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The Curvilinear Relationship Between Daily Time Pressure and Work Engagement: The Role of Psychological Capital and Sleep

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The present study focuses on the fluctuation in work engagement by examining the relationship between daily time pressure and daily work engagement. Based on the job demands-resources (JD-R) theory, this study also tests whether psychological capital and sleep moderate the influence of time pressure on work engagement. We conducted a diary study to gather 67 participants' data over 10 consecutive work days (502 daily measurement points), including their daily time pressure, work engagement, and sleep quality. Our results indicate that there is a curvilinear relationship between daily time pressure and work engagement in the form of an inverted U-shape. If it was lower than the optimal level, daily time pressure as a challenging stressor positively predicted daily work engagement. Substantial time pressure impaired daily work engagement. In addition, the curvilinear relationship between daily time pressure and work engagement was attenuated as a function of increasing psychological capital or chronic sleep quality. Specifically, compared with low psychological capital or chronic sleep quality, excessive time pressure could also positively predict daily work engagement if psychological capital or chronic sleep quality was high. In addition, this study provided preliminary evidence that daily sleep quality may not be enough to buffer the curvilinear relation. Implications for research on daily work engagement and intervention programs are discussed.

***Keywords**:* work engagement, time pressure, psychological capital, sleep, diary study

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With rapid economic development, organizations need to operate more efficiently to create value. At the same time, employees are faced with enormous time pressures daily. Re- searchers and enterprises must pay increasing attention to those positive psychological factors that can benefit the organization and bring happiness to employees. Accordingly, employees should not only have excellent skills and rich knowledge, but should also come to work in positive state. At the call of positive psychology, researchers and practitioners began to focus on work engagement. Work engagement is a work-related sense of well-being, a “perfect” state that allows people to experience positive emotional motives, including vigor, dedication, and absorption (Schaufeli, Salanova, González-Romá, & Bakker, 2002). Substantive research has indicated that engaged employees perform better. These studies have suggested that work engagement has a significant positive impact on performance (Bakker & Bal, 2010; Christian, Garza, & Slaughter, 2011; Salanova, Agut, & Peiró, 2005; Xanthopoulou, Bakker, Demerouti, & Schaufeli, 2009b) and health (Seppälä et

al., 2012). In recent years, researchers have begun to use a dynamic perspective to study the short-term fluctuations in work engagement and pay attention to day-level work engagement.

Because work engagement has an important impact on the individual and organization, much research has explored the antecedents of work engagement. Job demands-resources (JD-R) theory (Bakker & Demerouti, 2008) proposes that there were two main factors affecting work engagement: (a) job demands and (b) job resources. Job demands can consume psychological and physiological resources, whereas job resources, including physical and psychological resources, can supplement the loss caused by job demands (Bakker & Demerouti, 2017; Demerouti, Bakker, Nachreiner, & Schaufeli, 2001).

The present study is an exploration of the impact of specific job demands and resources on short-term work engagement from a dynamic perspective. Regarding job demands, in the present study, we focused on time pressure, which changes rapidly every day. Regarding job resources, sleep is an important contribution to physiological resources. Psychological capital, as an important psychological resource, has a significant impact on work engagement. Researchers have divided the antecedents of work engagement into two categories: situational factors and individual factors (Bakker, Demerouti, & Sanz-Vergel, 2014). Time pressure is a type of situational factor, whereas sleep quality and psychological capital are individual factors. Moreover, time pressure and sleep quality are more proximal predictors of an employee's work engagement state (Bakker, 2014).

Based on JD-R theory, combined with conservation of resources theory (COR; Hobfoll, 2011) and activation theory (Gardner & Cummings, 1988), we derived the following three propositions (see Figure 1). First, there is a curvilinear relationship between daily time pressure and work engagement. Second, daily sleep quality moderates the relations of time pressure to work engagement, such that the inverted U-shaped relationships are aggravated as a function of decreasing sleep quality. Third, psychological capital moderates the relations of time pressure and work engagement such that the inverted U-shaped relationships are aggravated as a function of decreasing psychological capital. In the following sections, we develop these predictions

in the framework of the JD-R model (Bakker & Demerouti, 2008) and other specific theories. Because of the short-term fluctuation of time pressure, sleep quality, and work engagement, we tested these predictions using a diary approach.

Development of Hypotheses Daily Time Pressure and Work Engagement

According to Schaufeli et al. (2002), work engagement is a positive mental state that includes vigor (employees feel full of physical energy), dedication (employees are enthusiastic about the content of their work and the things they do), and absorption (employees are so immersed in their work activities that time seems to fly). Work engagement initially referred to an enduring and persistent state of employees regarding their jobs. Although employees may have a high level of general work engagement, they may experience low work engagement on a specific day. That is, work engagement may vary from one day to another in response to specific situational and personal conditions (Sonnentag, Dormann, & Demerouti, 2010). Thus, *daily* work engagement was introduced to complement *enduring* work engagement (Bakker, 2014). The present study focused specifically on daily work engagement.

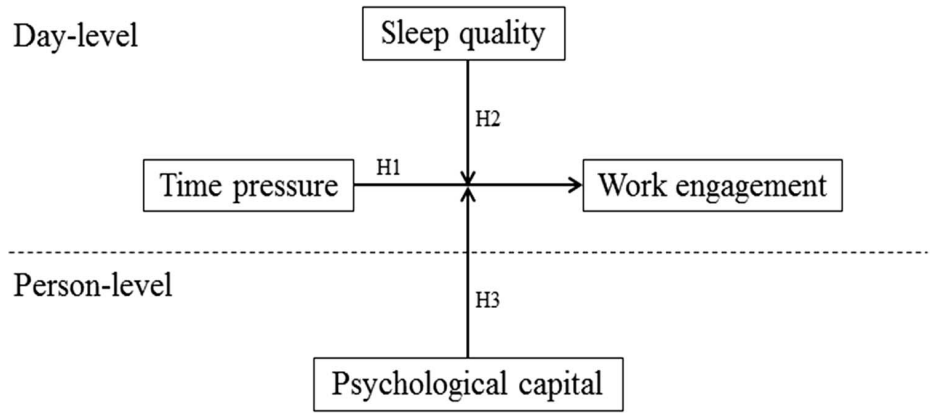

Figure 1. The proposed conceptual scheme.

Recently, researchers have focused on the short-term fluctuation of work engagement. Several studies have indicated that work engagement fluctuates significantly from day to day, and that these fluctuations can be predicted using the JD-R model (Bakker, 2014). Initially, the JD-R model proposed that job demands were unique

predictors of exhaustion, whereas job resources were unique predictors of engagement. Later, diary studies provided evidence that many forms of job resources, such as daily social support (Simbula, 2010; Xanthopoulou, Bakker, Heuven, Demerouti, & Schaufeli, 2008), daily autonomy (Xanthopoulou et al., 2009b), and job control (Kühnel, Sonnentag, & Bledow, 2012) had a significant impact on daily work engagement.

However, some researchers have proposed that job resources predict work engagement and that job demands can play a motivational role. J. A. Lepine, Podsakoff, and Lepine (2005) suggested that *challenge* stressors had a positive effect on motivation, whereas *hindrance* stressors had a negative effect on motivation. Based on the challenge– hindrance framework, Van den Broeck, De Cuyper, De Witte, and Vansteenkiste (2010) proposed the concept of challenge job demands and hindrance job demands in the JD-R model. Challenge job demands are defined as demands that require effort, but potentially promote employee personal growth and achievement. In contrast, hindrance job demands are defined as demands that require effort, but inhibit employee goal achievement (Bakker & Demerouti, 2017; Van den Broeck et al., 2010). However, there is still a lack of evidence to support the challenge– hindrance job demands framework in JD-R theory. It is important to distinguish between job demands that challenge and those that hinder.

Time pressure may be a considerable antecedent of daily work engagement for two main reasons. First, time pressure is some- times appraised as both challenging and hindering, depending on its level. Kühnel et al. (2012) conducted a diary study to test the linear relationship between time pressure and work engagement. In their study, 114 employees completed electronic questionnaires over 5 consecutive workdays. The results suggested that daily job control qualified the relationship between daily time pressure and work engagement. Specifically, when daily job control was higher, daily time pressure had a significant positive effect on daily work engagement. When daily job control was lower, daily time pressure had a significant negative effect on daily work engagement. However, this study ignored a possible nonlinear relationship between time pressure and work engagement.

Combined with activation theory (Gardner & Cummings, 1988), individuals are optimally stimulated when the activation resulting from time pressure is moderate. If

time pressure is too low, individuals feel bored, their attention is drawn away from work, and it is difficult to devote their energies to a task. If time pressure is too high, an individual stress response can occur, resulting in avoidance behavior and negative emotions. COR theory suggests that if stressful demands are too high, people often must choose to exit engagement processes in favor of meeting the demands of a serious challenge (Hobfoll, 2011). If time pressure is moderate, the individual can feel in control, work hard to complete the task, and then maintain a high level of motivation during work, thereby experiencing a positive mood. Schmitt, Ohly, and Kleespies (2015) conducted a cross-sectional study to examine the curvilinear relationship between time pressure and trait work engagement. Results from the data analysis of 191 employees indicated that there was an inverted U-shaped relation between time pressure and work engagement. However, their cross-sectional method ignored the dynamics and fluctuations of time pressure and work engagement. The dynamics of time pressure allow the accurate prediction of daily work engagement. The levels of time pressure may vary within the same employee from one day to another. Specifically, daily time pressure is a more flexible and proximal antecedent of daily work engagement. Diary studies enable researchers to capture the fluctuation of time pressure and work engagement at the day-specific level (Bakker, 2014). Recently, Reis, Hoppe, Arndt, and Lischetzke (2017) conducted a diary study to clarify the functional form (linear vs. curvilinear) of the relationship between daily time pressure and daily vigor/absorption, which are two dimensions of work engagement. According to the results of data analysis of 52 full-time employees over 10 consecutive workdays, there was an inverted U-shaped relationship between time pressure and vigor, but there was only a positive linear relationship between time pressure and absorption. For the present study, we intended to explore the relation between daily time pressure and daily work engagement as a whole, regardless of dimension. Based on the extended JD-R theory (Bakker & Demerouti, 2017) and activation theory (Gardner & Cummings, 1988), we proposed the first hypothesis.

Hypothesis 1: There is a curvilinear relationship between daily time pressure and daily work engagement.

The Moderate Effect of Daily Sleep Quality

Sleep, which conserves energy, is a fundamental requirement for human function (Siegel, 2005). Recently, authors have further extended the sleep literature into the organizational psychology literature (Barber, Munz, Bagsby, & Powell, 2010; Barnes, 2011, 2012). According to Buysse, Reynolds, Monk, Berman, and Kupfer (1989), sleep quality refers to "quantitative aspects of sleep, such as sleep duration, sleep latency, or number of arousals, as well as more purely subjective aspects, such as 'depth' or 'rest-fulness' of sleep." Recent research advances indicate that low sleep quality harms job satisfaction (Barnes, Ghumman, & Scott, 2013), increases workplace injuries (Kao, Spitzmueller, Cigularov, & Wu, 2016), and decreases charismatic leadership (Barnes, Guarana, Nauman, & Kong, 2016). The authors of these studies have suggested that sleep is an important individual resource in the workplace.

Work engagement requires resources that are already overcommitted in facing excessive time pressure. According to JD-R theory, there is an interaction effect between job demands and resources (Bakker et al., 2014). Job resources protect employees from the negative effect of hindering job demands. The reason for this effect is that job resources replenish energetic resources that are lost when meeting job demands by providing employees with fuel to cope with demands at work (Bakker et al., 2014; Breevaart & Bakker, 2017). Moreover, the attendant principle of the COR theory for engagement is that people must have the personal and environmental capacity to invest while they are addressing excessive daily time pressures (Hobfoll, 2011). This requirement suggests that they need strong energy resources, and they must have the capacity to attend the engagement process.

According to previous studies, sleep can be a vital resource. With a sample of 328 adult workers, Barber, Grawitch, and Munz (2013) conducted a cross-sectional study to test whether sleep hygiene can predict work engagement. The results indicated that the path from poor sleep hygiene to decreased work engagement was attributed to perceptions of personal resources that are needed to exert self-regulated energy at work. In addition, in a diary study (*N* 63), Diestel, Rivkin, and Schmidt (2015) tested whether sleep quality moderated the influence of emotional dissonance on daily work

engagement. The results indicated that the negative relation of daily emotional dissonance to daily work engagement is attenuated as a function of increasing daily sleep quality. As elaborated above and based on the extended JD-R theory (Bakker & Demerouti, 2017) and COR theory (Hobfoll, 2011), we propose that too much daily time pressure consumes resources and de- creases work engagement. We further argue that sleep quality facilitates coping with the daily hindered job demands. Otherwise, because of low resource availability, coping with excessive daily time pressure would be more straining if sleep quality on the previous night is low. Thus, we expected daily sleep quality to moderate the curvilinear relationship between daily time pressure and work engagement.

Hypothesis 2: Daily sleep quality moderates the curvilinear relationship between daily time pressure and daily work engagement. The inverted U-shape relationship was aggravated as a function of low sleep quality.

The Moderate Effect of Psychological Capital

According to Luthans, Avolio, Avey, and Norman (2007), psychological capital refers to an individual's positive psychological state of development, in which employees have confidence to take on and put in the necessary effort to succeed at challenging tasks (self-efficacy), make a positive attribution about succeeding now and in the future (optimism), persevere toward goals and redirecting paths to goals to succeed when necessary (hope), and when beset by problems and adversity, sustain and bounce back and even go beyond to attain success (resilience). Research suggests that psychological capital is positively associated with job satisfaction (Luthans, Avolio, et al., 2007), performance (Peterson, Luthans, Avolio, Walumbwa, & Zhang, 2011), creative behaviors (Gupta & Singh, 2014),and work engagement (Wang, Liu, Zou, Hao, & Wu, 2017), and is negatively associated with burnout (Leon-Perez, Antino, & Leon-Rubio, 2016).

JD-R theory proposes that personal resources can play a role similar to job resources (Bakker & Demerouti, 2008). Personal resources refer to the beliefs that people hold regarding how much control they have over their environment (Bakker &

Demerouti, 2017). Bakker and Demerouti (2008) suggested that personal re- sources, such as self-efficacy, optimism, resilience, and an active coping style are beneficial for work engagement. Specifically, personal resources not only have a direct positive effect on work engagement, but also buffer the negative effect of hindering job demands and boost the positive effect of challenging job demands on work engagement (Bakker & Demerouti, 2017). Xanthopoulou, Bakker, Demerouti, and Schaufeli (2009a) conducted a study among 163 employees to test the relations between personal re- sources and work engagement. The results indicated that self- efficacy and optimism positively predicted work engagement. Mache et al. (2014) also conducted a cross-sectional study to examine relations between personal resources and work engagement. The results indicated that resilience had a positive effect on work engagement. In another cross-sectional study, Rothmann and Storm (2003) suggested that an active coping style, a form of hope, had a positive effect on work engagement.

The core construct of psychological capital specifically includes the components mentioned above (i.e., self-efficacy, optimism, resilience, and hope) and positively predicts work engagement. A cross-sectional study among Chinese women nurses indicated that psychological capital was positively associated with work engage- ment (Wang et al., 2017). The aforementioned research provides evidence that psychological capital positively predicts enduring work engagement. However, there is still a lack of research literature to support the interaction effect of job demands and psycho- logical capital on work engagement. In addition, we were curious as to whether psychological capital would have the same desirable effect on work engagement when the work engagement was on measured on a day-specific scale. We proposed that psychological capital, as an important personal resource, buffers the negative effect of excessive time pressure on daily work engagement.

Hypothesis 3: Psychological capital moderates the curvilinear relationship between daily time pressure and daily work engagement. The inverted U-shape relationship is aggravated as a function of low psychological capital.

Method

Research Design

Because time pressure, work engagement, and sleep quality are not uniform across all days, we conducted a diary study. The participants completed questionnaires 3 times a day using a smart- phone over 10 consecutive work days. On weekends, the diary study was interrupted and then continued on the next regular work day. In the morning, the participants rated the sleep quality of the previous night. Day-specific time pressure was assessed at midday, and day-specific work engagement was assessed after the work day. The demographic information and psychological capital data were collected before starting the diary.

Participants

Participants in this study were recruited from various organizations through online advertisements and individual contacts. Participation in this diary study was voluntary and confidential. According to the American Psychological Association's (APA's) *Ethical Principles of Psychologists and Code of Conduct* (avail- able at http://www.apa.org/ethics/code/), 77 employees who enrolled in this study were presented with an informed consent document, which provided instructions for the study as well as assurances of confidentiality. There was a total of 30 questionnaires (3 times a day over 10 days), and each time participants completed a questionnaire, there was a one quarter to on sixth chance to get money. We also offered feedback about the study results after completing data collection as an incentive for participation and randomly selected a participant to receive a Kindle e-book reader as a reward. Ten people either provided fewer than two surveys over the 10 days or did not complete the psychological capital survey and were thus removed from the dataset. A final sample of 502 unit-days nested within 67 employees was yielded (74.93% response rate). Among the participants, 59.7% were women. The average age of the participants was 27.13 years (*SD* 4.81), ranging from 22 to 46 years. The average work tenure with the organization was 3.89 years (*SD* 4.64), ranging from less than a year to 25 years. The industries included Internet, finance, software, medical, and other. The job levels included ordinary employees (44), junior managers (18) and middle man- agers (5).

Measures

Gender, age, marital status, educational level, and work tenure were measured using one question, respectively. Because these variables did not significantly predict daily work engagement, they were not included in the subsequent data analysis (Becker, 2005).

Psychological capital. Psychological capital was measured with the 24-item Psychological Capital Questionnaire developed by Luthans, Youssef, and Avolio (2007). This questionnaire involved four facets: efficacy (e.g., “I feel confident in representing my work area in meetings with management.”), hope (e.g., “If I should find myself in a jam at work, I could think of many ways to get out of it.”), resilience (e.g., “I usually take stressful things at work in stride.”), and optimism (e.g., “I always look on the bright side of things regarding my job.”). The response format ranges from 1 (*strongly disagree*) to 6 (*strongly agree*). The average coefficient a for this measure was .85.

Sleep quality (morning). Daily sleep quality was measured with a shortened version of the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989), which was adapted for night-specific assessment. Specifically, all items referred to the previous night. This questionnaire involved four facets: sleep latency, sleep quantity, sleep efficiency, and sleep quality. Participants were asked the time at which they went to bed, how long it took to fall asleep, what time they woke in the morning, and how long they were awake after initially falling asleep. In the instructions to participants, participants were provided with an example to help them understand the meaning of time awake after initially falling asleep (“For example, if you were asleep until 1 a.m., woke at 1 a.m. and fell back asleep at 1:20 a.m. for the rest of the night, your answer would be 20 minutes”). These times were used to calculate sleep latency, sleep quantity, and sleep efficiency. One item assessed the participants’ sleep quality (“How would you rate the quality of your previous night’s sleep?”). The response format ranged from 0 (*very good*) to 3 (*very bad*). Because higher values of the original PSQI indicated lower sleep quality or impaired sleep, we recoded our scores (range 0 –12) so that the higher values would reflect higher day-specific sleep quality. Cronbach’s a for day-level variables are mean internal consistencies averaged over all measurement days. The coefficient a for this measure was .60.

Time pressure (noon). Time pressure was measured with five items adapted from Karasek (1979)'s Job Demands Scale, which was adapted for day-specific assessment (e.g., "Today, I do not think that I have enough time to finish my work."). The response format ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). The coefficient a for this measure was .92.

Work engagement (evening). The assessment of daily work engagement was based on the nine-item version of the Utrecht Work Engagement Scale (Schaufeli, Bakker, & Salanova, 2006), which was adapted for day-specific assessment and involved three facets: vigor (e.g., "Today, I felt strong and vigorous at my work."), dedication (e.g., "Today, I was enthusiastic about my job."), and absorption (e.g., "Today, I was immersed in my work."). The response format ranged from 0 (*never*) to 6 (*always*). The average coefficient a for this measure was .93.

Construct Validity

Although this study measured time pressure and work engagement at various time points, it used employee self-assessment. Therefore, it was necessary to further examine the distinction between these constructs. To test the validity of our measures, we performed multilevel confirmatory factor analyses (MCFAs). The MCFA for work engagement showed good data fit, $x^2(47)$ 145.496, $p < .001$, root-mean-square error of approximation (RM- SEA) .065, comparative fit index (CFI) .940, standardized root-mean-square residual within-person/between-person ($SRMR_{w/b}$) .042/.057. The MCFA for time pressure also showed good data fit, $x^2(6)$ 17.747, $p < .001$, RMSEA .062, CFI .990, $SRMR_{w/b}$ .008/.019. The distinctiveness of time pressure and work engagement was tested in a two-factor model. The two-factor model, $x^2(148)$ 414.036, $p < .001$, RMSEA .060, CFI .921, $SRMR_{w/b}$ .063/.094, fit our data better than the one-factor model, $x^2(150)$ 1,419.095, $p < .001$, RMSEA .130, CFI .625, $SRMR_{w/b}$ .203/.270). This result showed that the two variables of our study represent two different constructs, and that there was no serious common method deviation in this study.

Analytical Procedure

To test our hypotheses, we used multilevel modeling with random intercepts

because the day-level data (Level 1) were nested within the person-level data (Level 2), and this procedure considered the interdependence of both levels. We used HLM 7 (Scientific Software International, Skokie, IL) to analyze the data. The null model only included the intercept. In Model 1, we added daily time pressure to control the linear contribution. Model 2 included the square of daily time pressure to test the curvilinear relationship between time pressure and work engagement. Models 3 and 5 added daily sleep quality (Level 1) and psychological capital (Level 2), respectively, to test their main effects. In Model 4, we tested the interactions of time pressure and sleep quality. In Model 6, we tested the interactions of time pressure and psychological capital. On a conceptual level, our centering decision was based on the proposition that daily time pressure and sleep quality should be interpreted in absolute terms. Thus, all Level 1 and Level 2 variables were centered around their grand mean.

Results Descriptive Statistical Analysis

Table 1 displays the mean values, standard deviations, and correlations of the study variables. On the day level, there was a significant positive correlation between work engagement and time pressure, r .35, $p < .01$, but no significant correlation between work engagement and sleep quality, r -.01, *ns*. On the person level, work engagement was significantly and positively correlated with time pressure, r .49, $p <$ .01, and psychological capital, r .47, $p < .01$, but was not significantly correlated with sleep quality (r .06, *ns*).

Null-Model Analysis

Before the hypothesis test in the present study, we examined the within-person (Level 1) variance. For time pressure and sleep quality, the proportion of within-person variation was 50.71% and 64.60%, respectively. For work engagement and its subdimensions, the Level-1 variance was more than 30.71% (see Table 2). Consistent with our proposition of day-specific fluctuations, the results of variance decomposition necessitated the application of multilevel modeling.

Test of Hypotheses

Hypothesis 1 proposed that daily time pressure had a curvilinear effect on daily work engagement. To test the hypothesis, we first controlled the linear predictor of daily time pressure and then entered the squared term of daily time pressure into the regression equation. Because the analyses involved the squared term of positive affect, we tested nonlinear relationships by centering the predictor variables. Consistent with this proposition, multilevel estimates revealed that the coefficient of the squared term of daily time pressure was significant and negative (β= -.03, $p < .05$, $\Delta R^2 = .016$, see Table 3) in Model 2. The inclusion of the squared term of daily time pressure into the equation resulted in an improvement of R^2 from .079 (in Model 1) to .095 (in Model 2). Thus, in support of Hypothesis 1, there was a curvilinear relation- ship between daily time pressure and daily work engagement.

Hypothesis 2 proposed that daily sleep quality could moderate the curvilinear relationship between daily time pressure and daily work engagement. Models 3 and 4 showed that the main effect (β=.11, *ns*) and moderate effect (β=.00, *ns*) of daily sleep quality were insignificant. Hypothesis 2 was not supported.

Table 1
Means, Standard Deviations, and Intercorrelations Between Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Sleep quality		−.14**	−.01	.06	−.02	−.06										
2. Time pressure	−.30**		.35**	.34**	.32**	.32**										
3. Work engagement	.06	.49**		.93**	.95**	.92**										
4. Vigor	.12	.44**	.96**		.85**	.77**										
5. Dedication	.05	.47**	.97**	.92**		.81**										
6. Absorption	.00	.50**	.96**	.86**	.89**											
7. Psychological capital	.00	.21	.47**	.49**	.49**	.39**										
8. Efficacy	.07	.10	.41**	.45**	.46**	.28*	.80**									
9. Hope	−.10	.16	.30*	.31*	.32**	.25*	.79**	.52**								
10. Resilience	.01	.22	.36**	.35**	.37**	.33**	.81**	.61**	.50**							
11. Optimism	.01	.14	.36**	.38**	.34**	.32**	.64**	.24*	.36**	.35**						
12. Gender[a]	.07	−.05	−.12	−.17	−.12	−.07	−.16	−.25*	−.08	−.09	−.03					
13. Age	.16	−.22	−.04	−.02	−.05	−.06	.04	.17	.01	−.06	.00	.08				
14. Marital status[b]	−.17	.13	.04	.03	.04	.05	.07	−.01	.07	.13	.03	.00	−.58**			
15. Educational level	.13	−.13	.07	.09	.09	.02	.17	.24	.06	.14	.08	.21	.38**	−.21		
16. Work tenure	.15	−.17	.02	.05	.02	−.01	.03	.17	.02	−.07	−.05	.02	.90**	−.55**	.11	
M	9.24	15.40	28.98	9.58	10.25	9.16	109.10	28.54	26.79	27.93	25.85	1.60	27.13	2.63	3.27	3.89
SD	2.24	4.51	9.51	3.26	3.38	3.54	10.70	3.84	3.55	3.27	3.46	.49	4.81	.74	.62	4.64

Note. Below diagonal: person-level data ($N = 67$), above diagonal: day-level data ($N = 502$).
[a] 1 = male, 2 = female. [b] 1 = married with children; 2 = married without children; 3 = single.
* $p < .05$. ** $p < .01$.

Hypothesis 3 proposed that psychological capital could moderate the curvilinear relationship between daily time pressure and daily work engagement. Model 5 revealed that the person-level psychological capital could positively predict the day-level work engagement (β= .35, $p < .01$, $\Delta R^2 = .184$). Model 6 revealed that the moderate effect of psychological capital was significant (β= .001, $p < .05$, $\Delta R^2 = .124$). In particular, when psychological capital was high, there was a curvilinear relationship between daily

time pressure and work engagement, in which work engagement increased moderately. When psychological capital was low, there was an inverted U-shaped relationship between daily time pressure and daily work engagement (see Figure 2).

Table 2
Hierarchical Linear Modeling Estimates of Null Models

Variable	γ_{00}	σ^2	τ_{00}	ICC
Time pressure	15.38	10.66	10.36	50.71%
Sleep quality	9.22	3.23	1.77	64.60%
Work engagement	29.01	29.56	66.71	30.71%
Vigor	9.59	3.74	7.34	33.75%
Dedication	10.29	4.45	7.40	37.55%
Absorption	9.14	4.67	8.89	34.44%

Note. γ_{00} = intercept; σ^2 = within-person variance; τ_{00} = between-person variance; intraclass correlation (ICC) = $\sigma^2/(\sigma^2 + \tau_{00})$.

Supplementary Analyses

To provide additional insight on different functional forms of sleep quality, we performed a number of supplementary analyses. Specifically, we considered that chronic sleep quality may moderate the influence of daily time pressure on work engagement. We explored it to allow the possibility of finding useful information. As a first step, we examined whether chronic sleep quality was related to daily work engagement. Results indicated that the main effect of chronic sleep quality was insignificant (β=.34, *ns*). Next, we examined chronic sleep quality as a moderator of the daily time pressure–work engagement relationship (see Table 4). Results indicated that the moderate effect of person-level sleep quality was significant (β= .01, $p < .05$, ΔR^2 = .063). In particular, when person-level sleep quality was high, there was a curvilinear relationship between daily time pressure and work engagement, in which work engagement increased moderately. When person-level sleep quality was low, there was an inverted U-shaped relationship between daily time pressure and daily work engagement (see Figure 3).

Discussion

The present study integrated JD-R theory (Bakker & Demerouti, 2017), COR theory (Hobfoll, 2011), and activation theory (Gardner & Cummings, 1988) to examine the curvilinear relationship between daily time pressure and daily work engagement. The proposition about the interaction effect of job demands and re- sources suggested that both sleep quality and psychological capital would counteract the deleterious effect of excessive time pressure on work engagement. In a diary study, we found that there was a curvilinear relation between time pressure and work engagement. With an increase in time pressure, the positive effect of daily time pressure on work engagement gradually weakened, even to negative prediction. The findings were consistent with the propositions derived from activation theory. More specifically, in situations with moderate time pressure, employees experienced the highest levels of work engagement, whereas in situations with low or high time pressure, employees reported lower levels of work engagement.

Table 3
Multilevel Estimates for Models Predicting Work Engagement

Variable	Null model		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	β	(*SE*)	β	(*SE*)	β	(*SE*)	β	(*SE*)	β	(*SE*)	β	(*SE*)	β	(*SE*)
γ_{00} = Intercept	29.01**	1.02	29.13**	.94	29.65**	.95	29.72**	.95	29.76**	.95	29.72**	.85	29.73**	.85
γ_{10} = Time pressure (TP)			.39**	.09	.32**	.08	.31**	.08	.28**	.08	.33**	.08	.32**	.08
γ_{20} = TP^2					−.03*	.01	−.03*	.01	−.03*	.01	−.03*	.01	−.03*	.01
γ_{30} = Sleep quality (SQ)							.11	.13	.09	.15				
γ_{40} = TP × SQ									.01	.03				
γ_{50} = TP^2 × SQ									.00	.00				
γ_{01} = PsyCap											.35**	.08	.34**	.08
γ_{11} = TP × PsyCap													.01	.01
γ_{21} = TP^2 × PsyCap													.001*	.001
Random effects														
σ^2	29.56		27.22		26.76		26.53		26.49		26.74		26.70	
τ_{00}	66.71		54.03		53.81		54.24		53.93		41.71		42.48	
τ_{11}			.16		.07		.05		.04		.08		.10	
τ_{22}					.0016		.0016		.0019		.0018		.0016	
$R^2_{level\text{-}1}$			.079		.095		.103		.104		.095		.097	
$R^2_{level\text{-}2\ intercept}$			.190		.193		.187		.192		.375		.363	
$R^2_{level\text{-}2\ slope}$									—				.124	

Note. PsyCap = psychological capital; $R^2_{level\text{-}1} = (\sigma^2_{null\ model}[e]) - \sigma^2_{estimated\ model}[e])/\sigma^2_{null\ model}(e)$; $R^2_{level\text{-}2\ intercept} = (\tau_{00}[e]_{null\ model} - \tau_{00}[e]_{estimated\ model})/\tau_{00}(e)_{null\ model}$; $R^2_{level\text{-}2\ slope} = (\tau_{22}[e]_{main\ effect} - \tau_{22}[e]_{moderator\ effect})/\tau_{22}(e)_{main\ effect}$.
* $p < .05$. ** $p < .01$.

In addition, we tested whether sleep quality and psychological capital would moderate the daily curvilinear relationship. The present study provided preliminary evidence that daily sleep quality may not be enough to buffer the curvilinear relation. But in a longer time frame (e.g., 2 weeks), chronic sleep quality could moderate the curvilinear relationship between daily time pressure and daily work engagement. The inverted U-shape relationship was aggravated as a function of low chronic sleep quality. In the framework of JD-R theory, the present results suggest that chronic sleep quality, as an important physiological resource, replenishes the fuels consumed by job

demands.

In support of our proposition, when psychological capital was high, daily time pressure, as a challenging job demand, positively predicted daily work engagement. When psychological capital was low, there was an inverted U-shape relationship between time pressure and work engagement. Specifically, low psychological capital boosted the high time pressure from a challenging job demand into a hindering job demand and aggravated the curvilinear relationship between time pressure and work engagement. In the framework of JD-R theory, the present study suggests that psychological capital, as an important personal resource, replenishes the fuels consumed by job demands. Individuals with high psychological capital have greater tolerance for daily time pressure and routine job constraints than individuals with low psychological capital. Psychological capital could help people to cope with time pressure in a positive way and think of the time pressure as a challenging job demand. Hence, people with high psychological capital show a continuous increase in work engagement with increased time-pressure demands in their daily job routines. Individuals with low psychological capital first try to cope with in- creased time-pressure demands by engaging more with their work demands, but because of their own psychological weaknesses, they interest and/or lower activity in their routine work.

Theoretical Implications

falter when things rise beyond their tolerance levels and lose The present study provides evidence for the fluctuations of work engagement. Different from enduring work engagement, day- specific work engagement can be considered a core but transient experience of work-related well-being in the daily lives of employees.

The current study was a response to Bakker's (2014) call to explore more proximal, situational predictors of state work engagement. Time pressure at work is always changing. Based on the first proposition of JD-R theory, time pressure is a type of job demand. Thus, time pressure may be an effective predictor of daily work engagement in theory. The present study supports the proposition and enriches the types of antecedents for daily work engagement.

Furthermore, the present study extended the JD-R theory in terms of job

demands; an unresolved issue was the two types of job demands. The original author of the theory suggested that new research might uncover the conditions under which job demands act as hindrances versus challenges (Bakker & Demerouti, 2017). In the present study, we found that time pressure can be both challenging and hindering, depending on the level of time pressure. Specifically, there is a curvilinear relationship between time pressure and work engagement. The results provide empirical evidence to extend the JD-R theory to include that job demands can be either challenging or hindering.

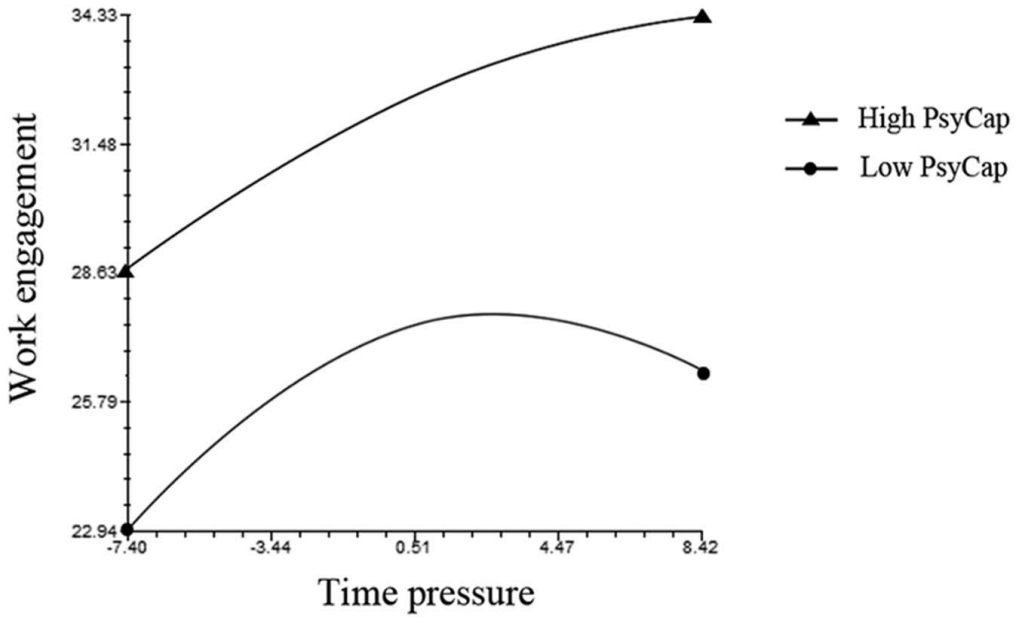

Figure 2. The moderate effect of psychological capital on the relationship between time pressure and work engagement.

In addition, the different effects of chronic and daily sleep quality provide a point worth noting. Our findings that chronic but not daily sleep quality acted as protective resource are consistent with research suggesting that hindrance stressors are more associated with chronic sleep quality than daily sleep quality (French, Allen, & Henderson, 2017). Indeed, chronic sleep quality could better reflect individuals' levels of personal-resource stability, whereas daily sleep indicators might more strongly reflect

personal-resource fluctuations. Just one good night's sleep may not be enough to replenish the fuels consumed by job demands. Employees need long-term good sleep to reserve personal re- sources.

Moreover, the findings that psychological capital has a moderate effect on the curvilinear relation between time pressure and work engagement highlight an important interaction between job de- mands and personal resources. In the framework of JD-R theory, a growing body of empirical evidence substantiates that psychological capital has a direct and mediating effect on work engagement (Mazzetti, Guglielmi, Chiesa, & Mariani, 2016; Vink, Ouweneel, & Le Blanc, 2011; Wang et al., 2017). However, Bakker and Demerouti (2017) stated that research has provided only limited support for this proposition, which indicates that more research is needed to test the Job Demands X Personal Resources interaction. The present study supports the proposition and indicates that psychological capital, as an important personal resource, moderates the inverted U-shape relation between daily time pressure and work engagement.

Table 4
Exploratory Analysis of Chronic Sleep Quality as A Moderator

Variable	Main effect β	Main effect (*SE*)	Moderate effect β	Moderate effect (*SE*)
Day-level ($N = 502$)				
γ_{00} = Intercept	29.65**	.95	29.61**	.93
γ_{10} = Time pressure(TP)	.32**	.08	.34**	.08
γ_{20} = TP^2	−.03*	.01	−.02*	.01
Person-level ($N = 67$)				
γ_{01} = Sleep quality(SQ)	.34	.66	.20	.66
γ_{11} = TP × SQ			−.003	.06
γ_{21} = TP^2 × SQ			.01*	.01
Random effects				
σ^2	26.76		26.72	
τ_{00}	54.79		53.65	
τ_{11}	.07		.07	
τ_{22}	.0016		.0015	
$R^2_{\text{level-2 slope}}$			.063	

$R^2_{\text{level-2 slope}} = (\tau_{22}[e]_{\text{main effect}} - \tau_{22}[e]_{\text{moderate effect}})/\tau_{22}(e)_{\text{main effect}}$.
* $p < .05$. ** $p < .01$.

Limitations and Future Research

The present study is subject to several limitations. First, our study variables were

assessed with self-report measures, which are sometimes prone to common method variance and bias results. In the future, researchers could consider physiological indicators, such as electroencephalograms (Barnes et al., 2013) and sleep actigraphs (Barnes, Schaubroeck, Huth, & Ghumman, 2011), to assess sleep quality.

Second, the sample sizes of this study was smaller than other similar studies (Barber et al., 2013; Kühnel et al., 2012). Shih (2008) provided detailed information about different sample sizes under different intraclass-correlational conditions. As in the present study, 67 clusters with a cluster size of 10 was enough to get relatively unbiased and accurate fixed- and random-component estimates. However, a larger sample would be preferable.

Third, the age distribution of the participants was not wide enough and trended toward those who were younger and middle- aged. Research has indicated that age is associated with sleep quality. Madrid-Valero, Martínez-Selva, Ribeiro do Couto, Sánchez-Romera, and Ordoñana (2017) surveyed 2,144 subjects aged between 43 and 71 years. The results indicated that there is a direct relationship between age and deterioration in the quality of sleep. However, Wrzus, Wagner, and Riediger (2014) conducted a diary study among 397 participants aged 12 to 88 years to test the relationship between sleep duration and morning affect. The results suggested that affective well-being was worse following nights with shorter or longer than average sleep duration for adults over 20 years of age. This effect was more pronounced the older the participants were. Future researchers may attempt to collect sleep data for employees of all ages and explore the moderate effect of age.

Finally, although we confirmed the curvilinear relationship be- tween daily time pressure and work engagement, the underlying mechanism is still unclear. One study indicated that the indirect effects of time pressure on learning are mediated by challenge appraisal (Prem, Ohly, Kubicek, & Korunka, 2017). Thus, cognitive appraisal may be an important mediator between time pressure and work engagement. Future researchers should explore more effective mediators.

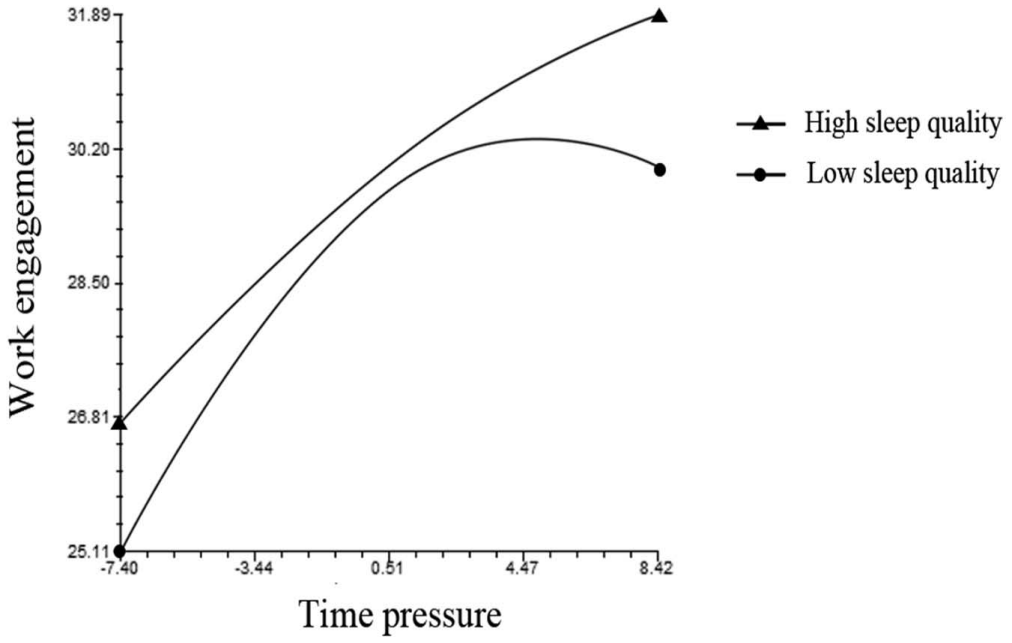

Figure 3. The moderate effect of chronic sleep quality on the relationship between time pressure and work engagement.

Practical Implications

Subject to objective conditions, time pressure and other job demands are difficult to change by the individual. Organizations also have difficulty changing their structure to slow down the staff's work rhythm. In the face of difficult job demands, employees and organizations should focus on personal resources that can be developed and trained. Our results suggest that people who have high psychological capital and good chronic sleep quality cope best with time pressure. Organizations could conduct training programs to develop employees' psychological capital (Luthans, Avey, Avolio, Norman, & Combs, 2006; Luthans, Avey, & Patera, 2008). Organizations should also design work schedules for their people in such a way that people's sleep routines are not disturbed abruptly. Sound sleep is an essential requirement for good health, and organizations need healthy people for better performance.

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