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Basic Psychological Need Satisfaction, Recovery State, and Recovery Timing

Madelon L. M. van Hooff

Behavioural Science Institute, Radboud University Nijmegen, The Netherlands

Paul E. Flaxman

Psychology Department, City, University of London, United Kingdom

Mia Söderberg

Psychology Department, City, University of London, United Kingdom

Chris B. Stride,

Management School, University of Sheffield, United Kingdom

Sabine A. E. Geurts

Behavioural Science Institute, Radboud University Nijmegen, The Netherlands;

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Author Note

Mia Söderberg is now at the Department of Occupational and Environmental Medicine, Sahlgrenska Academy and University of Gothenburg, Sweden.

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Abstract

This study aimed to provide insight into recovery from work-related load effects by examining (1) whether basic psychological need satisfaction (BPN satisfaction) during non-work days facilitates recovery; (2) whether the effect of BPN satisfaction is stronger in case of an unfavorable initial recovery state; and (3) whether the association between BPN satisfaction and recovery is stronger on non-work weekend days compared to non-work weekdays. Data were collected across seven consecutive days from 205 employees (39% shift workers). Fatigue and depressed mood were assessed as indicators of (failed) recovery. Multilevel analyses revealed that BPN satisfaction during non-work days was related to improved recovery state. This association was stronger if employees had experienced elevated fatigue on the preceding day, and on non-work weekend days compared to non-work weekdays.

Key words: basic psychological need satisfaction, effort, recovery, daily diary study, weekend, fatigue, depressed mood

Basic Psychological Need satisfaction, recovery state, and recovery timing

It is now widely acknowledged that sufficient recovery from load effects that build up at work is crucial to protect employees' daily well-being and long-term health. This can be understood from the perspective of Meijman and Mulder's (1998) Effort-Recovery model. This model posits that effort expenditure at work activates employees' bodily stress systems and draws upon employees' resources. As a consequence, certain negative load reactions develop, which are manifest in, for example, higher levels of fatigue or negative affect. These negative load reactions are reversible and cause no harm if the psychophysiological systems that were activated during the workday return to their baseline (pre-demand) levels during free time after work, a process that is usually called 'recovery' (Geurts & Sonnentag, 2006; Meijman & Mulder, 1998). Insufficient recovery will eventually cause employees' psychophysiological systems to malfunction, leading to more chronic physical and mental health problems (e.g., Devereux, Rystedt, & Cropley, 2011; Feldt, Huhtala, Kinnunen, Hyvönen, Mäkikangas, & Sonnentag, 2013; Sonnentag & Geurts, 2009).

Because these long-term negative consequences of insufficient recovery develop as a consequence of *day-to-day* incomplete recovery (Geurts & Sonnentag, 2006; Meijman & Mulder, 1998) it is important to examine employees' effort-recovery from a short term perspective. This issue is addressed within a growing body of daily diary studies, focusing on the association between employees' off-job experiences in relation to their recovery state (i.e., the present state of employees' psychophysiological systems regarding recovery). So far, research on experiences in relation to recovery has

predominantly concentrated on one or more of the experiences defined by Sonnentag and Fritz (2007), namely detachment, relaxation, mastery and/or control.

Another approach to understanding employees' off-job recovery experiences can be found in Deci and Ryan's Self-Determination theory (Deci & Ryan, 2000; Ryan & Deci, 2000a). Self-Determination theory poses that humans have three innate basic psychological needs, namely the needs for *autonomy* (i.e., the need to experience self-endorsement or volition in one's actions, and to act as the originator of one's own behavior; Patrick, Knee, Canevello, & Lonsbary, 2007; Ryan, Bernstein, & Brown, 2010), *competence* (i.e., the feeling of being effective in one's actions as well as having opportunities to use one's capacities; Deci, 1975) and *relatedness* (i.e., the need to feel close and connected to others; Baumeister & Leary, 1995; Ryan 1995). According to Self-Determination theory, 'basic psychological need satisfaction' – that is, the fulfillment of these three innate and basic psychological needs for autonomy, competence and relatedness - is an essential prerequisite for the maintenance and development of human well-being. Occupational health research informed by this theory has indeed shown that daily satisfaction of basic psychological needs (henceforth "BPN satisfaction") during off-job time contributes to employees' recovery at the end of the evening (Van Hooff & Geurts, 2014) and the following day (Mojza, Sonnentag & Borenemann, 2011).

The primary purpose of the present study is to enhance the understanding of the role of BPN satisfaction in employees' off-job recovery process during full non-work days, by examining potential moderators of the association between BPN satisfaction and day-level recovery. Specifically, the aim of this study is to investigate: (1) if BPN satisfaction obtained during non-work days (such as the weekend and other pre-scheduled

days off during the working week) facilitates employee recovery; (2) whether employees' initial recovery state affects the strength of the association between BPN satisfaction and recovery (focusing particularly on whether this association varies a) according to employees' recovery state just before the start of their non-work period and b) between the first and subsequent day(s) off); and (3) whether the timing of non-work days affects the strength of the association between BPN satisfaction and employees' recovery state (specifically whether this association varies between non-work days during the weekend and non-work days during the working week).

To address this set of research questions we adopted a seven-day diary methodology, and collected data from employees with different types of work schedules. We used fatigue and depressed mood as indicators of employees' recovery state. Although a high daily level of fatigue is perhaps the most recognized early marker of failed recovery, there has been growing interest in the role of depressed mood in the process of recovery and in the eventual development of work-induced burnout (e.g., Bianchi, Schonfeld, & Laurent, 2015a&b; Sonnentag & Natter, 2004; van Dam, 2016). For example, van Dam (2016) recently found that it was the presence of depression (rather than fatigue) that distinguished a subgroup of workers with the most debilitating burnout symptoms. At an earlier stage in the process, it is therefore conceivable that an inability to recover from work demands during a working week would manifest in slower "repair" of a low mood that has been triggered by common work-related stressors (see also Sonnentag & Fritz, 2007; Tennant, 2001). More generally, (in)complete mood repair is considered an essential element of (un)successful recovery (Geurts, 2014). Accordingly,

we examine daily levels of depressed mood on both work days and non-work days as a second indicator of impaired recovery.

BPN satisfaction during off-job days and recovery

The positive effects of BPN satisfaction on various indicators of well-being have been widely established (e.g., Nix, Ryan, Manly, & Deci, 1999; Sheldon, Ryan, & Reis, 1996; Van den Broeck, Vansteenkiste, De Witte, & Lens 2008). It has also been demonstrated that there are significant day-to-day variations in BPN satisfaction, which are associated with daily variations in well-being (e.g., Ryan, Bernstein, and Brown, 2010; Sheldon, et al., 1996). For these reasons, it is valuable to examine the degree to which the experience of BPN satisfaction influences employees' daily recovery. We believe that there are at least three processes that may explain a positive effect of BPN satisfaction on daily recovery from work demands. First, according to Self-Determination theory, BPN satisfaction will result in energy maintenance or enhancement (Ryan & Deci, 2008), which may facilitate the recovery process; this is because recovery requires the replenishment of employees' (energetic) resources that have been drawn upon during the workday (Meijman & Mulder, 1998).

Second, research has established that daily BPN satisfaction is accompanied by the experience of positive emotional states (Reis et al., 2000; Sheldon et al., 1996). Such positive emotions have been shown to be associated with the production of certain hormones in the brain's "pleasure reward" system (e.g., serotonin, dopamine) that down-regulate the stress response (Esch & Stefano, 2004). In a similar vein, Fredrickson's (2001) Broaden-and-Build theory states that positive emotions can counteract negative

emotions induced by a psychosocial stressor, an assumption that has been supported in experimental studies (Fredrickson, Mancuso, Branigan, & Tugade, 2000).

Third, the Broaden-and-Build theory proposes that positive emotions broaden people's thought-action repertoires - a process thought to enhance people's ability to interact with their environment (Fredrickson, 2001). This enhanced interaction ability is likely to boost employees' opportunities to increase their resources, or to regain resources that were lost due to previous effort expenditure at work. It is therefore plausible to assume that BPN satisfaction adds to the recovery process by allowing employees to gain new resources. As noted above, the few studies that have explored the role of BPN satisfaction in the daily recovery process have found that meeting basic needs is positively related to employee recovery during free evenings after work (Mojza et al., 2011; Van Hooff & Geurts, 2014). Building on these findings, and on the proposed theoretical mechanisms linking BPN satisfaction with recovery, we hypothesize:

Hypothesis 1: BPN satisfaction during off-job days will be positively related to employees' recovery state.

Employees' initial recovery state as a moderator of the association between BPN satisfaction and recovery state

In order to enhance understanding of the nature of the association between BPN satisfaction during off-job days and employees' recovery state, we examined if the strength of this relationship would be influenced by employees' recovery state just before the start of their off-job time (that is, on the day preceding the focal non-work day).

Addressing this issue seems important, given that some research has found that depleted (e.g., exhausted) employees do not obtain immediate or anticipated benefit from either

reducing job demands or active coping efforts (Demerouti, 2014). For example, when employees are excessively fatigued or in a negative mood following a demanding period of work, they may lack the energetic and emotional resources required to invest in those activities (e.g., valued social interactions) that have most potential to satisfy basic psychological needs. If this is the case, depleted employees may not show immediate recovery, and may instead require additional time to replenish energy resources and experience full mood repair.

In contrast, Meijman and Mulder's (1998) Effort-Recovery model suggests that daily levels of fatigue and negative affect can be viewed as naturally fluctuating "load reactions", that should return to some baseline (or "home base") level relatively quickly once work demands and pressures have ceased. From this theoretical perspective, the association between BPN satisfaction during off-job days and employees' recovery state might be stronger when employees are exhibiting a poorer recovery state just prior to (i.e., the day before) their off-job time. As we are most interested in capturing these daily load reactions, we posited that employees with an unfavorable recovery state (i.e., high fatigue and negative mood) would benefit more from BPN satisfaction on non-work days when compared to those employees already exhibiting a relatively more favorable recovery state. In other words, we assumed that when employees who are in a currently depleted state fulfill their basic psychological needs, the recovery aiding processes associated with BPN satisfaction would have more opportunities to operate, compared to a situation in which employees already feel recovered. An unfavorable recovery state implies that there is more stress to down-regulate (Esch & Stefano, 2004), more depleted energy to regain (Ryan & Deci, 2008), and more room for depleted resources to rebuild (Fredrickson,

2001). The idea that BPN satisfaction will have a stronger influence on the recovery status of those employees feeling most depleted can also be viewed through the lens of Conservation of Resources theory (Hobfoll, 2001). This theory posits that resource gain is likely to be more salient after resource loss. Applied to the association between BPN satisfaction and recovery, this implies that employees will respond more positively to satisfaction of their BPNs if this satisfaction takes place soon after they have experienced an unfavorable recovery state. In support of these related assumptions from Effort-Recovery and Conservation of Resources theory, previous research has found that recovery-rich off-job experiences (such as psychological detachment from work) have a stronger relationship with recovery at those times when employees have been expending increased levels of effort at work (Sonnentag & Bayer, 2005). On the basis of these theoretical assumptions we test the following hypothesis:

Hypothesis 2: The positive association between BPN satisfaction during off-job days and employees' recovery state will be stronger if employees report an unfavorable recovery state on the day preceding the off-job day.

Building on these ideas that the recovery potential of off-job experiences may depend on employees' initial level of load reactions, we additionally aimed to investigate if the strength of the association between BPN satisfaction and employees' recovery state varied between employees' first day off versus their subsequent day(s) off (where consecutive days of leave are taken). Based on the Effort-Recovery model (Meijman & Mulder, 1998), it can be assumed that employees' recovery state is most unfavorable immediately after a work period, as the load reactions that developed due to effort expenditure at work have not yet had time to diminish. Under normal circumstances,

however, it might be expected that these load effects decrease with increasing time off the job and that, consequently, employees' recovery state becomes progressively more favorable. Thus, based on the ideas that BPN satisfaction is especially beneficial for recovery if employees are experiencing an unfavorable initial recovery state, it is possible that it would show a stronger relationship with employees' recovery state on their first day off after a period of work compared to subsequent days off. In addition, the second or subsequent day(s) off are naturally closer to the next period of work, and recovery experiences may therefore be adversely affected by anticipatory stress, worry, or problem-solving cognitions about imminent work problems or demands (e.g., Flaxman et al., 2012; Querstret & Cropley, 2012). Thus, we hypothesize:

Hypothesis 3: The positive association between BPN satisfaction during off-job days and employees' recovery state will be stronger on their first day off compared to subsequent day(s) off.

Timing of non-work days as a moderator of the association between BPN satisfaction and employees' recovery state

Another way in which this study aims to gain insight into day-level moderators of the association between BPN satisfaction and recovery, is by examining the timing of non-work days. Specifically, we aimed to examine whether the strength of the association between BPN satisfaction and employees' recovery state varies between off-job days that occur during the weekend and off-job days that occur during the week. By doing so, we seek to make a more general contribution to the recovery literature, as the question of whether weekend and weekday respite days contribute differentially to recovery has (as far as we are aware) attracted little empirical attention.

For employees who work standard office hours (e.g., Monday to Friday), the weekend offers one of the most important opportunities to recover from work demands and pressures; and research has shown that experiences during the weekend (e.g., positive work reflection, detachment from work) contribute to recovery (Binnewies, Sonnentag, & Mojza, 2010; Fritz & Sonnentag, 2005). For employees who work irregular hours (e.g., shift-workers), weekly rest days may vary, and they may have their major recovery opportunities on week days.

As society is still generally constructed around the idea that employees work normal office hours and are free during the weekend, there is typically a larger variety of activities employees can choose from during weekends (e.g., many organized leisure activities such as sports, concerts, and parties take place during the weekend), and there is also typically more time available on the weekend to spend with one's significant others. Due to this greater range of off-job activities and typically increased availability of significant others, it may be easier to fulfill one's basic psychological needs to feel autonomous, competent and related to others during a non-work weekend day than on a non-work weekday. In other words, during weekends it is conceivable that employees would generally have to invest less of their resources (e.g., time, energy, seeking social interactions) to gain new resources (e.g., satisfaction of basic psychological needs) than during non-work weekdays. Consequently, the beneficial processes associated with BPN satisfaction may be more fully activated during the weekend, and may be less impeded by 'costs' (i.e., resource investment) associated with obtaining BPN satisfaction. Due to the lower 'costs' associated with obtaining BPN satisfaction on a weekend day, we anticipated that BPN satisfaction might show a stronger positive association with

employees' recovery state during non-work weekend days than during non-work weekdays. Based on this line of reasoning, we test the following hypothesis:

Hypothesis 4: The positive association between BPN satisfaction during off-job days and employees' recovery state will be stronger on off-job weekend days compared to off-job weekdays.

Method

Participants and Procedure

The majority of participants for this study were healthcare employees recruited from four regional hospital sites within the British National Health Service. A smaller group of participants was recruited from a local government and a central government organization also in the UK. The participating organizations employed individuals working on a range of different shift patterns. Employees were not compensated for their participation in the study.

A total of 496 healthcare employees and 181 governmental/other employees expressed interest in participating in the study and received survey booklets in the post. Each survey pack included three separate survey booklets (i.e., "Initial Survey", "Work Day Surveys", and "Non-Work Day Surveys"). The initial survey included measures of emotional stability (included as a control variable) and demographic questions. Participants were asked to complete this initial survey booklet first, before beginning the work day and non-work day survey booklets. Participants were instructed to complete the work day surveys at the very end of the day (i.e., just before going to bed) on any days they were working from a Thursday through to (and including) the following Wednesday in any typical working week of their choosing (ideally within one month of receiving the

survey pack). Similarly, participants were instructed to complete the non-work day surveys on any days they were not working between Thursday and the following Wednesday during the week of survey completion. Participants' recovery state was assessed both on work days and non-work days, whereas BPN satisfaction was only reported on non-work days.

A total of 205 employees participated in our study (30% response rate). Among this sample 61% ($n = 125$) were classified as working a "regular" shift pattern during the data-collection period; that is, Monday to Friday working with Saturday and Sunday off. Of these, 14 participants reported that they also had the Monday off in the week of participation in the study. The remaining 39% ($n = 80$) were classified as shift workers who worked non-regular hours punctuated by rest days. Out of these 80 shift workers, $n = 48$ had days off during the week as well as Saturday and/or Sunday during the data-collection period; a further 23 participants had days off only on weekdays during the data-collection period, and worked through the weekend; 7 participants had just one day off out of seven during the data-collection period, with that non-work day off falling on the weekend; and 2 participants reported having no days off at all during the week of survey completion. Out of the 205 participants, 197 completed measures of both their recovery state and their level of BPN satisfaction during non-work days, providing data that spanned a total of 453 non-work days.

The average age of participants was 43.17 years ($SD = 9.59$; range 23 to 64), 83% were female, and average tenure with current organization was 10.81 years ($SD = 8.81$; range 1 to 32 years). Participants reported working an average of 38.46 ($SD = 6.58$) hours in a typical working week ($M = 39.72$, $SD = 5.88$ for employees working 'regular' hours

and $M = 36.46$, $SD = 7.15$ for shift workers). With regard to marital status, 66.2% of participants were married or in a relationship, and approximately half (58.6%) of study participants lived with one or more children in the household. Participants were drawn from a wide range of healthcare and other public service roles and professions, including specific and general nursing, biomedical sciences, physiotherapy, and clinical and non-clinical managers. There were no relevant significant differences between participants working in the healthcare organizations and those working in the other type of organizations regarding shift patterns, recovery state and BPN satisfaction.

Measures Administered on Work Days and Non-Work Days

We utilized two indicators of employees' daily recovery state: fatigue and depressed mood. Both of these day-level markers of inadequate recovery were measured with items extracted from the affective well-being subscales originally developed by Warr and validated by Daniels and colleagues (Warr, 1990; see also Daniels, 2000; Daniels, Guppy, Peters-Bean, & Weatherstone, 1997). These brief adjective scales have demonstrated good psychometric properties among working populations, and have been used as outcome variables in previous studies of employees' respite experiences (e.g., Daniels, 2000; Flaxman et al., 2012; Mäkikangas, Feldt, & Kinnunen, 2007; Stride, Wall & Catley, 2007). Fatigue was measured with two items: "Tired" and "Fatigued". Depressed mood was measured with three negative affect items validated by Mäkikangas et al. (2007): "Miserable"; "Gloomy"; and "Depressed". In the present study, the instructions preceding these affective items on both work and non-work days asked participants to rate "how you have felt *today*". The items were rated on a five-point response scale that ranged from 1 (*not at all*) through to 5 (*a great deal*). Average

Cronbach's alpha for the 3-item depressed mood subscale was .87 ($.85 < \alpha < .90$) across seven days; average alpha for the 2-item fatigue subscale was .92 ($.91 < \alpha < .94$) across seven days. To examine if fatigue and depressed mood could be considered empirically distinct constructs, we conducted two multilevel CFA's (using WLSMV estimation). Results showed that a two-factor solution (separate factors for depressed mood and fatigue) fit the data well (RMSEA = .058, CFI = .976), and fit better than a one factor model (one factor for depressed mood and fatigue; RMSEA = .311; CFI = .144). Furthermore, to check the measurement invariance of the two recovery indicators between workdays and non-work days, we conducted a multigroup CFA. In a first model, two factors were specified (one for each recovery indicator), and factor loadings were constrained to be equal on workdays and nonwork days. The fit of this model was good ($X^2 = 47.82$, $df = 14$, RMSEA = .058, CFI = .992). Allowing the factor loadings to vary between workdays and nonwork days did not improve model fit ($\Delta X^2 = 1.70$, $\Delta df = 3$, *ns*). Therefore, we concluded that fatigue and depressed mood represent the same constructs on both types of days.

Measures Administered on Non-Work Days

Level of BPN satisfaction obtained during non-work days was measured on every non-work day that occurred during the week of survey completion. Competence and relatedness items were adapted from Reis et al. (2000) while the autonomy items were adapted from a decisional autonomy scale developed by Houliort, Kostner, Joussemet, Nantel-Vivier, and Lekes (2002). Competence BPN satisfaction was assessed with the single item, "How effective did you feel when performing your activities today?" This item was rated on a 7-point scale that ranged from 1 (*not at all effective*) through to 7

(*extremely effective*). Autonomy was assessed with two items: “To what extent did you feel you were pursuing your own goals today?”; and, “How much freedom and choice did you have over the things you did today?” Finally, relatedness was assessed with the following two items: “To what extent did you feel understood and appreciated by others today?”; and, “To what extent did you feel close and connected to the people you were with today?” The autonomy and relatedness items were rated on a 7-point scale ranging from 1 (*not at all*) to 7 (*a great deal*). Consistent with previous research (e.g., Van den Broeck, et al., 2008; Vansteenkiste, et al., 2007) we averaged across the items to create an overall measure of BPN satisfaction, with higher scores indicating greater fulfillment of psychological needs. This overall score was obtained by first computing the means for the autonomy and relatedness items, and then computing the average of these two means and the single item rating for competence. Average reliability of this 5-item BPN satisfaction scale was $\alpha = .89$ (α range .85 to .92 across seven days). By means of a CFA, we checked the measurement invariance of BPN satisfaction between free weekend and free weekdays. Compared to a model in which we modeled one factor to represent BPN satisfaction and in which factor loadings were constrained to be equal on nonwork weekdays and nonwork weekend days, allowing the factor loadings to vary between workdays and nonwork days did not improve model fit ($\Delta X^2 = 3.041$, $\Delta df = 4$, *ns*). We therefore concluded that BPN satisfaction represent the same constructs on both types of non-work days.

Control Variables

To acknowledge that recovery implies a beneficial change in employees’ affective state, we included the level of fatigue/depressed mood reported at the end of the previous day

as control variable in our analyses, implying that the dependent variable refers to a relative change in fatigue/depressed mood from the previous day to the day under study.

Analytic Strategy

As our day-level observations (level 1) are nested within subjects (level 2), we employed multilevel analysis (Hox, 2002; Snijders & Bosker, 1999) using SPSS v20 software to test this study's various hypotheses. As we were interested in the daily associations between BPN satisfaction and employees' recovery state per se, and not so much in within-person relationships between BPN satisfaction and recovery, our independent variables were grand-mean-centered (Ohly, Sonnentag, Niessen, & Zapf, 2010).

We tested our hypotheses by fitting a series of multilevel models for each recovery outcome (i.e., fatigue and depressed mood), and testing for model improvement at each stage by testing the reduction in the model deviance (i.e., the improvement in model fit) using a chi-square test. Our first baseline model included only an intercept (the unconditional model), and in the following models predictors corresponding to our hypotheses were added sequentially. Specifically, in Model 1, we included the level of fatigue or depressed mood reported at the end of the previous day. BPN satisfaction was subsequently added in Model 2 (to test Hypothesis 1). To examine whether the association between BPN satisfaction and recovery depends on employees' initial recovery level, we added the interaction between BPN satisfaction and fatigue/depressed mood as reported in the previous evening to the analyses in Model 3 (to test Hypothesis 2). The hypothesized differential function of BPN satisfaction on the first versus subsequent non-work day(s) was examined by adding another set of two models to Model

2: Model 4a additionally incorporated a dummy variable distinguishing between the first day off (1 = yes) and subsequent day(s) off. The interaction between this dummy variable and BPN satisfaction was added in Model 4b (to test Hypothesis 3). The role of non-work weekend days versus non-work weekdays in relation to recovery was examined in the final two models: Model 5a extended Model 2 by incorporating a dummy variable for ‘non-work weekend day’ (1 = yes). The interaction between BPN satisfaction and this dummy variable was then added to create Model 5b (to test Hypothesis 4).

Results

Means, standard deviations and correlations between study variables are presented in Table 1. Table 2 gives a more detailed overview of means and standard deviations of BPN satisfaction and the two recovery indicators for (non)work weekdays vs. (non)work weekend-days, and for the first days off vs. subsequent days off. With respect to the first categorization of types of days, post-hoc tests with Bonferroni correction showed that, for both fatigue and depressed mood, mean levels were significantly higher on workdays during the week compared to non-work weekdays ($d = 0.29$ for both fatigue and depressed mood) and non-work weekend-days ($d = 0.25$ for fatigue and $d = 0.22$ for depressed mood). The difference between work weekdays and work weekend-days was not significant ($d = 0.21$ for fatigue and $d = 0.11$ for depressed mood). Furthermore, non-work weekdays did not differ significantly from non-work weekend-days ($d = 0.05$ for fatigue and $d = 0.07$ for depressed mood).

Results for fatigue

Table 3 presents the results of the multilevel analyses conducted for day-level fatigue. Model 1 exhibited a better fit to our data than did the Null Model, and shows that fatigue

experienced during the previous day is significantly and positively related to fatigue experienced on the present day. Model 2 offered an improved fit over Model 1, and reveals, in support of Hypothesis 1, that – controlling for previous day's fatigue - BPN satisfaction experienced during non-work days is negatively related to fatigue on those days. A post-hoc power analysis showed that the power associated with this result was very high (i.e., .99).

With respect to Hypothesis 2, results showed that adding the interaction between BPN satisfaction and fatigue experienced during the previous evening in Model 3, resulted in a better fitting model, in which this interaction was significant. A post-hoc power analysis showed that the power associated with this result was below the traditionally accepted .80 (namely .70). A further examination of this interaction according to the procedure proposed by Preacher, Curran and Bauer (2006) revealed that, in support of Hypothesis 2, the association between BPN satisfaction during a non-work day and fatigue was stronger if employees had reported high levels of fatigue on the day preceding this non-work day (multilevel estimate = -0.39, $p < .01$) than if employees reported low levels of fatigue the previous day (multilevel estimate = -0.21, $p < .01$; see Figure 1). Adding the dummy variable distinguishing between first and subsequent non-work days to our model in Model 4a did not improve model fit, nor did adding the interaction between this dummy variable and BPN satisfaction during non-work days in Model 4b. For this analysis, a post-hoc power analysis indicated that the power was rather low (i.e., .06). Thus, Hypothesis 3, which assumed the association between BPN satisfaction during non-work days and employees' recovery state would be stronger on the first non-work day compared to subsequent non-work days, was not supported.

Regarding Hypothesis 4, Table 3 reveals that Model 5a (including the dummy variable indicating ‘non-work weekend day’) did not fit better than Model 2. However, Model 5b showed a better fit, and included a significant interaction between BPN satisfaction during non-work days and the weekend dummy variable. A post-hoc power calculation showed that the power associated with this finding was .72. An examination of the simple slopes (Preacher et al., 2006) revealed that, in accordance with Hypothesis 4, the association between BPN satisfaction and fatigue was stronger on non-work weekend days (multilevel estimate = -0.36, $p < .01$) than it was on non-work weekdays (multilevel estimate = -0.14, $p < .05$; see Figure 2).

Results for depressed mood

Results of similar analyses conducted for depressed mood are presented in Table 4. Model 1 showed improved fit over the Null Model, indicating that depressed mood on the previous day was positively related to depressed mood experienced on the present day. Including BPN satisfaction during non-work days in the analyses in Model 2 improved the model fit, and showed that – controlling for depressed mood on the previous day - depressed mood was lower if employees reported higher levels of BPN satisfaction on non-work days; this finding provides support for Hypothesis 1. A post-hoc power analysis showed that the power associated with this result was very high (i.e., .99). Adding the interaction between BPN satisfaction and depressed mood experienced during the previous evening in Model 3 did not improve model fit. Thus, Hypothesis 2 – which assumed the daily association between BPN satisfaction and depressed mood would be stronger if employees experienced high levels of depressed mood on the previous day was not supported. Also, the power associated with this result was low, namely .45.

Model 4a, which included the dummy variable distinguishing between the first and subsequent non-work days, showed a better fit than Model 2, and revealed that levels of depressed mood were generally lower on employees' first day off. Model 4b, which incorporated the interaction between the first/subsequent non-work day dummy variable and BPN satisfaction, did not fit better than Model 3b; thus Hypothesis 3 was not supported for depressed mood. A post-hoc analysis also revealed that the power associated with this result was very low (i.e., .06).

Model 5a also provided a better fit than Model 2, and showed that levels of depressed mood were generally higher during non-work weekend days compared to non-work weekdays. Finally, Model 5b exhibited a better fit to our data than did Model 5a, revealing a significant interaction between the 'weekend' dummy variable and BPN satisfaction during non-work days. The power associated with this result turned out to be very high (.95). A further analysis of the interaction effect (Preacher, et al., 2006) revealed that the association between BPN satisfaction and depressed mood was stronger on non-work weekend days (multilevel estimate = -0.22, $p < .01$) compared to non-work weekdays (multilevel estimate = -0.06, $p > .05$; see Figure 3), thus providing support for Hypothesis 4.

Additional analyses

In order to reduce the risk of spuriousness in the associations that were found between our study variables, we conducted additional analyses to test our hypotheses with the inclusion of demographic characteristics (gender, age, number of children, relationship status) and emotional stability as control variables. For both fatigue and depressed mood, these analyses (which can be obtained from the first author on request) yielded the same

conclusions regarding our hypotheses as those in which these control variables were not included.

Discussion

Although previous research clearly supports the positive association between BPN satisfaction and well-being, its role in the daily recovery process has received little empirical attention. Thus, the present study sought to make a unique contribution by examining the influence of non-work day BPN satisfaction on employees' recovery state. More importantly, we investigated whether the role of BPN satisfaction as an experience that contributes to recovery varies according to employees' initial recovery state, and between their first and subsequent non-work days. We also examined if the beneficial effect of BPN satisfaction is dependent upon the timing of non-work days (i.e., whether non-work days occur during the weekend or during the week).

Main findings and theoretical implications

This study's findings enhance the understanding of the influence of BPN satisfaction on employee recovery in three key ways. First, by showing that BPN satisfaction during off-job days is related to beneficial changes in both fatigue and depressed mood, this study's results strengthen the evidence in favor of BPN satisfaction being an important attribute of employees' off-job recovery experiences. Our results extend findings from previous studies that were conducted among employees working regular working hours, and in which it was shown that BPN satisfaction during free evenings related to lower levels of anxiety and higher levels of vigour at the end of the evening (Van Hooft & Geurts, 2014), and to lower levels of negative affect during the next workday (Mojza, et al., 2011).

Second, this study showed that the association between BPN satisfaction and employees' recovery state was stronger when employees reported a poor recovery state on the previous (working) day. BPN satisfaction turned out to be particularly influential in reducing fatigue among those employees who had experienced high levels of fatigue the previous day. This result is in accordance with an assumption of the Effort-Recovery model (Meijman & Mulder, 1998) and Conservation of Resources theory (Hobfoll, 2001) that the processes underlying the beneficial effects of BPN satisfaction will have more opportunities to operate in response to elevated load reactions. This finding is encouraging, not only because it is consistent with prominent recovery theory, but also because it suggests that employees who are most in need of recovery may obtain most benefit from fulfilling core psychological needs during non-work time.

While an elevated level of fatigue the previous day seemed to enhance the benefits of BPN satisfaction on non-work days, we did not find a similar effect in relation to depressed mood, although this effect was comparable in size to that found for fatigue. It may be that the presumed stronger effects of BPN satisfaction only start operating above a certain level of depressed mood, and that this level was not reached in our sample. Indeed, the levels of depressed mood were generally low in our sample, as indicated by the fact that only 6.8% of the daily reports entailed 'high' levels of depressed mood (i.e., a 'moderate amount' or higher).

For reasons similar to those underlying the presumed stronger association between BPN satisfaction and recovery for employees with a poorer initial recovery state, we expected the effects of BPN satisfaction to be stronger on the first day off compared to subsequent day(s) off. However, this hypothesis was not supported by our data. To

examine if we were correct in assuming that employees start their first day off in a less favorable recovery state, we conducted a t-test for each of the two recovery indicators. Results showed that employees indeed reported higher levels of fatigue ($M = 2.59$; $t(412) = -2.48$, $p < .05$; $d = 0.24$) and depressed mood ($M = 1.46$; $t(411) = -2.37$, $p < .05$; $d = 0.24$) on the evening preceding their first non-work day compared to the evening preceding a subsequent non-work day (fatigue: $M = 2.31$; depressed mood: $M = 1.30$). These differences were not very large, though, and probably not large enough to result in different effects of BPN satisfaction between the first/subsequent non-work days. Consequently, the contention that BPN satisfaction's relationship with employees' recovery state would be stronger on the first non-work day because they start such days with a less favorable recovery state was not supported in the present study. It remains to be investigated if these findings are unique to this sample or instead entail a general phenomenon. A tentative conclusion is that our study's results suggest BPN satisfaction has an equal effect on employees' recovery on the first and subsequent days off.

Third, we found that BPN satisfaction was more strongly related to employees' recovery state on free weekend days compared to free weekdays. This finding supports our assumption that satisfying one's basic psychological needs requires less resource investment during the weekend, and indicates that not all free days are created equal; free weekend days seem particularly important for enhancing the recovery functions of psychological need fulfillment.

Limitations and suggestions for future research

While we believe the present study has revealed some potentially important findings, a number of study limitations should be considered. First, BPN satisfaction and

employees' recovery state were measured at the same time on non-work days, at the end of each day. As a consequence, it is not possible to exclude the possibility that the causal associations proposed in the present study (also) operated in the opposite direction.

Nonetheless, the direction of the associations hypothesized in the present study concurs with basic assumptions derived from the Effort-Recovery model (Meijman & Mulder, 1998) and Self-Determination theory (Deci & Ryan, 2000). Post-hoc analyses of this study's data showed that (controlling for previous day's BPN satisfaction) both fatigue (multilevel estimate = -0.31, $p < .01$) and depressed mood (multilevel estimate = -0.45, $p < .01$) were negatively related to BPN satisfaction. These findings are in accordance with previous research that found a negative association between employees' recovery state at the end of their workdays, and BPN satisfaction during their subsequent free evenings (Van Hooff & Geurts, 2014). Future research could provide more insight in this respect, for example by measuring both BPN satisfaction and employees' recovery state multiple times during the course of a free day.

Second, our study only focused on BPN satisfaction during full non-workdays, and did not address BPN satisfaction during the evenings after work. The unique effects of BPN satisfaction during non-workdays compared to workdays could therefore not be examined. Furthermore, due to our study design it remains unknown if the positive relationships between BPN satisfaction and recovery that were found in the current study are equally strong for employees who do and employees who do not satisfy their basic psychological needs during workdays. In order to obtain a more complete understanding of the role of BPN satisfaction during non-workdays in the recovery process, future

research should examine this issue taking into account BPN satisfaction both during full non-work days and evenings after work.

Third, despite its pivotal role in the recovery process (Sonnentag & Geurts, 2009), we did not address sleep (quality and/or quantity) in our study. For example, sleep may mediate the association between BPN satisfaction and employees' next day recovery; and/or the previous night's sleep may affect the extent to which employees are able to fulfill their basic psychological needs during the day. We therefore recommend that future research provides more insight into the role of BPN satisfaction in the recovery process by also examining if and how it influences sleep (quality and/or quantity) and vice versa.

Fourth, our study focused exclusively on BPN satisfaction and did not pay attention to BPN frustration. As the latter has been shown to be related to ill-being (Vansteenkiste & Ryan, 2013), to provide more insight into the role of basic psychological needs in the recovery process, it might be valuable for future research to examine if and how frustration of the basic psychological needs relates to employees' recovery state, and vice versa.

Fifth, our research attracted an apparently healthy sample of employees, who were generally reporting relatively low levels of depressed mood and fatigue, and relatively high levels of BPN satisfaction. It is therefore not known at this stage if our findings can be generalized to employees who are experiencing more extreme levels of impaired mood or energy depletion and/or whose basic psychological needs are not being satisfied during off-job time. Although this possible restriction of range in study variables would have resulted in an underestimation, rather than overestimation, of the associations

studied, it would be valuable for future research to study the relation between BPN satisfaction and recovery in samples with more variation in recovery states and BPN satisfaction.

Sixth, there was substantial variation in the work patterns of the shift-workers in our sample (see Method section), with only a limited number of participants ($n = 23$) having days off only on weekdays. To further substantiate the current study's findings, it is recommended that it is replicated, employing a larger sample of employees who have their weekly days off on weekdays.

Finally, to our knowledge, this is the first study to demonstrate that the functional influence of BPN satisfaction was stronger on free weekend days compared to free weekdays. We assumed this was due to the fact that satisfying one's basic psychological needs requires less resource investment (e.g., time, energy) during the weekend. However, we did not directly investigate this potential mechanism. Future research may be able to enhance the understanding of the recovery functions of different types of off-job days by explicitly addressing the processes underlying such effects. It would also be useful to investigate whether similar differences between weekday/weekend days away from work pressures will be found for other recovery experiences (such as detachment from work and relaxation; Sonnentag & Fritz, 2007).

Practical implications

From a practical point of view, our study highlights the importance of employees satisfying their basic psychological needs during their off-job days. They can achieve this, for example, by becoming more aware of the types of activities that provide them with a

personal sense of autonomy, competence, and relatedness, and by reflecting on ways to increase the frequency of such activities/behaviors in their leisure time.

Given the stronger association between BPN satisfaction and recovery on such days, employees should particularly be encouraged to engage in need-satisfying behaviors on off-job days during the weekend and on off-job days that are preceded by an unfavorable recovery state. Obtaining BPN satisfaction on the latter type of days might be difficult, though, as previous research showed that employees with the highest need for recovery are least able to satisfy their BPNs (Van Hooff & Geurts, 2014), presumably because they lack the (self-regulatory) resources to pursue activities that contribute to BPN satisfaction. It is therefore additionally recommended that employees aim to make a habit of engaging in need satisfying behavior, as habitual behaviors require less (self-regulatory) resources and are therefore more likely to be pursued.

Also, given the stronger association between BPN satisfaction and recovery observed during non-work weekend days, it is essential that BPN satisfaction can be achieved during this type of day. This not only has implications for workers employed in professions that are traditionally characterized by shift-work, but also for other employees who are requested to be flexible and to adapt to the “24-hour economy”. Results of the current study highlight the importance of allowing employees to have at least some of their off-job days during the weekend. Employers can play an important role in this respect. They could for example contribute to their employees’ health and well-being by designing work schedules in such a way that free days regularly take place during weekends.

Conclusion

We conclude that this study has extended the understanding of employees' off-job recovery processes. Our results support and extend previous findings regarding the beneficial role of BPN satisfaction for employee recovery (see Mojza, et al., 2011; Van Hooff & Geurts, 2014), and also offer insight into factors that seem to impinge upon the strength of this positive association. Specifically, our study shows that fulfilling basic psychological needs during non-work days can be especially valuable for recovery if employees are experiencing an unfavorable recovery state on the preceding work day. Furthermore, our findings indicate that the timing of non-work days is important: the beneficial associations between BPN satisfaction and employees' recovery state were stronger during non-work weekend days than during non-work weekdays. We hope that future research can be designed with the aim of replicating this finding with other occupational groups and in relation to other recovery experiences beyond BPN satisfaction.

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Table 1. Means, standard deviations and correlations of the core variables under study (6-8) and control variables (1-5).

	M	SD	1.	2.	3.	4.	5.	6.	7.	8.
1. Gender ¹ (% male)	17%	-		-.01	.02	.05	.14	-.02	-.02	.03
2. Age	43.17	9.57	-		.05	.49**	.04	.04	-.11	-.11
3. Partner ² (% yes)	66%	-	-	-		.19**	-.04	.07	-.04	-.13
4. Number of children living at home	1.12	1.07	-	-	-		.02	.00	-.14	-.15*
5. Emotional stability	4.21	2.32	.14**	.04	-.04	.02		-.02	-.17*	-.20**
6. Daily need satisfaction on non-work days	5.10	1.19	-.01	.04	.07	.02	-.04		-.40**	-.35**
7. Daily fatigue	2.49	1.16	-.02	-.08**	-.04	-.10**	-.12**	-.42**		.49**
8. Daily depressed mood	1.44	0.70	.02	-.07**	-.09**	-.10**	-.13**	-.42**	.43**	

¹ 0 = female, 1 = male; ² 0 = no, 1 = yes Note : below diagonal: day-level correlations (n between 454 and 1428); above diagonal: person-level correlations (n between 198 and 205); * $p < .05$, ** $p < .01$ (2-tailed)

Table 2. Means and standard deviations of fatigue, depressed mood and BPN satisfaction on workdays vs. non-work days, weekday vs. weekend days and the first non-work day vs. subsequent non-work day(s)

(Non)workday vs Week(end) (n 62-883)										First non-work day vs. subsequent non-work day(s) (n 199-219)						
	Workday weekdays		Workday weekend		Non-workday weekdays		Non-workday weekend		<i>t</i> -test/ <i>F</i> -test	Effect size	First day off		Subsequent day off		<i>t</i> -test	Effect size
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Daily fatigue	2.58	1.19	2.83	1.24	2.25	1.07	2.30	1.08	<i>F</i> (1399,3) = 8.09**	Eta² =.02	2.33	1.08	2.25	1.09	<i>t</i> (415) = -0.74	<i>d</i> = .07
Daily depressed mood	1.49	0.73	1.57	0.79	1.30	0.58	1.34	0.62	<i>F</i> (1391, 3) = 6.09**	Eta² =.01	1.31	0.61	1.33	0.59	<i>t</i> (413) = 0.37	<i>d</i> = .03
Daily BPN satisfaction during non- work days	-	-	-	-	4.94	1.30	5.16	1.15	<i>t</i> (461) = -1.73	<i>d</i> = .18	5.09	1.16	5.19	1.17	<i>t</i> (420) = 0.85	<i>d</i> = .09

*Note : * $p < .05$, ** $p < .01$ (2-tailed)*

Table 3. Associations between need satisfaction during non-work days and fatigue, as well as interactions between need satisfaction during non-work days and a) fatigue levels on the previous day, b) the first vs. subsequent non-work day and c) non-work weekdays vs. non-work weekend days.

	Null Model	Model 1		Model 2		Model 3		Model 4a		Model 4b		Model 5a		Model 5b	
		unst. est. ^a	st. est. ^b	unst. est.	st. est.	unst. est.	st. est.	unst. est.	st. est.	unst. est.	st. est.	unst. est.	st. est.	unst. est.	st. est.
Intercept	2.30**	2.31**		2.32**		2.30**		2.35**		2.35**		2.27**		2.29**	
Fatigue prev. day		0.45**	.36	0.35**	.28	0.37**	.30	0.36**	.29	0.36**	.29	0.35**	.28	0.36**	.29
Need satisfaction on non-work day				-0.30**	-.24	-0.30**	-.24	-0.30**	-.24	-0.30**	-.24	-0.31**	-.25	-0.17*	-.14
Need satisfaction * fatigue prev. day						-0.07*	-.05								
First non –work day								-0.07	-.13	-0.07	-.13				
Need satisfaction on non-work day* first non-work day										-0.00	-.00				
Non-work weekend day												0.07	.16	0.05	.11
Need satisfaction on non-work day* non-work weekend day														-0.18*	-.17
-2* log	1134.80	1088.84		1033.37		1028.83		1032.57		1032.56		1032.93		1028.05	
Diff -2* log		45.96**		55.47**		4.54*		0.80		0.01		0.44		4.88*	
ΔDf		1		1		1		1		1		1		1	
Level 1 intercept var.	0.49	0.73		0.59		0.60		0.59		0.59		0.59		0.58	
Level 2 intercept var.	0.70	0.10		0.15		0.12		0.15		0.15		0.16		0.15	

Note: * $p < .05$; ** $p < .01$; ^a= unstandardized coefficient; ^b= standardized coefficient; $n = 412$

Table 4. Associations between need satisfaction during non-work days and depressed mood, as well as interactions between need satisfaction during non-work days and a) fatigue levels on the previous day, b) the first vs. subsequent non-work day and c) non-work weekdays vs. non-work weekend days.

	Null Model	Model 1		Model 2		Model 3		Model 4a		Model 4b		Model 5a		Model 5b	
		unst. est. ^a	st. est. ^b	unst. est.	st. est.	unst. est.	st. est.	unst. est.	st. est.	unst. est.	st. est.	unst. est.	st. est.	unst. est.	st. est.
Intercept	1.32**	1.33**		1.34**		1.33**		1.39**		1.39**		1.22**		1.23**	
Depressed mood prev. day		0.24**	.27	0.21**	.24	0.21**	.24	0.22**	.25	0.22**	.25	0.22**	.25	0.22**	.25
Need satisfaction on non-work day				-0.17**	-.33	-0.17**	-.33	-0.17**	-.33	-0.18**	-.35	-0.18**	-.35	-0.06	-.12
Need satisfaction * depressed mood prev. day						-0.05	-.07								
First non –work day								-0.10*	-.08	-0.10*	-.08				
Need satisfaction on non-work day* first non-work day										0.00	.00				
Non-work weekend day												0.16*	.11	0.14*	.10
Need satisfaction on non-work day* non-work weekend day														-0.15**	-.25
-2* log	650.64	631.25		579.73		577.52		574.13		574.12		572.78		562.42	
Diff -2* log		19.39**		51.52**		2.21		5.60*		0.01		6.95**		10.36**	
ΔDf		1		1		1		1		1		1		1	
Level 1 intercept var.	0.16	0.20		0.19		0.19		0.18		0.18		0.19		0.18	
Level 2 intercept var.	0.19	0.09		0.07		0.06		0.07		0.07		0.06		0.06	

Note: * $p < .05$; ** $p < .01$; ^a= unstandardized coefficient; ^b= standardized coefficient; $n = 407$