addition, individuals following sleep impairment are more susceptible to noticing and perceiving negative stimuli (Barber & Budnick, 2015; Yoo, Gujar, Hu, Jolesz, & Walker, 2007). Additionally, it is difficult to regulate and control moods and emotions when sleep is impaired (Gujar, McDonald, Nishida, & Walker, 2011; Minkel et al., 2012). The propensity, therefore, for experiencing negative moods and unambiguously high-activation negative moods, is greater when sleep quality is low (Bouwmans et al., 2016; Kamphuis et al., 2012).

Based on the logic that low-sleep quality leads to high-activation negative moods, which in turn produce harmful effects on innovative behavior of entrepreneurs, we propose the following hypothesis:

Hypothesis 3b*. At the within-person level, high-activation negative mood mediates the relationship between sleep quality and an entrepreneur's innovative behavior.*

Figure 1 displays the conceptual model we propose with these hypotheses.

"Insert Figure 1 Here."

METHOD

Data were collected from 121 entrepreneurs in two distinct stages. First, we measured demographic and personal data via a baseline survey. Next, throughout the course of ten working days (Monday to Friday), we collected information twice daily through the use of a signal contingent experience sampling methodology (ESM). This methodology excels in measuring dynamic person-centered interactions in real-world settings (Ohly, Sonnentag, Niessen, & Zapf, 2010) by capturing the variance during an actual work day and following the unfolding of events through within-person assessments at different points in time (Uy, Foo, & Aguinis, 2009). In our study, sleep and mood were reported through a smartphone application (MetricWire) during the mid-morning followed by descriptions of innovative behavior in the afternoon.

Sample

We recruited participants from Start-Up Chile, a renowned publicly funded ecosystem accelerator in Chile. From 190 entrepreneurs invited to participate in the research, 133 completed the baseline survey. Of these, 12 subsequently were removed from the study due either to not having compatible mobile devices or to an unexpected inability to work during the data-collection period. The final sample of 121 entrepreneurs represented a participation rate of 64% with all 121 completing the experience sampling survey. After an average of 11.5 weekdays, participation ceased when valid surveys were matched between the morning and afternoon for 10 unique days. This produced a total of 20 ESM surveys and one baseline survey per participant (2,420 total ESM surveys or 1,210 Level 1 data points). ESM responses were considered valid if the respondent completed the survey within two hours of the morning and afternoon survey notifications (Uy et al., 2009). In return for receiving support from the accelerator program, Start-Up Chile required participants to earn a certain number of credits by engaging with the wider startup community. By participating in our study, respondents qualified for such credits.

The sample consisted of young (m = 30 years) and predominantly male (83%) entrepreneurs in high-growth potential, early stage start-ups (less than two years old). The majority held university degrees in technical subjects and had previous experience in entrepreneurship (74%). The demographic data obtained from the accelerator indicated no significant demographic differences between the respondents and the entrepreneurs who did not respond to the invitation to participate.

Measures

Previously validated measures were drawn from prior literature and shortened for the experience sampling survey. Using a reduced number of items is typical in ESM designs due to the repetitive nature and short time-frame in which participants report (Fisher & To, 2012; To, Fisher, & Ashkanasy, 2015). To ascertain that the shortened scales represented the original scale, we conducted a pilot study with 30 respondents. Correlations between the focal variables did not change significantly when comparing short and full scales.

Innovative behavior, a proxy for innovative work behavior, was measured using four items from de Jong and Den Hartog's (2010) ten-item measure ($\alpha = 0.88$). The wording of the items was adapted slightly to reflect the short time periods and self-reflective reporting. Participants were asked to indicate on a five-point Likert scale (1 = none to 5 = a great deal) to what extent, during the past hours, they had 1) generated original solutions for problems, 2) wondered how things could be improved, 3) attempted to convince people to support an innovative idea, and 4) put effort into developing something new. These items represent one item from each of de Jong and Den Hartog's (2010) four innovative behavior dimensions: idea generation, idea exploration, idea championing and idea implementation.

We measured *mood* by using eight items of the Multi-Affect Indicator (Warr et al., 2014) representing a high-activation positive mood ($\alpha = 0.88$), a high-activation negative mood ($\alpha = 0.81$), a low-activation positive mood ($\alpha = 0.76$) and a low-activation negative mood ($\alpha = 0.92$). During the mid-morning period, participants were asked to indicate on a five-point Likert scale (1 = very slightly or not at all to 5 = extremely) the extent to which they felt enthusiastic, inspired, anxious, tense, relaxed, calm, depressed, or dejected. Comments from the first 32 participants suggested an excessive number of items were present in the survey. In response, we made a slight change in the data-collection strategy, removing the low-activation negative mood items.[3] The feedback on the burden of the study improved after this reduction in size. No significant differences were detected in the independent variables when comparing responses from the group reporting a day-level low-activation negative mood with the group who did not report experiencing this mood.

Subjective sleep quality was measured each morning using an item of the Pittsburgh Sleep Diary measure (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989; Monk et al., 1994). Participants were asked to indicate on a five-point Likert scale (1 = very poor to 5 = excellent) how they evaluated their night's sleep. This measure of sleep quality has demonstrated validity as a single item and has been utilized widely (Hahn, Binnewies, Sonnentag, & Mojza, 2011; Kühnel et al., 2016; Sonnentag et al., 2008). While both poor-sleep quality and low-sleep quantity strongly and significantly correlate with each other (Litwiller et al., 2017), the variance in day-to-day sleep quality tends to be higher for working adults (Kühnel et al., 2016). Sleep quality, therefore, is often a stronger predictor of workplace behavior (Barnes et al., 2016; Kühnel, Bledow, et al., 2016; Litwiller et al., 2017). Moreover, subjective sleep ratings tend to demonstrate a high level of accuracy when compared to objective sleep measures (O'Donnell et al., 2009) such as via polysomnography (Åkerstedt, Hume, Minors, & Waterhouse, 1994; Fung, Nguyen, Moineddin, Colantonio, & Wiseman-Hakes, 2014).

Control variables. Age, gender, nationality, product/service functionality, trait affectivity, and entrepreneurial self-efficacy were utilized as Level 2 control variables. Education also may influence behavior and mood, but as this factor lacks variance in our study, it was precluded. Since trait affectivity has been found to impact innovative behavior (Baron & Tang, 2011) and is widely

[3] Some 32 participants recorded a low-activation negative mood over a 10-day period, yielding 320 responses for this construct. Low-activation negative mood also was included in the multiple mediation model. Mplus requires a minimum of 0.1 covariance coverage when missing data is present (Muthén & Muthén, 2017). The low-activation negative mood has 0.264 covariance coverage, and meets the minimum covariance coverage required for inclusion in the multilevel model.

accepted as an important control for mood-related research (Madrid Cabezas et al., 2014; To et al., 2015; Uy, Sun, & Foo, 2017), it was justified as a control variable in the present study (Bernerth & Aguinis, 2016). Furthermore, previous research indicates that gender (Brody & Smith-Lovin, 1995; Robinson & Clore, 2002), nationality (De Dreu, 2010; Elfenbein & Ambady, 2003), age (Venz & Sonnentag, 2015), and self-efficacy (Frese, Garst, & Fay, 2007; Parker, Williams, & Turner, 2006) all heterogeneously influence day-level mood and entrepreneurial behaviors.

Innovation requirements may also influence the level of engagement in day-level innovative behavior (cf. Rosing & Zacher, 2016). As such, we controlled for the functionality of products or services in the analyses. Respondents were asked to identify the current stage of their product or service: classed as being at the concept and working prototype in development stage (coded as 0) or at the functional product/service and scaling stage (coded as 1). Trait affectivity was measured with ten positive (PTA, $\alpha = 0.89$, 0 = very slightly or not at all to 10 = extremely) and ten negative emotions (NTA, $\alpha = 0.83$) from the Positive and Negative Affect Schedule by Watson and Clark (1994). We measured entrepreneurial self-efficacy with a four-item scale (α = 0.75, 1 = no confidence to 5 = complete confidence) developed by Zhao et al. (2005).

RESULTS

Analytical strategy

As a first consideration, we tested the fit of the hypothesized model variables to the data via confirmatory factor analysis using Mplus version 8 (Muthén & Muthén, 2017) to estimate our models. Table 1 highlights the various measurement models we tested during the confirmatory factor analysis. The change in chi-squared test statistics from Model 1 to Model 4 indicate that every model iteration provided a significantly better fit than the previous one. Measurement Model 4 from Table 1 showed the best fit with our data (χ^2 (51, N = 1210) = 74.252, p = .018, SRMR = .023, RMSEA = .019, CFI = .996), indicating that the measured items fit their respective latent constructs well in this particular model (Browne & Cudeck, 1993). Second, we considered the multilevel nature of the data. Since day-level responses (*n* = 1210) are nested within individuals (*n* = 121), the data has a hierarchical structure. Failure to adopt a multilevel strategy in such cases would inflate the likelihood of Type I and Type II errors (Bliese, 2002). Third, we focused on the nature of the hypothesized model which involves two simultaneous mediation variables and indirect effects.

In order to estimate the indirect paths from sleep quality to innovative behavior through both mood mediators at the same time and to account for the dependent nature of our data with observations nested within individuals, we employed a multilevel structural equation model, MSEM (Preacher, Zyphur, & Zhang, 2010). We constructed a 1-(1,1)-1 MSEM model since all model variables were observed at the individual level (i.e., Level 1 as indicated in the 1-(1,1)-1 naming convention) on 10 separate days over a two-week period. The first number in the naming convention refers to the sleep-quality variable, measured at Level 1. The second set of 'ones' in the middle of the naming convention refer to the two mediating variables: the high-activation positive and negative moods. The last number represents the outcome variable: innovative behavior. We measured all four model variables at Level 1. The MSEM method concurrently partitions and estimates between- and within-person associations among our model variables allowing us to account for the non-independence of multiple responses from the same individual.

"Insert Table 1 Here"

Although other multilevel modeling procedures, such as traditional MLMs, require person-mean centering of Level 1 variables and grand-mean centering of Level 2 variables, MSEM does not require the mean centering of variables. This is because an MSEM model separates each observed Level 1 variable into latent, within and between components (Preacher et al., 2010). The partitioning in MSEM alleviates the confounds associated with a traditional MLM. These potential confounds include individual tendencies to rate items similarly over several measurement periods

(Ilies et al., 2007), or concerns that Level 1 observations might be confounded by personality or individual differences (Judge, Scott, & Ilies, 2006). As a precautionary analysis, we substituted mean-centered variables in each of our models after performing the main analysis. This substitution did not change the results reported below. In an additional effort to confirm the suitability of a multilevel modeling approach, we ran a series of unconditional models in Mplus to test for the presence of sufficient within-person variance as opposed to between-person variance. Our results indicated that 74.4% of the variance in sleep quality and 62.7% of the variance in innovative behavior resided at the within-person level. Additionally, 69.8% of the variance in high-activation positive mood and 58.5% of the variance in high-activation negative mood was within-person. In like manner, 70.3% of the variance in low-activation positive mood and 91.7% of the variance in low-activation negative mood took place within-person. Taken together, the nested nature of our data and the relatively large amount of within-person variance among the variables supported the appropriateness of a multilevel model for hypothesis testing.

Common-method variance

Any self-report research design holds the possibility of patterned responses from individual participants. Therefore, as a first step in reducing the potential for common-method variance, we introduced a time lag between collections of the independent and dependent variables each day (c.f., Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). This temporal separation consisted of independent variables being measured each morning, dependent variables each afternoon, and control variables on the day before the ESM began. Despite the use of a time lag, a concern remained regarding the potential patterns among individual responses. Thus we tested whether a common latent factor might fit the data as well as our confirmatory factor analysis. Common latent factor tests of model fit can help ameliorate common-method variance concerns in self-report research (Mossholder, Bennett, Kemery, & Wesolowski, 1998). The common latent factor analysis provided a poor fit with the data ($\chi2$ (39, N = 1210) = 3248.548, p < .001, SRMR = .170, RMSEA = .201, CFI = .448). These results did not necessarily disqualify the potential for common-method variance in our data. Nevertheless, the time-lagged collection of responses, along with the common latent factor analysis results, indicated that common-method variance was not a relevant concern with these data and that this variance was unlikely to confound the results from our analysis.

Hypothesis tests

*Within-person result*s. Table 2 shows both within- and between-person correlations among model and control variables. Hypothesis 1 predicted a relationship between sleep quality and innovative behavior. We constructed a simple multilevel model without mediators to test this relationship, controlling for time, days since previous survey, innovative behavior in the previous period, and high-activation moods in the previous period. The model revealed a significant and positive within-person association between sleep quality and innovative behavior (*c* path, *coeff.* = .108, *p* < .001, 95%CI [.052, .165]), thus supporting Hypothesis 1. Table 3 displays the within-person relationships between sleep quality and the mediating variables (*a* paths) in the MSEM models. Sleep quality had a significant positive relationship with both high-activation (*coeff.* = .315, *p* < .001, 95%CI [.259, .371]) and low-activation (*coeff.* = .237, *p* <.001, 95%CI [.176, .299]) positive mood. Although sleep showed a significant negative relationship with a high-activation negative mood (*coeff.* = -.130, *p* < .001, 95%CI [-.180, -.081]), we did not observe a similar relationship with a low-activation negative mood (*coeff.* = -.053, *p* = .146, 95%CI [-.124, .018]).

“Insert Table 2 and Table 3 Here”

The second and third sets of hypotheses anticipated that high-activation positive and negative mood would have a relationship with innovative behavior. An analysis of the association between within-person mood and innovative behavior (Model 1 in Table 4) revealed a significant positive relationship with high-activation positive mood (*coeff.* = .203, *p* < .001, 95%CI [.137,

.268]), supporting Hypothesis 2a. However, a high-activation negative mood did not have a significant relationship with innovative behavior (*coeff.* = .023, *p* = .526, 95%CI [-.047, .092]), in contrast to what we predicted in Hypothesis 3a.

The mediation hypotheses predicted that high-activation moods should mediate the relationship between sleep quality and innovative behavior, implying that high-activation mood measures offered more explanatory power in our model than their counterpart low-activation mood measures. Table 4 displays the indirect path estimates from sleep quality to innovative behavior through each type of mood in the model. The indirect path through high-activation positive mood (Model 2 in Table 4) was positive and significant (*coeff.* = .062, *p* < .001, 95%CI [.035, .088]), supporting Hypothesis 2b. The model did not support Hypothesis 3b which predicted mediation through high-activation negative mood (*coeff.* = -.003, *p* = .475, 95%CI [-.012, .006]). Furthermore, the path from sleep to innovative behavior was not mediated by low-activation positive (*coeff.* = .008, *p* = .292, 95%CI [-.007, .023]) or negative (*coeff.* = -.002, *p* = .638, 95%CI [-.009, .005]) mood. Figure 2 includes path and mediation results from our main model (Model 1 in Table 4).

"Insert Table 4 and Figure 2 Here"

Alternative explanations and robustness checks

Our model assumes that the previous night's sleep quality impacts innovative behavior during the day. We acknowledge, however, that innovative behavior or mood could influence the following night's sleep quality (Kühnel, Sonnentag, & Bledow, 2012; Pressman, Jenkins, Kraft-Feil, Rasmussen, & Scheier, 2017) and then, in turn, impact innovative behavior the following day. To test the relationship between the previous day's variables and the following night's sleep, we constructed time-lagged variables both for innovative behavior and high-activation positive mood. These variables enable a test of cyclical, day-to-day patterns within individuals.

To test the possibility of these cyclical effects, we designed two separate mediation models. The first model tested mediation paths from the previous day's high-activated mood to sleep quality that night, to innovative behaviors the following day. The results of this model indicated that the previous day's high-activated positive mood indeed did improve sleep quality that night and innovative behavior the following day (*coeff.* = .013, p = .046, 95%CI [.000, .025]). The second model tested mediation paths from the previous day's innovative behavior to sleep quality that night to innovative behaviors the following day. Results from this model indicated a significant relationship between innovative behavior from one day to the next, mediated by sleep quality (*coeff.* = .012, p = .050, 95%CI [.000, .024]). The results from these alternate models, although pointing to weaker indirect relationships than our main mediation model, substantiate the possibility for cyclical influences of day-level moods and sleep on innovative behavior.

We did not detect differences in the results with the exclusion of Level 2 control variables (Bernerth & Aguinis, 2016). Furthermore, the results remained unchanged when controlling for day effects (Level 1), i.e., the number of days elapsed since the previous survey, and the previous day's innovative behavior and moods. Similarly, when including low-activation mood variables as potential mediators, the pattern of within-person indirect results remained the same (see Table 4), thereby adding to the robustness of the model results. The model results above all include Level 1 control variables.

The interplay between mood and innovative behavior also may be more complex than we hypothesized. For example, Bledow, Rosing and Frese (2013) substantiate that a shift in mood throughout the day has a stronger effect on creativity than a day where moods remain relatively stable. In their sample of working professionals, these scholars found that creativity flourished in conditions where positive mood increased *and* negative mood decreased throughout the day. Known as affective shift, it stands to reason that innovative behavior might be affected by mood shifts in a similar fashion, particularly since positive moods relate to resource recovery as we earlier argued. Thus, as a final check of alternate explanations, we tested for the possibility of affective shift among our sample of entrepreneurs by reconstructing a results table originally designed by Bledow and colleagues (See Bledow et al., 2013). We did not find support for affective shift among these model tests.

DISCUSSION

The results of our study suggest that an entrepreneur's innovative behavior is at the mercy of their sleep. Drawing on ERM and Broaden and Build Theory, we found that with higher quality sleep, an entrepreneur's subsequent day-level innovative behavior also was higher. Additionally, a better-rested entrepreneur is more likely to experience more high-activation positive moods and fewer high-activation negative moods. Interestingly, we found that high-activation positive moods mediated the relationship between sleep quality and innovative behavior. Thus, while sleep was a significant driver of day-level entrepreneurial behavior, the influence of high-activation positive moods largely explained this relationship. Conversely, while poorer sleep quality predicted high-activation negative moods, these moods did not appear to predict innovative behavior.

Theoretical implications

First, by focusing on within-person variance in sleep, mood and innovative behavior, our findings highlight the important role of fluctuations in day-level behaviors. New ventures emerge from an iterative process (Foo, Uy, & Baron, 2009) and not necessarily from a single act or solitary decision (Alvarez & Barney, 2007; Dimov, 2007). As such, focusing on within-person fluctuations of innovative behavior advances our understanding of the role of individual agency for entrepreneurial outcomes (McMullen, 2015; McMullen & Dimov, 2013). Markedly, the reduction in innovative behavior on a particular day may be costly in entrepreneurship where the efficacious and imaginative use of limited resources is vital. This study, therefore, furthers behavioral views in entrepreneurship research by bringing further insight into the dynamic character of entrepreneurial behavior (Foo et al.,, 2009; Uy et al., 2017) and illustrating the centrality of mood as a driver of that variation (Cardon, Foo, Shepherd, & Wiklund, 2012; Delgado-García et al., 2015).

Second, Gunia (2017) recently challenged scholars to consider the ways in which sleep might help or hurt entrepreneurial behaviors. We responded by taking a first step in understanding how sleep quality relates to the innovative behavior in an early-stage entrepreneurship context. We provide relevant insights about the implications of sleep fluctuations in entrepreneurially oriented tasks such as generating, exploring, championing, and implementing innovative ideas in entrepreneurship (c.f., Gish, Wagner, Barnes, & Grégoire, 2018). More importantly, we contribute empirical evidence that suggests poor sleep quality has the potential to undermine an entrepreneur's ability to develop a new venture successfully. This finding challenges entrepreneurship rhetoric rife with persuasive arguments for low-sleep quality and quantity (e.g., Routledge, 2016; Sklinar, 2015).

Instead, our research points to the *importance* of sleep for the health and well-being of entrepreneurs. The study's results emphasize the relevance of sleep for experiencing more positive and fewer negative moods, and, thereby, providing important work-related resources. Other research indicates that sleep also is an important construct for short- and long-term mental, emotional and physical health as well as work safety (Barnes & Drake, 2015; Barnes & Wagner, 2009; Mullins et al., 2014; in accordance with ERM Meijman & Mulder, 1998). Despite the centrality of sleep for well-being and work performance (Barnes, 2012; Litwiller et al., 2017) and the calls for empirical research on the bi-directional relationships between well-being or health-related behaviors and entrepreneurial outcomes (Cardon & Patel, 2015; Shepherd & Patzelt, 2015), entrepreneurship scholars largely have been silent on the topic of sleep with a few exceptions

(Gunia, 2017). Consequently, this study provides a starting point for exploring the link between sleep, emotional well-being (Stephan, 2018) and innovative behavior.

Third, this research has implications for the debate on how mood drives behavior. Importantly, our study reveals that high-activation positive moods, in particular, mediate the relationship between sleep and innovative behavior. This finding goes beyond what already has been published on the link between sleep and innovative type behaviors (cf., Weinberger et al., 2018). Previous studies only examined the relationship between sleep and innovative thinking tasks, leaving out the role of mood in explaining this effect (Cai et al., 2009; Harrison & Horne, 1999; Nelson et al., 1995; Wagner et al., 2004). We extend this line of reasoning to entrepreneurship by identifying an influential mediating mechanism.

Interestingly, despite the postulated influence, we found no relation between high-activation negative moods and innovative behavior. This may suggest opposing effects between activation and valence (cf. Fay & Sonnentag, 2012) and a contrasting influence of mood on the convergent and divergent tasks found in innovative behavior (c.f., Bledow, Frese, Anderson, Erez, & Farr, 2009). In other words, although a high-activation negative mood may be largely ill-suited to divergent tasks and, therefore, runs contrary to the dominant demands of innovative behavior, this effect may be obscured. High-activation negative moods might have a positive effect on innovative behavior since they drive action (Russell, 2003). This may be particularly beneficial for the initiation of innovative behavior (Sonnentag & Starzyk, 2015) and for tasks that require convergent processes (i.e., idea evaluation: Bledow et al., 2009). Notwithstanding, we did not discover any evidence to indicate that high-activation negative moods played a dynamic role in influencing innovative behavior when applying an affective-shift model (Bledow, Schmitt, Frese, & Kühnel, 2011). As such, this topic warrants additional exploration. Nonetheless, the conclusions from our present study contribute to the recent calls for research incorporating the activation function of mood in addition to valence (Foo et al., 2015; Warr et al., 2014) while also substantively exploring the role of high-activation negative moods.

Importantly, the results in relation to the mediating role of mood, raise compelling theoretical questions. According to the emotion-as-feedback theory,[4] individuals consider the emotional consequences of behavior, and then pursue the emotional outcomes they desire through their behavior (Baumeister et al., 2007). Conversely, the emotion-as-direct-causation view holds that behavior is a direct outcome of previous emotion. Yet innovative behavior is broadly considered to be a “risky” behavior (Janssen et al., 2004) that potentially may produce negative emotional outcomes in the short-term. In other words, the emotional outcomes of innovative behavior are not certain a priori. Therefore, the current study provides a different lens for viewing the emotion-as-feedback and emotion-as-direct-causation debate by connecting mood, sleep and innovative behavior through quantitative research.

Our results provide evidence to suggest that such emotionally risky behavior holds a higher appeal to entrepreneurs when they experience a more highly-activated positive mood than usual. Thus, entrepreneurs may be more likely to take the emotional risk inherent in engaging in innovative behavior (Janssen et al., 2004) because physiological and psychological resources are available and not compromised (Meijman & Mulder, 1998). In addition, the entrepreneurs’ appraisals of the likelihood of future emotional outcomes may be more positively influenced from a high-activated positive mood. While future research is needed to tease apart the effect of current mood states in ascertaining appraisals of future emotional outcomes versus perceptions of current affective resources (DeWall, Baumeister, Chester, & Bushman, 2016), this study contributes to theory by illustrating the importance of considering mood when studying subsequent behavior.

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[4] We thank an anonymous reviewer for this point.

Limitations

Definitive causative conclusions cannot be drawn from this study alone. Scholars should replicate this research in a range of entrepreneurial contexts and laboratory settings to identify conclusive causative relations. Nonetheless, our findings are largely consistent with isolated controlled laboratory studies which have respectively tested causal relationships between sleep, mood and innovative-type behaviors. Moreover, our research design collected snapshots of sleep, together with mood and innovative behavior, twice per day for two weeks. We employed both a lagged and a time-dependent analysis to explore the unfolding of events. Regarding generalizability, however, the sampling procedure did not draw on the general population of entrepreneurs, but rather made use of samples of convenience. Therefore, the potential for generalizing the findings presented in this study to all entrepreneurs, beyond that which is speculative in nature, is limited.

The lack of support for Hypotheses 3a and 3b (i.e., the relationships between high-activation negative emotions and innovative behavior) may be explained by a lack of affinity between the variables of interest. That is, the innovative behavior measures used in our study may be naturally closer to positive emotions than negative ones. Our innovative behavior measures focused on the divergent dimension of the innovation process (idea generation, exploration, championing and implementation) in contrast to the convergent dimension (idea evaluation and selection). The dialectic model of innovation[5] (Bledow et al., 2009) suggests that the innovative process cycles between the divergent and convergent dimensions, and that these two dimensions have a heterogeneous affinity towards positive and negative emotions respectively. Thus, our findings may not offer a complete picture since we excluded convergent innovation behavior measures which are more strongly affected by negative emotions.

[5] We thank an anonymous reviewer for highlighting this point.

Additionally, self-reported measures involve potential weaknesses. In relation to mood, for example, disadvantages include interrupting participants during the course of their work and relying on emotional awareness. Fortunately, technological advances provide new possibilities for physiological measurement that may help avoid such issues (Eatough, Shockley, & Yu, 2016). For instance, in conjunction with self-reports, high activated-mood and sleep may be interpreted via physiological measures. Notwithstanding, self-reported measures currently are considered the standard approach to data collection in this field (Uy et al., 2009; Warr et al., 2014).

Finally, we cannot completely rule out the possibility of common-method variance, a potential issue in studies employing self-reported measures. However, this threat is reduced through the temporal separation of independent and dependent variables (Podsakoff et al., 2003) which we achieved by conducting surveys in the morning and afternoon. Additionally, our analyses focused on within-person variation, thereby reducing the emphasis on between-person patterned responses (cf. Raudenbush & Bryk, 2002).

Areas for future research

Our day-level longitudinal (ESM) study explored the link between sleep, mood and innovative behavior with a focus on the within-individual level of analysis. Nevertheless, scholars have identified that entrepreneurs often operate in groups or work closely with stakeholders (Harper, 2008). Thus, entrepreneurs' sleep, moods and behaviors can have significant outcomes on the experiences of others (Breugst & Shepherd, 2017). For example, teams may be susceptible to mood contagion (Anglin, McKenny, & Short, 2016; Barsade & Gibson, 2012). Conversely, individuals may have fundamental differences in sleep patterns (Volk, Pearsall, Christian, & Becker, 2017) and in their experience of mood (Drnovsek, Cardon, & Murnieks, 2009) which may lead to interesting interactions and outcomes in new venture teams.

Similarly, little is known of how an entrepreneur's sleep may impact the behavior and perceptions of others in the entrepreneurial team and beyond. What influence, for instance, does a single entrepreneur's sleep impairment have on various stakeholder behaviors and perceptions (Barnes, Lucianetti, Bhave, & Christian, 2015)? This factor could be particularly important for understanding funding and stakeholder decisions. Recent studies also indicate that restricted sleep influences social appeal and attractiveness (Sundelin, Lekander, Sorjonen, & Axelsson, 2017) as well as the degree of charisma in leaders' speeches (Barnes et al., 2016). Future research exploring this process at the group level will make valuable contributions to the literature.

To further complement the progress made in entrepreneurship research on mood, feelings and emotions (Cardon et al., 2012; Delgado-García et al., 2015), scholars have been calling for additional integration of psychological perspectives in alignment with the themes presented in this study (Shepherd, 2015). In addition to the implications for sleep, the present article highlights the need for more research on the role of resource recovery and mood in innovative behavior. As an example, the data in this study does not support the link between high-activation negative moods and innovative behavior. That conclusion indicates that further research should consider additional nuance and moderating factors that may untangle the role of possible opposing motivational and cognitive forces on innovative behavior and its dimensions (Fay & Sonnentag, 2012). A potential study could include Level 1 control variables and consider the role other factors such as entrepreneurial passion play in pushing entrepreneurs to "overcome obstacles and remain engaged" (Cardon, Wincent, Singh, & Drnovsek, 2009) when experiencing negative moods.

Practical implications

The present study's results suggest that innovative behavior is dynamic within individuals and may be manipulated by a seemingly simple construct: sleep quality. Regulating moods to achieve certain ends is notoriously taxing and difficult (Lyubomirsky, Sheldon, & Schkade, 2005; Mauss, Tamir, Anderson, & Savino, 2011). Sleep, on the other hand, can be significantly improved by better sleep hygiene (Barber, Rupprecht, & Munz, 2014; Lanaj et al., 2014).

We recommend that entrepreneurship educators challenge the popular rhetoric that tends to promote and glorify impaired sleep in entrepreneurship. Instead, we encourage educators to pay more attention to the body of knowledge on sleep-dependent learning that stresses the importance of sleep as well as short daytime naps for improving learning performance (Mednick, Nakayama, & Stickgold, 2003). Other than promoting dedicated napping zones for students on campus (Wise, 2018), educators could provide experiential learning for students in the form of daily sleep logs. In courses where students work in teams to develop their own ventures, daily logs and subsequent critical reflection could raise awareness of the importance of sleep and of the dynamic nature of innovative behavior. Similarly, entrepreneurial advisers could encourage entrepreneurs to leverage their decision-latitude (van Gelderen, 2016) in order to craft a role in their venture in a manner that observes good sleep practices.

CONCLUSION

Innovative behavior at the day-level is critical in entrepreneurship since the entrepreneurial process is fundamentally experimental and often resource-constrained (Baker & Nelson, 2005; Morris, Kuratko, Schindehutte, & Spivack, 2012). In this study we found that, on a given day, high-quality sleep enhanced an entrepreneur's innovative behavior and that high-activation positive moods mediated this relationship. These findings illustrate how entrepreneurs' day-level innovative behavior is susceptible to significant fluctuation and that sleep as a resource renewal activity plays a key role in influencing entrepreneurs' individual-innovative activities. We also demonstrated that considering activation and valence as interrelated aspects of mood is indeed a promising approach. Additionally, for sleep studies, this exploration emphasizes the mediating potential of mood. In conclusion, our study reveals that sleep may be a valuable resource for entrepreneurs and attests to the important contributions a focus on sleep and a day-level within-person perspective brings to the field of entrepreneurship.

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FIGURES AND TABLES

Table 1: *Confirmatory factor analysis model fit for various model configurations*

Model	χ^2	*df*	$\Delta\chi^2$	Δdf	*p*	CFI	TLI	RMSEA (90%CI)	SRMR
Model 1: One factor	3,248.55	65				.448	.338	.201 (.195, .207)	.170
Model 2: Four factors (combined mood valence)	1,104.59	60	2,143.96	5	< .001	.819	.765	.120 (.114, .126)	.125
Model 3: Four factors (higher-order activation)	209.94	56	894.65	4	< .001	.973	.963	.048 (.041, .055)	.068
Model 4: Six factors (full model)	74.25	51	135.96	5	< .001	.996	.994	.019 (.008, .029)	.023

Note. n = 1,210. Four and six factor models allowed the highest-order factors to correlate. CFI = comparative fit index; TLI = Tucker-Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual. $\Delta\chi^2$ = change in chi-squared test statistic from the previous model. Model 2 combines high and low-activation positive mood into one factor for positive valence, and combines high and low-activation negative mood into one factor for negative valence. Model 3 creates a higher-order factor for each type of mood activation, both high and low.

Table 2: *Descriptive statistics and between and within-person[a] correlations for study variables*

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
Level 1 (within-person)															
1. Sleep quality	3.58	1.10	–	0.38	-0.16	0.27	-0.04	0.14							
2. HA[b] positive mood	3.54	0.96	0.73	–	-0.18	0.34	-0.09	0.24							
3. HA negative mood	2.20	1.02	-0.46	0.02	–	-0.23	0.33	-0.03							
4. LA positive mood	3.10	1.00	0.14	0.30	-0.28	–	-0.14	0.12							
5. LA negative mood	1.45	0.79	0.03	0.12	0.56	-0.45	–	-0.01							
6. Innovative behavior	3.35	0.98	0.41	0.68	0.09	0.02	0.46	–							
Level 2 (between-person)[c]															
7. Age	29.59	6.40	0.14	0.13	0.13	-0.16	0.24	0.04	–						
8. Gender	0.83	0.38	-0.08	-0.02	-0.05	0.18	-0.31	-0.14	-0.04	–					
9. Functional product	0.50	0.50	0.07	0.20	0.14	0.14	0.58	0.22	-0.06	0.03	–				
10. Nationality	1.77	1.13	-0.29	-0.10	0.10	0.11	0.09	-0.07	-0.08	-0.04	0.15	–			
11. Trait positive affect	7.34	1.26	0.29	0.33	0.15	0.00	0.18	0.35	0.04	0.01	0.03	-0.26	–		
12. Trait negative affect	3.27	1.37	-0.32	-0.31	0.31	-0.33	0.15	-0.19	-0.20	-0.08	-0.14	-0.01	0.02	–	
13. Self-efficacy	7.44	1.28	0.18	0.22	0.14	0.00	-0.04	0.29	0.07	0.31	0.09	-0.02	0.41	-0.13	–

Note. Level 1, n = 1,210; Level 2, n = 121. Gender (0 = female, 1 = male). Functional product (0 = concept or prototype in development, 1 = functional product). Nationality (0 = Oceania, 1 = South America, 2 = Asia, 3 = Europe, 4 = North America). All between-person (within-person) correlations greater than or equal to .06 (.18) are statistically significant at the .05 level.
[a]Within-person correlations appear above the diagonal. [b]HA = high-activation, LA = low-activation. [c]Level 2 control variables.

Table 3: *Mediation model results for a paths*

Dependent variable	HA positive mood (*a1* path)	HA negative mood (*a2* path)	LA positive mood (*a3* path)	LA negative mood (*a4* path)
Model type	1-(1,1)-1		1-(1,1,1,1)-1	
Model number	1	1	2	2
Sleep	.315***	-.130***	.237***	-.053
	(.028)	(.025)	(.031)	(.036)
Observations	1210	1210	1210	320
Pseudo R^2	0.144	0.025	0.073	.005

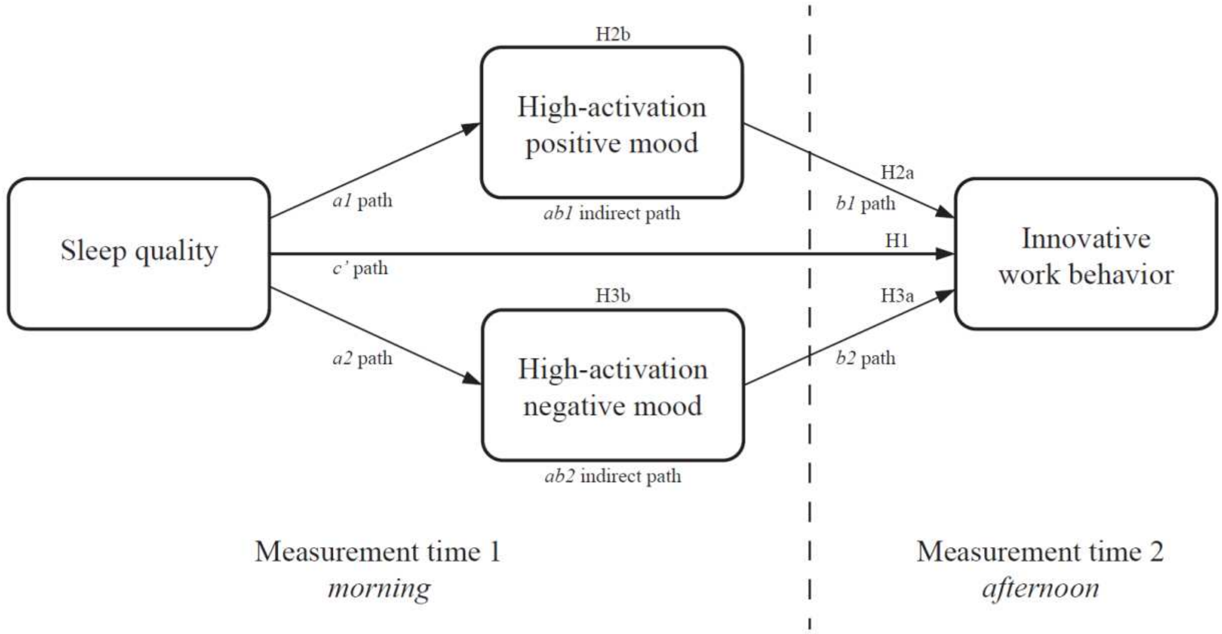
Note. This table is at the within-in person level of analysis, and presents the *a* paths of the MSEM mediation models (see Figure 1). *a* paths = first stage effect, from sleep to mood. HA = high-activation, LA = low-activation. Model 1 is a 1-(1,1)-1 model, that includes one exogenous predictor variable, two mediating variables, and one outcome variable, all measured at Level 1. Model 1 thus presents the association between sleep and high-activation positive and negative mood. Model 2 is a 1-(1,1,1,1)-1 model, that adds two mediating variables, both measured at Level 1. Model 2 therefore presents the association between sleep and high *and low*-activation positive and negative mood. Standard errors are in parentheses. *** $p < .001$

Table 4: *Mediation model results for c and c' paths, b paths, and ab (indirect) paths*

Dependent variable	Innovative behavior					
Model number and type	Model 0 *c* path		Model 1 1-(1,1)-1		Model 2 1-(1,1,1,1)-1	
	estimate	*SE*	*estimate*	*SE*	*estimate*	*SE*
Direct effects						
Sleep (*c* and *c'* paths)	.108***	(.029)	.047	(.030)	.044	(.029)
HA positive mood (*b1* path)			.203***	(.033)	.195***	(.036)
HA negative mood (*b2* path)			.023	(.036)	.025	(.036)
LA positive mood (*b3* path)					.034	(.032)
LA negative mood (*b4* path)					.033	(.063)
Indirect effects						
HA positive mood (*ab1* path)			.064***	(.013)	.062***	(.014)
HA negative mood (*ab2* path)			-.003	(.005)	-.003	(.005)
LA positive mood (*ab3* path)					.008	(.008)
LA negative mood (*ab4* path)					-.002	(.004)
Level-1 control variables						
Day (time control)	.004	(.010)	.007	(.009)	.007	(.009)
Days since previous survey	.002	(.022)	-.006	(.021)	-.006	(.021)
Previous period IWB	.030	(.040)	.038	(.040)	.036	(.041)
Previous period pos. mood	.032	(.041)	-.004	(.040)	-.004	(.041)
Previous period neg. mood	-.003	(.034)	-.004	(.034)	-.006	(.035)
Observations	1210		1210		1210	
log*L*	-11143.0		-16362.2		-18257.9	
Pseudo R^2	0.075		0.114		0.116	
Free parameters	22		88		108	

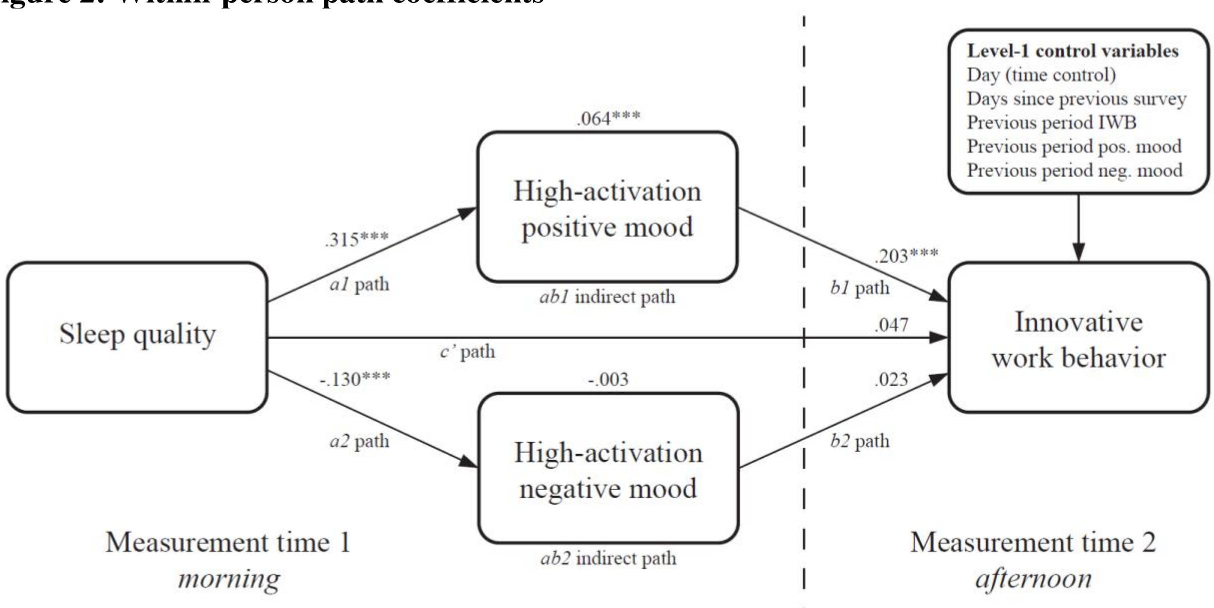
Note. This table is at the within-person level of analysis. IWB is the dependent variable in all MSEM models. *b* paths = second stage effect, from mood to innovative behavior (IWB). *c'* path = direct effect, from sleep to IWB. *ab* paths = indirect effect coefficients, that is, the indirect effect of sleep on innovative behavior through the listed mediating variables. Previous period mood is represented by high-activation mood reported in the previous measurement period. Model 1, is a 1-(1,1)-1 model, that includes one exogenous predictor variable, two mediating variables, and one outcome variable, all measured at Level 1. Model 1 therefore demonstrates the association between sleep and innovative behavior, by way of high activation moods. Model 2 is a 1-(1,1,1,1)-1 model, that adds two mediating variables, both measured at Level 1. Model 2 thus shows the association between sleep and innovative behavior, by way of high *and low* activation moods. HA = high-activation, LA = low-activation.. *, **, and *** indicate statistical significance at the 5%, 1% and 0.1% level, respectively.

Figure 1: Within-person conceptual model of innovative behavior



Note. 1-(1,1)-1 model of innovative behavior. Time-lagged within-person effects were measured over a ten-day period. Each measurement time listed above has ten data points for each study participant (Level 1 n = 1,210; Level 2 n = 121).

Figure 2: Within-person path coefficients



Note. 1-(1,1)-1 model of innovative behavior (Model 1 in Tables 3 and 4). Path coefficients are reported on the arrows. Indirect effect coefficients are reported above the mediating variable. (Level 1 n = 1,210; Level 2 n = 121). *** $p < .001$.