

Work-related flow and energy at work and at home: A study on the role of daily recovery

EVANGELIA DEMEROUTI^{1*}, ARNOLD B. BAKKER², SABINE SONNENTAG³
AND CLIVE J. FULLAGAR⁴

¹*Industrial Engineering and Innovation Sciences, Eindhoven University of Technology, Eindhoven, the Netherlands*

²*Work and Organizational Psychology, Erasmus University Rotterdam, Rotterdam, the Netherlands*

³*Department of Psychology, University of Mannheim, Mannheim, Germany*

⁴*Kansas State University Department of Psychology, Manhattan, Kansas, U.S.A.*

Summary

In this diary study, we aimed to examine the moderating effects of the following: (i) recovery efforts at work and (ii) detachment from work on the relationship between work-related flow and energy after work. Specifically, we hypothesized that flow would be beneficial for energy after work when employees failed (versus managed) to recover during work breaks. Additionally, we predicted that when employees experience flow at work, they would be more vigorous (and less exhausted) at the end of the day when they detached from work in the evening compared with days when they failed to detach. The study tracked 83 participants who completed daily surveys over four consecutive days. Results of multilevel analyses indicated that some characteristics of flow, such as absorption and enjoyment, were significantly associated with energy after work. Recovery at work and detachment from work moderated the relationship between flow (specifically the enjoyment component) and after-work energy. Copyright © 2011 John Wiley & Sons, Ltd.

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One of the repercussions of positive psychology, and its related field of positive organizational behavior, has been a re-focus on what makes workers flourish and on understanding positive work states such as engagement and flow (Bakker & Schaufeli, 2008). Such positive states have been shown to broaden our behavioral repertoires and enable us to develop skills and resources that help us be more resilient when confronted with adversity (Fredrickson, 1998, 2001). Although recent research has found that positive work experiences have a positive impact on job performance (Bakker & Bal, 2010; Demerouti, 2006; Demerouti & Cropanzano, 2010), relatively little research has investigated how positive experiences at work influence non-work functioning.

In this daily diary study, we focus on flow at work defined as a short-term peak experience characterized by absorption, work enjoyment, and intrinsic work motivation (Bakker, 2005, 2008). We ask whether flow acts like a typical positive state-like construct and contributes to individuals flourishing (*cf.* Luthans, 2002). Specifically, we examine whether flow is beneficial for employees' levels of energy after work and at the end of the day, and there are specific conditions under which the flow experience is more energizing and less exhausting. We focus on state vigor and exhaustion during work and non-work time, as neither has been examined as possible outcomes of flow. Nonetheless, both state vigor and exhaustion are important outcomes of work. For example, accumulated, chronic exhaustion has been found to predict work disability (van Amelsvoort, Kant, Beurskens, Schröer, & Swaen, 2002), impaired job performance (Cropanzano, Rupp, & Byrne, 2003; Taris, 2006), increased personnel turnover (Wright & Cropanzano, 1998), and increased sickness absence (De Croon, Sluiter, & Frings-Dresen, 2003).

*Correspondence to: Evangelia Demerouti, Eindhoven University of Technology, Industrial Engineering and Innovation Sciences, Eindhoven, the Netherlands. E-mail: e.demerouti@tue.nl

Our main assumption is that recovery during and after work is an important factor that determines whether flow experiences will fuel employees' energy resources. Recovery is the process that repairs the negative effects of strain (Demerouti, Bakker, Geurts, & Taris, 2009) or the process during which an individual's functioning returns to its pre-stressor level (Sonnetag & Natter, 2004). Whereas most studies on (daily) recovery focus exclusively on the engagement in off-job activities that may reduce fatigue and restore physiological and psychological readiness (for an overview, see Demerouti et al., 2009), our study will examine the function of recovery both at work and at home, namely the recovery experience after breaks at work and psychological detachment from work when being at home. Surprisingly, little research has examined the role of work breaks in the replenishment of energy resources. The current research contributes to the literature in several ways. First, it investigates the role of recovery at work in the process of energy replenishment. Second, it distinguishes between two kinds of recovery: recovery during work that takes place when the "stressor" is present or will re-occur shortly and recovery after work that occurs when the stressor is no longer present. We hypothesized that each type of recovery would have a different impact on energy after work. We summarized all examined relationships in Figure 1.

Flow experience

Csikszentmihalyi (1975) conceived flow as "the holistic sensation that people feel when they act with total involvement" (p. 4)—a state that is characterized by a sense of self-control and pleasure. An important precondition for flow is that there should be a balance between the challenges inherent in a task and the skills necessary to meet these challenges. Like other positive states, it is associated with a broadened sense of awareness and enhanced functioning (Fredrickson, 2001; Novak, Hoffman, & Yung, 2000). According to Bakker (2005, 2008), there are three related dimensions of flow. *Absorption* refers to total concentration and immersion in the activity. It represents the dimension that flow and work engagement (as conceived by Schaufeli and Bakker (2004)) have in common. However, work engagement refers to a chronic and pervasive affective-cognitive state that is not focused on any particular object, event, individual, or behavior, whereas flow is a more acute state of absorption on a particular task. The *enjoyment* dimension of flow is the outcome of cognitive and affective evaluations of the flow experience. Finally, *intrinsic motivation* refers to the state in which people engage in the work activity for their own sake rather than for some extrinsic reward.

Consistent with the hedonic perspective, flow theory states that flow has a direct impact on subjective well-being by fostering the experience of happiness in the here and now (Moneta, 2004). There are two explanations for the expected beneficial role of flow for energy (i.e., vigor and exhaustion). First, according to Fredrickson (1998, 2001), positive emotions broaden people's momentary thought-action repertoires and build their resilience. Positive emotions such as joy, happiness, and interest have been shown to have long-term adaptive benefits by building on physical, intellectual, social, and psychological resources (Fredrickson, 1998, 2001; Fredrickson & Branigan,

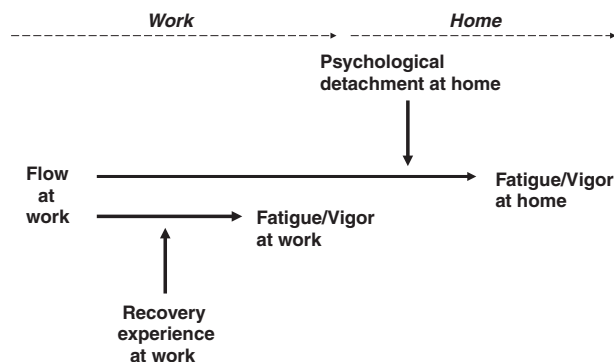


Figure 1. Hypothesized relationships

2005). Furthermore, the broaden-and-build theory suggests that positive emotions have a unique ability to physiologically down-regulate lingering negative emotions (Fredrickson & Levenson, 1998; Fredrickson, Mancuso, Branigan, & Tugade, 2000) and to trigger upward spirals of emotional well-being (Fredrickson & Joiner, 2002). In this way, flow can help build resilience and facilitate successful recovery from stressors and energy draining experiences (Vaugh, Fredrickson, & Taylor, 2008).

In addition, motivation has been found to offset the negative consequences of resource depletion. Specifically, depleted participants will continue to work on tasks when they believe that these are important and that there are personal benefits from the task (Muraven & Slessareva, 2003). On the basis of self-determination theory (Deci & Ryan, 2000), Trougakos and Hideg (2009) suggest that engaging in work tasks that are intrinsically motivating can have two possible effects. First, less energy resources are consumed, and consequently, less resource depletion is experienced. Second, such an engagement fosters the building and replenishment of affective resources because the activities are interesting and enjoyable. In this way, engaging in work tasks that are intrinsically motivating and have the potential for a flow experience may lead to higher levels of energy (i.e., more vigor and less exhaustion).

Previous research on flow has tended to focus on the performance outcomes of optimal experience, such as in-role and extra-role behavior (Bakker, 2008; Demerouti, 2006; Eisenberger, Jones, Stinglhamber, Shanock, & Randall, 2005). Moreover, researchers have found flow experiences to be associated with positive affect and subjective well-being (Bloch, 2002; Clarke & Haworth, 1994; Delle Fave & Massimini, 2004; Fullagar & Kelloway, 2009; LeFevre, 1988). There is also some support to suggest that flow conforms to Fredrickson's (2001) broaden-and-build theory. Steele and Fullagar (2009) found that students' engagement in academic activities not only induced positive psychological states but also increased physical resources and resiliency and enabled students to cope more effectively with demanding situations and to function at an optimal level.

Recovery

Recovery at work

An obvious way to restore energy is to rest, or take a break, from activities that deplete energy resources (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Meijman & Mulder, 1998). Work breaks can include anything from sleep to going out for lunch, having a cup of coffee, checking one's email, or doing some stretching exercises. Most research on breaks has focused on the long-term consequences of extensive breaks such as sabbaticals (Davidson et al., 2010), vacations (Fritz & Sonnentag, 2006; Westman & Eden, 1997), weekends (Fritz & Sonnentag, 2005), and evenings (Sonnentag, 2001, 2003). Little is known about recovery from short breaks that occur during the working day. One exception is the experience sampling study by Trougakos, Beal, Green, and Weiss (2008) who found that employees who engaged in more respite activities (for example, napping, relaxing, and socializing) during work breaks experienced higher levels of positive emotions and lower levels of negative emotions during these breaks and higher levels of positive affect after the breaks.

However, not all breaks are beneficial for recovery. Trougakos et al. (2008) found that engaging in chores (for example, running errands, practicing material, and preparing for upcoming meetings) during breaks was associated with negative emotions. Even participating in social activities during lunch has been positively related to daily fatigue (Trougakos, Hideg, & Cheng, 2011). It would appear that for a work break to result in recovery, individuals must utilize this time to engage in activities that reduce demands on energy resources and allow the opportunity for these resources to be recovered (Trougakos & Hideg, 2009). The current study, rather than further identifying activities that enhance recovery, focuses on the *recovery experience* after breaks and the impact of breaks on the restoration of energy resources. Recovery experience after breaks at work refers to the degree to which individuals perceive that the breaks they take help them to restore energy resources (*cf.* Sonnentag & Natter, 2004). Similar to Sonnentag and Natter (2004) who measured recovery experience during non-work time, our participants have to indicate the degree to which they felt recovered after taking breaks at work. This method corresponds to a person's state of being recovered (Binnewies, Sonnentag, & Mojza, 2009) and refers to the recovery *effect* of breaks and not to a long list of *activities* that might not necessarily enhance recovery.

Recovery at home

One strategy that individuals can use to recover from the mental and physical efforts of work is to detach mentally from work. Psychological detachment refers to an individual's sense of being away from work (Etzion, Eden, & Lapidot, 1998). Detachment implies more than just being physically distant from work. It means that the individual stops thinking about work and disengages himself or herself mentally from both the negative and positive aspects of work (Sonnentag & Bayer, 2005; Sonnentag & Fritz, 2007; Fritz & Sonnentag, 2006). Detachment interferes with the recovery process when resources used at work are still cognitively aroused at home (Cropley, Dijk, & Stanley, 2006). In contrast, when individuals detach psychologically from their work, no further functional demands tax their psychobiological system (Demerouti et al., 2009; Sonnentag & Fritz, 2007). Diary studies indicate that individuals who experience psychological detachment from work report better mood, less negative affect, fatigue, and sleep disturbances at home (Cropley et al., 2006; Sonnentag & Bayer, 2005; Sonnentag, Binnewies, & Mojza, 2008a).

Recovery as a moderator of the flow-energy relationship

We expect differential moderating effects of recovery on the relationship between flow and energy, depending on whether the recovery process takes place at work or at home. In the work context, we expect that flow will act as a protective factor against inadequate recovery, and thus, there will be a stronger favorable effect of flow on energy when recovery is low (as compared with high). For recovery at home, we expect that work-related flow will be associated with more energy at the end of the day when employees detach from work while being at home compared with those days when they fail to detach. There are two reasons for this. First, recovery during work, when the "stressor" is present, functions differently than recovery after work, when the stressor is no longer present. Specifically, the reaction to acute stressors is called reactivity or recovery depending on the timing of the measure. When psychophysiological data are gathered during an acute stressor task, they represent an index of reactivity; when they are collected during the time directly following an acute stressor task, they reflect an index of recovery (Gump & Matthews, 1999). Gump and Matthews (1999), in their review of the research, indicate that there is an inconsistent relationship between heightened background stressors and stressor reactivity, with the majority of research indicating a positive relationship, but a sizable minority of studies indicating a negative association. These authors suggest coping resources, stressor or event characteristics, and the meaning of the events for the individual as possible moderators of the relationship.

To justify the moderating effect of recovery at work on the flow-energy relationship, we draw upon two theories: the Cognitive Activation Theory of Stress (CATS; Ursin & Eriksen, 2004) and broaden-and-build theory (Fredrickson, 2001). According to CATS, the general response to stress stimuli is a non-specific alarm response, eliciting a general increase in wakefulness and brain arousal to deal with the reasons for the alarm. This is referred to as arousal or activation and represents an optimal, positive, and desirable response, where physiological resources are mobilized to initiate and improve performance. In a healthy organism, a short-lasting activation has no proven ill effects. In humans, this arousal seems to manifest in an increase in epinephrine, heart rate, and testosterone levels (Arnetz, 1996; Ursin, Baade, & Levine, 1978). This short-term arousal pattern has training effects but no straining effects and may be referred to as an anabolic stress response (Arnetz, 1996). It is the prolonged or sustained activation of these systems that has detrimental effects.

When individuals recover by taking breaks during the performance of work tasks, activation is lowered, and thus no detrimental effects on energy should be found. In this case, work-related flow does not necessarily lead to more favorable outcomes as energy levels may be even reduced during the recovery period. In contrast, because flow represents the full immersion in an activity (Csikszentmihalyi, Rathunde, & Whalen, 1993), taking long breaks during work might conflict with the experience of flow and constitute an interruption of optimal experience (Strongman & Burt, 2000). In addition, such breaks may cause production output to drop (Henning, Pierre, Kissel, Sullivan, & Alteras-Webb, 1997).

However, when recovery after breaks is insufficient, we expect that flow will play a protecting role to preserve energy. Research by Fredrickson and colleagues (Fredrickson & Levenson, 1998; Fredrickson et al., 2000) has shown that positive emotions can reduce the physiological effects of negative emotions. As Fredrickson (2001) suggests, positive emotions have an “undoing” effect. Because positive emotions broaden individuals’ thought–action repertoires, they should also serve as efficient antidotes for the unfavorable effects of negative emotions that narrow thought–action repertoires. In other words, positive emotions might “correct” or “undo” the aftereffects of negative emotions (Fredrickson & Levenson, 1998). Fredrickson et al. (2000) found that positive emotions themselves do not generate cardiovascular reactivity but instead quell any existing cardiovascular reactivity caused by negative emotions. This means that flow (representing a positive state) should overrule the process of energy depletion that takes place during task execution. Therefore, we hypothesize that

Hypothesis 1: Recovery at work moderates the relationship between flow at work and energy (vigor and low exhaustion) at the end of the working day. The relationship between flow and energy (vigor and low exhaustion) after work will be stronger when employees fail to recover during work breaks than when they manage to recover.

At home, the pattern of the moderator effect is expected to be different. In this case, the flow experience has already been terminated because, most probably, individuals have spent several hours at leisure activities during non-work time. However, individuals can still experience aftereffects of being pleasantly immersed in an enjoyable activity. In order for employees to regain their energy, it is important that they psychologically distance themselves from activities at work (Sonnentag & Bayer, 2005). Although experiencing flow at work might imply that the energizing effect of flow spills over into home life in the evening, we propose that the relation between flow at work and low exhaustion and high vigor at home might not occur in all instances. Specifically, we hypothesize that flow experienced at work is negatively related to exhaustion at home and positively related to vigor at home, particularly when employees mentally detach from work when being at home but not when they stay mentally connected to work.

The CATS (Ursin & Eriksen, 2004) provides a useful framework for understanding the effects of psychological detachment. The core assumption of the CATS is that repeated or chronic cognitive activation, such as worrying or rumination, produced by stress may prolong physiological activation and lead to health impairment. In a similar vein, Brosschot, Gerin, and Thayer (2006) argue that perseverative cognition prolongs a stressor’s psychophysiological activation by maintaining its cognitive representation. In support of this hypothesis, it has been found that rumination impedes the recovery process by prolonging physiological activation (McCullough, Orsulak, Brandon, & Akers, 2007). Moreover, other research has shown that detachment moderates the relationship between stressors and burnout, such that stressors are less strongly associated with burnout among individuals who experience high detachment from work (Etzion et al., 1998). There is also evidence that individuals who experience psychological detachment from work during leisure time report more positive mood and less fatigue (Sonnetttag & Bayer, 2005). Our second hypothesis is based on this theoretical framework.

Hypothesis 2: Detachment from work when being at home moderates the relationship between flow at work and energy (vigor and low exhaustion) at the end of the day. Employees who experience flow at work will be more vigorous (and less exhausted) at the end of the day when they detach from work compared with days when they fail to detach.

Method

Procedure and sample

Flow has often been measured through experience sampling methods (e.g., Csikszentmihalyi & Hunter, 2003). In this study, we measure flow by using a daily diary approach where we ask employees to report the extent to which they

experienced flow during a working day at the end of that working day. We chose this approach because we were not interested in fluctuations of the experience during the working time *per se* but in the outcomes of this experience.

Employees from 13 different organizations participated in the study. Research assistants recruited the participants. Research assistants distributed questionnaires and diaries through their personal contacts. In this way, heterogeneity of the sample and their jobs was guaranteed. Data collectors directly described the objectives of the research to those employees who agreed to participate and gave them a package that included the following: (i) a letter describing the purpose of the study and assuring the anonymity and confidentiality of all responses; (ii) instructions about the completion of the surveys; (iii) a general questionnaire; (iv) a diary booklet; and (v) return envelopes. The participants received no incentive in order to participate to the study.

The study participants filled in the general questionnaire and, after that, they completed daily questionnaires twice a day, during four consecutive working days: (i) an afternoon questionnaire (to be completed after work when still being at work) and (ii) a night questionnaire (to be completed before bedtime). The participants completed the afternoon questionnaire on average at 17.30 hrs, whereas 41 per cent of the participants filled it in between 17.00 and 18.30 hrs. The participants completed the night questionnaire on average at 21.30 hrs, whereas 23 per cent of the participants filled it in at 22.00 hrs. Therefore, it seems that the participants complied with our instructions.

Of the 120 survey packages distributed, excluding the participants who did not fill in all the days or answered at wrong times, 83 persons responded to the general and daily questionnaires (69 per cent response rate). Of the participants, 40 were German, and 43 were Dutch. The participants worked in a broad range of sectors, including business and financial sector (20 per cent), education (15 per cent), health and welfare (12.5 per cent), governmental organizations (12.5 per cent), and hotel and catering industry (9 per cent). The mean age of the participants in the sample was 41.86 years ($SD = 13.80$). Fifty-nine per cent of them were women. Most participants lived with a partner (67 per cent) and had children (54 per cent). On average, they worked 38.20 hrs per week ($SD = 17.00$). The mean organizational tenure was 19.01 ($SD = 13.18$). The most frequently mentioned educational level was high school/vocational training (32 per cent) followed by university (26 per cent) and college (18 per cent) degree. Finally, 34 per cent of the sample had a leadership position.

Measures

General questionnaire measures

We used the general questionnaire to assess sociodemographic information and general level of the measures. The participants were asked to complete this questionnaire before they started to fill in the daily survey. These variables served as control variables in the analyses.

General level of exhaustion. We measured the general level of exhaustion by using a subscale of the Maslach Burnout Inventory General Survey (Schaufeli, Leiter, Maslach, & Jackson, 1996). The exhaustion scale includes five items that refer to severe fatigue (sample item: "I feel used up at the end of the workday.") The items were scored on a 7-point rating scale, ranging from 0 = *never* to 6 = *always* (Cronbach's $\alpha = .90$).

General level of vigor. For assessing the general level of vigor, we used the subscale of the Utrecht Work Engagement Scale (Schaufeli, Salanova, Gonzales-Roma, & Bakker, 2002). This scale includes three items that assess the levels of energy and mental resilience while working (sample item: "At my work, I feel bursting with energy"). Items were rated on a 7-point scale, ranging from 0 = *never* to 6 = *always* (Cronbach's $\alpha = .93$).

Other variables. As additional control variables, we measured nation (0 = *Dutch*; 1 = *German*), age, the presence of children, and the number of work hours actually worked per week. We included these variables, which have been the most commonly assessed in daily studies about stressors and strains (e.g., Sonnentag & Bayer, 2005;

Sonnentag & Zijlstra, 2006; Xanthopoulou, Bakker, Heuven, Demerouti, & Schaufeli, 2008), to avoid the existence of spurious relations between the variables under study.

Daily questionnaire measures

For all measures except the control variables, we used subsets of three items instead of the full versions to keep the daily surveys short (Ohly, Sonnentag, Niessen, & Zapf, 2010). All responses were given on 5-point scales ranging from 1 = *not true at all* to 6 = *totally true*. Cronbach's alphas for day-level variables are mean internal consistencies averaged over all measurement days.

Flow at work. We assessed the flow at work using the instrument developed by Bakker (2005, 2008). Whereas this instrument includes 13 items, we included three items per dimension and modified the items such that they referred to today. Examples are as follows: "Today at work, I forgot everything else around me" (*absorption*), "Today I did my work with a lot of enjoyment" (*work enjoyment*), and "Today, I got my motivation from the work itself, and not from the reward for it" (*intrinsic work motivation*). The instrument has good factorial validity, satisfactory internal consistencies, and good test-retest reliability within a time lag of six weeks (Bakker, 2008). In this study, the average Cronbach's alpha for absorption was .65 and ranged between .60 and .70 during the days. For intrinsic motivation and enjoyment, the mean Cronbach's alpha was .65 (ranging between .60 and .70) and .74 (ranging between .65 and .79), respectively.

Recovery after breaks. To measure the degree of recovery after breaks at work, we used the previous literature on recovery (e.g., Sonnentag & Natter, 2004) to develop three items for this study. Specifically, the participants reported how recovered they felt after a respite during the work schedule (Today ... "During a break I could recuperate," "After a pause, I was again full of energy," and "After a pause, I felt like continue working"). The average Cronbach's alpha was .85 ranging from .80 to .89.

Psychological detachment. We measured psychological detachment using three items of the scale developed by Sonnentag and Fritz (2007), a scale based on core findings from affect-regulation research (Parkinson & Totterdell, 1999). An example item is "When I came home today ... I forgot about work." The average Cronbach's alpha of the scale was of .87, which ranged between .82 and .91.

Exhaustion at work and at bedtime. The participants indicated their level of exhaustion right after finishing their work and at bedtime responding to a three-item scale adapted from the Maslach Burnout Inventory General Survey (Schaufeli et al., 1996). Items were modified such that to measure exhaustion at work, employee replied to statements referring to momentary feelings regarding work. In case of exhaustion at bedtime, items did not refer to work issues but to levels of exhaustion in general. A sample item is "At this moment, I feel emotionally drained." The average Cronbach's alpha for exhaustion at work was .85 (ranging between .83 and .87) and for exhaustion at home was .83 (ranging between .82 and .87).

Vigor at work and at bedtime. The participants reported their level of vigor right after finishing their work and at bedtime responding to a three-item scale adapted from the Utrecht Work Engagement Scale (Schaufeli et al., 2002). As in the previous case, for vigor at work, items refer to momentary work-related feelings, whereas for vigor at bedtime, items did not refer to work issues but to levels of energy and activity in general. A sample item is "At this moment, I feel bursting with energy." The average Cronbach's alpha for vigor at work was .75 (ranging between .65 and .80) and for vigor at home was .75 (ranging between .70 and .80).

Although the scales of vigor and exhaustion were available in both Dutch and German languages by the developers of the scales, the recovery scales were available in German, whereas the flow scale was available in Dutch. The latter two scales were translated to the other language and translated back to the original language to ensure the correspondence of the two versions, as recommended by Hambleton, Merenda, and Spielberger (2005).

Results

Preliminary analyses

Because our data had a hierarchical structure with daily measures nested within persons, we used hierarchical linear modeling for analyzing the data (Bryk & Raudenbush, 1992). We centered the person-level control variables at the grand mean and all day-level predictors at the respective person mean. Before testing our hypotheses, we examined the between-person and within-person variance components of vigor and exhaustion at work and at home. For vigor at work, 56.30 per cent of the total variance was within persons, whereas for exhaustion at work, 33.08 per cent of the total variance was within persons. For vigor and exhaustion at home, the percentages were almost similar, that is, 56.60 and 33.33, respectively. Thus, vigor and exhaustion at work and at home varied both within and between persons, warranting an examination of predictor variables at the person and the day level. We displayed the means, the standard deviations, and the correlations among all the study variables in Table 1. We average the day-level variables across the four days to correlate them with measures at the person level.

Test of hypotheses

To test our hypotheses, we started with a null model that included the intercept as the only predictor. In Model 1, we entered person-level control variables. These include sociodemographic characteristics (nation, age, presence of children, number of working hours per week) and the general level of the respective dependent variable. In Model 2, we entered our predictor variables of interest, namely the state flow dimensions of absorption, enjoyment and intrinsic motivation and recovery at work for vigor/exhaustion at work, or detachment from work for vigor/exhaustion in the evening. In Model 3, we entered the interaction terms between the state flow dimensions and recovery at work (for work-related vigor/exhaustion) or detachment from work during off-job time (for vigor/exhaustion at bedtime). We examined fixed effects and tested the improvement of each model over the previous one by computing the differences of the respective log likelihood statistic $-2 \cdot \log$ and submitted this difference to a chi-squared test.

Vigor/exhaustion at work

For vigor at work as the outcome variable (Table 2), Model 1, that consisted of the person-level control variables, provided a better fit with the data than the null model (difference $-2 \cdot \log = 61.860$, $p < .001$). Three of the four control variables entered in Model 1 were significant. Number of contract hours and general level of vigor were positively related to vigor at work, whereas nation was unrelated. Model 2, that included the state flow dimensions as well as recovery at work, provided a better fit with the data than Model 1 (difference $-2 \cdot \log = 84.645$, $p < .001$). Of the predictor variables, only absorption and enjoyment had significant positive estimates indicating that the higher a person's absorption and the higher the enjoyment during a specific working day, the higher the vigor at the end of the working day. In Model 3, we incorporated the interaction terms between state flow and recovery at work. The model fit further increased (difference $-2 \cdot \log = 11.117$, $p < .05$), and one of the three interaction terms was statistically significant. Specifically, the interaction between enjoyment and recovery at work was negatively related to vigor at work. To examine the interaction effect in more detail, we ran simple slope tests (Aiken & West, 1991). In line with Hypothesis 1, the analysis showed that for employees with low recovery after breaks at work, enjoyment showed a positive relation with vigor at the end of work ($\gamma = 1.02$, $SE = 0.16$, $z = 6.38$, $p < .001$). However, when employees had sufficient recovery during work, enjoyment had no effect on vigor ($\gamma = -0.21$, $SE = 0.24$, $z = -0.84$, *not significant*). Figure 2 displays this interaction pattern.

Table 3 shows the findings for exhaustion at work as the outcome variable. Similar to the results for vigor at work, Model 1, that included the person-level control variables, provided a better fit with the data than the null model (difference $-2 \cdot \log = 94.307$, $p < .001$). General level of exhaustion was positively related to exhaustion at

Table 1. Means, standard deviations, and correlations of the study variables, $N = 83$ participants, and $N = 332$ data points.

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Nation ^a	1.48	0.50														
2. Age	41.67	13.72	.13*													
3. Presence of children ^b	0.53	0.50	.21**	.72**												
4. Contract hours	39.21	11.28	.09	.28**	-.06											
5. Exhaustion (G) ^c	2.45	1.49	-.13*	-.07	.03	-.18**										
6. Vigor (G) ^c	3.83	1.29	.04	.25**	.27	.01	-.27**									
7. Absorption (S) ^d	2.83	0.71	-.18*	-.01	.08	.08	-.12*	.38**								
8. Intrinsic motivation (S) ^d	2.84	0.72	.02	.06	.10	.15**	-.13*	.31**	.68**							
9. Enjoyment (S) ^d	3.28	0.71	-.14*	.07	.05	.05	-.43**	.50**	.65**	.59**						
10. Recovery at work (S) ^d	2.99	0.81	.03	.01	-.01	.12*	-.29**	.26**	.45**	.41**	.51**					
11. Detachment at home (S) ^d	3.20	0.94	.17**	.11	.06	-.08	-.10	.06	-.08	-.08	.10	.22**				
12. Vigor at work (S) ^d	3.31	0.63	-.09	.33**	.23**	.18**	-.38**	.52**	.53**	.41**	.64**	.40**	-.04			
13. Exhaustion at work (S) ^d	2.51	0.99	-.25*	-.27**	-.16**	-.20**	.65**	-.38**	-.14*	-.10	-.44**	-.16**	-.31**	-.46**		
14. Vigor at home (S) ^d	3.20	0.65	-.12*	.29**	.15**	.15**	-.44**	.47**	.41**	.32**	.58**	.45**	.19**	.82**	-.53**	
15. Exhaustion at home (S) ^d	2.47	0.97	-.29*	-.22**	-.11*	-.16**	.65**	-.32**	-.05	-.03	-.37**	-.26**	-.34**	-.40**	.92**	-.52**

Note.
^a0 = Dutch.
^b1 = German.
^c0 = no, 1 = yes.
^d(G) = general level.
^d(S) = state.
^{*} $p < .05$.
^{**} $p < .01$.

Table 2. Multi-level estimates for models predicting vigor at work, $N=83$ participants, and $N=332$ data points.

	Model 1			Model 2			Model 3		
	Estimate	SE	Sign	Estimate	SE	Sign	Estimate	SE	Sign
Constant	3.215	0.107	***	3.216	0.105	***	3.215	0.105	***
Nation ^a	-0.211	0.115		-0.221	0.113		-0.169	0.114	
Age	0.004	0.006		0.005	0.006		0.003	0.006	
Presence of children	0.219	0.172		0.173	0.168		0.218	0.168	
Contract hours	0.008	0.003	*	0.007	0.003	*	0.007	0.003	*
General level of vigor	0.233	0.046	***	0.245	0.046	***	0.249	0.045	***
Absorption				0.279	0.076	**	0.303	0.075	***
Intrinsic motivation				0.042	0.083		0.049	0.082	
Enjoyment				0.243	0.070	***	0.242	0.069	***
Recovery at work				0.067	0.054		0.073	0.053	
Absorption \times recovery							0.210	0.138	
Intrinsic motivation \times recovery							-0.122	0.144	
Enjoyment \times recovery							-0.409	0.137	**
$-2 \times \log$ (lh)		673.178			588.533			577.416	
Diff- $2 \times \log$		61.860	***		84.645	***		11.117	*
<i>Df</i>		4			4			3	
Between person (level 2) variance	0.152	0.041		0.161	0.039		0.162	0.039	
Within person (level 1) variance	0.393	0.036		0.307	0.029		0.293	0.028	

Note.

^a0 = Dutch, 1 = German; Model 1 was compared with a null model with the intercept as the only predictor ($\gamma = 3.310$; $SE = 0.070$; $t = 47.286$; $-2 \times \log = 735.038$; level 1 variance = 0.389; $SE = 0.035$; level 2 variance = 0.302; $SE = 0.063$).

* $p < .05$.

** $p < .01$.

*** $p < .001$.

work. Model 2 also included the state flow dimensions and recovery at work and fitted the data better than Model 1. Of the predictor variables, only enjoyment had a significant positive estimate, indicating that the higher a person's enjoyment during a specific working day, the lower the exhaustion at the end of that working day. In Model 3, we added the interaction terms between state flow and recovery at work. Model fit further increased, and one of the three interaction terms was significant (difference $-2 \times \log = 8.310$, $p < .05$). Similar to the findings of vigor at work,

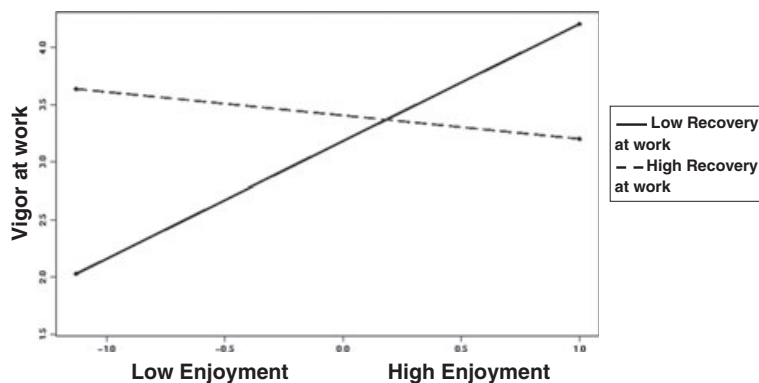


Figure 2. Interaction effect of enjoyment and recovery at work on vigor at work

Table 3. Multi-level estimates for models predicting exhaustion at work, $N=83$ participants, and $N=332$ data points.

	Model 1			Model 2			Model 3		
	Estimate	SE	Sign	Estimate	SE	Sign	Estimate	SE	Sign
Constant	2.624	0.143	***	2.630	0.142	***	2.628	0.142	***
Nation	-0.295	0.155		-0.272	0.155		-0.319	0.156	*
Age	-0.006	0.008		-0.007	0.008		-0.005	0.008	
Presence of children	-0.288	0.229		-0.284	0.228		-0.317	0.228	
Contract hours	-0.004	0.005		-0.005	0.005		-0.005	0.005	
General level of exhaustion	0.415	0.051	***	0.416	0.051	***	0.408	0.051	***
Absorption				-0.067	0.086		-0.087	0.085	
Intrinsic motivation				-0.071	0.094		-0.078	0.093	
Enjoyment				-0.189	0.079	*	-0.191	0.078	*
Recovery at work				0.023	0.061		0.017	0.060	
Absorption \times recovery							-0.120	0.159	
Intrinsic motivation \times recovery							0.094	0.168	
Enjoyment \times recovery							0.341	0.158	***
$-2 \times \log(lh)$		738.503			689.208			680.898	
Diff- $2 \times \log$		94.307	***		49.295	***		8.310	*
<i>Df</i>		4			4			3	
Between person (level 2) variance	0.341	0.072		0.3427	0.072		0.344	0.071	
Within person (level 1) variance	0.426	0.039		0.388	0.036		0.378	0.036	

Note.

Model 1 was compared with a null model with the intercept as the only predictor ($\gamma=2.523$; $SE=0.109$; $t=23.147$; $-2 \times \log=832.810$; level 1 variance = 0.430; $SE=0.039$; level 2 variance = 0.870; $SE=0.153$).

* $p < .05$.

** $p < .01$.

*** $p < .001$.

the interaction between enjoyment and recovery at work was significantly related to exhaustion at work. Simple slope tests indicated that for employees with low recovery after breaks at work, enjoyment showed a negative relation with exhaustion at the end of work ($\gamma = -0.84$, $SE = 0.27$, $z = -3.11$, $p < .001$). However, when employees recovered during work, enjoyment was not related to exhaustion at the end of work ($\gamma = 0.18$, $SE = 0.23$, $z = 0.79$, *not significant*). Figure 3 displays this interaction pattern.

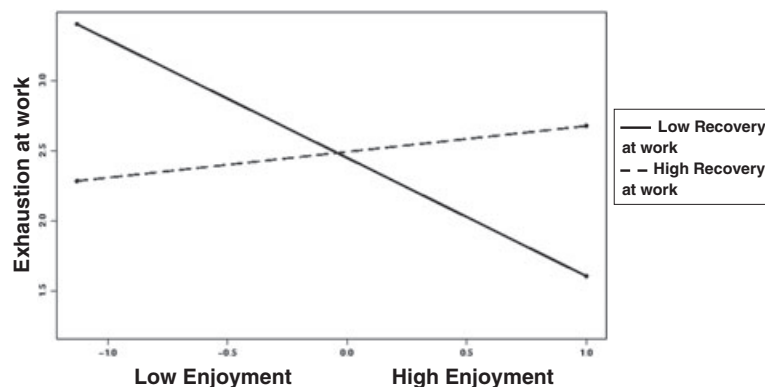


Figure 3. Interaction effect of enjoyment and recovery at work on exhaustion at work

Vigor/exhaustion at bedtime

Table 4 shows the findings for vigor at bedtime as the outcome variable. General level of vigor was positively related to vigor at bedtime. Further, Model 2, that included the state flow dimensions of absorption, intrinsic motivation, and enjoyment at work as well as detachment at home, produced a better fit with the data than Model 1 (difference $-2*\log = 50.663$, $p < .001$). The more participants were intrinsically motivated and enjoyed their work on a specific day, and the more they detached from work when being at home, the more vigorous they felt at bedtime. Model 3, that included the interactions between the state flow dimensions at work and detachment at home, resulted in an improvement of model fit (difference $-2*\log = 9.167$, $p < .001$). Similar to the findings regarding vigor at work, the interaction between state enjoyment at work and detachment at home was significant. Figure 4 displays this interaction pattern. Employees with high enjoyment during work experienced higher vigor at bedtime when they detached from work while being at home compared with their counterparts low on detachment.

Finally, Table 5 displays the findings for exhaustion at bedtime as the outcome variable. Similar to the previous findings, control variables contributed significantly to the prediction of exhaustion at bedtime. Nation was negatively related, and general level of exhaustion was positively related to exhaustion at bedtime. Model 2, that also included the state flow dimensions and detachment at home, improved the fit with the data compared with Model 1 (difference $-2*\log = 36.712$, $p < .001$). However, only state enjoyment was negatively related to exhaustion at bedtime. Model 3, that included the interactions between the state flow dimensions at work and detachment at home, resulted in a further improvement of model fit (difference $-2*\log = 9.167$, $p < .05$). Again, results indicated that the interaction between state enjoyment at work and detachment at home was significant. Employees with high enjoyment during work experienced lower exhaustion at bedtime when they detached from work while being at home compared with their counterparts low on detachment. Figure 5 displays this interaction pattern.

Table 4. Multi-level estimates for models predicting vigor at bedtime, $N = 83$ participants, and $N = 332$ data points.

	Model 1			Model 2			Model 3		
	Estimate	SE	Sign	Estimate	SE	Sign	Estimate	SE	Sign
Constant	3.215	0.114	***	3.212	0.116	***	3.212	0.075	***
Nation	-0.188	0.122		-0.187	0.125		-0.208	0.125	
Age	0.008	0.007		0.008	0.007		0.009	0.007	
Presence of children	0.033	0.182		0.018	0.185		0.021	0.186	
Contract hours	0.007	0.004		0.006	0.004		0.006	0.004	
General level of vigor	0.224	0.049	***	0.229	0.050	***	0.228	0.050	***
Absorption				0.017	0.083		0.013	0.082	
Intrinsic motivation				0.190	0.089	*	0.202	0.087	*
Enjoyment				0.176	0.076	*	0.178	0.075	*
Detachment at home				0.193	0.050	***	0.203	0.050	***
Absorption \times detachment							-0.254	0.134	
Intrinsic motivation \times detachment							0.138	0.166	
Enjoyment \times detachment							0.245	0.124	*
$-2*\log$ (lh)		699.946			649.283			640.116	
Diff- $2*\log$		58.584			50.663	***		9.167	*
<i>Df</i>		4			4			3	
Between person (level 2) variance	0.178	0.046		0.198	0.047		0.200	0.047	
Within person (level 1) variance	0.418	0.038		0.365	0.034		0.352	0.033	

Note.

Model 1 was compared with a null model with the intercept as the only predictor ($\gamma = 3.198$; $SE = 0.072$; $t = 44.417$; $-2*\log = 758.530$; level 1 variance = 0.416; $SE = 0.038$; level 2 variance = 0.319; $SE = 0.067$).

* $p < .05$.

** $p < .01$.

*** $p < .001$.

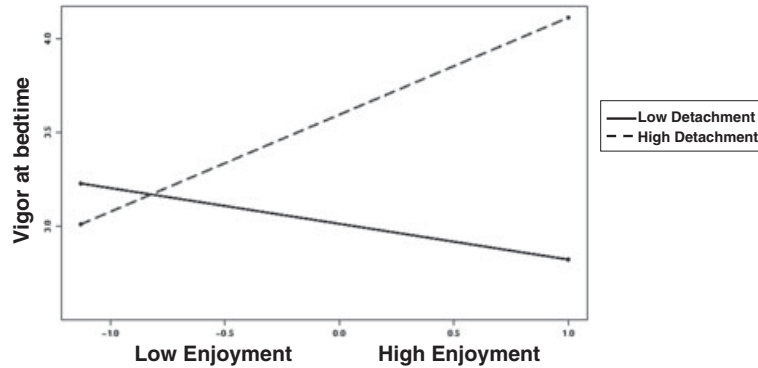


Figure 4. Interaction effect of enjoyment and detachment on vigor at bedtime

Overall, the results of hierarchical linear modeling analyses provided full support for Hypotheses 1 and 2, on the moderating role of recovery in the relationship between state flow at work and energy at the end of work and at bedtime, but only for the enjoyment dimension of flow. For intrinsic motivation and absorption, both hypotheses were rejected as there were only main effects. Multilevel analysis further showed that after controlling for background variables and for the general level of the outcome variables, enjoyment at work was positively related to vigor after work and at the end of the day. Absorption was positively related to vigor after work. Finally, intrinsic work motivation was positively related to vigor at the end of the day.

Table 5. Multi-level estimates for models predicting exhaustion at bedtime, $N=83$ participants, and $N=332$ data points.

	Model 1			Model 2			Model 3		
	Estimate	SE	Sign	Estimate	SE	Sign	Estimate	SE	Sign
Constant	2.509	0.144	***	2.505	0.147	***	2.511	0.146	***
Nation	-0.401	0.156	*	-0.395	0.160	*	-0.362	0.132	*
Age	-0.006	0.008		-0.007	0.009		-0.007	0.008	
Presence of children	-0.136	0.230		-0.126	0.234		-0.126	0.234	
Contract hours	-0.003	0.005		-0.002	0.005		-0.002	0.005	
General level of exhaustion	0.405	0.052	***	0.404	0.053	***	0.404	0.052	***
Absorption				-0.050	0.086		-0.043	0.086	
Intrinsic motivation				-0.129	0.092		-0.132	0.092	
Enjoyment				-0.172	0.079	*	-0.162	0.079	*
Detachment at home				-0.096	0.052		-0.113	0.052	*
Absorption × detachment							0.085	0.142	
Intrinsic motivation × detachment							0.139	0.178	
Enjoyment × detachment							-0.262	0.132	*
-2*log (Ih)		740.007			703.054			699.127	
Diff-2*log		72.989	***		36.712	***		9.167	*
Df		4			4			3	
Between person (level 2) variance	0.348	0.073		0.371	0.076		0.365	0.075	
Within person (level 1) variance	0.423	0.039		0.392	0.037		0.387	0.036	

Note.

Model 1 was compared with a null model with the intercept as the only predictor ($\gamma=2.477$; $SE=0.107$; $t=23.150$; $-2*\log=822.246$; level 1 variance=0.415; $SE=0.039$; level 2 variance=0.830; $SE=0.146$).

* $p < .05$.

** $p < .01$.

*** $p < .001$.

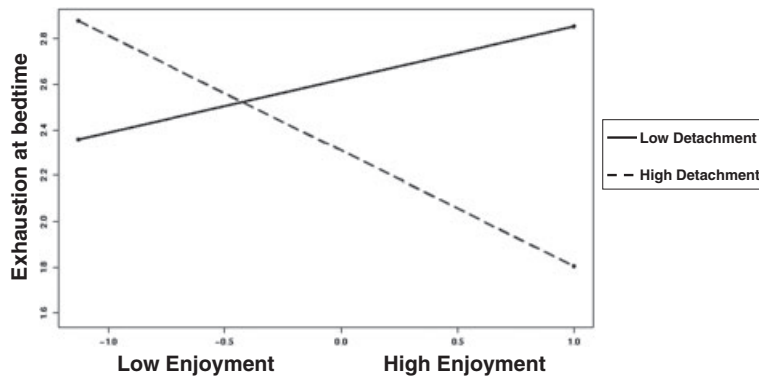


Figure 5. Interaction effect of enjoyment and detachment on exhaustion at bedtime

Discussion

This diary study aimed to examine the relationship between flow at work and energy, both immediately after work and at the end of the evening. The findings suggest that flow at work, particularly enjoyment, is positively related to vigor and negatively related to exhaustion both at the end of the working day and at the end of the evening. However, we found that recovery moderates the relationship between the enjoyment dimension of flow and energy at work and at home. As predicted, a different interaction pattern emerged depending on whether recovery took place at work or at home. At work, recovery suppressed the positive effect of work enjoyment on energy as there was a positive relationship between enjoyment and energy when employees did not feel recovered after breaks. At home, recovery strengthened the positive effect of work enjoyment on energy at the end of the evening.

Main findings

This study is the first to examine whether flow experienced during the working day fuels the energy that individuals have at the end of their working day and at the end of the evening. In line with Fredrickson's (1998, 2001) work, it was expected that flow—which represents a positive emotion at work (Bakker, 2005, 2008)—would be related to more vigor and less exhaustion because it builds personal resources and resilience and helps successful recovery from stressors and energy-draining events (Fredrickson & Levenson, 1998; Fredrickson et al., 2000; Waugh et al., 2008). Similarly, as flow is a highly motivating state, it was expected to consume less energy resources and to replenish affective resources (Troughakos & Hideg, 2009). We found that absorption and intrinsic motivation were positively related to vigor at work and at home, respectively, whereas enjoyment was positively related to vigor and low exhaustion both at work and at the end of the day. This finding agrees with Steele and Fullagar (2009), who found that flow is positively related to physical health and underscores the importance flow as a positive emotion at work. Luthans (2002) cautioned that for positive psychological concepts to avoid being labeled as fads by the academic community, they should be empirically related to human flourishing, valid and unique, and capable of being developed and enhanced through organizational interventions. Flow, as conceptualized in this study, seems to adhere to these requirements. Moreover, this diary study suggests that flow is a critical daily work experience that not only influences the energy level when being at work but also *spills over* to the non-work domain by influencing positively the energy level during off-job time.

Next to the beneficial (main) spillover effect of flow on energy level, we found that flow at work is positively related to vigor and negatively related to exhaustion after work, particularly when employees do *not* recover sufficiently during

work breaks. When employees experienced sufficient recovery after breaks at work, enjoyment had no effect on vigor and exhaustion after work. Consistent with CATS (Ursin & Eriksen, 2004), the general response to stress stimuli is arousal or activation that has no proven ill-effects when it is short lasting. Alternatively, when individuals took breaks such that they recovered sufficiently after the breaks, they might have interrupted the optimal experience of being totally immersed in an activity (Csikszentmihalyi, 1999). It was when recovery after breaks was insufficient that we found a stronger positive effect of the enjoyment dimension of flow on vigor and a negative effect on exhaustion after work. This pattern suggests that at work, enjoyment can overrule fatigue effects in that enjoyment acts as a protective factor against inadequate recovery (*cf.* Fredrickson et al., 2000). In line with Fredrickson's theory, as flow generates positive mood (Fullagar & Kelloway, 2009) and increases resources (Fredrickson, 1998), it makes employees resilient and corrects the unfavorable effects of negative emotions (Fredrickson & Levenson, 1998) including the depletion of energy. It seems that the positivity generated by absorbing and enjoyable work carries individuals over insufficient rest or recovery periods and acts as a substitution for rest. The critical question is, however, how long can flow experiences protect against energy depletion during work. Our daily diary study sheds light on relationships taking place on a daily level. Flow and recovery at work referred to experiences of a specific (working) day, whereas vigor and exhaustion were momentary experiences at the end of the working day. Longitudinal studies are necessary to examine whether such effects can be found over longer time spans.

When our participants went home, we found that the more flow they experienced during working time, the more vigorous and the less exhausted they were at the end of the day under one specific condition: when they psychologically detached from work during non-work time. When individuals continued thinking about their work during the evening, the beneficial effect of flow on energy disappeared. Thus, the prolonged positive effect of flow at work can only be experienced when mentally detaching from work when at home. This finding is also consistent with CATS theory (Ursin & Eriksen, 2004) that suggests that the individual interpretation of potential stressors is the main framework from which one can understand the effect of the stressors and that detachment diminishes the prolonged psychophysiological activation caused by stress (Brosschot et al., 2006). Although flow is associated with immediate positive affective states (Fullagar & Kelloway, 2009), this affective benefit of flow occurs only when gaining some distance from work during non-work time. This finding implies that although there is an affective gain from immersing oneself fully into one's work when being at work, continued thinking about work when being at home has a clear drawback in that it prolongs activation and undermines the positive effects of flow. In other words, next to the spillover effect of flow on energy, we also find evidence for the segmentation hypothesis inherent in the concept of psychological detachment. Not detaching from work is associated with increased level of negative affective states (Sonnentag et al., 2008a), which interferes with the positive after effects of flow. Therefore, it seems that it is the combination of experiencing flow and immersing oneself fully into one's work when being *at* work and gaining distance from work when *not* being at work that is most beneficial for positive affective states (Sonntag, Mojza, Binnewies, & Scholl, 2008b).

As already indicated, of the three flow dimensions, the significant interactions resulted only for the enjoyment dimension of flow. One explanation could be that it is the affective component of flow that is most important in sustaining resources both during and after work rather than the behavioral components of the experience (absorption) or the reasons why individuals are engaging in specific activities (intrinsic motivation). Further, an empirical explanation could be that the predictive value of absorption and intrinsic motivation was diminished because of a lower reliability coefficient as compared with the reliability of the enjoyment dimension. As a result, measurement error may have precluded absorption and intrinsic motivation from interacting with recovery in the hypothesized way. However, it should be noted that intrinsic work motivation and absorption had main effects on vigor at the end of the day and vigor after work, respectively. This suggests that the measurement was not a serious concern in our study.

Limitations

The current study has several limitations. First, we collected self-report data, which raises concerns about common-method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). To face this problem, we gathered data through

two different types of questionnaires and used person-centered scores in the analyses. Moreover, we included both positive and negative indicators of energy in order to increase the validity of the findings and minimize biased answers to questions including solely negatively or positively worded formulations. Because the phenomena under study take place in domains where participants are interacting with other people, colleagues and spouses could provide independent information about the individual's energy. To avoid mono-method, future researchers could include data from such multiple sources.

A second limitation is related to the data collection procedure. Although other daily studies have used survey packages (e.g., Xanthopoulou et al., 2008), we are aware that handheld computers provide more reliable results because participants know exactly when they have to fill in the questionnaires. Although participants received specific instructions and were asked to complete the questionnaire in the appropriate range of hours, by using more advanced instruments, we can objectively determine the exact time when the survey was completed to ascertain if participants are complying with the research instructions.

Another limitation is that our participants were not randomly selected from the entire German and Dutch working population. Thus, it is possible that potential selection biases might have influenced the results. The advantage of our recruitment method, however, was that the participants were employed in very heterogeneous jobs, thereby enhancing the generalizability of the findings. Moreover, because the design of this diary study (including two measurement points per day) is very demanding for the participants, we had to apply this technique to find a sufficient number of respondents. Future studies should try to replicate the findings in more representative samples and in other countries.

Finally, two of the flow dimensions measured in the diary showed relatively low Cronbach's alpha coefficients during some days, which may be attributed to the fact that not all statements of the respective flow dimension (included in each item) were experienced on each specific day. As this lowers the inter-item correlation, the value of Cronbach's alpha coefficient becomes lower also. Nevertheless, unreported analyses showed that items of each day-level scale were more highly correlated with each other than with items of other scales. Future researchers on flow are challenged to investigate more thoroughly whether adaptation of general scales is the best way to measure flow on the day level.

Implications and conclusion

Our findings suggest that it is important to help employees to preserve their energy resources while being at work or during off-job time by providing them with sufficient recovery possibilities during work, creating flow-enhancing conditions and stimulating the recovery strategy of detachment from work-related issues. Because sufficient recovery after breaks was found to place no risk on the energy level of the individual, it seems plausible to suggest that organizations should organize work such that breaks during work time are possible for employees to take at the right moment. Moreover, organizations should emphasize to their employees the importance of breaks for short-term and long-term levels of energy. Sufficient breaks might have important long-term consequences. In support of this, it has been generally demonstrated that taking breaks at work reduces fatigue and maintains performance in the long run (Tucker, 2003).

In addition, our findings suggest that it is worthwhile for organizations to promote flow among their employees by creating flow-evoking working conditions through work (re)design approaches. As our study showed, the flow experience is particularly useful on days when recovery at work is inadequate. Researchers found that job characteristics such as task variety, autonomy, job feedback, task identity, and task significance are conditions that evoke flow at work (Bakker, 2005, 2008; Demerouti, 2006). Our results indicate that redesigning work to be more conducive to flow increases vigor and decreases exhaustion in employees.

We found that psychological detachment preserves energy resources after work. Sonnentag, Kuttler, and Fritz (2010) suggest several approaches that might help individuals to detach. First, employees might want to plan and enact non-work activities that require full attention (e.g., specific hobbies). Second, when coming home from work,

employees may first want to share information about the working day with their spouses and afterwards move on to other topics for the rest of the night. Third, in order to prevent work-related demands from intruding into private life, employees may want to develop “rituals” that help to detach (such as not accessing emails or work phone calls). Apart from such individual approaches, organizations should organize work such that they allow employees to devote time to their personal life and to help them disconnect from work and to have more control over their leisure time. In addition, in this study, we found that recovery after breaks correlated positively with detachment from work when at home. Thus, organizations and employees should be aware of the importance of recovery during and after work.

To conclude, this study advanced our knowledge on the relationship between flow experiences at work and energy during work and non-work time. This is the first diary study to show that on days that employees experience flow, they also feel more vigorous and less exhausted. In addition, we saw that recovery during work and non-work time is crucial for employees’ energy reserves. Moreover, this study is the first to show that recovery may have different functions depending on whether it takes place during the presence of the stressor or after the stressor is no longer active. Finally, this study showed that it is important to investigate the effects of recovery not only after work but also during the working day. By applying research designs such as diaries, day reconstruction, and experience sampling, we can get better insight into the micro processes influencing employee health as they unfold during the course of an entire day.

Author biographies

Evangelia Demerouti is a full professor at Eindhoven University of Technology, the Netherlands. Her research interests include topics from the field of work and health, including positive organizational behavior, the job demands–resources model, work-family interface, crossover of strain, and recovery.

Arnold B. Bakker is a full professor of Work and Organizational Psychology at Erasmus University Rotterdam, the Netherlands. Dr. Bakker’s research interests include positive organizational behavior, the job demands–resources model, emotional labor, crossover, burnout, and work-family interaction.

Sabine Sonnentag is a full professor of Work and Organizational Psychology at the University of Mannheim, Germany. In her research, Dr. Sonnentag is mainly interested in how individuals can achieve sustained high performance at work and remain healthy at the same time. She studies recovery from job stress, proactive work behavior, learning, and self-regulation in the job context.

Clive J. Fullagar is a full professor of Industrial/Organizational Psychology at Kansas State University in the U.S. A. His main areas of interest are psychological involvement and participation in labor organizations and understanding the situational and dispositional predictors of work “flow” and its impact on psychological and physical well-being.

References

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.
- van Amelsvoort, L. G. P. M., Kant, I. J., Beurskens, A. J. H. M., Schröer, C. A. P., & Swaen G. M. H. (2002). Fatigue as a predictor of work disability. *Occupational and Environmental Medicine*, *59*, 712–713.
- Arnetz, B. (1996). Techno-stress: A prospective psychophysiological study of the impact of a controlled stress-reduction program in advanced telecommunication systems design work. *Journal of Occupational and Environmental Medicine*, *38*, 53–65.
- Bakker, A. B. (2005). Flow among music teachers and their students: The cross-over of peak experiences. *Journal of Vocational Behavior*, *66*, 26–44.
- Bakker, A. B. (2008). The work-related flow inventory: Construction and initial validation of the WOLF. *Journal of Vocational Behavior*, *72*, 400–414.

- Bakker, A. B., & Bal, P. M. (2010). Weekly work engagement and performance: A study among starting teachers. *Journal of Occupational and Organizational Psychology*, 83, 189–206.
- Bakker, A. B., & Schaufeli, W. B. (2008). Positive organizational behavior: Engaged employees in flourishing organizations. *Journal of Organizational Behavior*, 29, 147–154.
- Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology*, 74, 1252–1265.
- Binnewies, C., Sonnentag, S., & Mojza, E. J. (2009). Daily performance at work: Feeling recovered in the morning as a predictor of day-level job performance. *Journal of Organizational Behavior*, 30, 67–93.
- Bloch, C. (2002). Moods and the quality of life. *Journal of Happiness Studies*, 3, 101–128.
- Brosschot, J. F., Gerin, W., & Thayer, J. F. (2006). The perseverative cognition hypothesis: A review of worry, prolonged stress-related physiological activation and health. *Journal of Psychosomatic Research*, 60, 113–124.
- Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models: Application and data analysis methods*. Newbury Park, CA: Sage.
- Clarke, S. G., & Haworth, J. T. (1994). “Flow” experience in the daily lives of sixth-form college students. *British Journal of Psychology*, 85, 511–523.
- Cropanzano, R., Rupp, D. E., & Byrne, Z. S. (2003). The relationship of emotional exhaustion to work attitudes, job performance, and organizational citizenship behaviors. *Journal of Applied Psychology*, 88, 160–169.
- Cropley, M., Dijk, D.-J., & Stanley, N. (2006). Job strain, work rumination and sleep in school teachers. *European Journal of Work and Organizational Psychology*, 15, 181–196.
- Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety*. San Francisco: Jossey-Bass.
- Csikszentmihalyi, M. (1999). If we are so rich, why aren't we happy? *American Psychologist*, 54, 821–827.
- Csikszentmihalyi, M., & Hunter, J. (2003). Happiness in everyday life: The uses of experience sampling. *Journal of Happiness Studies*, 4, 185–199.
- Csikszentmihalyi, M., Rathunde, K., & Whalen S. (1993). *Talented teenagers: The roots of success and failure*. New York: Cambridge University Press.
- Davidson, O. B., Eden, D., Westman, M., Cohen-Charash, Y., Hammer, L. B., Kluger, A. N., Avraham, N., Krausz, M., Maslach, C., O'Driscoll, M., Perrewé, P. L., Quick, J. C., Rosenblatt, Z., & Spector, P. E. et al. (2010). Sabbatical leave: Who gains and how much? *Journal of Applied Psychology*, 95, 953–964.
- De Croon, E., Sluiter, J., & Frings-Dresen, M. (2003). Need for recovery after work predicts sickness absence. *Journal of Psychosomatic Research*, 55, 331–339.
- Deci, E. L., & Ryan, R. M. (2000). The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11, 227–268.
- Delle Fave, A., & Massimini, F. (2004). Bringing subjectivity into focus: Optimal experiences, life themes and person-centered rehabilitation. In P. A. Linley, & S. Joseph (Eds.), *Positive psychology in practice* (pp. 581–597). Hoboken, NJ: Wiley.
- Demerouti, E. (2006). Job characteristics, flow, and performance: The moderating role of conscientiousness. *Journal of Occupational Health Psychology*, 11, 266–280.
- Demerouti, E., Bakker, A. B., Geurts, A. E. G., & Taris, T. W. (2009). Daily recovery from work-related effort during non-work time. In S. Sonnentag, P. L. Perrewé, & D. C. Ganster (Eds.), *Current perspectives on job-stress recovery: Research in occupational stress and well being* (Vol. 7, pp. 85–123). Bingley, UK: JAI Press.
- Demerouti, E., & Cropanzano, R. (2010). From thought to action: Employee work engagement and job performance. In A. B. Bakker, & M. P. Leiter (Eds.), *Work engagement: A handbook of essential theory and research* (pp. 147–163). Hove, UK: Psychology press.
- Eisenberger, R., Jones, J. R., Stinglhamber, F., Shanock, L., & Randall, A. T. (2005). Flow experiences at work: For high need achievers alone? *Journal of Organizational Behavior*, 26, 755–775.
- Etzion, D., Eden, D., & Lapidot, Y. (1998). Relief from job stressors and burnout: Reserve service as a respite. *Journal of Applied Psychology*, 83, 577–585.
- Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology: Special Issue: New Directions in Research on Emotion*, 2, 300–319.
- Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist: Special Issue*, 56, 218–226.
- Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought–action repertoires. *Cognition and Emotion*, 19, 313–332.
- Fredrickson, B. L., & Joiner, T. (2002). Positive emotions trigger upward spirals toward emotional well-being. *Psychological Science*, 13, 172–175.
- Fredrickson, B. L., & Levenson, R. W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition and Emotion*, 12, 191–220.
- Fredrickson, B. L., Mancuso, R. A., Branigan, C., & Tugade, M. M. (2000). The undoing effect of positive emotions. *Motivation and Emotion*, 24, 237–258.

- Fritz, C., & Sonnentag, S. (2005). Recovery, health, and job performance: Effects of weekend experiences. *Journal of Occupational Health Psychology, 10*, 187–199.
- Fritz, C., & Sonnentag, S. (2006). Recovery, well-being, and performance-related outcomes: The role of workload and vacation experiences. *Journal of Applied Psychology, 91*, 936–945.
- Fullagar, C. J., & Kelloway, E. K. (2009). 'Flow' at work: An experience sampling approach. *Journal of Occupational and Organizational Psychology, 82*, 595–615.
- Gump, B. B., & Matthews, K. A. (1999). Do background stressors influence reactivity to and recovery from acute stressors? *Journal of Applied Social Psychology, 29*, 469–494.
- Hambleton, R. K., Merenda, P. F., & Spielberger, C. D. (2005). *Adapting educational and psychological tests for cross-cultural assessment*. London: Lawrence Erlbaum Associates.
- Henning, R., Pierre, J., Kissel, G., Sullivan, A., & Alteras-Webb, S. (1997). Frequent short rest breaks from computer work: effects on productivity and well-being at two field sites. *Ergonomics, 40*, 78–91.
- LeFevre, J. (1988). Flow and the quality of experience during work and leisure. In M. Csikszentmihalyi, & I. Csikszentmihalyi (Eds.), *Optimal experience: Psychological studies of flow in consciousness* (pp. 307–318). New York: Cambridge University Press.
- Luthans, F. (2002). The need for and meaning of positive organizational behavior. *Journal of Organizational Behavior, 23*, 695–706.
- McCullough, M. E., Orsulak, P., Brandon, A., & Akers, L. (2007). Rumination, fear, and cortisol: An in vivo study of interpersonal transgressions. *Health Psychology, 26*, 126–132.
- Meijman, T. F., & Mulder, G. (1998). Psychological aspects of workload. In P. J. D. Drenth, & H. Thierry (Eds.), *Handbook of work and organizational psychology* (Vol. 2, pp. 5–33). Hove: Psychology Press.
- Moneta, G. B. (2004). The flow experience across cultures. *Journal of Happiness Studies, 5*, 115–121.
- Muraven, M., & Slessareva, E. (2003). Mechanism of self-control failure: Motivation and limited resources. *Personality and Social Psychology Bulletin, 29*, 894–906.
- Novak, T. P., Hoffman, D. L., & Yung, Y.-F. (2000). Measuring the customer experience in online environments: A structural modeling approach. *Marketing Science, 19*, 22–42.
- Ohly, S., Sonnentag, S., Niessen, C., & Zapf, D. (2010). Diary studies in organizational research: An introduction and some practical recommendations. *Journal of Personnel Psychology, 9*, 79–93.
- Parkinson, B., & Totterdell, P. (1999). Classifying affect-regulation strategies. *Cognition and Emotion, 13*, 277–303.
- Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*, 879–903.
- Schaufeli, W. B., & Bakker, A. B. (2004). Job demands, job resources, and their relationship with burnout and engagement: A multi-sample study. *Journal of Organizational Behavior, 25*, 293–315.
- Schaufeli, W. B., Leiter, M. P., Maslach, C., & Jackson, S. E. (1996). The Maslach Burnout Inventory-General Survey. In C. Maslach, S.E. Jackson, & M.P. Leiter (Eds.), *Maslach Burnout Inventory. Manual* (3rd ed). Palo Alto, CA: Consulting Psychologists Press.
- Schaufeli, W. B., Salanova, M., Gonzales-Roma, V., & Bakker, A. B. (2002). The measurement of engagement and burnout: A two sample confirmatory factor analytic approach. *Journal of Happiness Studies, 3*, 71–92.
- Sonnentag, S. (2001). Work, recovery activities, and individual well-being: A diary study. *Journal of Occupational Health Psychology, 6*, 196–210.
- Sonnentag, S. (2003). Recovery, work engagement, and proactive behavior: A new look at the interface between non-work and work. *Journal of Applied Psychology, 88*, 518–528.
- Sonnentag, S., & Bayer, U.-V. (2005). Switching off mentally: Predictors and consequences of psychological detachment from work during off-job time. *Journal of Occupational Health Psychology, 10*, 393–414.
- Sonnentag, S., Binnewies, C., & Mojza, E. J. (2008a). Did you have a nice evening? A day-level study on recovery experiences, sleep, and affect. *Journal of Applied Psychology, 93*, 674–684.
- Sonnentag, S., & Fritz, C. (2007). The recovery experience questionnaire: Development and validation of a measure for assessing recuperation and unwinding from work. *Journal of Occupational Health Psychology, 12*, 204–221.
- Sonnentag, S., Kuttler, I., & Fritz, C. (2010). Job stressors, emotional exhaustion, and need for recovery: A multi-source study on the benefits of psychological detachment. *Journal of Vocational Behavior, 76*, 355–365.
- Sonnentag, S., Mojza, E. J., Binnewies, C., & Scholl, A. (2008b). Being engaged at work and detached at home: A week-level study on work engagement, psychological detachment, and affect. *Work and Stress, 22*, 257–276.
- Sonnentag, S., & Natter, E. (2004). Flight attendants' daily recovery from work: Is there no place like home? *International Journal of Stress Management, 11*, 366–391.
- Sonnentag, S., & Zijlstra, F. R. H. (2006). Job characteristics and off-job activities as predictors of need for recovery, well-being, and fatigue. *Journal of Applied Psychology, 91*, 330–350.
- Steele, J. P., & Fullagar, C. J. (2009). Facilitators and outcomes of student engagement in a college setting. *The Journal of Psychology: Interdisciplinary and Applied, 143*, 5–27.

- Strongman, K. T., & Burt, C. D. B. (2000). Taking breaks from work: An exploratory inquiry. *Journal of Psychology, 134*, 229–243.
- Taris, T. W. (2006). Is there a relationship between burnout and objective performance? A critical review of 16 studies. *Work & Stress, 20*, 316–334.
- Trougakos, J. P., Beal, D. J., Green, S. J., & Weiss, H. M. (2008). Making the break count: An episodic examination of recovery activities, emotional experiences, and positive affective displays. *Academy of Management Journal, 51*, 131–146.
- Trougakos, J. P., & Hideg, I. (2009). Momentary work recovery: The role of within-day work breaks. In S. Sonnentag, P. L. Perrewé, & D. C. Ganster (Eds.), *Current perspectives on job-stress recovery: Research in occupational stress and well being* (Vol. 7, p. 37–84). Bingley, UK: JAI Press.
- Trougakos, J. P., Hideg, I., & Cheng, B. H. (2011). Lunch breaks unpacked: Examining the effect of daily lunch break activities and control over break activities on fatigue. Manuscript submitted for publication.
- Tucker, P. (2003). The impact of rest breaks upon accident risk, fatigue and performance: A review. *Work and Stress, 17*, 123–137.
- Ursin, H., Baade, E., & Levine, S. (1978). *Psychobiology of stress: A study of coping men*. New York: Academic Press.
- Ursin, H., & Eriksen, H. R. (2004). The cognitive activation theory of stress. *Psychoneuroendocrinology, 29*, 567–592.
- Waugh, C. E., Fredrickson, B. L., & Taylor, S. F. (2008). Adapting to life's slings and arrows: Individual differences in resilience when recovering from an anticipated threat. *Journal of Research in Personality, 42*, 1031–1046.
- Westman, M., & Eden, D. (1997). Effects of a respite from work on burnout: Vacation relief and fade out. *Journal of Applied Psychology, 82*, 516–527.
- Wright, T. A., & Cropanzano, R. (1998). Emotional exhaustion as a predictor of job performance and voluntary turnover. *Journal of Applied Psychology, 83*, 486–493.
- Xanthopoulou, D., Bakker, A. B., Heuven, E., Demerouti, E., & Schaufeli, W. B. (2008). Working in the sky: A diary study on work engagement among cabin attendants. *Journal of Occupational Health Psychology, 13*, 345–356.