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The impact of within-day work breaks on daily recovery processes: An event-based pre-/post-experience sampling study

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Research on recovery from work stress has emphasized the importance of within-day work breaks. However, prior research has not been designed and analysed in a way that fully aligns with the processes described by the underlying theoretical framework (i.e., the effort-recovery model). The current paper examines the effects of within-day work breaks on recovery using an event-based pre-/post (EBPP)-design, in a way that more fully captures the recovery process as described by the effort-recovery model. We also included designs used in previous studies (i.e., an interval-based design and an event-based design without pre-break strain measures) to demonstrate the differences between the EBPP design and previous designs. The results of the EBPP model using a sample of Chinese white-collar employees showed that within-day work breaks are significantly associated with reduced fatigue and negative affect and increased positive affect, supporting the predicted recovery effects of within-day work breaks. However, mixed results were found in the interval-based design, and non-significant results were found in the event-based design without pre-break measurements. We discuss methodological implications and explain how the EBPP design could be applied to study other episodic phenomena.

Practitioner points

- An event-based pre-/post-design (EBPP) can be used to study recovery and other momentary, episodic events at work.
- Within-day work breaks can help employees reduce fatigue and negative affect and increase positive affect.
- Relaxation break activities, nutrition-intake activities, social activities, and cognitive activities help recovery.

Insufficient recovery from the strain reactions triggered by job demands is harmful to well-being (Sianoja, Kinnunen, de Bloom, & Korpela, 2015; Sonnentag, Venz, & Casper, 2017). Accordingly, research has accumulated seeking to understand how employees

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experience recovery from work demands (Parker, Zacher, de Bloom, Verton, & Lentink, 2017). Recovery is defined by the effort-recovery model as the process by which individual functional systems activated in response to work demands return to the pre-stress level (Meijman & Mulder, 1998). One type of activity that appears to be particularly important for facilitating recovery is within-day work breaks (also referred to as work breaks) – 'period(s) of the workday when work-related tasks are not required or expected or when employees proactively shift their attention away from work tasks as needed' (Hunter & Wu, 2016, p. 302). While many types of breaks (e.g., vacations and evening leisure time) contribute to recovery processes, within-day work breaks are the primary mechanism for recovery during the workday.

The development and application of experience sampling methodology (ESM) has helped advance research on within-day work breaks. Compared to other methodologies (e.g., cross-sectional surveys), ESM allows for capturing the fleeting effects and within-person variability in within-day work breaks (Beal & Weiss, 2003). The recovery effects of within-day work breaks are generally supported by ESM studies, which have shown that within-day work breaks are associated with recovery outcomes (e.g., affect and fatigue; Bosch, Sonnentag, & Pinck, 2018; Hunter & Wu, 2016; Trougakos, Beal, Green, & Weiss, 2008; Zacher, Brailsford, & Parker, 2014). For instance, Trougakos *et al.* (2008) found that respite activities during scheduled breaks were positively related to positive emotional experiences and inversely related to negative emotional experiences.

Though previous ESM studies (Hunter & Wu, 2016; Kim, Park, & Niu, 2016; Trougakos, Hideg, Cheng, & Beal, 2014; Trougakos *et al.*, 2008; Zacher *et al.*, 2014) have examined the recovery effects of within-day work breaks, the design of these studies do not fully capture the theoretical mechanisms specified by the effort-recovery model (Meijman & Mulder, 1998). That is, while the effort-recovery model conceptualizes recovery as a process (Meijman & Mulder, 1998) that occurs when an employee takes a break and which manifests as a *reduction* in strain reactions following a break, previous ESM designs do not reveal whether within-day work breaks *reduce* strain reactions but rather capture whether characteristics of within-day work breaks (e.g., break length and break activities) are *associated with* recovery outcomes after within-day work breaks (Kim *et al.*, 2016; Trougakos *et al.*, 2008).

Furthermore, within-day work break research based on the effort-recovery model has conceptualized breaks as discrete episodes and their effects as immediate and short-lived (Trougakos & Hideg, 2009), necessitating the need to study specific within-day work break episodes and their immediate effects. However, many within-day work break studies have not captured these specific episodes and their effects, but rather (1) measured break characteristics over longer time intervals (e.g., from the past afternoon) that include both break and task episodes, and (2) measured recovery outcomes (e.g., affective states) after numerous episodes (e.g., a whole afternoon or workday) rather than after each discrete within-day work break (Kim *et al.*, 2016; Trougakos *et al.*, 2014).

While theories in many areas of organizational research describe processes of change, study designs and analytic methods often do not use designs and analyses that capture that change (Ployhart & Vandenberg, 2010). We suggest that this is currently true of the within-day work break literature. By not measuring recovery as the *reduction* in strain reaction and by not capturing the immediate effects of discrete within-day work break episodes, prior studies have not fully tested the recovery mechanism specified by the effort-recovery model. Thus, different designs are needed to more fully capture these mechanisms.

We proposed using a design – the event-based pre-/post-design (EBPP) – that more fully aligns with the effort-recovery model. The EBPP design allows us to (1) capture the episodic nature and immediate effects of within-day work breaks and (2) assess the *reduction* in strain reactions, thereby overcoming limitations of prior designs and answering the call to align analyses with the theoretical framework upon which it is based (Ployhart & Vandenberg, 2010). Thus, this paper contributes to the literature on how within-day work breaks promote recovery by presenting and demonstrating the usefulness of a design that more fully captures the recovery process as described by the effort-recovery model (i.e., changes in strain levels as a result of taking a break), conforming to recommendations to align analyses with the processes described by the theory driving the research. This study also contributes to the organizational literature more generally by highlighting an alternative method to examine the momentary effects of episodic events or voluntary behaviours at work.

Theoretical background

Before describing prior work break studies, it is necessary to first explain the theoretical framework used to guide these studies – the effort-recovery model (Meijman & Mulder, 1998). According to the effort-recovery model, the exertion required to meet work demands results in short-term physiological and psychological reactions (also called 'strain reactions'), which manifest experientially as feelings of fatigue, negative affect, and reduced positive affect (Meijman & Mulder, 1998; Sonnentag & Fritz, 2007). These short-term strain reactions are reduced – that is, recovery occurs – when individuals take breaks from work, decreasing exposure to demands and allowing functional systems activated in strain reaction processes to return to baseline levels (Meijman & Mulder, 1998).

Within-day work breaks should help facilitate recovery for two reasons. First, recovery occurs when job stressors cease during within-day work breaks. By not working, workers are alleviated from exposure to work demands, which reduces fatigue and improves affect. Furthermore, within-day work breaks can provide psychological detachment from job-related demands, preventing further activation of the psychophysiological systems activated during work (Bakker, Demerouti, Oerlemans, & Sonnentag, 2013; Sonnentag & Fritz, 2007).

Second, within-day work breaks can be used to engage in specific activities (e.g., relaxing activities and social activities) that help recovery. For example, relaxing activities are ideal for facilitating recovery (Tyler & Burns, 2008; Vohs *et al.*, 2008), since they require little mental or physical effort and therefore help the functional systems return to baseline (Sonnentag & Fritz, 2007). Relaxing activities also help repair mood since they are generally experienced as pleasant (Sonnentag & Fritz, 2007; Stone, Kennedy-Moore, & Neale, 1995) and thus can help promote positive affect and reduce negative affect resulting from job demands (Fredrickson, 2001; Stone *et al.*, 1995). Additionally, some break episodes involve social interactions (e.g., chatting with co-workers), which can provide a sense of relatedness (Bosch *et al.*, 2018), when workers share joys and concerns with other persons and perceive themselves as being a part of a group and as accepted by others. Bosch *et al.* (2018) found that relatedness during lunch breaks is positively associated with the state of being recovered after lunch breaks (Bosch *et al.*, 2018). Moreover, within-day work breaks can provide workers a sense of control since workers can decide what to do during recovery opportunities (Bosch *et al.*, 2018; Sonnentag & Fritz, 2007). Given the above reasons, within-day work breaks should facilitate recovery.

Common ESM designs in the work break literature

Studies examining the effects of within-day work breaks on recovery have used two types of designs (i.e., interval-based designs and event-based designs without pre-tests). In the following sections, we explain these designs and their methodological limitations for understanding the effects of within-day work breaks on recovery, as understood from the perspective of the effort-recovery model.

Interval-based designs

Of the eight experience sampling studies or diary studies previously published on within-day work breaks and recovery (Bosch *et al.*, 2018; von Dreden & Binnewies, 2017; Hunter & Wu, 2016; Kim *et al.*, 2016; Kühnel, Zacher, de Bloom, & Bledow, 2017; Trougakos *et al.*, 2008, 2014; Zacher *et al.*, 2014), five applied interval-based designs (Bosch *et al.*, 2018; Kim *et al.*, 2016; Kühnel *et al.*, 2017; Trougakos *et al.*, 2014; Zacher *et al.*, 2014). These studies measured characteristics of within-day work breaks (e.g., break length or break activities) retrospectively for a set interval, such as the past few hours or the past workday, and used this measure as a predictor of recovery outcomes at the end of the interval (Trougakos *et al.*, 2014; Zacher *et al.*, 2014) or as a moderator of the effects of daily demands on recovery outcomes at the end of the workday (Kim *et al.*, 2016).

The interval-based designs are not optimal for assessing the effects of within-day work breaks on recovery for several reasons. First, the interval-based designs do not fully test the recovery process. The recovery process is understood as a *reduction* or *elimination* of strain reactions (Meijman & Mulder, 1998). However, none of the interval-based studies measured strain reactions immediately before and after breaks and thus cannot capture the *reduction* in strain, precluding a full test of the process described by the effort-recovery model.

Second, the interval-based designs do not capture the episodic nature of within-day work breaks. From the episodic perspective, 'the continuous flow of daily work can be divided into natural units' (Trougakos & Hideg, 2009), including task episodes and break episodes (Beal, Weiss, Barros, & MacDermid, 2005). Because interval-based designs measure within-day work breaks over an interval (e.g., a shift, a workday, or half a day) that also includes task episodes, they cannot rule out the confounding effects of task episodes, given the fact that workplace events (e.g., an uncivil interaction with a supervisor or co-worker, an unexpectedly heavy workload, or praise or commendation from a supervisor or co-worker) may induce specific affective experiences (Spector & Fox, 2002; Weiss & Cropanzano, 1996). Thus, task episodes could offset or exacerbate the recovery effects of within-day work breaks, precluding conclusions about the effects of within-day work breaks that are separable from the effects of task episodes (Xanthopoulou, Bakker, & Ilies, 2012).

Third, by assessing within-day work breaks retrospectively over a set interval (i.e., over an entire workday or afternoon), interval-based designs fail to capture the immediate effects of break episodes. Given that momentary psychological states such as affect are conceptualized as short-lived reactions (Fisher, 2010; Gray, Watson, Payne, & Cooper, 2001) that vary widely within workdays (Xanthopoulou *et al.*, 2012), the effects of within-day work breaks on recovery are of limited duration. As such, interval-based designs which measure strain reactions only at the end of the workday are not optimal for capturing these short-lived effects of breaks on recovery.

We do note that, while the above methodological challenges apply to the most commonly used interval-based designs, there are some exceptional designs that are less severely limited – albeit still somewhat limited – by the methodological issues we discuss. For instance, unlike other interval-based studies, Zacher *et al.* (2014) had shorter intervals with breaks measured every hour. Moreover, Time 1 measures of well-being were controlled when using within-day work breaks to predict Time 2 measures of well-being one hour later, which captures changes in indicators of recovery. While this study is less vulnerable to the above-mentioned limitations than most work break studies, the shorter-interval design does not fully rule out the impact of task episodes, as the one-hour intervals still combine task and break episodes and do not measure recovery immediately before and after breaks.

Event-based designs

In contrast to interval-based designs, three prior ESM studies applied event-based designs in which recovery was measured after each discrete break episode (von Dreden & Binnewies, 2017; Hunter & Wu, 2016; Trougakos *et al.*, 2008). While such designs overcome some problems with interval-based designs by measuring recovery immediately following discrete break episodes, they examine indicators of recovery only *after* within-day work breaks.[1] As explained previously, since the recovery process is understood as a *reduction* or *elimination* of strain reactions, measures of strain reactions prior to within-day work breaks are necessary to fully capture the recovery process. In the one event-based study that did measure pre-break strain levels (Hunter & Wu, 2016), pre-break strain was measured retrospectively after each break. Such retrospective measures are also not ideal. Given the momentary and fleeting nature of these strain reactions, retrospective biases likely influence the accuracy of recall of pre-break strain levels (Robinson & Clore, 2002; Schwarz, 2007).

These methodological limitations suggest that prior studies have not tested the effects of within-day work breaks on recovery in a way that fully captures the process as described by the effort-recovery model. Instead, what is captured is whether within-day work breaks or characteristics of breaks are *associated with* recovery outcomes, in the case of both interval-based designs and event-based designs without pre-tests. Further, interval-based designs are additionally limited by measuring breaks over time intervals that confound task episodes and break episodes, and potentially fail to capture the short-lived effects of breaks. These limitations of prior designs may explain why ESM studies on the effects of work breaks on recovery have not consistently yielded positive results (Bosch *et al.*, 2018; Hunter & Wu, 2016; Kim *et al.*, 2016).

It is worth noting that field experiments (Boucsein & Thum, 1997; Dababneh, Swanson, & Shell, 2001; Henning, Jacques, Kissel, Sullivan, & Alteras-Webb, 1997; Scholz *et al.*, 2018) have examined the effects of within-day work breaks and shown the importance of work breaks in recovery. These studies have typically manipulated the length, frequency, or activities of within-day work breaks (i.e., participants were asked to take a break of a specific length at a certain time or to do a certain break activity). Similar methodology has been applied to intervention studies (de Bloom *et al.*, 2017; Krajewski, Wieland, & Sauerland, 2010; Sianoja, Syrek, de Bloom, Korpela, & Kinnunen, 2017). While these studies have been useful for understanding the causal effects of experimentally manipulated within-day work breaks, they have not assessed the effects of voluntary

[1] *For an exception, see von Dreden and Binnewies (2017). They measured vigour one hour before lunch breaks and one hour after lunch breaks. Since this study did not measure vigour immediately before or after lunch breaks, their design has similar limitations with interval-based designs that the one-hour intervals included task episodes.*

within-day work breaks in naturalistic settings. Doing so is essential for gaining of fuller picture of how employees' break behaviours impact recovery.

Current study and hypotheses

We suggest that these methodological limitations can be overcome by implementing an EBPP design (Lischetzke, Reis, & Arndt, 2015). While this method has been applied in other areas (e.g., daily interventions at work), it has not yet been applied to study the effects of within-day work breaks on recovery. The EBPP design asks employees to report every within-day work break they take and to fill in a survey measuring current strain levels immediately before a break episode and a survey on break engagement and current strain levels immediately after a break episode. The EBPP model captures break episodes by using an event-based design and measures immediate recovery effects of within-day work breaks in a non-retrospective way. By including measurements of strain levels before and after each break episode, the EBPP design assesses the *reduction* in strain reactions as a function of taking a break.

Consistent with previous research, we focus specifically on the effects of within-day work breaks on affect and fatigue (i.e., a subjective feeling of tiredness resulting from demanding tasks; Inzlicht, Schmeichel, & Macrae, 2014; Trougakos *et al.*, 2014) – the most frequently used outcomes in previous studies examining the effects of within-day work breaks on recovery. For the EBPP design, we tested the following hypotheses, which follow directly from the predictions of the effort-recovery model, as explained above:

Hypothesis 1: Within individuals, within-day work breaks are associated with a *decrease* in fatigue.

Hypothesis 2: Within individuals, within-day work breaks are associated with (1) an *increase* in positive affect and (2) a *decrease* in negative affect.

Following recent trends, we also think it is necessary to capture different types of activities (Kim *et al.*, 2016; Parker *et al.*, 2017; Zacher *et al.*, 2014). In line with calls for studying various break activities and their effects on short-term recovery processes (Fritz, Lam, & Spreitzer, 2011; Trougakos & Hideg, 2009), we included four types of respite activities (i.e., relaxation, social, nutrition-intake, and cognitive activities) in exploratory analyses of event-based designs. Following previous predictions, we predicted that all the four respite activities had beneficial effects on recovery outcomes (Kim *et al.*, 2016).

To demonstrate how different designs for testing the same prediction of the effort-recovery model – that work breaks promote recovery – can yield different conclusions, we compared the findings of our EBPP design to that of a typical interval-based design[2] and a typical event-based design without pre-tests. Representing a typical interval-based design, we examined how break length over a workday predicts recovery outcomes at the end of the workday. Representing a typical event-based design without pre-tests, we investigated how the length of a break episode impacts levels of fatigue and affect immediately after break episodes.

The main differences in these designs are twofold. First, the EBPP design operationalizes within-day work breaks as taking a break, whereas the other designs operationalize

[2] *We acknowledge that the interval-based design in this study is not comparable to Zacher* et al. *(2014), which used a design with shorter intervals.*

within-day work breaks as break length (either over an entire interval or during a single break). Break length was chosen as the operationalization of break characteristics because it is commonly used in prior studies (Hunter & Wu, 2016). Secondly, whereas the measurement of recovery indicators both before and after each discrete within-day work breaks allows the EBPP design to assess changes in recovery as a function of a within-day work break, the other designs do not assess change in outcomes as a function of a discrete break episode. Rather they assess the associations of break length with recovery outcomes.

While the effort-recovery model suggests that time spent on breaks should impact recovery, these effects are likely detectable only when study methods are aligned with the process described by the effort-recovery model. If this is the case, we should see differences in the results from the EBPP design compared to results from the typical interval-based and event-based designs, with the typical interval- and event-based designs being more likely to show weaker effects of breaks on recovery outcomes. Specifically, we suggest that the recovery effects of work breaks are most detectable when the design aligns with theory. That is, given the limitations of the alternative models mentioned earlier, we suggest that the two alternative models are less likely to detect effects of breaks on recovery than the focal model.

Specifically, interval-based designs may not show strong effects of within-day work breaks on recovery because breaks are not measured as discrete episodes, and thus, their fleeting effects may not be fully captured. Also, measuring breaks across intervals that contain both break episodes and task episodes may impact the extent to which the effects of breaks can be detected. Given that the interval-based designs do not operationalize the recovery process (i.e., the reduction in strain reaction resulting from a work break) and confound other work episodes with break episodes, we suggest that the interval-based design is less likely than the EBPP design to detect the recovery effects of work breaks.

In the case of event-based designs without pre-break measures, by not measuring and controlling for levels of fatigue or affect immediately prior to the break, such designs fail to capture changes in strain reactions. By not separating the effects of within-day work breaks from the effects of fatigue or affect immediately prior to the breaks, such designs may be less likely to detect effects of breaks on recovery. The confounding effects of pre-break fatigue or affect might disguise the relationship between break length and fatigue or affect after a break episode. Therefore, the event-based design without pre-test is less likely than the EBPP design to show effects of work breaks on recovery.[3]

Method

Sample and procedure

We recruited Chinese participants through an online newsletter and word of mouth in 2016. To encourage participation, we offered participants lottery prizes (rewards included a laptop, a Kindle, and three vouchers that are worth 15 US dollars each) and

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[3] *We acknowledge that with different operationalizations of within-day work breaks (i.e., the EBPP examines the effects of taking a break, while the others examine the effects of break length), these models are not directly comparable. While these designs do not yield directly comparable results, they do represent two importantly different ways of examining the same phenomenon and thus it is important to see how results differ across these designs, even though the effect sizes generated are not directly comparable.*

feedback on the results of the study. Of 109 employees who expressed interest, 97 completed a general survey that assessed demographic information, yielding a response rate of 88.99% for the general survey. Among the 97 participants who completed the general survey, 16 participants did not answer any daily surveys. Among participants who completed daily surveys, 55% of the participants were male. Age ranged from 22 to 57 years (M = 35, SD = 10.41). For education, 41.3% of the participants held a university degree, 35% of them held a master's degree, 13.8% held a vocational-training degree, 6.3% had high school degree or below, and 1.3% held doctoral degree or above. Regarding tenure, 46.2% had 3 years' or <3 years' work experience, followed by 21.7%, 20.5%, and 11.6% for work experience of 3–10 years, 10–30 years, and more than 30 years, respectively. On average, most people worked 30–50 hr per week (85.9%); the rest (14.1%) worked 51 hr or more. Sixty-one per cent of the participants worked in government or government-owned units, followed by private sectors (14.1%), international companies (11.5%), self-owned business (6.4%), and others (5.1%).

Participants first completed a one-time questionnaire to assess demographic variables. At the start of the following week, participants began a two-week period during which they completed online daily surveys using a combination of interval-based and event-based sampling strategies (see Figure 1).

Event-based sampling

We provided participants with two online survey links – a pre-break survey link and a post-break survey link – and asked them to complete the surveys before and after each within-day work break. We explained the definition of within-day work breaks as episodes when an employee proactively stops doing work-related tasks or when work-related tasks are not required or expected, and instructed them to report all within-day work breaks regardless of the duration, and to fill in the survey immediately before and after the break. Each short survey took approximately 20–30 s. We measured fatigue, positive affect, and negative affect, both before and after the breaks. We also asked participants to report the types of their breaks and the amount of time they spent on specific break types. Seventy-five participants completed at least one matched survey, resulting in a response rate of 77.32%. Figure 1a presents the procedure for the EBPP design, and Figure 1b shows the procedure for the event-based design without pre-tests.

Interval-based sampling

Participants were asked to fill out an afternoon survey at the end of each workday. It measured current fatigue, positive affect, negative affect, and total amount of time spent on within-day work breaks. Considering concerns about participant burdens in the event-based sampling and inaccuracy to recall and estimate the total amount of time spent on each activity over the workday (Fisher & To, 2012), we did not measure time spent on specific break types in the interval-based sampling at the end of the workday. Since assessing the effects of specific types of breaks was not the focus of the paper, we considered it more important to alleviate the burden of filling out surveys on the participants than to assess specific activity types (Fisher & To, 2012). Eighty participants completed at least one end-of-day survey, yielding a response rate of 84.54%. See Figure 1c for the procedure of the interval-based sampling.

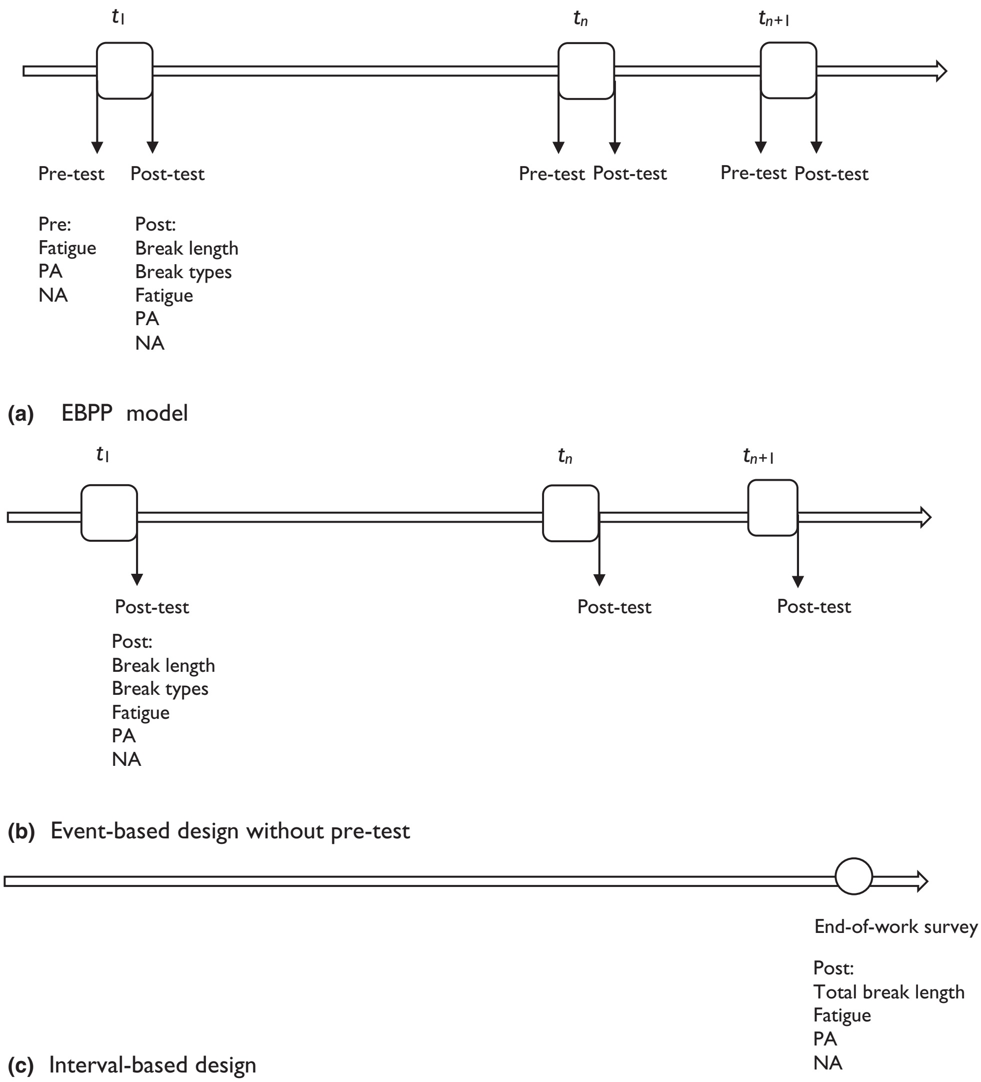

Figure 1. Designs of each model. *Note.* Square stands for a break episode. Vertical arrows represent assessments. PA = positive affect; NA = negative affect.

Measures

Break engagement

We measured four types of within-day work break activities – relaxation activities, nutrition-intake activities, social activities, and cognitive activities, which were originally used in Kim *et al.*'s (2016) study. Consistent with prior studies, relaxation activities consist of both physical and psychological activities, such as walking and daydreaming. Nutrition-intake activities involve consuming food and beverages. Social activities include face-to-face conversation with co-worker on non-work-related topics and connecting with others (e.g., friends, co-workers, and significant others) through the Internet. Cognitive activities involve reading news, watching video, and online shopping. We asked participants whether they engaged in relaxation activities, nutrition-intake activities, social activities, and cognitive activities (0 = No; 1 = Yes). A sample item is 'Did you chat with co-workers on non-work-related topics during the last break episode?' If the participants indicated they had participated in this activity during the last break episode, they were asked to rate how much time (in minutes) they spent on that type of break activity. A sample item is 'How much time did you spend chatting with co-workers on non-work-related topics?'

For the interval-based design, we assessed total break length during the workday by one self-developed item measuring total amount of break time by asking participants 'How much time did you spend on breaks in total on this workday (in minutes)?'

Fatigue

We measured fatigue with five items presented in Christian and Ellis (2011). These items were originally drawn from Twenge, Muraven, and Tice (2004) and were adapted to refer to the present moment. Sample items are 'Right now, it would take a lot of effort for me to concentrate on my work' and 'I feel drained right now'. The items were the same for event-based and interval-based samplings. Responses ranged from 1 = very slightly or not at all to 5 = very much. The mean coefficient alpha (across days) was .93 for pre-break fatigue, .92 for post-break fatigue, and .94 for end-of-workday fatigue. See Appendix for the full scale.

Affect

Positive affect was measured by two items (i.e., happy and excited) from the Positive and Negative Affect Schedule (PANAS). Negative affect was measured by two items (i.e., sad and irritable) from PANAS and one item (i.e., anxious) from Job-Related Affective Well-Being Scale (Van Katwyk, Fox, Spector, & Kelloway, 2000). Consistent with previous studies (Sonnentag, Binnewies, & Mojza, 2008; Trougakos *et al.*, 2008), we did not choose all items from one scale due to limited space in each survey for an ESM design; instead, we chose items that are likely to occur at work and to fluctuate within day and thus provide the within person variance needed for the experience sampling designs. Participants were asked to rate the extent to which they were currently experiencing each affect via a 5-point scale (from 1 = very slightly or not at all to 5 = very much). All the affect items were the same for the event-based and the interval-based samplings. The mean coefficient alphas (across days) were .86 (pre-tests) and .88 (post-tests) for positive affect and .77 (pre-tests) and .76 (post-tests) for negative affect. For the interval-based design, the mean coefficient alphas (across days) were .85 for end-of-workday positive affect and .82 for end-of-workday negative affect.

Analyses

Due to the nested nature of the data, we used hierarchical linear modelling (HLM; Raudenbush & Bryk, 2002) to analyse the data. All level 1 variables were group-mean-centred (Hofmann, Griffin, & Gavin, 2000).

Results

Focal model: EBPP design

Descriptives

The final sample consisted of 1,616 observations (808 breaks in total; an average of 11 breaks per participant). The average duration of reported breaks was 29 min. Table 1 displays the means, standard deviations, and within person correlation coefficients of pre-break and post-break fatigue and affect.

Analyses

The between-individual variances [ICC(1)] in fatigue, positive affect, and negative affect were 50.7%, 53%, and 43.3%, thus justifying the use of HLM (Lebreton & Senter, 2008). To test the reduction in fatigue and negative affect and improvement in positive affect (i.e., the difference between the means of fatigue or affect before and after within-day work breaks), we used Lischetzke *et al.*'s (2015)'s 'mean difference between fixed occasions' model (Lischetzke *et al.*, 2015):

Level 1 (within person):

$$Y = \pi_0 + \pi_1^*(\mathrm{POST})$$

Level 2 (person level):

$$\pi_0 = \beta_{00} + R_0$$

$$\pi_1 = \beta_{10} + R_1$$

In this model, Y refers to recovery outcomes (fatigue or affect). The varying intercept term π_0 stands for individuals' levels of fatigue or affect before breaks, and the varying slope term π_1 represents the differences in levels of fatigue or affect before and after within-day work breaks (post-tests minus pre-tests). The POST score is a dummy variable coded 0 for pre-tests and 1 for post-tests. At the person level, β_{00} represents mean levels of pre-break measures across individuals and β_{10} represents mean difference between pre-tests and post-tests (i.e., post-tests minus pre-tests) across

Table 1. Means, standard deviations, and correlations of event-level fatigue, positive affect, and negative affect before and after within-day work breaks

	M	*SD*	1	2	3	4	5	6
1 Pre-break fatigue	1.88	0.86	–					
2 Pre-break PA	2.04	0.84	−.17**	–				
3 Pre-break NA	1.41	0.60	.47**	−.16**	–			
4 Post-break fatigue	1.47	0.63	.46**	.02	.41**	–		
5 Post-break PA	2.33	0.95	.02	.46**	−.03	−.09*	–	
6 Post-break NA	1.26	0.52	.26**	.09*	.57**	.53**	−.01	–
7 Break length	29.54	26.72	.001	.06	−.08*	−.02	.06	−.01

Notes. $N = 808$. PA = positive affect; NA = negative affect. All variables were centred at the person-level before the correlations were computed. *$p < .05$; **$p < .01$.

individuals. The *R* terms represent deviations in individual scores around these means. Note that there is no level 1 residual because the level 1 equation serves only to decompose the two measures of each individual into the pre-test score and the pre-/post-difference score. Using this model, a significant β_{10} indicates a significant difference in fatigue or affect between pre-tests and post-tests across individuals (see Lischetzke *et al.*, 2015, Model 2 for more details).

Effects of taking a break on recovery. In our analyses for fatigue, β_{10} was negative and significant ($\beta_{10} = -.42$, $SE = .05, p < .001$), supporting Hypothesis 1, which predicted that within-day work breaks are associated with a decrease in fatigue. Hypothesis 2 was also supported, as HLM results showed that within-day work breaks were associated with an increase in positive affect ($\beta_{10} = .16$, $SE = .05, p < .001$) and a decrease in negative affect ($\beta_{10} = -.10$, $SE = .02, p < .001$).

Exploratory analyses on effects of taking specific types of breaks. We also examined whether specific types of break activities help recovery. See Table 2 for the means and standard deviations of pre-break and post-break fatigue and affect for each type of break. Results showed that all break activities contribute to recovery. Specifically, relaxation break activities are significantly associated with decreases in fatigue ($\beta_{10} = -.50$, $SE = .07, p < .001$) and negative affect ($\beta_{10} = -.13$, $SE = .06, p = .029$), and an increase in positive affect ($\beta_{10} = .23$, $SE = .06$, $p < .001$). Nutrition-intake activities are significantly associated with decreases in fatigue ($\beta_{10} = -.6$, $SE = .11, p < .001$) and negative affect ($\beta_{10} = -.13$, $SE = .04$, $p = .006$), and an increase in positive affect ($\beta_{10} = .30$, $SE = .10, p = .002$). Social activities are significantly associated with decreases in fatigue ($\beta_{10} = -.47$, $SE = .08$, $p < .001$) and negative affect ($\beta_{10} = -.16$, $SE = .04$, $p < .001$), and an increase in positive affect ($\beta_{10} = .3$, $SE = .06$, $p < .001$). Cognitive activities are significantly associated with decreases in fatigue ($\beta_{10} = -.5$, $SE = .1$, $p < .001$) and negative affect ($\beta_{10} = -.16$, $SE = .07$, $p = .02$), and an increase in positive affect ($\beta_{10} = .42$, $SE = .1, p < .001$). Thus, Hypotheses 1 and 2 were supported for each specific type of within-day work breaks.

Table 2. Means and standard deviations of event-level fatigue, positive affect, and negative affect before and after within-day work breaks on each break activity

	Relaxation *M* (*SD*)	Nutrition-intake *M* (*SD*)	Social *M* (*SD*)	Cognitive *M* (*SD*)
Pre-break fatigue	1.84 (0.85)	1.90 (0.87)	1.90 (0.85)	1.93 (0.82)
Post-break fatigue	1.40 (0.61)	1.46 (0.63)	1.48 (0.59)	1.42 (0.56)
Pre-break PA	2.03 (0.84)	1.94 (0.85)	2.02 (0.81)	2.11 (0.72)
Post-break PA	2.36 (0.94)	2.35 (1.09)	2.34 (0.9)	2.49 (0.85)
Pre-break NA	1.37 (0.57)	1.36 (0.57)	1.47 (0.65)	1.40 (0.53)
Post-break NA	1.23 (0.48)	1.23 (0.47)	1.31 (0.57)	1.13 (0.32)
N	363	242	314	71

Note. PA = positive affect; NA = negative affect. *N* represents sample size.

Interval-based model

Descriptives

The final sample consisted of 575 surveys. Table 3 displays the means, standard deviations, and correlations of day-level break length, end-of-day fatigue, and affect.

Analyses

The between-subject variances in fatigue, positive affect, and negative affect were 52.7%, 54%, and 54.7%, thus justifying the use of HLM.

Effects of time spent on break. We regressed end-of-workday fatigue/positive affect/negative affect onto total amount of time spent on breaks. Time spent on within-day work breaks was not related to end-of-day fatigue ($\beta = -.05$, $SE = .04$, $p = .156$). However, it was positively associated with positive affect ($\beta = .13$, $SE = .05$, $p = .012$) and negatively associated with negative affect ($\beta = -.06$, $SE = .03$, $p = .039$).[4]

Event-based model without pre-tests

Descriptives

Consistent with the focal model, the final sample consisted of 808 surveys.

Analyses

ICC(1)s for fatigue, positive affect, and negative affect were 58.4%, 49.2%, and 61%, respectively. For this model, we focused on break length (i.e., amount of time spent on a single break episode) and amount of time spent on four types of break activities.

Table 3. Means, standard deviations, and correlations of day-level break, fatigue, positive affect, and negative affect

	M	*SD*	1	2	3
1 Break length	83.3	91.1	–		
2 Fatigue	2.01	0.89	−.05	–	
3 PA	2.24	0.87	.15**	−.22**	–
4 NA	1.46	0.66	−.06	.37**	−.14**

Note. $N = 575$. PA = positive affect; NA = negative affect. Break length is in minutes. All variables were centred at the person level before the correlations were computed. $^{**}p < .01$.

[4] *We did additional analyses by controlling for morning fatigue/positive affect/negative affect in the equations, respectively, as this is a common approach in the literature. Results showed that time spent on within-day work breaks was not related to end-of-day fatigue ($\beta = -.05$, SE = .04, p = .134), positive affect ($\beta = .07$, SE = .08, p = .397), or negative affect ($\beta = -.00$, SE = .03, p = .935). Morning fatigue/positive affect/negative affect was not related to the corresponding end-of-work strain levels (fatigue: $\beta = .11$, SE = .08, p = .150; PA: $\beta = .05$, SE = .07, p = .454; NA: $\beta = -.16$, SE = .10, p = .122).*

Effects of time spent on breaks. We regressed post-break fatigue/positive affect/negative affect onto break length. Break length was not related to the levels of fatigue ($\beta = -.02$, $SE = .03$, $p = .614$), positive affect ($\beta = .06$, $SE = .05$, $p = .279$), or negative affect ($\beta = -.01$, $SE = .03$, $p = .825$) after breaks.

Exploratory analyses on effects of time spent on specific break activities. There were 697 observations that contained information on the amount of time spent on each type of break. We regressed post-break fatigue/positive affect/negative affect onto time spent on each of the four types of activities.

We did not find any significant effects of relaxation, nutrition-intake, social, or cognitive activities on any outcomes. Specifically, time spent on relaxation activities was not significantly related to the levels of fatigue ($\beta = .03$, $SE = .07$, $p = .718$), positive affect ($\beta = .05$, $SE = .05$, $p = .333$), or negative affect ($\beta = .06$, $SE = .06$, $p = .362$) after breaks. Time spent on nutrition-intake activities was not significantly associated with the levels of fatigue ($\beta = -.02$, $SE = .04$, $p = .564$), positive affect ($\beta = -.05$, $SE = .05$, $p = .321$), or negative affect ($\beta = -.04$, $SE = .04$, $p = .308$) after break. Time spent on social activities was not significantly associated with the levels of fatigue ($\beta = -.05$, $SE = .04$, $p = .226$), positive affect ($\beta = .08$, $SE = .06$, $p = .133$), or negative affect ($\beta = -.02$, $SE = .03$, $p = .531$) after breaks. Time spent on cognitive activities was not significantly related to the levels of fatigue ($\beta = -.02$, $SE = .02$, $p = .378$), positive affect ($\beta = -.01$, $SE = .03$, $p = .650$), or negative affect ($\beta = -.02$, $SE = .02$, $p = .324$) after breaks.

Discussion

Overview of study rationale and findings

The primary purpose of this study was to advance work break research by adopting a new design. We used an event-based design in which participants reported their fatigue and affect levels before and after discrete break episodes. Doing so allowed us to examine the effects of within-day work breaks on recovery in a way that more fully aligns with the process described by the effort-recovery model. Consistent with our hypotheses, we observed that the post-tests of fatigue and negative affect were significantly lower than the pre-tests, whereas the post-tests of positive affect were significantly higher than the pre-tests, demonstrating that within-day work breaks help employees recover from strain reactions.

When the research question was examined as how break length is associated with recovery outcomes, there were weaker effects in the interval-based design and event-based design without pre-tests. The results supported the prediction that these distinct ways of examining the effects of within-day work breaks on recovery would lead to weaker observed effects, suggesting that the way in which studies are designed to test this effect has important implications for the conclusions that are drawn. We suggest that, by better aligning the design with the underlying theoretical framework, the EBPP model can more effectively detect the effects of within-day work breaks on recovery. Even though some prior studies have found significant results using interval-based and event-based designs without pre-tests, the effect sizes in these studies might be underestimated because of the limitations associated with their designs.

Methodological implications

The main contribution of our paper is to test an alternative design for examining the effects of within-day work breaks on recovery that more fully aligns with – and more accurately tests – the processes described by the underlying theoretical framework (i.e., the effort-recovery model), and to show how this design compares to other commonly used designs in the work break literature. This contribution is consistent with the recommendations by Ployhart and Vandenberg (2010), which suggest that designs and analyses should capture the processes of change described by the theories in organizational studies. We have applied this perspective to the work break research, suggesting that previous analyses that have been used have not fully captured the recovery processes described by the underlying theoretical framework. The design and analyses we suggest allow us to capture the processes described by the effort-recovery model. While these recommendations to better align methods and analyses with theory have been applied primarily to typical longitudinal studies that examine change over longer time frames, these recommendations are also relevant for ESM designs (Beal & Weiss, 2003). Therefore, we recommend using a EBPP design in future research exploring the effects of within-day work breaks.

While our focus has been on within-day work breaks, this design has wider applications that are worth noting. We suggest that studies on discretionary behaviours can also adopt this approach to improve study designs. For example, an EBPP design can be used to study performance episodes. As suggested by Beal *et al.* (2005), performance episodes are commensurate with the dynamic nature of affect (Beal *et al.*, 2005). By measuring affect before and after a performance episode, researchers can understand how task-relevant affect before the episode influences follow-up performance, and, in turn, how the performance episode impacts participants' or workers' affect changes. Moreover, researchers could apply this design to explore the effects of specific off-job activities on well-being – for instance, whether pursuing leisure activities replenishes psychological resources or whether one type of leisure (e.g., active leisure, such as playing sports) more effectively improves well-being than another (e.g., passive leisure, such as watching TV).

Implications for understanding the consequences of within-day work breaks

Given that within-day work breaks are the most frequent types of respites, understanding the role within-day work breaks play is essential. Within-day work breaks have become somewhat controversial in practice. On one hand, within-day work breaks reduce worktime and may be regarded as deviant behaviours (Gruys & Sackett, 2003). To the extent that breaks are understood by managers or workers as deviant behaviours, employees may not have enough break experiences, since they may be cautious to avoid crossing the ambiguous line between legitimate breaks and workplace deviation. On the other hand, breaks are likely to demonstrate beneficial effects and to help employees restore personal resources (Kim *et al.*, 2016). Our findings add to the literature providing support for the positive viewpoint on within-day work breaks. This study has practical implications for management, such that organizations should create supportive climate of taking work breaks to help employees restore resources. For example, managers can take breaks to benefit from the recovery effects themselves and also creating a norm of taking work breaks.

Strengths, limitations, and future research

It is necessary to study within-day work breaks with different designs for the purpose of critical multiplism – the necessity of examining a research question from diverse methodological vantage points to obtain a more complete picture of the robustness and boundary conditions of a research programme (Lilienfeld, 2017; Shadish, 1995). The EBPP design supplements experimental designs and intervention studies (de Bloom *et al.*, 2017; Krajewski *et al.*, 2010; Sianoja *et al.*, 2017) by studying naturalistic work breaks. Moreover, the EBPP design advances ESM studies by providing a more rigorous design than most ESM studies.

To our knowledge, the current study is the first to directly test the recovery effects of within-day work breaks using an event-based design that measures levels of strain immediately before and after breaks, aligning with the effort-recovery model. Future research can further explore the effects of break characteristics in combination with the practice of within-day work breaks. Specifically, future studies can apply an EBPP design and include break characteristics as moderators. In using this model, future research could test the conditional effects of break characteristics in addition to the general effects of within-day work breaks.

Furthermore, according to the change perspectives, it is important to investigate temporal processes over time in organizational research (Sonnentag, 2012). This also applies to work break research. Future research can expand the EBPP design by including longer-term measures after each break episode, in addition to the immediate pre- and post-measures, to study how long the break effects last, facilitating understanding of the follow-up effects of work breaks (e.g., whether larger change leads to longer effect).

Our study is, however, limited in some respects. First, because all data were self-reported, common method bias may exist (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Future studies should rely on multiple sources of data such as ratings from supervisors or co-workers and physiological data. For instance, future studies may improve their designs by using monitors to collect physiological data (e.g., heart rate and electrodermal activity) to reduce common method bias. This method also facilitates understandings on momentary changes in physiological indicators while employees are switching between different work and break activities. Second, this study used a convenient sample with a small sample size. Future studies should have more representative samples with larger sample sizes to better generalize the results to the population. Third, since we did not use a randomized controlled design, experimenter effects might exist in our ESM designs. While experimental effects are a concern, we did disguise the purpose of the study to mitigate such effects.

Fourth, the interval-based design in this study is not representative of previous interval-based design with shorter intervals (Zacher *et al.*, 2014), which is a more rigorous interval-based design. However, it is comparable to the majority of interval-based studies, which used longer intervals. The shorter-interval design can serve as an alternative measure of episodic work events when situations do not allow the use of a EBPP design. Fifth, we acknowledge that it is possible that the participants reported fewer within-day work breaks than they took in the event-based design, leading to failure of capturing the full range of types and lengths of breaks. Future studies can more accurately assess within-day work breaks with an EBPP design by providing clear, immediate feedback to participants regarding their response rate (for example, research assistants can inform participants on their progress in the noon and at the end of the workday by providing the total number of complete within-day work breaks they reported so far on each day), which has been shown to dramatically increase the amount of usable data (Christensen, Barrett, Bliss-Moreau, Lebo, & Christensen, 2003). Last, while work-related variables might also influence strain levels, this study did not control for any work-related variables, consistent with several work break papers (Hunter & Wu, 2016; Kim *et al.*, 2016; Trougakos *et al.*, 2014), because of the complex nature of the design and the small sample size of this study. Future research should include a larger sample size to allow for including work-related control variables.

Conclusion

The present study used an event-based design with strain levels measured immediately before and after discrete work breaks. Compared with previous ESM designs, the EBPP design allows us to examine the recovery effects of within-day work breaks in a way that is more fully aligned with the effort-recovery model, demonstrating that within-day work breaks effectively alleviate fatigue, negative affect, and improve positive affect.

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Appendix

Break engagement (event-based design only)

Did you do the following activities during the past break? (Yes or No)

1. Surfing the Internet: If the participants selected surfing the Internet, they were asked what online activities they did.
   1.1. Chatting with friends, co-workers, or significant others
   1.2. Online shopping
   1.3. Checking personal SNS
   1.4. Reading news
   1.5. Watching video
   1.6. Others
2. Chatting with co-workers on non-work-related topics (face-to-face)
3. Drinking coffee, tea, or other beverages or eating snacks

4. Walking around
5. Mind-wandering
6. Having lunch
7. Napping
8. Others______

Break length (event-based design only)

If the participants indicated they had participated in this activity during the last break episode, they were asked to rate how much time (in minutes) they spent on that type of break activity. [List varied for each break]

Recovery outcomes (event-based and interval-based design)

Fatigue

1. I feel drained.
2. My mind feels unfocused.
3. My mental energy is running low.
4. I feel like my willpower is gone.
5. It would take a lot of effort for me to concentrate on something.

Positive Affect

1. Happy
2. Excited

Negative Affect

1. Sad
2. Irritable
3. Anxious

Break engagement (interval-based design only)

How much time did you spend on breaks in total on this workday (in minutes)?