Take five? Examining the impact of microbreak duration, activities, and appraisals on human energy and performance

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TAKE FIVE? EXAMINING THE IMPACT OF MICROBREAK DURATION, ACTIVITIES, AND APPRAISALS ON HUMAN ENERGY AND PERFORMANCE

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

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“Not everything that can be counted counts, and not everything that counts can be counted”
– William Bruce Cameron

With the quantitative emphasis of this dissertation, I placed this quote on my desk for over a year to remind me of two things. First, I will not try to number the amount of people who have helped me along this journey, and certainly believe that if I tried I would leave out someone unintentionally. Second, and more importantly, all of them have given me more than I can define with data or numbers. For all of those in my life who have given me something that counts – parents, family, teachers, friends – I am truly grateful.
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Virginia Commonwealth University, 2015

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Employees in many occupations deplete cognitive resources of attention and energy (Dodge, 1913; Kahneman, 1973), impacting performance on subsequent work tasks (Dalal, Bhave, & Fiset, 2014). Individuals spend upwards of 10% of formal work time taking a break completing non-work tasks (Esteves, 2013; McGehee & Owen, 1940) in an effort to replenish these resources (Fritz, Lam, & Spritzer, 2011; Kim et al., 2014). This study used a randomized controlled experiment to answer three questions that are new contributions to the literature. First, I explored if engaging in a specific activity (watching a funny video, meditating, or completing a different work task) during the microbreak helped induce recovery processes. Second, I questioned if an individual’s appraisal (psychological detachment, relaxation, and enjoyment) of the break impacted outcomes in addition to, or potentially more than, engaging in a break activity. Third, I investigated if the time duration (1-minute, 5-minute, or 9-minute) of the microbreak impacted outcomes. Results show that taking any break between work tasks allowed individuals to feel less fatigued, more energized, and more attentive. Surprisingly, in many
instances a 1-minute break was just as effective as taking a longer break of 5 or 9 minutes, and for these shorter break periods, engaging in a different work task for a short period rather than disengaging from work was the best at improving attention. In addition, to increase feeling energized at work, appraising the break as being enjoyable was more important than the actual break activity. Combined, this study has both an academic and practical impact, finding that just like with work that depletes physical resources, short breaks also benefit employees engaging in work that depleted cognitive resources.
Chapter 1: Introduction

Imagine the following scenario: two employees go to work doing the same job for the same company. At the beginning of the day, both employees complete their work tasks at the same pace. But as the day goes on, one employee feels more tired and is not performing their work as well, whereas the other employee still has a high level of energy and is completing tasks as effectively as he or she was earlier in the day. Is this just a difference between the two individuals, meaning that one employee just naturally feels more tired each day? Maybe, but suppose that the employees have similar personalities and lives outside of work, so there are no confounding factors. What explains this variation that two employees in the same job have each day in their energy levels and work performance? In this study, I consider that one employee might take more effective microbreaks, or work breaks less than ten minutes in duration (Sluiter, Frings-Dresen, Meijman, & van der Beek, 2000). Many organizations have policies or norms that encourage microbreaks, often in accordance with state laws (e.g., California Industrial Welfare Commission, 2001). I propose that the employee with higher energy and better performance at the end of the day better utilizes these short break periods in between work tasks to recover, or replenish resources used to complete work tasks (Meijman & Mulder, 1998). That is, it might be that short breaks during work time, not just lunch breaks or other authorized breaks, can have a substantial impact on employee well-being and performance at work.

This study addresses the call from other scholars to explicitly examine if the combination of duration, activities, and appraisals have a systematic difference in outcomes (Trougakos, Hideg, Cheng, & Beal, 2014). In other words, is there an optimal combination of break time,
break activity, or break appraisal for the “best” recovery of resources and subsequent performance? There are three research questions embedded within this inquiry. First, does the duration of a microbreak matter? Is it possible that a shorter duration of a microbreak could be more beneficial for employee energy and performance? Second, does the activity during the microbreak matter? What actually benefits an employee more: relaxing at one’s desk, mentally detaching from work by watching a funny video or checking Facebook, or simply changing work tasks? A recent qualitative study has found that employees use all three types of break activities when they desire to take a break (Kim et al., 2014). I therefore ask: are some microbreak activities better or worse than not having a break, and are certain microbreak activities more or less effective than switching tasks? Third, does the microbreak activity itself matter, or is it only how one appraises the microbreak? If two employees meditate at their desk during a break, but one employee finds meditating to be relaxing while the second employee is bored while meditating, does the appraisal of that same activity matter more than activity itself?

Human energy is a moment-to-moment assessment of how much an individual feels energized (Quinn, Spreitzer, & Lam, 2012) and is considered a proximal indicator of well-being (Sonnentag, 2012). Momentary fluctuations in energy predict long-term well-being outcomes that are important for organizations. For example, studies show that employees who have low energy, sometimes defined as feeling fatigued or exhausted, also had increased employee burnout (Maslach, Schaufeli, & Leiter, 2001), turnover (Wright & Cropanzano, 1998), and health complaints like headaches and insomnia (Hunter & Wu, 2013). In addition, momentary fluctuations in energy have the potential to have a short-term impact on individual job performance (Dalal, Bhave, & Fiset, 2014).
The impact of work breaks on employee energy and performance has been theoretically important to academics for over a century (e.g., Clark, 1916; Cooke, 1913), but there are also practical implications for organizations. States like California have labor laws specifying the duration and frequency of work breaks for employees (California Industrial Welfare Commission, 2001). In addition, organizations implement new break programs and policies to improve the performance of their employees, such as providing rooms where employees can play video games (Edelhauser, 2007) or take a nap (Diamond, 2011). However, there is limited empirical support for these laws and workplace changes. Individuals within the workplace appear to be looking for ways to increase energy and productivity as well. There are a myriad of articles written for business professionals on the topic, with titles like “Worn-out employees? 5 ways to crank up the energy” (Olguin, 2013), “Refuel, recharge and reenergize your employees” (Durkin, 2014), and “5 ways to boost your energy at work” (Tarkan, 2012). In addition, there exist products that claim to improve employee energy. The supplement brand 5-hour Energy starts a television commercial asking “You know what 2:30 in the afternoon feels like, right? Sleepy. Groggy. Dying for a nap”. This commercial tapped into the need for increased energy at work, and led to more than $1 billion in retail sales within a decade (O’Connor, 2012). Overall, employee energy and performance matters to employees, managers, and organizations.

To examine how microbreaks impact employee energy and performance, I used an experimental design that manipulates microbreak durations and activities, assessing how different durations, activities, and appraisals impact individual resources and performance. There are two strengths to using an experimental design. First, most research on work recovery uses a daily diary or cross-sectional research design. These studies by scholars of management, psychology, and engineering have provided a wealth of information regarding relationships
between recovery activities, appraisals, and durations with a multitude of work-related outcomes. In addition, most utilize naturally occurring workplace settings. However, in a workplace study, other reasons could explain differences in energy and performance. Daily interactions with coworkers or different pay structures for each employee could explain the variation rather than recovery periods. The strength of an experiment is that these confounding variables are eliminated and there is a more direct, causal test of changes occurring from each duration and break activity manipulation. Second, I use an experiment is because it allows for a randomized controlled trial, the “gold standard” of research in the social sciences (Reay, Berta, & Kohn, 2009). By randomly assigning individuals to different groups, we assume that individual differences are placed equally into each group (e.g., different microbreak times and activities). In sum, these two key strengths of a controlled experiment allow me to infer causality to determine what is, or is not, a beneficial microbreak. The potential to discover how break durations, activities, and appraisals impact employee energy and performance can create a unique and compelling contribution to the field.

An overview of the study design is as follows. First, participants engaged in a work episode requiring the use of attentional resources, simulating the processes required for employees at a Fortune 500 power company. Some participants were then prompted to engage in a microbreak, with each group having a different break activity and duration manipulation. This is followed by a second period of work requiring the use of attentional resources. A control group did not receive a break period between the first and second work periods. The outcome variables assessed are subjective feelings of energy at the end of each work and break period, attentional resources after each work and break period, and task performance during the two work periods. The study used a 3x3 experimental design, whereby break activity manipulations
(psychological detachment, relaxation, and task change) are crossed with duration manipulations (1 minute, 5 minutes, and 9 minutes). These break activity manipulations were chosen to induce specific recovery experiences drawn from the Sonnentag and Fritz (2007) framework, as well as to correspond with recovery activities from previous studies. The duration manipulations are a dosage manipulation similar to organizational and medical interventions (Toker & Biron, 2012), and are based on both theoretical and practical findings.
Chapter 2: Theory and Hypotheses

As western economies have shifted from an industrial economy to a postindustrial or “knowledge economy” (Adler, 2001), employees are engaging less in physical work and more in mental work, or the use of cognitive resources to complete work tasks (Dodge, 1913) that utilize information and generate knowledge (Hitt, 1998). Recent advances in psychology and neuroscience have found that individuals have several cognitive resources available to them, and that cognitive processes like attention and memory draw from a limited pool of cognitive resources (Spreng, Mar, & Kim, 2009). Just like how there are individual limitations of physical resources, such as the amount of strength one has to lift a heavy object, individuals also have a limited capacity of cognitive resources and energy (Halbesleben, Neveu, Paustian-Underdahl, & Westman, 2014). Many occupations draw upon cognitive resources and the self-regulation necessary for the continued use of these resources (Lord, Diefendorff, Schmidt, & Hall, 2010). For example, some jobs require consistent focus to notice visual changes on a monitor, such as technicians at an electrical power company or air traffic controllers (e.g., Kanfer, Ackerman, Murtha, Dugdale, & Nelson, 1994). Lifeguards must notice if a swimmer in the ocean went under a wave but has not come back above the water surface (e.g., Fenner, Leahy, Buhk, & Dawes, 1999). Pilots (e.g., van Dijk, van de Merwe, & Zon, 2011) and truckers (e.g., Charlton & Starkey, 2011) have to recognize and react to changes in their environment, such as vehicles, pedestrians, or other obstacles entering the future travel space. Doctors, nurses, and medical technicians must observe and respond quickly to a change in a patient’s breathing, heart rate, and other vital signs (e.g., Schulz et al., 2011). In these occupations, performance on job tasks
requires sustained visual focus, which depletes both attentional resources and subjective energy (Kanfer & Ackerman, 1989).

Fortunately, it is possible to recover these individual resources. The term *recovery* is used to describe the process of stopping resource loss and replenishing resources (Meijman & Mulder, 1998). Scholars of exercise physiology and ergonomics found that resources used during physical work can be replenished once the work load ceases (e.g., Weltman, Stamford, & Fulco, 1979). That is, by stopping the task that consumed resources, one can not only stop the depletion of resources, but replenish resources as well. Recovery periods can be as short as a few seconds or as long as several days (Sluiter et al., 2000). From an occupational standpoint, for many years scholars focused primarily on physical work and corresponding physiological resource changes such as muscular fatigue (e.g., Chaffin, 1973). In 1998, Theo Meijman and Gijsbertus Mulder took the classic load-capacity model from physical work and extended it to include mental work, or the tasks that use cognitive and psychological resources. This was termed the Effort-Recovery Model (ERM; Meijman & Mulder, 1998). ERM has three main components. First, individuals mobilize (or consume) psychological resources just like they can consume physical resources. Second, this resource mobilization leads to both task performance and resource depletion. Third, resource recovery must occur or an individual will incur negative effects such as reduced task performance and impaired well-being.

Within the ERM framework, scholars from multiple disciplines have studied recovery processes in relation to energy and performance variations. Sonnentag’s seminal work with school teachers in 2001 examined how *recovery activities*, or what an individual engaged in after work, contributed to the recovery process. These activities were measured by asking employees each night to report the duration of time spent on after-work tasks in specific categories, as well
as report their subjective well-being. Using a daily diary methodology in which participants responded to survey items for five consecutive working days, the study found that employees engaging in social, relaxing, and physical activities during the evening also reported improved well-being before bed, whereas employees who spent more time each night on work-related activities had reduced well-being before bed. A major weakness of this and subsequent research on recovery activities (e.g., Rook & Zijlstra, 2006; Sonnentag & Zijlstra, 2006) is that one individual can interpret or experience an activity differently than someone else. To address this, researchers began studying recovery appraisals, or how an individual feels about time spent during non-work time. In 2007, Sonnentag and Fritz confirmed through factor analysis that individual recovery appraisals fell into four broad categories: how much individuals felt they mentally detached, relaxed, were positively challenged, or in control during a non-work period. Multiple studies have since confirmed that these recovery experiences of psychological detachment, relaxation, mastery, and control are unique predictors of employee energy (e.g., Sonnentag & Fritz, 2007) and job performance (e.g., Binnewies, Sonnentag, & Mojza, 2010; Fritz, Yankelevich, Zarubin, & Barger, 2010). In sum, research in the organizational sciences have provided a wealth of information showing that non-work activities and individual appraisals of these activities can benefit employee well-being and performance.

However, there are several areas of the work recovery literature that are still unclear. Organizational scholars have discussed how microbreaks, or brief respites from a work task that are under ten minutes in duration (Sluiter et al., 2000), have the potential to benefit employees (Scott, 1914). Researchers even theorize that short-term recovery opportunities “are important in maintaining attention and improving future performance” (Dalal et al., 2014, p. 1427), but scholarly research about recovery has primarily focused on formal non-work periods such as
evenings and weekends (e.g., Etzion, Eden, & Lapidot, 1998; Lounsbury & Hoopes, 1986; Totterdell, Spelten, Smith, Barton, & Folkard, 1995). Thus, organizational research on work breaks is sparse. What is known is that employees use between 5-15% of their formal, “on-the-clock” work time on non-work tasks (e.g., Esteves, 2013; McGehee & Owen, 1940). It is also known that employees in jobs that deplete cognitive resources report taking a break (i.e., engaging in a non-work task) because they feel that they need respite from work (D’Abate, 2005). In addition, some states have labor laws requiring specific break durations for employees (e.g., California Industrial Welfare Commission, 2001). Because of this, scholars have recently called for organizational researchers to examine non-formal breaks during the workday (Sonnentag, Niessen, & Neff, 2011), break durations shorter than one hour (Trougakos et al., 2014), and how both break durations and what an employee does during that break time impacts individual variations in energy and performance (Tucker, 2003). In conclusion, scholars a) have theorized that breaks are beneficial, b) know that people need breaks and take “unauthorized” breaks, and c) understand that some states require break periods for employees. Nonetheless, the organizational sciences have not yet rigorously examined how these short breaks impact employees.

Additionally, organizational scholars are rarely explicit about time durations of recovery periods. By not explicitly measuring durations of recovery, there are potential confounding explanations for why some employees have improved outcomes while others do not. It is possible that conflicting results in the literature might be caused by differences in break durations. For example, one study found that employees engaging in work-related activities during a break had decreased energy (Trougakos et al., 2014), whereas another study has found that employees increased energy after engaging in work-related activities during a break (Hunter
& Wu, 2014). The Trougakos et al. study examined only one-hour lunch breaks, whereas the study by Hunter and Wu did not track break durations. Thus, to provide a better causal understanding of the recovery process, organizational researchers should heed the call from other scholars in the field and explicitly examine durations and the impact time can have on outcomes (George & Jones, 2000). Using a temporal lens to conduct research puts time duration and time intervals as a primary focus, and allows scholars the potential to discover patterns of phenomenon (Ancona, Goodman, & Lawrence, 2001).

Fortunately, scientific fields like ergonomics and industrial engineering have examined durations and explicitly focused on work breaks. Henning, Sauter, Salvendy, and Kreig (1989) instructed employees to take microbreaks after every 40 minutes of work, and found that individuals who took longer breaks had improved job performance (e.g., reduced typing errors) following the break. Break durations were at the employee’s discretion, and ranged from eight seconds to more than three minutes. One limitation of this and similar studies (e.g., Henning, Kissel, & Maynard, 1994) is that individuals are instructed to take a break, but what employees do during this time is not measured. Other studies in ergonomics have focused on well-being outcomes rather than performance. For example, Galinsky, Swanson, Sauter, Hurrell, and Schleifer (2000) found that when data-entry employees take 5-minute breaks at work they report less muscular discomfort and eye strain. While studies like this improve our understanding of the relationship between breaks and well-being, they focus on the depletion of physical resources (impacting physical well-being) rather than cognitive resources.

In sum, research in the organizational sciences has focused on recovery activities and appraisals, yet not explicitly examined recovery durations. Engineering and ergonomics research has focused on durations, but does not examine what people do during the break and rarely
focuses on the depletion and recovery of cognitive resources. While the interdisciplinary nature of organizational research has been well-established in the areas of work task and job design (Grant & Parker, 2009), the research focused on recovery from knowledge work rarely integrates with industrial engineering and ergonomics. This study blends these literatures to gain a better understanding of work breaks in knowledge work environments.

The purpose of this study is to examine if momentary changes in energy and performance stem from different microbreak durations, engaging in different microbreak activities, or experiencing (i.e., appraising) microbreaks differently. My study answers these questions using an experimental design with randomized controlled trials. By integrating disparate research streams and manipulating break durations and break activities, this study provides an improved causal understanding of work recovery that studies using daily diary and cross-sectional survey designs are not able to do. By including objective outcome measures (e.g., accuracy on task), this study improves our understanding beyond self-report subjective measures that have been used in most organizational research.

This chapter is organized as follows. First, I provide an overview of the Effort-Recovery Model (Meijman & Mulder, 1998), the main framework within which this study is grounded. Second, I define the individual resources examined in this study: energy and attention. Finally, I describe the recovery process, accentuating and differentiating recovery activities, recovery appraisals, and durations of recovery. The recovery section also includes hypotheses and research questions for my experiment.
Theoretical foundations

In 1998, Meijman and Mulder summarized research about the impact of depletion of mental resources in the workplace. They then drew from exercise physiology research that showed how physical resources deplete and can be replenished. Combing these two streams, they proposed the Effort-Recovery Model (ERM; Meijman & Mulder, 1998), which explained that cognitive resources can also be replenished and how recovery impacts employee task performance, energy, and well-being. Figure 1 shows their model in its entirety.

As shown, work potential, work demands, and decision latitude all impact an individual’s work procedure. This work procedure has two outcomes: task performance (“product” in their model), and load reactions. The current recovery literature (e.g., Fritz & Sonnentag, 2006; Trougakos et al., 2014) and remainder of my study calls these load reactions resource depletion. As shown in the bottom of the figure, these resource depletion outcomes are reversible, meaning that depletion of cognitive resources can be stopped and can also be replenished. This is the recovery process. If the recovery process does not occur, this can lead to the accumulation of additional resource loss, an increase in negative psychological outcomes, and a decrease in task performance (Fritz & Sonnentag, 2006; Lilius, 2012; Totterdell et al., 1995; Trougakos et al., 2014).
Figure 1

The Effort-Recovery Model (Meijman & Mulder, 1998, p. 9)
For jobs at a power company or air traffic control tower, employees might have little decision latitude or changes in task demands. Thus, this study focuses only on the work potential aspect of ERM. By using an experimental design, I hold constant the work demands and decision latitude aspects of this model, meaning these components do not change during any portion of the experiment. In doing so, I measure how recovery during microbreaks impacts variations in individual resources (called “actual mobilization” in Figure 1), as well as how this recovery of resources impacts task performance. Figure 2 shows a simplified version of ERM that only includes the components related to this study.

Figure 2
*Simplified Effort-Recovery Model*

![Simplified Effort-Recovery Model Diagram]

Note: If no recovery, negative effects accumulate

To understand the recovery process better, consider again the employee whose job task includes monitoring changes on computer screens. In order to maintain attention and performance in a task like this, individuals must increase the amount of energy they use (Kahneman, 1973). Using attention and energy is resource mobilization. The task performance...
component is watching a screen and making adjustments to what is viewed. If an individual feels that they are using more energy (or increasing their effort) as the work shift continues throughout the day, this leads to that person feeling more fatigued (Meijman, 1997). Depleting attentional resources and energy is *resource depletion*. As mentioned earlier, employees have a limited supply of attentional and energetic resources. By the end of a work shift, one individual might still feel energized and maintain a high level of job performance, while another might feel exhausted and not perform as well on job tasks. The difference is that one employee has had adequate *recovery*. Thus, the focus of this study is examining how a brief respite from work tasks (Scott, 1914) impacts the recovery process and helps individuals both stop resource loss and replenish resources.

**Resource definitions**

Meijman and Mulder drew from their previous work (Van Ouwerkerk, Meijman, & Mulder, 1994) and modeled how individual resources impacted work potential. They realized that individual work potential, which I call resource mobilization, uses both cognitive processes and energetic processes. Figure 3 is the figure used by Meijman and Mulder showing how cognitive and energetic resources are integrated into ERM.
Figure 3

Integration of Resources Into ERM (Meijman & Mulder, 1998, p. 19)
In this figure and throughout their work, Meijman and Mulder use the term *process*. Recent organizational research on this topic typically uses the term *resource* instead (Westman et al., 2004). However, there is a slight difference in these two terms. Process is the action, or the ongoing activity, that draws from a resource pool. Individual resources are defined as “objects, personal characteristics, conditions, or energies that are valued by the individual or that serve as a means for attainment of these objects, personal characteristics, conditions, or energies” (Hobfoll, 1989, p.516). Recent work refines this definition and emphasizes that resources are unique within individuals and are what an individual perceives can help with goal achievement (Halbesleben et al., 2014). This clearly aligns with Meijman and Mulder’s model of computational and energetical processes leading to goals (“plan”) and then a work procedure. As shown in Figure 3, and as discussed by other scholars (Hobfoll, 1989; Quinn et al., 2012), resources can help an individual engage in a work procedure and achieve a goal.

**Energy.** The study of human energy has been of interest to organizational scholars for many years (e.g., Baker & Burney, 1928), including differences in energy usage for work and non-work activities (Passmore & Durnin, 1955) and how motivation impacts an individual’s energy and effort towards work tasks (Vroom, 1964). Energy has received increased attention recently as being a key component to making organizations more sustainable (Pfeffer, 2010). This is because “energy benefits both individuals and employer organizations” (Dutton, 2003, p. 7) and is considered the “fuel that helps organizations run successfully” (Fritz, Lam, & Spreitzer, 2011, p. 28). An increasing awareness of the role of human energy as an individual resource has led scholars to emphasize that "future research could focus more on the role of energy, and explicitly research the effects on human energy level" (Schippers & Hogenes, 2011, p. 200).
Human energy is categorized in two ways: physical energy and energetic activation (Quinn et al., 2012). Physical energy is the action or capacity to engage in action, and can be measured using chemical changes such as calories needed to complete a work task. Of greater importance to occupations requiring mental work, energetic activation is the feeling of being energized and is measured with subjective scales such as assessing if one feels “bursting with energy” (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001) or feels “depleted” and “tired” (Michielsen, De Vries, & Van Heck, 2003). Energy is a limited resource and is dynamic in nature, meaning that it fluctuates within an individual (ten Brummelhuis & Bakker, 2012a). The subjective feeling of energy has two components: high energy or activation, and low energy or the lack of activation (Thayer, 1986). There is ongoing scholarly debate concerning the nature of the energy construct (Cole, Walter, Bedeian, & O’Boyle, 2012). However, recent studies have shown that high energy and low energy are related but distinct components of the energy construct and have unique antecedents, fluctuations, and outcomes (Fritz et al., 2011; Halbesleben, 2010; Mäkikangas, Feldt, Kinnunen, & Tolvanen, 2012). For example, evening psychological detachment from work predicted increased vigor at bedtime but did not predict reduced exhaustion at bedtime (Demerouti, Bakker, Sonnentag, & Fullagar, 2012).

In the social sciences, high energy is measured as vitality (e.g., Ryan & Deci, 2000), vigor (e.g., Shirom, 2004), positive activation (e.g., Watson & Clark, 1999), arousal (e.g., Thayer, 1986), and being alert (e.g., McNair, Lorr, & Droppleman, 1971). Typically these measures are adjective checklists with an individual using a Likert-type scale to assess how they feel, such as how alert they feel at that moment or in general each day at work (McNair et al., 1971). Other measures have individuals rate how they feel using a Likert-type scale to items such as “I feel bursting with energy” (Demerouti et al., 2001). These feelings of high energy are
proposed to be part of an overall approach-oriented behavior system, meaning it is used to direct individuals towards the procurement of resources (Shirom, 2004). Studies have shown that individuals with higher levels of energy are rated as being better performers by their supervisors (Carmeli, Ben-Hador, Waldman, & Rupp, 2009), and a recent meta-analysis reported that energy outcomes have a moderate to strong relationship with all ratings of individual job performance (Ford, Cerasoli, Higgins, & Decesare, 2011). In addition to examining performance, a longitudinal study over three years found that individual feelings of high energy is related to better health outcomes (Armon, Melamed, & Vinokur, in press).

The study of low energy has been examined more frequently in the social sciences (Sonnentag et al., 2011), in part because the majority of research in the stress and well-being literature views energy as a scare rather than abundant resource (Quinn et al., 2012). Low energy is most frequently described as feeling fatigued (e.g., McNair, Lorr, & Droppleman, 1971), exhausted (e.g., Demerouti, Bakker, Nachreiner, & Schaufeli, 2001), tired (e.g., Watson & Clark, 1999), or used up (e.g., Maslach, Schaufeli, & Leiter, 2001). Unlike high energy, which can be used to direct or engage in future behaviors, low energy is considered an antecedent of withdraw-oriented behaviors (Shirom, 2004). It has been proposed that “feeling[s] of fatigue may result from the subconscious analyses of cost and benefits to expend energy, or to conserve energy” (Boksem & Tops, 2008, p. 131). Longitudinal studies have found that feelings of low energy predict reduced self-rated task performance and citizenship behaviors (Halbesleben & Bowler, 2007), as well as lower supervisor-rated job performance (Wright & Cropanzano, 1998).

Scholarly research has also found that feelings of low energy (e.g., exhaustion) but not positive affect or negative affect are predictive of employee performance (Wright & Cropanzano, 1998). Thus, there is a distinction between feelings of energy or activation and feelings of affect,
although some models also differentiate affective states as having high or low activation components (Cropanzano, Weiss, Hale, & Reb, 2003). Collectively, this research stream provides convincing evidence that an individual’s energy level is important for employee well-being, individual performance, and the entire organization. One contribution of this study is the simultaneous examination of both the expansion and scarcity viewpoints of energy are missing from most organizational research (Quinn et al., 2012). That is, I examine both high and low energy levels at the same time in this experiment. I do this by investigating how microbreaks influence both the replenishment and depletion of energy (Marks, 1977).

**Attention.** Attention is the cognitive process that “filters and prioritizes information” (Steinman & Steinman, 1998, p. 147) and is a distinct component of working memory in the Effort-Recovery Model (Meijman & Mulder, 1998). There are two metaphors to illustrate the human attention system: attention as a search light and attention as a resource. With attention as a search light or flash light, everything within the beam of light is processed and everything outside that beam of light is not processed, and one can widen or narrow his or her attentional focus to process more or less information (Cowan, 1988). However, these attention-demanding processes consume resources, and there is a limited capacity of these attentional resources (Wickens, 1984). There are two attention mechanisms. One is stimulus-induced attention, or an involuntary response to a change in the environment such as a change in one’s field of vision. Second is voluntary or sustained attention, which is a controlled cognitive process (Kahneman, 2003).

Current neuroscientific and behavioral studies use a framework that distinguishes three attention networks: alerting, orienting, and executive control (Posner & Petersen, 1990; Posner & Rothbart, 2007). The alerting network allows one to maintain a constant vigilant state, the
orienting network allows one to alter attentional focus to different spaces and sensory information, and the executive control network allows one to monitor attentional focus and resolve conflicts between expectations, stimuli, and responses (MacLeod et al., 2010). Within this human attention system, the alerting and orienting networks fluctuate on a momentary basis, whereas executive control is more stable and fluctuates between individuals (Fan, Wu, Fossella, & Posner, 2001). In the larger scope of how the human attention system impacts task performance, the momentary fluctuations of the alerting and orienting networks impact short-term fluctuations in performance. Executive control is more closely related to working memory capacity (Engle, 2002; Kane, Conway, Hambrick, & Engle, 2007), and this individual difference impacts self-regulation of behaviors (Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008).

In sum, attention is the vital link between the employee’s goals and performance (Dijksterhuis & Aarts, 2010).

Attention resources and task performance. At this point, it is necessary to consider an alternative point of view. Some scholars might contend that the loss of attention regulation resources and the use of microbreaks to restore these resources might not have substantial value. This has some merit, especially considering recent research showing that individuals can adapt to tasks that require self-regulation (Converse & DeShon, 2009). Their results from three experimental studies show that when repeating the same work tasks over multiple work periods, individuals used less self-regulatory resources during subsequent trials. This was based on initial theorizing that with increased duration on a task, skills used during the task becomes proceduralized and resource-allocation decreases (Norman & Bobrow, 1975). However, in all three studies, Converse and DeShon (2009) used persistence in behavior “as the index of effortful self-regulation” (p. 1320). As they acknowledge, maintaining attention and persistence
on a difficult task are different components of self-regulation. It is likely that behavioral persistence on a difficult task is a better indicator of impulse control (e.g., controlling the impulse to stop the task) than attention regulation (Hofmann, Friese, & Roefs, 2009). In addition, there is evidence that attentional resources do not adapt after multiple trials or rounds of the same task, like what was found with persistence tasks. Rather, attentional resources adapt over time within one performance episode and start again with each task performance trial after a rest (Jung, Makeig, Stensmo, & Sejnowski, 1997; Van Orden, Jung, & Makeig, 2000).

In sum, we know that employees in attention-critical settings use attentional cognitive processes and deplete attention regulation resources over a period of time on the same task. Research has shown that as attentional resources deplete, an employee is more prone to attentional failure, which is correlated with decreased safety ratings, days missed from work, and injuries on the job (Wallace & Chen, 2005). However, these attentional resources can be replenished. Thus, an employee that engages in adequate recovery processes during microbreaks has an opportunity to enhance well-being and performance. The next section provides an overview of such a recovery process, and sets up the proposed experimental study of microbreak durations, activities, and appraisals.

**Recovery**

The process of ending depletion and replenishing individual resources is called recovery (Meijman & Mulder, 1998). The recovery process occurs during periods of non-work or respite. There are three main streams in work recovery research. The organizational and psychological sciences have focused on two similar areas: participation in specific tasks during non-work periods, called recovery activities, and the appraisal of time spent during non-work periods, called recovery experiences. These two streams place little emphasis on time duration. Industrial
engineering and ergonomics focused more on the duration of time for non-work periods, but has not examined what an individual does or feels during that time.

Within all recovery literatures, there are four time distinctions: macrolecovery, metarecovery, mesorecovery, and microrecovery (Sluiter et al., 2000). Macrolecovery involves respite periods longer than two days. Changes in energetic resources have been studied during periods such as weekends (e.g., Fritz, Sonnentag, Spector, & McInroe, 2010), vacations (e.g., Fritz & Sonnentag, 2006), or sabbaticals (e.g., Davidson et al., 2010). Metarecovery periods range from one hour to two days. Studies examining metarecovery of energetic resources often assess non-work time during evenings (e.g., Sonnentag et al., 2008) and two-hour work breaks (e.g., Trougakos et al., 2008). Mesorecovery ranges from ten minutes to one hour, with studies focused on changes in energetic resources after lunch breaks (e.g., Trougakos, Hideg, Cheng, & Beal, 2014). Microrecovery periods, or microbreaks, are short non-work periods lasting ten minutes or less, and are the focus of this study. The study of microbreaks is rare in the organizational sciences literature (Trougakos et al., 2014). Yet, it is vital to understand what employees can do during brief, informal breaks such as the time occurring in between work tasks (Sonnentag et al., 2011). Understanding within-person fluctuations in energy and performance, rather than only focusing on between-person differences, is vital to helping organizational performance (Dalal et al., 2014). The remainder of this section highlights previous research on recovery activities, recovery appraisals, and durations of recovery.

**Recovery activities.** Recovery activities became a focus in the organizational sciences after publication of an influential five-day dairy study of Dutch teachers (Sonnentag, 2001). This study focused on the total amount of time spent each day for the period between leaving the workplace and before bed in five categories: work-related activities, such as preparing for the
next day; household activities, such as cooking or child care; low-effort activities, such as taking a bath or watching television; social activities, such as a phone call or meeting friends; and physical activities, such as participating in sports or dancing. Results indicated that work-related activities had a negative effect on situational well-being before bed, and that low-effort, social, and physical activities had a positive effect on situational well-being before bed.

Following this study, additional research was conducted used similar measurement methods of asking individuals to report time spent in specific activity categories. Rook and Zijlstra (2006) replicated Sonnentag (2001) and added to the study by examining sleep quality, but found some different results from the original study. These different results could have occurred because their measure of energy focused on subjective fatigue rather than physical fatigue. Neither work-related activities nor household activities had any statistically significant impact on energy, compared to the negative effect found previously. Low-effort and social activities also did not have a statistically significant impact, contrary to the beneficial results found in 2001. In this study, physical activities actually increased feelings of fatigue. Other replications have found inconsistent findings as well, such as time spent on low-effort and physical activities having no statistically significant relationship with fatigue (Sonnentag & Jelden, 2009). These studies with low energy measures of fatigue or exhaustion are better at understanding if recovery activities can stop the depletion of energy, as low energy is conceptualized as the absence of energy (Quinn et al., 2012). Changes in low energy can indicate either that an individual’s energy continues to be reduced or that this depletion period has ended.

Rather than focus on energy depletion, some studies have focused on replenishment of energy by measuring if evening activities led to increases in high energy measures such as feelings of vigor or vitality. Feelings of high energy are more indicative of an abundance of
energy and not just reduced depletion of energy (Binnewies et al., 2010). Sonnentag and Niessen (2008) discovered that spending evening time on work-related activities decreased vigor each day, and this decreased vigor accumulated each day during the week, meaning an individual’s high energy decreased more rapidly each day that one worked at home during the evening. This study also showed that the combined time spent on low-effort, social, and physical activities each day had no impact on replenishing energy each day, but there was an accumulated benefit over time, meaning time spent on consecutive days added up to increase feelings of high energy later. Bakker, Demerouti, Oerlemans, and Sonnentag (2013) also found that work-related activities in the evening decreased feelings of vigor at bedtime. Their investigation found that both physical and social activities were statistically significant predictors of vigor at bedtime each day, but did not investigate accumulation effects. The relationship between vigor and specific activities seem to hold true when measured at several intervals (e.g. after work, before bed, or the next morning). Work-related activities reduced vigor and social, physical, and low-effort activities increased vigor when subjective vigor was measured the next morning rather than before bedtime (ten Brummelhuis & Bakker, 2012b). Using Likert-type measures of time spent on activities, Fritz and Sonnentag (2005) found that social activities during the weekend was not a statistically significant predictor of reduced fatigue at the beginning of the work week. However, social activities did predict increases in self-reported task performance at work.

In 2008, a shift in the organizational literature occurred and scholars began to also examine what individuals do during the work day. This began with Trougakos et al. (2008), when they examined employees engaging in work chores (e.g., errands, preparing for work, working with customers) or respite (e.g., napping, relaxing, socializing) activities during two-hour breaks. Focusing on affective states and subsequent affective displays of instructors at a
cheerleading camp, the results showed that employees who reported engaging in more respite activities during their break was correlated with higher employee-reported positive emotions and lesser degrees of negative emotions, as well as more other-rated positive affective displays during their instructional sessions. Employees engaging in more chores reported increased negative emotions after the break period but did not show a statistically significant change in job performance (i.e., affective displays). Following up on this study, Trougakos and colleagues examined the interplay of recovery activities and recovery appraisals during formal lunch breaks. Similar to research on longer respites like evenings and weekends, employees who reported engaging in work-related activities during their lunch break were observed by others to have higher fatigue at end of workday (Trougakos et al., 2014).

In sum, there have been a wide range of recovery activities researched for over a decade. Table 1 provides a definition and outcomes examined from previous studies of work recovery activities. Based on the framework from Sonnentag and Fritz (2007) that grouped recovery processes into psychological detachment, relaxation, mastery, and control, I focus on three recovery activities that can induce these processes and are most likely to occur during a microbreak: psychological detachment, relaxation, and task change activities. Psychological detachment activities are those in which one can mentally disengage from the work task, such as by watching a funny video (Rzeszotarski, Chi, Paritosh, & Dai, 2013). The detachment activity in this experiment is intended to induce a mental disconnect from the work task, and is similar to previous studies using detachment activities. Relaxation activities are those that provide a respite from work tasks, such as napping or relaxing (Trougakos et al., 2008). The relaxation activity in this experiment is an activity intended to induce a relaxation response, and is similar to previous work examining low-effort, respite, and passive activities. Task change activities are those in
which one continues to complete work-related tasks (Sonnentag, 2001). The work-related activity in this experiment is a break manipulation during which individuals change work tasks rather than continuing with the same work task. This extends earlier studies by differentiating that the work task completed during non-work time is different from the previous work task completed. I did not include physical activities in the break manipulations because it is more likely that individuals participate in these activities during breaks longer than ten minutes (e.g., 15-minute walk; Ryan et al., 2010). I did not include social activities during a microbreak because this would be difficult to control within the confines of an experiment. I did not include household activities because this study is focused on individuals in a work location that is physically distinct from the home environment, and thus would not be able to complete these tasks. Inducing mastery experiences, by its nature of using longer periods of time as to tackle a positive challenge, is not appropriate for the study of short microbreak time periods. I did not induce control experiences through an activity as this experiment requires that participants engage in a specific activity.
## Table 1

*List of Recovery Activities*

<table>
<thead>
<tr>
<th>Recovery activity</th>
<th>Description / Sample item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activities</td>
<td>“Sports, cycling, or dancing”</td>
<td>(Sonnentag, 2001)</td>
</tr>
<tr>
<td>Social activities</td>
<td>“Meeting with others or making a phone call to chat”</td>
<td>(Sonnentag, 2001)</td>
</tr>
<tr>
<td>Low-effort activities</td>
<td>“Watching television or taking a bath”</td>
<td>(Sonnentag, 2001)</td>
</tr>
<tr>
<td>Household activities</td>
<td>“Cooking, doing the dishes, shopping, and taking care of the children”</td>
<td>(Sonnentag, 2001)</td>
</tr>
<tr>
<td>Work-related activities</td>
<td>“Finishing or preparing for work duties”</td>
<td>(Sonnentag, 2001)</td>
</tr>
<tr>
<td>Detachment activities</td>
<td>“Cognitive-focused” story break with an “eye-catching comic to read”</td>
<td>(Rzeszotarski et al., 2013)</td>
</tr>
<tr>
<td></td>
<td>“While performing this activity, I could ‘switch off’ completely”</td>
<td>(Sonnentag &amp; Bayer, 2005)</td>
</tr>
<tr>
<td>Passive activities</td>
<td>“Reading a novel or watching television”</td>
<td>(de Bloom et al., 2011)</td>
</tr>
<tr>
<td>Chore activities</td>
<td>“Working with customers, running errands, practicing material, and preparing for upcoming sessions”</td>
<td>(Trougakos et al., 2008)</td>
</tr>
<tr>
<td>Respite activities</td>
<td>“Napping, relaxing, and socializing”</td>
<td>(Trougakos et al., 2008)</td>
</tr>
<tr>
<td>Volunteer activities</td>
<td>“How much time did you spend on volunteer work activities today, for example, in church, political activities?”</td>
<td>(Mojza, Lorenz, Sonnentag, &amp; Binnewies, 2010)</td>
</tr>
<tr>
<td>Chance-related gambling activities</td>
<td>Game where one chooses “to risk earned money for a fair chance of more payout”</td>
<td>(Rzeszotarski et al., 2013)</td>
</tr>
<tr>
<td></td>
<td>Playing slot machines, bingo, or other chance-related games</td>
<td>(Bourgeois, 2011)</td>
</tr>
<tr>
<td>Skill-related gambling activities</td>
<td>Playing card games or skill-games for money</td>
<td>(Bourgeois, 2011)</td>
</tr>
</tbody>
</table>
Psychological detachment activities. The Effort-Recovery Model (Meijman & Mulder, 1998) proposed that time away from work tasks allows for the psychobiological load to cease, reducing resource loss and allowing resources to replenish. This time away from work tasks creates psychological distance or detachment, and the nature of being away is beneficial because resources are no longer being drained as a result of work tasks (Etzion et al., 1998). Evidence from previous studies support that detachment can induce a recovery process leading to resource replenishment, and some scholars have even proposed that psychological detachment is “the most powerful recovery experience” (Siltaloppi, Kinnunen, & Feldt, 2009, p. 344). High levels of detachment after work have been found to reduce energy depletion (Demerouti et al., 2012; Sonnentag & Bayer, 2005). Conversely, low levels of detachment after work predict higher feelings of energy depletion the next day (Sonnentag, Binnewies, et al., 2008; Sonnentag, Kuttler, & Fritz, 2010). Ten Brummelhuis and Bakker (2012b) found that individuals participating in evening activities that lead to increased psychological detachment reported subsequently higher levels of energy the next day. Missing from these previous studies are an examination of shorter recovery periods. However, in a study of 30-second microbreaks, individuals engaging in activities that induced detachment by reading a story or short comic saw increased subsequent performance in two of three types of work tasks (Rzeszotarski et al., 2013).

In summary, ERM proposes that resource mobilization leads to both task performance but also depletes resources, and that recovery processes can replenish resources, ultimately leading to improvements in subsequent task performance. ERM also proposes that detachment from the work task can induce the recovery process. Previous studies have found that individuals engaging in detachment activities predicts increased feelings of high energy and reduced feelings of low energy, but these results have only been examined for metarecovery periods (e.g.,
evenings). Based on these findings, I propose that there will be the same relationship between detachment activities and energy for microbreaks. Although to my knowledge there are no previous studies examining the relationship between detachment activities with attention regulation resources, ERM proposes that this resource can be replenished during microrecovery periods just like other resources (e.g. energy; see Figure 3). Lastly, a previous study of microrecovery periods found that individuals engaging in detachment activities resulted in improved task performance, which aligns with ERM. In this current study, I use different measures of task performance and a different detachment task, but I expect to confirm this positive relationship between microbreak detachment activities and task performance. Based on ERM and results from previous studies showing that detachment activities can induce the recovery process, and this recovery process can impact subsequent resources and performance, I propose the following about the detachment microbreak condition:

**Hypothesis 1:** Individuals in the detachment microbreak condition will have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no work break (control) condition.

**Relaxation activities.** Relaxation activities are defined as those that require little effort (e.g. watching television; Sonnentag, 2001) and induce feelings of calmness and decreased wakefulness (Sommer, Stürmer, Shmuilovich, Martin-Loeches, & Schacht, 2013). Ten Brummelhuis and Bakker (2012b) confirmed that non-work activities in the evening requiring only small amounts of effort were experienced as relaxation. Relaxation has been found to have multiple benefits for employee well-being (e.g. Siltalippi et al., 2009; Sonnentag & Fritz, 2007). For example, in a randomized-control trial with a workplace intervention, seven individuals
participated in a 20-minute relaxation exercise during their lunch break each day while the control group engaged in normal social activities in the break room (Krajewski, Sauerland, & Wieland, 2011). Results from the study showed that levels of cortisol (used as a stress indicator) were only reduced in the relaxation group after lunch, and the benefit of relaxation continued when measured at bedtime and next morning.

Results from previous studies with different recovery lengths (e.g., metarecovery, mesorecovery, microrecovery) support the notion that relaxation induces recovery, which impacts energy resources. Several studies have found that relaxation in the evening predicts increased employee feelings of high energy (e.g., Sonnentag, Mojza, Binnewies, & Scholl, 2008; ten Brummelhuis & Bakker, 2012b) and decreased feelings of low energy (e.g., Derks & Bakker, in press; Feldt et al., 2013). For mesorecovery periods, one study discovered that individuals who reported engaging in relaxing activities during an hour-long lunch break were rated by coworkers as being less fatigued at the end of the work day (Trougakos et al., 2014). This negative relationship between relaxation and fatigue was a direct effect in the study, but the study also found that if an individual felt that he or she had little control over their lunch break activity, then that person actually felt more fatigue rather than decreased fatigue. Based on these findings, I expect that this negative relationship between relaxation activities and feelings of low energy will be the same for microbreaks as well. Previous microrecovery studies have found that mediation activities during a microbreak were correlated with increased employee vitality (Fritz et al., 2011). I expect to confirm this relationship in the current study.

Some scholars have proposed that when individuals engage in relaxing activities like meditation, attentional resources will be restored (Kaplan, 2001). This aligns with the Effort-Recovery Model, which proposes that relaxing or low-effort activities will be beneficial because
involving minimal amounts of activation of one’s psychobiological systems will halt resource loss and replenish resources (Stone, Kennedy-Moore, & Neale, 1995). To my knowledge, there are no direct tests of microbreak relaxation activities with attention or performance. Nonetheless, ERM details that low-effort activities induce the recovery process, and should thus replenish attention regulation resources and subsequent task performance (see Figure 3). Therefore I propose that the following about the relaxation break condition:

_Hypothesis 2:_ Individuals in the relaxation microbreak condition will have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition.

**Task change activities.** Although less frequently studied than recovery activities in the organizational sciences, scholars recognize that individuals switch tasks and have multiple work performance episodes during a workday (Beal, Weiss, Barros, & MacDermid, 2005). It has been proposed that the very nature of changing tasks may facilitate recovery (Trougakos & Hideg, 2009). As discussed in the Relaxation Activities section, Krajewski et al.’s study in 2011 was an excellent study design with a lunch break relaxation intervention over multiple days. However, one limitation is that it is possible that the change in lunch routine created a Hawthorne effect (Roethlisberger & Dickson, 1939), or that changing routines and not the relaxation induction impacted employee experiences and subsequent outcomes. This study examines task change explicitly to help tease out this potential confounding explanation.

Regarding energy resources, Horsman (2011) studied individuals who spent one weekend each month as a Canadian Armed Forces Army Reservist. Results showed that this change in work tasks and work environment for a weekend predicted reduced feelings of fatigue. Using an
experimental design, Lorist et al. (2000) found that changing tasks during a work period decreased feelings of high energy (e.g., vigor) but had no statistically significant effect on low energy (e.g., fatigue). Based on these findings, I expect that individuals changing tasks during a microbreak will have reduced feelings of low energy and reduced feelings of high energy.

Regarding attentional processing and attentional regulation resources, Hunter and Wu (2013) used an event-contingent experience sampling methodology to examine work breaks (but not necessarily microbreaks, as duration of break was not reported). Although not termed “task change” in their study, employees responded to survey items each time after they believed they had engaged a break. Employees would not have responded if they were continuing with the same work task, but rather if they felt that they were taking a break and engaging in work-related activities. Results showed that employees who reported engaging in work-related activities during the break predicted increased feelings of concentration directly after the break. Based on these findings, I expect that changing work tasks during a microbreak can improve attention regulation resources.

Regarding task performance, Longman, Lavric, and Monsell (2013) found that perceptual change tasks (tasks that change visual attention) creates a delay in full access to visual attentional processes and prolongs visual response time to a stimulus for one-half to two-thirds of a second. After this brief delay there is a reorientation of attention, and this reorientation actually increases performance on the task at hand over a longer period of time. The underlying mechanisms for why changing tasks can improve performance are likely due to goal reactivation. For example, results from one study in an educational setting found that students had improved learning outcomes if they took a break and changed tasks when feeling either bored or frustrated, and this was proposed to be because task switching allowed one to pause and then subsequently renew
learning goals (Sabourin, Rowe, Mott, & Lester, 2011). Subsequent studies have since confirmed that when task change activities have different goals, meaning an individual deactivates the original work goal and later reactivates the original work goal, task performance improves (e.g., Ariga & Lleras, 2011; Weaver & Arrington, 2013). Based on these results, I expect that individuals in the microbreak task change condition will have improved subsequent task performance in comparison to individuals in the control (no break) condition. Collectively, I propose that:

**Hypothesis 3:** Individuals in the task change condition will have (a) decreased levels of low energy, (b) decreased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition.

**Recovery appraisals.** While the focus on recovery activities in the evening and weekend was an appropriate way to begin the examination of the recovery process in employees, there are some limitations to these studies as well. One limitation of these studies is the assumption that all individuals have the same amount of time available to engage in recovery activities during the evening. Studies often ask for individuals to report the number of minutes spent on a recovery activity each evening and assess subjective well-being before bed (e.g., Bakker et al., 2013), drawing conclusions from time use. The concerns with this approach are that causality cannot be determined without multiple assessments over time and that individuals may differ in the amount of time available for recovery each evening. For example, study results could find that detachment activities are “best”, yet the individuals who engaged in the highest amount of detachment activities also engaged in more recovery activities than others, thus skewing the results. During the time that these concerns were being raised, new information was emerging.
regarding how individuals perceived their time on these activities. Sonnentag and Bayer (2005) 
used a daily diary design to assess how much individuals experienced psychological detachment, 
or “switching off”, when engaging in after-work recovery activities. Individuals who reported 
experiencing more psychological detachment after work also reported higher positive mood and 
lower fatigue before bed than those who did not report high levels of detachment. This finding 
was important because individual reports of time spent on recovery activities (i.e., work-related, 
household, low-effort, physical, and social) were not statistically significant predictors of 
positive mood or fatigue at bedtime. Thus, recovery experiences are related, but not identical to, 
leisure or recovery activities (Sonnentag & Fritz, 2015).

Previous work in the stress and well-being literature found that appraisals of stress impact 
employees, including that stress appraisals can increase attention to tasks (Chajut & Algom, 
2003). An experimental study then found that the way individuals appraised a situation predicted 
their emotional response more than the situation itself, even when the situation was the same for 
all participants (Siemer, Mauss, & Gross, 2007). For this reason, it has been proposed that “it is 
not a specific activity per se that helps to recover from job stress but its underlying attributes 
such as relaxation or psychological distance from job-related issues” (Sonnentag & Fritz, 2007, 
p. 204). This seminal work by Sonnentag and Fritz in 2007 found that there were four distinct 
recovery experiences: psychological detachment, relaxation, mastery, and control. Psychological 
detachment is when one is cognitively removed from work. Relaxation is when an individual 
feels that he or she is only required to use small amounts physical or psychological effort. 
Mastery experiences are challenging and provide personal growth or learning opportunities not 
related to one’s work. Control is an appraisal when one feels able to choose how he or she uses 
their non-work time. These four recovery experiences are assessed with sixteen items (the four
most construct valid items of each appraisal) in the Recovery Experience Questionnaire (REQ; Sonnentag & Fritz, 2007). There is increasing evidence that these items from the REQ assess recovery appraisals and are valid predictors of various aspects of employee well-being. In addition to initial validation in Germany, the REQ has been validated in Spain (Sanz-Vergel et al., 2010), Japan (Shimazu, Sonnentag, Kunota, & Kawakai, 2012), and Finland (Kinnunen, Feldt, Siltaloppi, & Sonnentag, 2011). More recently, a state-level version of REQ was validated in the Netherlands (Bakker, Sanz-Vergel, Rodríguez-Muñoz, & Oerlemans, 2014). In addition, the REQ has been used to investigate the relationship between recovery appraisals and individual resources in more than 50 studies, providing overall support that these four recovery appraisals are distinct predictors of individual resource changes (Bennett, 2013).

For this study of microbreaks, I focus only on detachment and relaxation appraisals as these are also direct manipulations of recovery activities. I chose not to induce mastery activities or assess mastery appraisals because mastery experiences, by definition, require sufficient time for learning and growth, which is extremely difficult to do during respite periods less than ten minutes in duration. I chose not to assess control appraisals for two reasons. One is because allowing for participant control over break time would interfere with the experimental microbreak time manipulations. I decided to explicitly test different time intervals rather than allow for an individual to have control over break time because research has shown that individuals have poor conceptualizations of short amounts of time such as taking a microbreak (Sonnenberg, Riediger, Wrzus, & Wagner, 2012). Second, previous research has shown that when individuals have control over their own time during a break, they either fail to spend an adequate amount of time to recover (Henning et al., 1989) or choose break activities that hinder rather than aid in recovery (Fritz et al., 2011).
Unique effect of recovery appraisals. Many studies have found that recovery appraisals impact resource and performance outcomes. Psychological detachment appraisals during the evening predict decreased feelings of fatigue after work and at bedtime (Sonnentag & Bayer, 2005) and increased feelings of vigor after work and at bedtime (Sanz-Vergel, Demerouti, Bakker, & Moreno-Jimenez, 2011). Detachment appraisals of lunch breaks has been shown to predict a decrease in subjective attentiveness (Lin, 2009). Evening detachment appraisals have a small positive relationship with self-reported job performance (Shimazu et al., 2012), although this relationship is likely curvilinear such that high or low detachment predicts lower other-rated task performance and a medium level of detachment predicts higher other-rated task performance (Fritz, Yankelevich, et al., 2010). Relaxation appraisals of evening time predicts decreased levels of exhaustion (Sonnentag & Fritz, 2007) and fatigue in the morning (Sonnentag, Binnewies, et al., 2008), as well as increased vigor the next morning (ten Brummelhuis & Bakker, 2012b). Relaxation appraisals of lunch break activities have been shown to predict increased feelings of attentiveness (Lin & Fritz, 2014). Evening relaxation appraisals also predict self-reported job performance (Shimazu et al., 2012). In addition to appraisals of detachment and relaxation, the appraisal of enjoyment, pleasure, or preference for an activity might matter as well. Van Hooff, Geurts, Beckers, and Kompier (2011) found that fatigue was reduced and vigor was increased if an individual felt that off-job time was spent on a pleasurable activity. Related to this, a recent study has found that the best predictor of resource replenishment occurred if an individual appraised that they engaged in a preferred activity during a work break (Hunter & Wu, 2013). The appraisal of enjoyment of non-work activities has been mentioned as a specific area for future research in the recovery literature (ten Brummelhuis & Bakker, 2012b).
The Hunter and Wu (2013) study also discovered that the type of activity employees engaged in (e.g., work-related, social, effortful, outside the office) during a work break did not impact employee energy, but the appraisal of the activity (e.g., preferred) did statistically predict reduced employee fatigue. Other studies have examined both recovery activities and recovery appraisals before as well, each with different findings. A study of vacation periods found that the statistically significant predictors of post-vacation outcomes were both time spent on activities (non-work activities) and appraisals (psychological detachment and relaxation; de Bloom, Geurts, & Kompier, 2012). The study by Van Hooff, Geurts, Beckers, and Kompier (2011) not only found that appraisals of pleasurable evening activities decreased feelings of fatigue and increased feelings of vigor, but that that time spent on physical and social activities increased feelings of fatigue at bedtime as well. In sum, there is some evidence that both the non-work activity and the appraisal of the activity can impact energy and performance outcomes.

Having discovered that that appraisals of activities were important predictors of employee well-being (Sonnentag & Fritz, 2007), scholars have proposed that recovery appraisals could be a mediator between recovery activities and outcomes. That is, time spent on an activity impacts an individual’s appraisal of that experience, which in turn impacts an individual’s momentary energy assessment and thus the allocation of future effort (Sonnentag et al., 2011). This mediation model has since been confirmed in an empirical test, showing that evening activities impacted recovery appraisals, and these recovery appraisals then predicted next-day energy and subsequent engagement during the work day (ten Brummelhuis & Bakker, 2012b). Additional models have tested and found support for appraisals as a mediator in the recovery process. For example, Kinnunen, Feldt, Siltaloppi, and Sonnentag (2011) found support for recovery appraisals as a partial mediator between both job demands and job resources with
outcomes. This testing of a mediation model was a significant contribution to the field because it builds off of the work showing that appraisals are a necessary component to predicting affective outcomes (ten Brummelhuis & Bakker, 2012b). Missing from these studies are comparisons of similar activities and appraisals. In other words, a limitation of the recovery research is that studies focus on time spent in broad categories like physical activities and then assessing appraisals (Mojza, Sonnentag, & Bornemann, 2011), rather than explicitly asking individuals to engage in an activity that will induce feelings of detachment or relaxation. Two studies that have examined recovery appraisals following specific activities are van Hooff and Baas (2013) who found that a 15-minute meditation activity reduced stress and increased serenity mediated through relaxation and mastery but not psychological detachment, and Eschleman, Madsen, Alarcon, and Barelka (2014) who found that a creative activity had both direct and indirect effects on performance as mediated by all recovery experiences except psychological detachment. Just as recovery appraisals have been found to mediate the relationship between broader recovery activities and outcomes, I propose that:

_Hypothesis 4:_ Recovery appraisals of (a) detachment, (b) relaxation, and (c) enjoyment partially mediate the relationship between break activity conditions and energy, attention, and performance outcomes.

**Time duration of recovery.** Individuals are more likely to need a rest from mental tasks rather than physical tasks (Strongman & Burt, 2000). In a knowledge work environment, employees have reported that they engage in work breaks (e.g., coffee break, surfing the internet) because they are bored or require a respite (D’Abate, 2005). But, how long of a break is necessary to recover? McGehee and Owen (1940) studied clerical workers and found that individuals took unauthorized rest pauses for an average of three minutes for every hour at work.
These were considered unauthorized because the pauses were not within a formal work break period and occurred during paid work time. Even after altering formal work and break schedules, employees still took over one minute of unauthorized work pauses each hour. Doerr, Mitchell, Klastorin, and Brown (1996) conducted similar research at a fish processing plant. They manipulated work flow conditions in multiple ways, and found that when individuals had more idle time between work episodes (i.e., a longer break duration), individuals had subsequent increased task performance. Esteves (2013) recently studied employees at a technology company who had complete control over their time spent at work. These employees were observed spending an average of 58 minutes of every eight hour work day on non-work tasks. Individuals reported spending this time, roughly 12% of their working day, on non-work tasks because they desired a respite or wanted to engage in activities of personal convenience (e.g. checking e-mail). This study did not examine the impact of these break durations on well-being or performance, but does show that employees take breaks often.

Overall, there is “little hard evidence concerning the optimum length of rest breaks,” especially in relation to reducing fatigue, increasing alertness, and increasing performance (Tucker, 2003, p. 123). In this study, I experimentally manipulate durations of breaks to address this issue. For example, Trougakos et al. (2008) had individuals indicate (yes or no) if they had respite time during a work break, but it is possible that one individual might have a work respite of five minutes whereas another individual could have a respite of thirty minutes. Being explicit with different durations allows for the measurement of a dose-response to manipulations. Similar to testing the effectiveness of different dosages in medical interventions, time has been used to test the dose-response in industrial and organizational psychology as well (e.g., Toker & Biron, 2012). To conduct a dose-response examination, I tested microbreaks of shorter, medium, and
longer durations with evenly-spaced interventions of 1-minute, 5-minute, and 9-minute microbreaks.

**Longer microbreak durations.** Longer microbreaks are interesting from a legal perspective because California requires that personal service employees have a paid 10 minute break for every four hour working period (California Industrial Welfare Commission, 2001). Multiple scientific studies focus on these longer breaks as well. In an experimental design, Kanfer and Ackerman (1989) included 10-minute breaks after participants completed 30 minutes on tasks depleting attentional resources. They reported that these breaks were included to minimize practice effects, but there was no assessment during or after recovery periods. A study by Dababneh, Swanson, and Shell (2001) increased the duration and frequency of work breaks. Employees underwent two weeks each in a control group that their regular daily break schedule (one 30-minute lunch break, two 15-minute breaks), one manipulation that added 12 3-minute breaks into the work day, and a second manipulation added four 9-minute breaks. Neither break manipulation helped or hindered overall productivity, but the productivity rate increased in both break conditions, meaning individuals were more productive during their time on task even though they had less time to accomplish these tasks due to the added microbreaks. The 9-minute breaks were preferred over the 3-minute breaks by employees, and also led to a reduction in physical discomfort at the end of the work day. This study also only analyzed the second week of data from each manipulation, as this helped reduce any impact in the results occurring because of change (Hawthorne effects). Based on the above, I propose the following about individuals in the longer (9-minute) break condition:
Hypothesis 5: Individuals in the 9-minute break condition will have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition.

Medium microbreak durations. A study by Galinsky et al. (2000) found in their field study that adding four 5-minute microbreaks into the work day improved employee well-being (decreased discomfort and decreased visual problems), but no statistically significant performance differences were found. This study also used exemplary methodology, as the participants were randomly placed into different groups (added breaks vs. no break manipulations) and only data from the third and fourth week of the manipulation were analyzed to reduce the potential impact of Hawthorne effects. During a visual attention task of an air traffic controller simulation, Kanfer et al. (1994) provided some participants with two 4-minute breaks during which they were instructed to sit in their chair and not talk with anyone. Individuals in this break condition (versus no breaks between trials) saw improved performance as measured by fewer flight errors (rule violations).

Three-minute breaks have also been studied. As discussed earlier, a 9-minute break was preferred over a 3-minute break, but there was no statistically significant difference between the no-break and 3-minute break conditions in performance or well-being (Dababneh et al., 2001). Another study focused on employees at two different work sites who performed both data entry tasks and customer service (Henning, Jacques, Kissel, Sullivan, & Alteras-Webb, 1997). Participants were prompted with a visual cue to take three 30-second breaks and one 3-minute break each hour. Some individuals were asked to perform stretching exercises at their desk, while the control group was allowed to do as they pleased during the breaks. Overall, employees
preferred the 3-minute break, and the majority of the time did not comply with the cue to take a 30-second break. Employees from both sites who were in the stretching condition reported less discomfort at the end of the day. No other statistically significant results were found overall at the work site with more employees. However, at the work site with fewer employees, employee well-being (i.e. mood) and productivity improved in the break condition versus the control group with no additional break. In addition, productivity was further improved when breaks included stretching exercises. Thus, I propose the following about individuals in the medium (5-minute) break condition:

*Hypothesis 6:* Individuals in the 5-minute break condition will have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition.

*Shorter microbreak durations.* Shorter microbreaks have also been examined from various perspectives, with several studies drawing on the seminal work of Henning et al. (1989). This study found that when data entry operators were allowed to control the length of their break, they often did not allow adequate time for recovery. The average break duration was 37 seconds. However, the standard deviation was 33 seconds, and individuals with longer breaks had improved outcomes. Another significant result from this study was that the degree of recovery, measured with subjective mood and heart rate, was linked to the duration of the break, such that individuals who had longer break durations were more recovered and individuals who had the shortest breaks did not have adequate recovery. A second study focusing on 30-second breaks manipulated the frequency of breaks, where the control group could decide when to take a break, the first experimental group were provided a 30-second break every 20 minutes, and the second
The experimental group was provided a 30-second break every 40 minutes (Mclean, Tingley, Scott, & Rickards, 2001). The results from this study were rather minimal, only noting that individuals who were provided a break reported better well-being (less discomfort), with no positive or negative impact on productivity. The results from these studies begin to indicate that employees at least a 1-minute break might be necessary for effective recovery of well-being outcomes.

Short microbreaks have also been examined in the examination of cognitive resources. Henning, Bopp, Tucker, Knoph, and Ahlgren (1997) examined 1-minute breaks every 10 minutes for dyads completing work tasks. Although the main manipulation was the amount of feedback the group received about the break (when to take a break), dyads who were provided a cue to take a break and complied by taking the 1-minute break had improved productivity and less mood irritability (impatience) versus those groups that had less feedback or did not take a break. In educational setting, Rosen, Cheever, and Carrier (2012) found that a 1-minute technology break after a 15-minute lesson improves individual attentional focus.

There is some support for short microbreaks having a positive impact on task performance as well. Rzeszotarski et al. (2013) found that individuals engaging in 30-second psychological detachment activities between work trials had improved performance compared to individuals in the no-break control group. Based on these findings regarding the impact of short microbreaks on employee well-being, cognitive resources, and performance, I propose that:

*Hypothesis 7:* Individuals in the 1-minute break condition will have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition.
**Time duration and nonlinear outcomes.** Results from previous studies examining the duration of microbreaks all have some evidence of positive outcomes, but there are potentially conflicting or unclear results. For example, one study showed that individuals preferred 3-minute breaks over 30-second breaks (Henning, Jacques, et al., 1997). Another study showed that individuals preferred 9-minute breaks over 3-minute breaks (Dababneh et al., 2001). So it might appear that a longer break is better or more preferred, yet studies have also found that individuals were given control over the duration of their break, they often spent an inadequate amount of time on the break to fully recover (Henning et al., 1989). In addition, the relationship between break duration and performance, energy, and well-being is inconsistent. For example, performance increased in one study of 30-second breaks (Rzeszotarski et al., 2013) but not another (Mclean et al., 2001). A three-minute break improved employee mood and performance at one work site but not another (Henning, Jacques, et al., 1997). Performance increased in a study with 4-minute breaks (Kanfer et al., 1994) but not in a study with 5-minute breaks (Galinsky et al., 2000). The study with a 9-minute break showed improved employee well-being but not productivity (Dababneh et al., 2001). These conflicting results are potentially caused by different work tasks in each

Combined, these studies show that there might be a “sweet spot”, or optimal break duration for recovery based on the task demands. Increased break duration should increase alertness and decrease fatigue, and these changes in energy levels mediate the relationship between the temporal components of breaks and performance improvements (Ong, 1984). Previous organizational scholars have proposed that the relationship between duration and outcomes is nonlinear (Blount & Janicik, 2001). Studies of recovery have recently used sinuous transformations to account for the nonlinear nature of time and recovery (e.g., Trougakos et al.,
2014). Sine and cosine transformations are used when there is a pattern of cyclical variance (Beal & Weiss, 2003), indicating that in these studies there is a nonlinear relationship between time and recovery outcomes.

Drawing from industrial engineering provides better evidence that more rapid recovery occurs earlier in time. With respect to physical resource recovery, the Rohmert curve predicted that recovery from physical fatigue should be reduced in a non-linear manner, such that first half (50%) of recovery time should reduce fatigue by 75% (Rohmert, 1973). Multiple studies have modeled and confirmed a nonlinear pattern of physical resource recovery (e.g., El ahrache, Imbeau, & Farbos, 2006; Ma, Chablat, Bennis, Zhang, & Guillaume, 2010; Xia & Law, 2008). This work supports a nonlinear trend between rest break durations with performance and fatigue outcomes from tasks depleting physical resources. However, there have been no causal examinations of this recovery process for mental resources. There is initial evidence that longer breaks (15 minutes) might not be as effective as shorter breaks (7.5 minutes) to reduce subjective and objective measures of fatigue (Boucsein & Thum, 1997). In addition, prior research has found that employees recover faster in the first few minutes of a break than in the later stages of a break (Konz & Johnson, 2000). The Effort-Recovery Model (Meijman & Mulder, 1998) proposes that mental resource recovery behaves in a similar way as theories and models of physical resource recovery, I expect that there will be a nonlinear relationship for time and mental resource recovery. Figure 4 is a visual representation of this expected nonlinear relationship between time and resource recovery. Because this study has individuals participate in 10-minute work episodes, I expect that the optimal microbreak duration will occur for the 5-minute condition, stated as:
Hypothesis 8: Individuals in the 5-minute and 9-minute break conditions will have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the 1-minute break condition.

Hypothesis 9: Individuals who have a 9-minute break will see no statistically significant difference in (a) levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the 5-minute break period.

Figure 4

Expected Non-linear Relationship between Time and Recovery

Optimal microbreak durations and activities. The hypotheses of this study propose that all types of activities and durations will have beneficial outcomes in comparison to a control group. The hypotheses also explicate that some breaks durations could yield improved outcomes over others durations. While there is no known theoretical or empirical study contrasting
combinations of time durations and recovery activities, this could have a tremendous practical impact on individuals in the workplace. For example, it could be that a 1-minute detachment activity is best to decrease feelings of low energy, but a 9-minute relaxation activity is best for increasing feelings of high energy and subsequent performance. Several studies provide evidence that this could occur. An unpublished meta-analysis has found that appraisals of psychological detachment and relaxation during the evening were better predictors for reducing feelings of low energy, with no statistically significant impact on increasing feelings of high energy (Bennett, Bakker, & Field, 2014). Previous research finding that changing tasks for a short time period increases feelings of high energy (Ariga & Lleras, 2011) might show that resource replenishment occurs more strongly for this recovery activity. Recent studies have also found that when relaxation is induced through mindfulness mediation practice, mental alertness increases but there is not an increase on a subsequent cognitive task (Amihai & Kozhevnikov, 2014). In addition, individuals who engaged in a relaxation activity during a 3-minute break replenished their self-regulation resources as well as those in 10-minute break (Tyler & Burns, 2008). In sum, there is tentative evidence that specific activities, appraisals, and durations could yield varying outcomes. However there is not enough information to support a hypothesized relationship that one combination of break activity and duration is better than another. Thus, I ask:

Research question 1: Are there optimal interactions between break activity conditions and duration conditions to (a) decrease feelings of low energy, (b) increase feelings of high energy, (c) increase attention, and (d) improve subsequent performance after a break?
Chapter 3: Methods

This study examined the impact of microbreak duration, activities, and appraisals on subjective energy, attention regulation resources, attentional cognitive processes, and task performance using an experimental design. The benefit of using an experiment is that it reduces other plausible explanations for the findings, strengthening causal inference (Schwab, 2005).

Population and procedure

Participants in the study were students at a large southeastern university enrolled in Management or Accounting courses, receiving extra credit in exchange for participation. Students were recruited during class time and with e-mails sent by instructors. An a priori power analysis was conducted to determine a suitable number of participants required. Following statistical conventions, I set the probability of making a Type I error at 5% (α=0.05) and the probability of making a Type II error at 20% (β=0.80). I examined effect sizes from previous research with energy and performance outcomes, and the smallest effect size was f=0.30 (based on group mean differences in reaction time of orienting network after experimental manipulation; Berman, Jonides, & Kaplan, 2008). With a 3x3+1 factorial design and multiple outcomes, I anticipated 10 groups, 9 predictors, 6 response variables (dependent variables), and 4 covariates (control variables). Using G*Power 3.14 (Faul, Erdfelder, Lang, & Buchner, 2007), there is no direct power analysis for a MANCOVA. However, I ran a priori power analyses separately with this information for ANCOVA and MANOVA tests, with the total sample size required to find an effect being 183 and 30, respectively.
All students participated on a voluntary basis and registered for an experiment session that best fit their schedule using an online system (www.signupgenius.com). There were 71 experiment sessions conducted in a computer laboratory, and all sessions were randomly assigned to an experimental condition. In total, 270 students began the experiment. Due to technical difficulties (e.g., experimental program shutting down unexpectedly during sessions; video manipulations not loading), and one individual failing all quality control checks, 65 participants were removed. Thus, the final sample comprised of 205 participants (75.9% retained), and was largely female (56.1%) and white (45.4%; 23.4% Asian American, 18.5% black, 6.3% Hispanic/Latino, 0.5% Native American, 5.9% other/preferred not to answer.). Participants were 24.2 years old on average and worked 17.8 hours on average per week.

Procedure. An overview of the study design is as follows. First, students were provided instructions about the experiment (see Appendix A). These instructions were read aloud and displayed on the computer screen. Next, participants engaged in a 10-minute work episode that utilized attentional resources. This trial length was chosen because attentional resources deplete in a monotonic pattern for the first 10 minutes on attentional tasks, and then plateau (Jung et al., 1997; Van Orden et al., 2000). Thus, the 10-minute trial was a sufficient time to induce maximum resource depletion. All non-control group participants were then prompted to engage in specific recovery or work activities (i.e., detachment, relaxation, task change) for a variable duration (i.e., 1 minute, 5 minutes, 9 minutes). This was followed by a second 10-minute period of work requiring attentional resources. The control group did not receive a period of time between the first and second work periods. The overall study design is shown in Figure 5. The entire experiment was run using E-Prime 2.0 Professional (Psychology Software Tools, 2014).
Figure 5

*Overall Study Procedure*

<table>
<thead>
<tr>
<th>Time 1 measures</th>
<th>Time 2 Work task</th>
<th>Time 3 measures</th>
<th>Time 4 Break / No-break</th>
<th>Time 5 measures</th>
<th>Time 6 Work task</th>
<th>Time 7 measures</th>
</tr>
</thead>
</table>

Measured during Time 1 were baseline subjective energy resources and attention regulation resources. Measured during Time 2 (the first 10-minute work period) was task performance. Measured during Time 3 (after the first work period) were subjective levels of energy and attention resources. There were no measures during Time 4 (break conditions, when applicable). Subjective levels of energy and attention and recovery appraisals of the break activity were measured at Time 5 after the break condition. Measured during Time 6 (the second 10-minute work period) was task performance. Time 7 (after the second work period) measured subjective energy and attention resources, as well as control variables and demographic data.

For the nine break manipulation groups, there were measures during Times 1, 2, 3, 5, 6, and 7. For the control group with no break period, measures were only at Time 1, Time 2, Time 3, Time 6, and Time 7. In other words, individuals in the control group completed baseline measures (Time 1), a 10-minute work period (Time 2), subjective resource measures after the first work period (Time 3), a second 10-minute work period (Time 6), and subjective resource measures after the second work period (Time 7). Details of each experiment scenario are shown in Table 2.
Table 2

*Detailed Experimental Design*

<table>
<thead>
<tr>
<th>Time period</th>
<th>Task</th>
<th>Length of time</th>
<th>Measures</th>
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<tbody>
<tr>
<td>Time 1</td>
<td>Baseline measures</td>
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<td>Energy resources</td>
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<td>Attention regulation resources</td>
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<td>Time 2</td>
<td>Attentional Network Test</td>
<td>10 minutes</td>
<td>Task performance</td>
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<tr>
<td>Time 3</td>
<td>Resource measures</td>
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<td>Energy resources</td>
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<td>Attention regulation resources</td>
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<tr>
<td>Time 4</td>
<td>Microbreak manipulations</td>
<td>Variable: 1-, 5-, or 9-minutes</td>
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<tr>
<td>Time 5</td>
<td>Resources measures</td>
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<td>Energy resources</td>
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<td>Attention regulation resources</td>
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<tr>
<td>Time 6</td>
<td>Attentional Network Test</td>
<td>10 minutes</td>
<td>Task performance</td>
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<tr>
<td>Time 7</td>
<td>Resource measures, controls, &amp; demographics</td>
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<td>Energy resources</td>
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<td>Attention regulation resources</td>
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**Work Tasks**

There are many different types of attention tasks that have been used in past research. A complex attention task uses both attentional focus (attention processing) and retrieval of information from storage (working memory capacity). Simple attention tasks provide an assessment of just attentional processing, and do not require high amounts of working memory capacity to complete the task. For job tasks like monitoring computer screens, a simple attention task is appropriate. To simulate this work task, I used the Attention Network Test (ANT; Fan, McCandliss, Sommer, Raz, & Posner, 2002) which combines a flanker task with a cuing paradigm and has been found in multiple studies to assess three distinct attentional networks of
alerting, orienting, and executive control (e.g., Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Wang, Fan, & Johnson, 2004). The ANT has been used in research to be highly correlated with task performance on work-related performance measures requiring attention (e.g., driving performance of an automobile; B. Weaver, Bédard, McAuliffe, & Parkkari, 2009). Figure 6 is a screen shot of what is viewed by participants in the ANT.

Figure 6

Screenshot of Attentional Network Test (ANT; from Posner & Fan, 2004, p. 30)

In the ANT, participants are asked to notice when the middle arrow on the screen is pointing in the same or opposite direction as the other arrows in the same horizontal line. Each individual is instructed to complete this task as quickly and efficiently as possible. Once the participant has confirmed the direction of the middle arrow on the screen, a new trial begins. Although there could be some concern that attention is shifted with the use of a keyboard,
previous research has found that cognitive resources and psychomotor resources draw from separate resources pools in similar tasks (Huddleston et al., 2013).

The use of 10-minute task trials is common in experiments focused on attention (e.g., Einöther, Martens, Rycroft, & De Bruin, 2010; Lorist et al., 2000; Sato et al., 1999), and the 10-minute version of the ANT has been found to be as valid as versions with longer durations (B. Weaver, Bédard, & McAuliffe, 2013). In previous experiments, the test-retest reliability of the ANT with 10-minute breaks between trials ranges from 0.52 to 0.77 (Fan et al., 2002). However, test-retest reliability may be an inappropriate reliability measure as the second test round scores are expected to show group mean differences caused by the experimental conditions. Taking this into consideration, I note that the original scoring method has low split-half reliability, and this could impact statistical power. MacLeod et al. (2010) found split-half reliability of reaction times to be 0.20 in the alerting network, 0.32 in the orienting network, and 0.65 for the executive control network. A new scoring method using median response times and difference scores that have less overlap in attentional networks reports higher split-half reliability than the older scoring method, with a value of 0.71 for the reaction time scores across all networks (Y. Wang et al., 2014). For this reason, the new scoring method was used.

**Independent Variables**

**Microbreak Recovery Activity Manipulation Conditions.** Three microbreak activity conditions were designed to simulate different types of work break activities that an employee uses to induce recovery processes. The three activities used in this experiment a psychological detachment activity, a relaxation activity, and a task change activity.

**Psychological detachment microbreak condition.** The detachment microbreak manipulation used a 1-minute, 5-minute, or 9-minute video that provided a brief story and
humor. This activity was intended to help an individual think of something other than the work tasks. Drawing from previous studies (e.g., Muraven, Tice, & Baumeister, 1998), each video clip was from Saturday Night Live. The use of funny video clips has been in experiments examining cognitive resources (e.g., Schmeichel, Volokhov, & Demaree, 2008; Tsai, Levenson, & Carstensen, 2000), and experiments have used similar video clips with different durations (e.g., Fredrickson & Kahneman, 1993). Watching online (e.g. YouTube, www.break.com) video clips is in line with previous research showing that individuals surf the internet during short work breaks (D’Abate, 2005; Fritz et al., 2011; Lim & Chen, 2012), and this includes watching videos (Hunter & Wu, 2013). Videos are also shown to have improved affective inductions than other methods (Ferrer, Grenen, & Taber, 2015). A link to these videos is provided in Appendix B.

Relaxation microbreak condition. For the relaxation microbreak activity, I used guided mindfulness meditation activities. Just like the detachment break activities, these were YouTube videos watched by participants. I chose these videos specifically because this type of relaxation activity is available to the public and is used by individuals in the workplace. Mindfulness meditation has been shown to induce a relaxed state and to improve subsequent attentional resources (for a review, see Holzel et al., 2011). Previous studies have found that individuals use meditation as a recovery activity during work breaks (Fritz et al., 2011), and that mindfulness impacts both recovery processes (Hülshheger et al., in press) and energy outcomes (Hülshheger, Alberts, Feinholdt, & Lang, 2013). A link to these videos is provided in Appendix B.

Task change microbreak condition. Based on research showing that changing to a very different task can create interference and decrease performance (Kiesel et al., 2010), the microbreak task change activity needed to have a similar goal orientation (i.e., noticing a change on a screen) while still consisting of a different work task or work routine. Thus, individuals in
the task change microbreak condition participated in a computerized version of the Stroop Color-Word Conflict Test (Stroop, 1935). The Stroop test requires attentional focus (Olk, 2013) and presents a series of words in congruent or incongruent colors (e.g., the word “green” written in green text [congruent], or the word “green” in red text [incongruent]). Participants were asked to select the color or written word in the center of the screen. The Stroop test and its variations have been widely used in psychological and organizational research (e.g., Converse & DeShon, 2009; Ganster, Schaubroeck, Sime, & Mayes, 1991), including studies focused on depleting and replenishment of resources (e.g., Gailliot et al., 2007). Previous studies (e.g., Fan et al., 2002) have used the Stroop test as a task change activity during trials of the Attention Network Test, with empirical evidence showing that these two tests assess the same cognitive constructs using different tasks (Breton et al., 2011; Lyche, Jonassen, Stiles, Ulleberg, & Landrø, 2011).

Microbreak Recovery Time Duration Manipulations. The microbreak experimental conditions included different durations of each recovery activity. Similar to research examining organizational interventions or medical trials, these time increments are considered a dosage manipulation (Toker & Biron, 2012). Each recovery activity (i.e., psychological detachment, relaxation, and task change) had a 1-minute, 5-minute, and 9-minute manipulation. In the psychological detachment and relaxation microbreak activity conditions, the video clips had similar content. The use of video clips with different durations but similar content has been used in previous research studies (e.g., Fredrickson & Kahneman, 1993). The task change conditions for each time manipulation used the same work task (Stroop), with the duration as the only change. The duration of each manipulation is included in Appendix B.
Microbreak Recovery Appraisals. All non-control group participants assessed how they appraised the break activity. Participants responded on a Likert-type scale from 1 (strongly disagree) to 5 (strongly agree) with how much they agree with the statements provided.

Detachment and relaxation appraisals. Recovery appraisal items were from the Recovery Experience Questionnaire (REQ; Sonnentag & Fritz, 2007). There are four psychological detachment appraisal items and four relaxation appraisal items. Versions of these items have been validated in multiple countries and cultures (Burke & El-Kot, 2009; Sanz-Vergel et al., 2010; Shimazu et al., 2012), and have been used to assess both the general level of recovery appraisal (e.g., Sonnentag & Fritz, 2007) and state-level, or more momentary, recovery appraisals (Bakker et al., 2014). Items from the Recovery Experience Questionnaire have been adapted to assess recovery appraisals of week-long (e.g., Flaxman, Ménard, Bond, & Kinman, 2012), weekend (e.g., Hahn, Binnewies, & Haun, 2012), evening (e.g., Fritz, Yankelevich, et al., 2010), and work break (e.g., Trougakos et al., 2014) time periods. In the current study, items were at the state-level (Bakker et al., 2014) and prompted individuals to evaluate their appraisal of the microbreak (e.g., Trougakos et al., 2014). At the state-level of assessment, the internal consistency (Cronbach’s alpha) of these items typically ranges from 0.88 to 0.95 (Bakker et al., 2014). The items used in this study are included in Appendix C, and the internal consistency of psychological detachment (α= .90) and relaxation (α= .93) was within the typical range.

Enjoyment appraisals. To assess enjoyment of the break, I drew from studies examining enjoyment during recovery periods (e.g., Van Hooff et al., 2011) and preference of recovery activities (e.g., Hunter & Wu, 2013). I used four of the five items from an enjoyment scale for work break research (Reinecke, Klatt, & Kramer, 2011). A fifth item was removed because the wording was duplicative (i.e., “The break was enjoyable” was kept and “I enjoyed the break”
was removed). Similar items have been used to assess enjoyment appraisals of work-related tasks (Brown, 2005). On a 7-point Likert-type scale, participants indicated how much they agreed with the items. All items are included in Appendix C. The internal consistency of this scale was adequate ($\alpha = .77$).

**Dependent variables**

**Energy resources.** Individual assessments of energy levels were assessed with the Profile of Mood States (POMS; McNair et al., 1971). Participants responded on 5-point scale to each adjective with how they felt at the moment, ranging from “not to all” to “extremely”. High energy was measured with eight items from the vigor-activity subscale. Low energy was assessed with seven items from the fatigue-inertia subscale. POMS has been used in previous recovery research (e.g., Fritz et al., 2011; Sonnentag, Binnewies, et al., 2008) and is ideal for this experiment because it assesses affective states of a short duration (Shirom, 2004) rather than longer-term moods or emotions (Elfenbein, 2007). These items are provided in Appendix D. The internal consistency at each time point was: vigor at Time 1 ($\alpha = .87$), vigor at Time 3 ($\alpha = .91$), vigor at Time 5 ($\alpha = .91$), vigor at Time 7 ($\alpha = .89$), fatigue at Time 1 ($\alpha = .89$), fatigue at Time 3 ($\alpha = .90$), fatigue at Time 5 ($\alpha = .92$), and fatigue at Time 7 ($\alpha = .91$).

**Attentional resources.** Attentional resources were assessed with the self-regulation component of attention often described as attention regulation resources (Hofmann et al., 2009). I assessed the attention regulation resources that an individual felt he or she had available by adapting an attention scale used in research in which participants assessed their attention during an ANT task (Davis & Yi, 2004). The measure was adapted by changing the wording from “during the video demonstration” to “during the previous task”, and was chosen over measures in the organizational sciences like the Cognitive Failure Scale (Wallace & Chen, 2005) because
measures assessing cognitive failure and cognitive liveliness are assessments of outcomes (i.e.,
failure) rather than direct assessments of attentional resources. These items are in Appendix E.
The internal consistency of this scale was suitable at Time 1 ($\alpha = .87$), Time 3 ($\alpha = .92$), Time 5
($\alpha = .91$), and Time 7 ($\alpha = .96$).

**Task performance.** Task performance was assessed using response time measures from
the ANT. There are three attentional networks that impact performance: alerting, orienting, and
executive control. The alerting network is used to achieve and maintain an alert state, the
orienting network is used to select information from what is visually observed, and the executive
control network is used to resolve conflict among responses and remain vigilant on the task over
time (Fan et al., 2002). An individual uses all three attention networks in different but related
ways. One workplace example is an air traffic controller. The employee uses the alerting network
to respond to flashing points or changes in color of a shape on the monitor, uses the orienting
network to move his/her visual attention to the appropriate location on the monitor, and uses the
executive control network to remain on task and stay focused. Thus, task performance is a value
in milliseconds assessing each attentional network rather than an overall response time.

In the ANT, individuals respond using a keyboard to indicate the direction (left or right)
of the middle arrow in a row of five arrows. Trial conditions vary by having a random
combination of a) presenting or not presenting a visual alerting cue before the flanker arrows, b)
presenting or not presenting a visual spatial orienting cue before the flanker arrows, and c)
having congruent or incongruent flanker arrows. Figure 6 is an example of a trial condition in
which there is an alerting cue (the asterisk flashes on the screen before the arrows), a spatial cue
(the alerting cue appears above the fixation cross rather than on the fixation cross), and
incongruent flanker arrows (the middle arrow points left and the surrounding flanker arrows
There are six combinations of trial conditions used to score task performance. The no-cue congruent combination is when there is no alerting or orienting cue and the flanker arrows point the same direction as the center arrow. The center-cue congruent combination is when there is an alerting cue on the fixation cross and the flanker arrows point in the same direction as the center arrow. The spatial-cue congruent condition is when the alerting cue is above or below the fixation cross and the flanker arrows point the same direction as the center arrow. The center-cue congruent condition is when the alerting cue is displayed directly on the fixation cross and the flanker arrows point the same direction as the center arrow. The no-cue congruent condition is when there is no alerting cue displayed and the flanker arrows point the same direction as the center arrow. The no-cue incongruent condition is when there is no alerting cue and the flanker arrows point in the opposite direction as the center arrow.

Scoring for each attentional network is calculated using the equations in Wang et al. (2014). These equations are an improvement over the Fan et al. (2001) scoring method because the equations provide a more direct examination of each attentional network by utilizing fewer overlapping conditions in each equation (see MacLeod et al., 2010 for a thorough discussion of this problem) and uses the median response time (rather than mean) of each condition because response times do not have a normal distribution. Alerting RT is calculated by subtracting the median response time of the center-cue congruent trials from the median response time of the no-cue congruent trials. A positive Alerting RT value indicates that an individual was faster when there was a short cue before the flanker screen, and is a benefiting effect (B. Weaver et al., 2009). Orienting RT is calculated by subtracting the median response time of the spatial-cue congruent trials from the median response time of the center-cue congruent trials. A positive Orienting RT value is when an individual responded quicker (in milliseconds) from knowing
both when and where the flanker would occur. Thus, a positive (rather than negative) value indicates improved performance. Executive Control RT is calculated by subtracting the median response time of no-cue congruent trials from the median response time of the no-cue incongruent trials. A positive value indicates a slower response time (in milliseconds) that it took an individual to respond when the center arrow was pointing in a different direction from the other arrows in the flanker portion, and this is a negative (or cost) effect (B. Weaver et al., 2009).

Overall, when comparing performance values between groups, better performance occurs when an individual has a higher Alerting RT and Orienting RT value and a lower Executive Control RT value.

To assess performance differences caused by the experiment condition (different break activities), performance values were calculated using the response times on ANT trials after the manipulation (Time 6). To ensure that this was appropriate, I conducted one-way analysis of variance to test if the 10 experimental groups had different response times in the first round of the ANT (Time 2) before the experiment manipulations began. There were no statistically significant differences between experiment groups for Alerting RT in Round 1 ($F(9,195) = .83, n.s.$) or Orienting RT at Time 2 ($F(9,195) = .46, n.s.$). There was a statistically significant difference between groups for Executive Control RT at Time 2, ($F(9,189) = 2.08, p = .03$), and a post-hoc test showed this only occurred between the Control group and the 9-minute Detachment group (mean difference = 99, $p = .05$). Given the random assignment of individuals to experiment conditions, and that Executive Control assesses more stable and trait-like differences (Redick & Engle, 2006), this difference was likely by chance.
Control variables and covariates

In addition to analyzing data without control variables, I provide supplementary analyses that control for several variables having an impact on energy, attention, and task performance outcomes. The inclusion of control variables helped provide better causal inference because I not only examined changes over time with an experiment, but I had the potential to determine the incremental impact of microbreaks to explain the within-person variance beyond trait-level variables. First, I controlled for extraversion ($\alpha=.73$) and neuroticism ($\alpha=.63$) using two items each from the Big Five Shortened Scale (Gosling, Rentfrow, & Swann, 2003). Controlling for these two traits is imperative given that extraversion and neuroticism have been found to affect perceptions of fatigue (Boksem & Tops, 2008), and extraversion has been correlated with the ANT Executive Control RT (Matthews & Zeidner, 2012). Second, I controlled for caffeine consumption with one item asking participants to indicate the number of cups (8oz) of caffeinated coffee, tea, and soda they have consumed in the past four hours. Caffeine consumption has been shown to impact feelings of energy (Lorist & Tops, 2003; Young & Benton, 2013). In addition, caffeine consumption up to 200mg improves Alerting RT and Executive Control RT on the ANT (Brunyé, Mahoney, Lieberman, & Taylor, 2010) and Stroop tests (Kenemans, Wieleman, Zeegers, & Verbaten, 1999). Lastly, I controlled for sleep quality with a single item (“How would you rate your sleep quality overall?”; 1 = very bad; 4 = very good) from the Pittsburg Sleep Quality Questionnaire (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), given the fact that sleep quality has been shown to impact individual resources and task performance (Querstret & Cropley, 2012; Takahashi et al., 2011; Tucker, Dahlgren, Akerstedt, & Waterhouse, 2008). All control variable and demographic items are provided in Appendix F.
Data Analysis

I used a 3x3+1 incomplete factorial design, meaning there is a fully-crossed 3x3 design with one additional cell for a control group condition. This design allowed for both absolute comparisons of each treatment condition against the control condition and relative comparisons of treatment groups. The hypotheses and research questions in this study examined between-group mean differences. Thus, the overall analysis plan examined the statistical significance of these mean differences using multivariate analysis of covariance (MANCOVA).

Hypotheses 1, 2, 3, 5, 6, and 7 proposed that each experimental condition (activity type and duration) would exhibit a statistically significant mean difference compared to the control group. To analyze these hypotheses, I conducted a one-way multivariate analysis of covariance (MANCOVA). The independent variables in these hypotheses are each microbreak condition (activity or duration). There are four related dependent variables: the change in high energy from after the work period to after break (change from Time 3 to Time 5), change in low energy from after the work period to after break (change from Time 3 to Time 5), change in attention regulation resources from after the work period to after break (change from Time 3 to Time 5), and task performance (response time) in the second work period (Time 6). The covariates were the control variables (i.e., extraversion, neuroticism, caffeine, sleep quality).

Hypothesis 4 predicted that recovery appraisals would partially mediate the relationship between microbreak recovery activities and outcomes. I used a bootstrapping technique to estimate the statistical significance of the total, direct, and indirect effects (Preacher & Hayes, 2004) using the PROCESS macro in SPSS (Hayes & Preacher, 2014).

Hypothesis 8 predicted that individuals in the 5-minute and 9-minute microbreak durations would have statistically significant changes in outcomes when compared to the 1-
minute microbreak condition. Hypothesis 9 predicted that individuals in the 9-minute microbreak duration would not have statistically significant differences in outcomes compared to the 5-minute microbreak condition. Similar to Hypotheses 1, 2, 3, 5, 6, and 7, I used one-way MANCOVA to test the mean differences between groups. However, for these hypotheses I compared the means of one microbreak duration condition against another microbreak duration condition.

Research Question 1 asked if there are any optimal microbreak conditions that impact subjective levels of energy resources, attention regulation resources, and task performance. Similar to previous hypotheses, I was interested if there were statistically significant mean differences in outcomes, and tested this using MANCOVA. To assess what combinations of duration and recovery activity had statistically significant mean differences in outcomes, I conducted a post hoc analysis. Levene’s test for homogeneity was not significant for all outcome variables ($p > .05$), indicating that I could assume equal variances between groups. Therefore I used the Tukey / LSD post hoc test.
Chapter 4: Results

The means, standard deviations, and correlations between focal variables are presented in Table 3.

Table 3

Means, Standard Deviations, and Correlations of Focal Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraversion</td>
<td>4.07</td>
<td>1.59</td>
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<td>-</td>
<td></td>
<td></td>
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<tr>
<td>Neuroticism</td>
<td>3.21</td>
<td>1.35</td>
<td>-0.01</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Caffeine</td>
<td>1.00</td>
<td>1.26</td>
<td>0.11</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SleepQuality</td>
<td>2.62</td>
<td>0.84</td>
<td>0.00</td>
<td>-0.03</td>
<td>0.01</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>BreakTime</td>
<td>4.37</td>
<td>3.44</td>
<td>0.08</td>
<td>-0.12</td>
<td>0.16*</td>
<td>0.02</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>BreakActivity</td>
<td>1.83</td>
<td>1.03</td>
<td>0.07</td>
<td>0.02</td>
<td>0.09</td>
<td>-0.06</td>
<td>0.32**</td>
<td>-</td>
<td>-</td>
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<td>PsychDetach</td>
<td>3.16</td>
<td>1.19</td>
<td>0.07</td>
<td>0.10</td>
<td>0.02</td>
<td>0.05</td>
<td>0.01</td>
<td>0.48**</td>
<td>-</td>
</tr>
<tr>
<td>Relax</td>
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<td>0.00</td>
<td>0.06</td>
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<td>0.04</td>
<td>0.05</td>
<td>0.60**</td>
<td>0.74**</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>3.34</td>
<td>1.01</td>
<td>0.06</td>
<td>0.02</td>
<td>0.08</td>
<td>0.03</td>
<td>0.10</td>
<td>0.43**</td>
<td>0.52**</td>
</tr>
<tr>
<td>VigorAfterBreak</td>
<td>2.47</td>
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<td>0.05</td>
<td>0.06</td>
<td>0.07</td>
<td>0.09</td>
<td>0.10</td>
<td>0.24**</td>
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<tr>
<td>FatigueAfterBreak</td>
<td>2.31</td>
<td>1.03</td>
<td>0.01</td>
<td>0.14*</td>
<td>0.06</td>
<td>0.20**</td>
<td>0.10</td>
<td>0.12</td>
<td>0.22**</td>
</tr>
<tr>
<td>AttentionAfterBreak</td>
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<td>1.42</td>
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<td>0.08</td>
<td>0.02</td>
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<td>0.19**</td>
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<td>AlertingRT</td>
<td>36.61</td>
<td>63.68</td>
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<td>0.00</td>
<td>0.01</td>
<td>0.07</td>
<td>0.09</td>
<td>0.02</td>
<td>0.05</td>
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<tr>
<td>OrientingRT</td>
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<td>49.23</td>
<td>0.05</td>
<td>0.00</td>
<td>0.01</td>
<td>0.03</td>
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<td>0.11</td>
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<td>ExecutiveControlRT</td>
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<td>94.68</td>
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<td>0.02</td>
<td>0.07</td>
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<td>0.04</td>
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<tbody>
<tr>
<td>Relax</td>
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<tr>
<td>VigorAfterBreak</td>
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</tbody>
</table>

Note. N = 205 for all correlations except recovery appraisals after break (N = 180 for PsychDetach, Relax, & Enjoyment) as the control group did not complete these.

**p < .05. *p < .01.
All of the hypotheses tested between-group effects in outcomes. Overall results indicated that statistically significant between-group differences exist for fatigue after break ($F_{(9, 190)}=2.62$, $p<.01$, partial $\eta^2=.11$) and attention after break ($F_{(9, 190)}=2.41$, $p=.013$, partial $\eta^2=.10$). Between-groups differences were marginally statistically significant for Executive Control RT ($F_{(9, 190)}=1.90$, $p=.054$, partial $\eta^2=.08$) and Orienting RT ($F_{(9, 190)}=1.67$, $p=.099$, partial $\eta^2=.07$), and were not statistically significant for vigor after break ($F_{(9, 190)}=1.23$, n.s., partial $\eta^2=.06$) and Alerting RT ($F_{(9, 190)}=.69$, n.s., partial $\eta^2=.03$).

Partial eta-squared values provided are an effect size that explain the proportion of the variation in each outcome attributed to differences in break conditions partialling out (excluding) other factors, ranging from 0 to 1 (Pierce, Block, & Aguinis, 2004). For example, 11% of the variation in fatigue is caused from an individual being placed in one break condition versus another. For comparison, the effect size of $\eta^2=.08$ is the same as $f=.30$, the effect size I used when conducting my *a priori* power analysis. Statistical power is the likelihood that the hypothesis test will reject the null hypothesis when a relationship exists (Murphy, 2002). A post-hoc power analysis revealed that the statistical power of this experiment ($\alpha=.05$) is .96 for fatigue, .63 for vigor, .94 for attention, .37 for Alerting RT, .79 for Orienting RT, and .86 for Executive Control RT.

For ease of interpretation and to better compare differences with unequal sample sizes, estimated marginal means (corrected for covariates) and standard errors of between-group outcomes are presented.
Hypothesis 1

Hypothesis 1 predicted that individuals in the detachment work break condition would have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition. Table 4 presents the estimated marginal means and standard errors of these two groups. I conducted a multivariate analysis of covariance including all dependent variables to assess if differences exist in outcomes between the group that watched a funny video during a break to induce detachment and the control group. Results showed that individuals in the detachment break condition reported lower fatigue, higher vigor, increased attention, and had reduced delays in response times when completing incongruent flanker tasks. There was no statistically significant difference between groups in Alerting RT and Orienting RT. Thus, Hypotheses 1a, 1b, and 1c were supported, and Hypothesis 1d was partially supported.

Table 4

Statistical Results for Hypothesis 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>Fatigue M</th>
<th>Fatigue SE</th>
<th>Vigor M</th>
<th>Vigor SE</th>
<th>Attention M</th>
<th>Attention SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (no break) condition</td>
<td>25</td>
<td>2.50</td>
<td>0.20</td>
<td>2.31</td>
<td>0.18</td>
<td>4.67</td>
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<tr>
<td>Detachment break condition</td>
<td>52</td>
<td>1.94*</td>
<td>0.14</td>
<td>2.80*</td>
<td>0.13</td>
<td>5.41*</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>AlertingRT M</th>
<th>AlertingRT SE</th>
<th>OrientingRT M</th>
<th>OrientingRT SE</th>
<th>ExecutiveControlRT M</th>
<th>ExecutiveControlRT SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (no break) condition</td>
<td>25</td>
<td>39.70</td>
<td>12.92</td>
<td>22.02</td>
<td>9.93</td>
<td>151.82</td>
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<tr>
<td>Detachment break condition</td>
<td>52</td>
<td>40.73</td>
<td>8.96</td>
<td>29.76</td>
<td>6.89</td>
<td>98.64*</td>
</tr>
</tbody>
</table>

*Note. Statistical significantly different means between groups indicated by ** at the p < .01 level and * at the p < .05 level.*
Hypothesis 2

Hypothesis 2 predicted that individuals in the relaxation microbreak condition would have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition. Table 5 presents the estimated marginal means and standard errors of these two groups. Following the same protocol in testing Hypothesis 1 for Hypothesis 2, results showed that there were no statistically significant differences between groups for any outcome variables. Thus, Hypotheses 2a, 2b, 2c, and 2d were not supported.

Table 5

Statistical Results for Hypothesis 2

<table>
<thead>
<tr>
<th></th>
<th>Fatigue</th>
<th>Vigor</th>
<th>Attention</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>SE</td>
</tr>
<tr>
<td>Control (no break) condition</td>
<td>25</td>
<td>2.50</td>
<td>0.20</td>
</tr>
<tr>
<td>Relaxation break condition</td>
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<td>0.14</td>
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</thead>
<tbody>
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<td>SE</td>
</tr>
<tr>
<td>Control (no break) condition</td>
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<td>12.92</td>
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<td>Relaxation break condition</td>
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<td>31.02</td>
<td>8.79</td>
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</tbody>
</table>

Note. Statistical significantly different means between groups indicated by ** at the \( p < .01 \) level and * at the \( p < .05 \) level.
Hypothesis 3

Hypothesis 3 predicted that individuals in the task change condition would have (a) decreased levels of low energy, (b) decreased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition. Table 6 presents the estimated marginal means and standard errors of these two groups. Results showed that there were no statistically significant differences between groups for any outcome variables. Thus, Hypotheses 3 was not supported.

Table 6

Statistical Results for Hypothesis 3

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<tr>
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<th>Attention</th>
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<td>SE</td>
</tr>
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<td></td>
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<tr>
<td>Control (no break) condition</td>
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<tr>
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<td>7.78</td>
<td>38.35</td>
<td>5.98</td>
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Note. Statistical significantly different means between groups indicated by ** at the $p < .01$ level and * at the $p < .05$ level.

Hypothesis 4

Hypothesis 4 proposed that appraisals of a) psychological detachment, b) relaxation, and c) enjoyment of the work break would partially mediate the relation between the work break condition (detachment activity, relaxation activity, work activity) and outcomes. I used the
bootrapping technique with the PROCESS macro to resample 10,000 samples and estimate the
direct, indirect, and total effects from each break activity, as well as the direct and total effects
from each appraisal (Hayes, 2009). If data was missing for an appraisal, I imputed data using the
mean value for the entire sample. Table 7 provides these effect size estimates. I tested mediation
by gauging the statistical significance of the indirect effects when the direct effect was also
modeled (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Only vigor and attention
after the break had statistically significant indirect effects (indicating mediation occurred). Thus,
Hypothesis 4 was partially supported.

Individuals had higher levels of vigor after the microbreak when engaging in a
detachment or relaxation break activity. The indirect effect for these two activities was
statistically significant, and the total effect was not statistically significant. The direct effect for
relaxation appraisals was statistically significant. Thus, appraisals of relaxation fully mediated
the relationship. In other words, individuals felt more vigorous in the relaxation or detachment
break activity as a result of appraising the break as relaxing.

Individuals also reported higher levels of attention when changing work tasks for the
break. The statistically significant indirect effect of this relationship, combined with the
statistically significant direct effects for detachment and enjoyment appraisals, provide evidence
that these appraisals mediate the relationship between changing tasks and the break. However,
the direct and total effects for this relationship were also statistically significant. This indicates
that detachment and enjoyment appraisals partially mediated the relationship. In other words,
individuals felt more attentive both because of the task change activity and because they
appraised the activity as either enjoyable of as experiencing psychological detachment from the
original work task.
Table 7

Tests of Mediation

<table>
<thead>
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<td>Psychological detachment</td>
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<td>.14</td>
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<td>Relaxation</td>
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<td>Working task</td>
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<td>Psychological detachment</td>
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<td>-.13</td>
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<td>.15</td>
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<tr>
<td>Enjoyment</td>
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<tr>
<td>Relaxation</td>
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<td>-.13</td>
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<td>Working task</td>
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<td>-.17*</td>
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<table>
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<th>AlertingRT</th>
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<tr>
<td>Enjoyment</td>
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<td>.27*</td>
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<table>
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<td>Relaxation</td>
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<td>8</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>-7</td>
<td>-7</td>
</tr>
</tbody>
</table>

Note. N = 200 (5 cases deleted for missing data). Fatigue, Vigor, and Attention values are regression weights. AlertingRT, OrientingRT, and ExecutiveControlRT values are milliseconds. *p < .05 and **p < .01.
Hypothesis 5

Hypothesis 5 predicted that individuals in the 9-minute break condition would have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition. Table 8 presents the estimated marginal means and standard errors of these two groups. Results showed that the only statistically significant difference between groups was that individuals in the 9-minute group had faster response times when an orienting cue was presented before the flanker task. Thus, Hypotheses 5a, 5b, and 5c were not supported, and Hypothesis 5d was partially supported.

Table 8
Statistical Results for Hypothesis 5

<table>
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<th>Attention</th>
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<tbody>
<tr>
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<td>SE</td>
</tr>
<tr>
<td>Control (no break) condition</td>
<td>25</td>
<td>2.50</td>
<td>0.20</td>
</tr>
<tr>
<td>9-minute break condition</td>
<td>56</td>
<td>2.40</td>
<td>0.14</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th></th>
<th>AlertingRT</th>
<th>OrientingRT</th>
<th>ExecutiveControlRT</th>
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<tbody>
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<td>SE</td>
</tr>
<tr>
<td>Control (no break) condition</td>
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<td>39.70</td>
<td>12.89</td>
</tr>
<tr>
<td>9-minute break condition</td>
<td>56</td>
<td>28.39</td>
<td>8.61</td>
</tr>
</tbody>
</table>

*Note. Statistical significantly different means between groups indicated by ** at the p < .01 level and * at the p < .05 level.*
Hypothesis 6

Hypothesis 6 predicted that individuals in the 5-minute break condition would have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition. Table 9 presents the estimated marginal means and standard errors of these two groups. Results showed that the only statistically significant difference between groups was that individuals in the 5-minute group had reduced delays in response time for incongruent flanker tasks. Thus, Hypotheses 6a, 6b, and 6c were not supported, and Hypothesis 6d was partially supported.

Table 9

Statistical Results for Hypothesis 6

<table>
<thead>
<tr>
<th></th>
<th>Fatigue</th>
<th>Vigor</th>
<th>Attention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>M</td>
<td>SE</td>
</tr>
<tr>
<td>Control (no break) condition</td>
<td>25</td>
<td>2.50</td>
<td>0.20</td>
</tr>
<tr>
<td>5-minute break condition</td>
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<td>2.42</td>
<td>0.13</td>
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<table>
<thead>
<tr>
<th></th>
<th>AlertingRT</th>
<th>OrientingRT</th>
<th>ExecutiveControlRT</th>
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</thead>
<tbody>
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<td></td>
<td>n</td>
<td>M</td>
<td>SE</td>
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<tr>
<td>Control (no break) condition</td>
<td>25</td>
<td>39.70</td>
<td>12.89</td>
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<tr>
<td>5-minute break condition</td>
<td>61</td>
<td>37.59</td>
<td>8.25</td>
</tr>
</tbody>
</table>

*Note. Statistical significantly different means between groups indicated by ** at the p < .01 level and * at the p < .05 level.
**Hypothesis 7**

Hypothesis 7 predicted that individuals in the 1-minute break condition would have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the no microbreak (control) condition. Table 10 presents the estimated marginal means and standard errors of these two groups. Results showed that individuals in the 1-minute microbreak groups reported statistically significant higher levels of attention, and had reduced delays in response time for incongruent flanker tasks. Thus, Hypotheses 7c were supported, 7d was partially supported, and 7a and 7b were rejected.

Table 10

*Statistical Results for Hypothesis 7*

<table>
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<tr>
<th></th>
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<th>Attention</th>
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<td>SE</td>
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</tr>
<tr>
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<tr>
<td>1-minute break</td>
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<td>2.40</td>
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<tr>
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*Note.* Statistical significantly different means between groups indicated by ** at the $p < .01$ level and * at the $p < .05$ level.
Hypothesis 8

Hypothesis 8 predicted that individuals in the 5-minute and 9-minute break conditions would have (a) decreased levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) increased subsequent task performance after the break period than individuals in the 1-minute break condition. Table 11 presents the estimated marginal means and standard errors of these groups, comparing the 1-minute versus the 5-minute microbreak group, and then the 1-minute versus the 9-minute microbreak group. Results show that individuals in the 5-minute microbreak conditions reported higher levels of fatigue and lower levels of attention than individuals with a 1-minute microbreak. Individuals in the 9-minute microbreak versus the 1-minute condition also had increased response times when an orienting cue was present and had increased delays in response for incongruent flanker tasks. Collectively, these are almost entirely opposite of the hypothesized predictions. Thus, Hypotheses 8a, 8b, 8c, and 8d were rejected.
Table 11

*Statistical Results for Hypothesis 8*

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<table>
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*Note.* Statistical significantly different means between groups indicated by ** at the $p < .01$ level and * at the $p < .05$ level.
Hypothesis 9

Hypothesis 9 predicted that individuals in the 9-minute break conditions would not have a statistically significant difference in (a) levels of low energy, (b) increased levels of high energy, (c) increased attention, and (d) task performance after the break than individuals in the 5-minute break period. Table 12 presents the estimated marginal means and standard errors of these two groups. Results showed that the only statistical significant difference was that individuals in the 9-minute microbreak conditions had faster response times when an orienting cue was presented before the flanker tasks. Thus, Hypothesis 9a, 9b, and 9c was supported, and Hypothesis 9d was partially supported.

Table 12

*Statistical Results for Hypothesis 9*

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<th>Attention</th>
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<td>SE</td>
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<th>AlertingRT</th>
<th></th>
<th>OrientingRT</th>
<th></th>
<th>ExecutiveControlRT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>SE</td>
<td>M</td>
<td>SE</td>
<td>M</td>
</tr>
<tr>
<td>5-minute break</td>
<td>61</td>
<td>37.59</td>
<td>8.25</td>
<td>31.23</td>
<td>6.26</td>
<td>107.48</td>
</tr>
<tr>
<td>condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-minute break</td>
<td>56</td>
<td>28.39</td>
<td>8.61</td>
<td>52.77*</td>
<td>6.53</td>
<td>133.22</td>
</tr>
<tr>
<td>condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Statistical significantly different means between groups indicated by ** at the \( p < .01 \) level and * at the \( p < .05 \) level.
Research Question 1

Research Question 1 asked if there were optimal interactions between break activity conditions and duration conditions to (a) decrease feelings of low energy, (b) increase feelings of high energy, (c) increase attention, and (d) improve subsequent performance after a break. Table 13 presents the mean outcomes for each of the 10 experiment conditions, and Figure 7 depicts these results in visual form. The statistical significance of the estimated marginal mean differences between each condition was assessed by running multiple analysis of covariance. Individuals in the 1-minute and 9-minute detachment conditions (watching a funny video) reported the lowest fatigue after the microbreak, and the means from these two conditions were statistically different from the control, 5-minute task change, and 9-minute task change conditions. Individuals in the 9-minute task change (Stroop task) reported the highest level of fatigue after the microbreak, and the mean of this group was statistically higher than all other break activities except the 5-minute relaxation group. The 5-minute and 9-minute detachment groups reported the highest levels of vigor after the microbreak, and the estimated marginal means from these two conditions were statistically different from the control, 1-minute task change, and 5-minute task change conditions. Interestingly, individuals in the 1-minute task change condition reported the highest level of attention after the microbreak, and the mean of this group was statistically higher than all other break activity conditions except the 1-minute and 9-minute detachment groups. Regarding performance differences, none of the experiment groups had a statistically significant estimated marginal mean difference in response times when an alerting cue occurred before a flanker task. Individuals in the 9-minute task change condition had a statistically faster response time than the control, 1-minute detachment, 5-minute detachment, 1-minute task change, and 5-minute task change groups when an orienting cue was present.
before a flanker task. However, this 9-minute task change group also had much larger delays on incongruent flanker tasks, and the mean of the delay (in milliseconds) for this group is statistically different at the $p < .05$ level from 1-minute detachment, 5-minute detachment, 9-minute detachment, 1-minute relaxation, 1-minute task change, and 5-minute task change groups.

Table 13

*Mean Outcome Variables for each Experiment Condition*

<table>
<thead>
<tr>
<th>Experiment group</th>
<th>Fatigue</th>
<th>Vigor</th>
<th>Attention</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Control</td>
<td>$2.50^{1,3}$</td>
<td>$2.31^3$</td>
<td>$4.67^{1,3,7}$</td>
</tr>
<tr>
<td>1 Detach 1min</td>
<td>$1.89^{0,8,9}$</td>
<td>2.61</td>
<td>5.51$^0$</td>
</tr>
<tr>
<td>2 Detach 5min</td>
<td>$2.16^9$</td>
<td>$2.86^7$</td>
<td>4.87$^{2,7}$</td>
</tr>
<tr>
<td>3 Detach 9min</td>
<td>$1.77^{0,8,9}$</td>
<td>$2.95^{0,7,8}$</td>
<td>5.88$^{0,3,5,6,9}$</td>
</tr>
<tr>
<td>4 Relax 1min</td>
<td>$2.21^9$</td>
<td>2.39</td>
<td>5.04$^7$</td>
</tr>
<tr>
<td>5 Relax 5min</td>
<td>$2.30^9$</td>
<td>2.43</td>
<td>4.93$^{3,7}$</td>
</tr>
<tr>
<td>6 Relax 9pm</td>
<td>$2.34^9$</td>
<td>2.41</td>
<td>4.96$^{3,7}$</td>
</tr>
<tr>
<td>7 New task 1min</td>
<td>$2.01^{8,9}$</td>
<td>$2.23^{2,3}$</td>
<td>$6.07^{0,2,4,5,6,8,9}$</td>
</tr>
<tr>
<td>8 New task 5min</td>
<td>$2.65^{1,3,7}$</td>
<td>$2.36^3$</td>
<td>$5.05^7$</td>
</tr>
<tr>
<td>9 New task 9min</td>
<td>$2.96^{1,2,3,4,5,6,7}$</td>
<td>2.48</td>
<td>4.83$^{3,7}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experiment group</th>
<th>AlertingRT</th>
<th>OrientingRT</th>
<th>ExecutiveControlRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Control</td>
<td>39.70</td>
<td>22.02$^{6,9}$</td>
<td>151.82$^{1,4,8}$</td>
</tr>
<tr>
<td>1 Detach 1min</td>
<td>32.13</td>
<td>31.11$^9$</td>
<td>93.92$^0,9$</td>
</tr>
<tr>
<td>2 Detach 5min</td>
<td>41.68</td>
<td>22.26$^{6,9}$</td>
<td>106.85$^9$</td>
</tr>
<tr>
<td>3 Detach 9min</td>
<td>49.94</td>
<td>36.13</td>
<td>95.53$^9$</td>
</tr>
<tr>
<td>4 Relax 1min</td>
<td>47.65</td>
<td>35.38</td>
<td>90.32$^0,9$</td>
</tr>
<tr>
<td>5 Relax 5min</td>
<td>24.71</td>
<td>33.76</td>
<td>126.79</td>
</tr>
<tr>
<td>6 Relax 9pm</td>
<td>22.25</td>
<td>56.63$^{0,2,7}$</td>
<td>122.45</td>
</tr>
<tr>
<td>7 New task 1min</td>
<td>51.68</td>
<td>20.41$^{6,9}$</td>
<td>100.75$^9$</td>
</tr>
<tr>
<td>8 New task 5min</td>
<td>43.13</td>
<td>35.28</td>
<td>95.72$^0,9$</td>
</tr>
<tr>
<td>9 New task 9min</td>
<td>17.30</td>
<td>62.23$^{0,1,2,7}$</td>
<td>174.15$^{1,2,3,4,7,8}$</td>
</tr>
</tbody>
</table>

*Note.* Superscripts 0-9 indicate that the mean difference between the two experiment groups was statistically significant at the $p < .05$ level.
Figure 7

*Mean Outcome Variables for each Experiment Condition*

**Mean energy**

- Fatigue
- Vigor

**Attention**

- Attention
Summary of Study Findings

Table 14 provides a summary of this study’s research findings, and compares the direction of the results with the hypothesized relationship and previous findings in the resource recovery literature. For this table, improved performance is when the Alerting RT and Orienting RT have a positive value (indicating a faster response) and when the Executive Control RT value is lower (indicating a shorter delay). Table 15 provides a summary of all hypotheses. As shown in results and collectively in these tables, many of the findings from this experiment are in the hypothesized direction but not always statistically significant. This could be due to a lack of statistical power for some variables (i.e., Alerting RT). However, the statistical power was relatively high ($\beta \geq .79$) for Fatigue, Attention, Orienting RT, and Executive Control RT, indicating that at least with these variables the experiment was rigorous enough to find statistically significant differences if they existed. Nonetheless, some non-statistically significant findings could have practical significance. For example, results from Hypothesis 2 found that engaging in a relaxing activity during a break is better than not taking a break at all.
<table>
<thead>
<tr>
<th>Break activity</th>
<th>Fatigue</th>
<th>Vigor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Previous research</td>
<td>Hypothesis direction</td>
</tr>
<tr>
<td>Detachment</td>
<td>a b</td>
<td>-</td>
</tr>
<tr>
<td>Relaxation</td>
<td>a</td>
<td>-</td>
</tr>
<tr>
<td>Task change</td>
<td>a</td>
<td>-</td>
</tr>
<tr>
<td>Break appraisal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological detachment</td>
<td>b</td>
<td>-</td>
</tr>
<tr>
<td>Relaxation</td>
<td>b</td>
<td>-</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>---</td>
<td>-</td>
</tr>
<tr>
<td>Break duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-minute (long)</td>
<td>---</td>
<td>-</td>
</tr>
<tr>
<td>5-minute (medium)</td>
<td>---</td>
<td>-</td>
</tr>
<tr>
<td>1-minute (short)</td>
<td>---</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Break activity</th>
<th>Attention</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Previous research</td>
<td>Hypothesis direction</td>
</tr>
<tr>
<td>Detachment</td>
<td>---</td>
<td>+</td>
</tr>
<tr>
<td>Relaxation</td>
<td>---</td>
<td>+</td>
</tr>
<tr>
<td>Task change</td>
<td>+ a</td>
<td>+</td>
</tr>
<tr>
<td>Break appraisal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological detachment</td>
<td>---</td>
<td>+ *</td>
</tr>
<tr>
<td>Relaxation</td>
<td>---</td>
<td>+ *</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>---</td>
<td>+ *</td>
</tr>
<tr>
<td>Break duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-minute (long)</td>
<td>---</td>
<td>+</td>
</tr>
<tr>
<td>5-minute (medium)</td>
<td>---</td>
<td>+</td>
</tr>
<tr>
<td>1-minute (short)</td>
<td>+ a</td>
<td>+</td>
</tr>
</tbody>
</table>

*Note.* Direction of relationship and statistical significance for break activities and break durations is based on hypothesis tests, and break appraisals is based on zero-order correlations. A plus sign (+) indicates a positive relationship, and a negative sign (-) indicates a negative relationship. --- indicates no previous research support. Superscript a indicates that the previous research finding was from a study of work breaks, superscript b indicates that the previous research finding was from a study of evening or weekend recovery. *p < .05.*
Table 15

Summary of Hypotheses Results

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Hypothesis 1: Detachment activity vs. control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a: Lower levels of fatigue</td>
<td>Supported</td>
</tr>
<tr>
<td>1b: Higher levels of vigor</td>
<td>Supported</td>
</tr>
<tr>
<td>1c: Higher levels of energy</td>
<td>Supported</td>
</tr>
<tr>
<td>1d: Better performance</td>
<td>Partially supported (only Executive Control RT had statistically significant difference)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Hypothesis 2: Relaxation activity vs. control</th>
</tr>
</thead>
<tbody>
<tr>
<td>2a: Lower levels of fatigue</td>
<td>Not supported (lower level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>2b: Higher levels of vigor</td>
<td>Not supported (higher level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>2c: Higher levels of attention</td>
<td>Not supported (higher level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>2d: Better performance</td>
<td>Not supported (Orienting RT and Executive Control RT were better, but mean difference not statistically significant)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Hypothesis 3: Task change activity vs. control</th>
</tr>
</thead>
<tbody>
<tr>
<td>3a: Lower levels of fatigue</td>
<td>Not supported (higher level)</td>
</tr>
<tr>
<td>3b: Lower levels of vigor</td>
<td>Not supported (lower level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>3c: Higher levels of attention</td>
<td>Not supported (higher level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>3d: Better performance</td>
<td>Not supported (Orienting RT and Executive Control RT were better, but mean difference not statistically significant)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Hypothesis 4: Recovery appraisals partially mediates between break activity and outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4a: Psychological detachment appraisal</td>
<td>Partially supported (only statistically significant direct effect for attention)</td>
</tr>
<tr>
<td>4b: Relaxation appraisal</td>
<td>Partially supported (only statistically significant direct effect for vigor)</td>
</tr>
<tr>
<td>4c: Enjoyment appraisal</td>
<td>Partially supported (only statistically significant direct effect for attention)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Hypothesis 5: 9-minute break vs. control</th>
</tr>
</thead>
<tbody>
<tr>
<td>5a: Lower levels of fatigue</td>
<td>Not supported (lower level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>5b: Higher levels of vigor</td>
<td>Not supported (higher level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>5c: Higher levels of attention</td>
<td>Not supported (higher level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>5d: Better performance</td>
<td>Partially supported (only Executive Control RT had statistically significant difference)</td>
</tr>
</tbody>
</table>
Table 15 (continued)

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypothesis 6: 5-minute break vs. control</strong></td>
<td></td>
</tr>
<tr>
<td>6a: Lower levels of fatigue</td>
<td>Not supported (lower level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>6b: Higher levels of vigor</td>
<td>Not supported (higher level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>6c: Higher levels of attention</td>
<td>Not supported (higher level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>6d: Better performance</td>
<td>Partially supported (only Executive Control RT had statistically significant difference)</td>
</tr>
<tr>
<td><strong>Hypothesis 7: 1-minute break vs. control</strong></td>
<td></td>
</tr>
<tr>
<td>7a: Lower levels of fatigue</td>
<td>Not supported (lower level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>7b: Higher levels of vigor</td>
<td>Not supported (higher level, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>7c: Higher levels of attention</td>
<td>Supported</td>
</tr>
<tr>
<td>7d: Better performance</td>
<td>Partially supported (only Executive Control RT had statistically significant difference)</td>
</tr>
<tr>
<td><strong>Hypothesis 8: 5-minute &amp; 9-minute vs. 1-minute break</strong></td>
<td></td>
</tr>
<tr>
<td>8a: Lower levels of fatigue</td>
<td>Not supported (statistically significant in opposite direction - fatigue higher for 5-minute and 9-minute break groups)</td>
</tr>
<tr>
<td>8b: Higher levels of vigor</td>
<td>Not supported (higher level as predicted, but mean difference not statistically significant)</td>
</tr>
<tr>
<td>8c: Higher levels of attention</td>
<td>Not supported (statistically significant in opposite direction – attention lower for 5-minute and 9-minute break groups)</td>
</tr>
<tr>
<td>8d: Better performance</td>
<td>Not supported (only Orienting RT in predicted direction, but Executive Control RT was statistically significantly different in opposite direction of prediction)</td>
</tr>
<tr>
<td><strong>Hypothesis 9: 9-minute vs. 5-minute break</strong></td>
<td></td>
</tr>
<tr>
<td>9a: No difference in fatigue</td>
<td>Supported</td>
</tr>
<tr>
<td>9b: No difference in vigor</td>
<td>Supported</td>
</tr>
<tr>
<td>9c: No difference in attention</td>
<td>Supported</td>
</tr>
<tr>
<td>9d: No difference in performance</td>
<td>Partially supported (9-minute break had statistically significant better Orienting RT)</td>
</tr>
</tbody>
</table>
Supplementary Analyses

With a randomized experimental design, between-person differences are considered negligible. However, I also collected theoretically-relevant individual-level data that could have altered the relations between constructs in previous research. Two of the four control variables (neuroticism and sleep quality) had statistically significant zero-order correlations with feelings of fatigue after the break. Two other control variables (extraversion and caffeine) did not have statistically significant relationships with outcome variables at the $p < .05$ level.

When including these four control variables as additional covariates in the model, Hypotheses 3c and 7a became supported (statistically significant between-group differences at the $p < .05$ level). Support for Hypothesis 3c indicates that individuals reported that they felt they were paying greater attention after changing tasks during a microbreak than those in the control condition. Support for Hypothesis 7a indicates that individuals in the 1-minute microbreak groups reported statistically significant lower levels of fatigue than individuals in the control condition.

There is also the potential concern that the detachment and relaxation break activities could be creating a mood boost (Thayer, Newman, & Mcclain, 1994) rather than inducing a specific recovery appraisal. Table 16 examines mean appraisal values (1-5 scale) for each break condition, with the detachment activity leading to the highest appraisals of detachment, relaxation, and enjoyment. Individuals engaging in a relaxation activity during the break reported on average higher appraisals of detachment, relaxation, and enjoyment than individuals in the task change break activity condition.
Table 16

*Mean Appraisal Values for Each Break Activity Condition*

<table>
<thead>
<tr>
<th>Break group</th>
<th>Detachment</th>
<th>Relaxation</th>
<th>Enjoyment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Detachment activity</td>
<td>3.76 (^3)</td>
<td>3.87 (^{2,3})</td>
<td>3.98 (^{2,3})</td>
</tr>
<tr>
<td>2 Relaxation activity</td>
<td>3.54 (^3)</td>
<td>3.50 (^{1,3})</td>
<td>3.25 (^{1,3})</td>
</tr>
<tr>
<td>3 Task change activity</td>
<td>2.40 (^{1,2})</td>
<td>3.06 (^{1,2})</td>
<td>2.92 (^{1,2})</td>
</tr>
</tbody>
</table>

*Note.* Superscripts 1, 2, and 3 indicate that the mean difference between the two experiment groups was statistically significant at the \(p < .05\) level.
Chapter 5: Discussion

This study began broadly as a way to examine microbreaks, or breaks between work tasks that are shorter than ten minutes in duration. As the nature of work has changed in developed nations to become knowledge-based economies (Machlup, 1962), scholars have found that, just like with physical resources, individuals use cognitive and psychological resources to complete work tasks and have a limited supply of these resources (Halbesleben et al., 2014). Drawing on Meijman and Mulder’s (1998) Effort-Recovery Model, I explored how work tasks deplete individual resources and also how microbreaks can potentially aid in the replenishment of mental resources. Using an experimental design, I tested how microbreaks impacted individual resources like energy and attention as well as job performance outcomes with three main questions. First, I explored if the activity one engages in during the microbreak had an impact on outcomes. Individuals were randomly placed into an experiment condition that had no break activity (control group), watched a funny video during the break (psychological detachment condition), watched a mindfulness meditation video during the break (relaxation condition), or worked on a new task during the break (task change condition). Second, I questioned if an individual’s appraisal of the break impacted outcomes in addition to, or potentially more than, engaging in a break activity. To examine this, I asked individuals in all nine break conditions to what extent the microbreak made one think about something other than the work task (psychological detachment appraisal), feel calm and relaxed (relaxation appraisal), or was perceived as fun and enjoyable (enjoyment appraisal). Third, I investigated how the time duration of the microbreak impacted outcomes. For each microbreak activity condition,
individuals were randomly placed into a 1-minute, 5-minute, or 9-minute group. Collectively, I explored if there is an optimal combination of break time, break activity, or break appraisal for the “best” recovery of resources and subsequent performance in attention-demanding work tasks.

**Theoretical Contributions**

This study makes several contributions to the work recovery literature. Scholars of work recovery have primarily focused on evening, weekend, or longer respite time such as vacations, even though past research has shown that individuals spend approximately 5-15% of their time at work doing non-work-related activities (Esteves, 2013; McGehee & Owen, 1940) in an attempt to replenish resources (D’Abate, 2005; Fritz et al., 2011). The exceptions to this research have focused on formal break periods such as a 2-hour break between work sessions (Trougakos et al., 2008) or a 1-hour lunch break (Trougakos et al., 2014). Thus, one major contribution is that I extended recovery research to microbreaks, or non-work time less than ten minutes in duration (Sluiter et al., 2000), responding to the call to focus on recovery during actual work time (Sonnentag & Fritz, 2015). Many of the results from this study align with previous findings about recovery activities. The statistically significant findings from this study that are new to the work recovery literature or examined in a work break context for the first time are that, in comparison to a control group with no work break, individuals engaging in detachment break activities reported lower levels of fatigue, higher levels of vigor, and increased levels of attention. New findings regarding recovery appraisals for work breaks are that psychological detachment appraisals are negatively related to fatigue, positively related to vigor, and positively related to attention. Both relaxation appraisals and enjoyment appraisals had a statistically significant positive correlation with vigor and attention as well.
However, not all results of this study are the same as those found from studies of longer recovery periods like evenings or weekends, potentially indicating that shorter recovery periods may have different outcomes, or that the precision of my experiment ruled out confounding variables affecting prior results. Previous research findings and my hypotheses predicted that changing work tasks would reduce fatigue and vigor. In this sample, the changing tasks break condition had increased fatigue and increased vigor from the control group, although neither of these increases were significantly higher from the control group. Previous research also found that detachment and relaxation appraisals had a positive relationship with performance, but in this sample there were very mixed findings regarding recovery appraisals and performance, which may be due to the performance measure being a more objective measure of response time rather than self-reported performance (e.g., Binnewies et al., 2010).

These differential findings also highlight the importance of considering the impact of time in organizational research. The second major contribution of the study is that it responds to the call from other scholars to include time in theory building (George & Jones, 2000) and to explicitly include time and the temporal ordering of variables to establish causality in resource recovery (Sonnentag & Fritz, 2015). Drawing from physical resource replenishment literature, I used the Rohmert curve (Rohmert, 1973) to develop and test new theory that microbreak durations have differential outcomes on mental resources and work tasks that utilize these resources. The only statistically significant finding from this research that had not been tested before was that a short, 1-minute break reduced fatigue in comparison to individuals who did not take a break. Contrary to what was expected, individuals in the longer 5-minute and 9-minute breaks had consistently worse outcomes than individuals in the 1-minute break condition. However, there were very few changes in outcomes for individuals in the 5-minute and 9-minute
break conditions. The lack of new statistically significant findings and findings that were opposite of the hypotheses could be because all break conditions were grouped together. For example, the hypotheses that tested break time versus a control group included detachment, relaxation, and work change activities during the break, and combining all groups for the hypothesis test may have muddled the results. Research Question 1 helped clarify these initial findings and parse out what actually occurred between break groups. There were no statistically significant differences between 1-minute and 5-minute break activities. However, individuals in the 9-minute detachment and 9-minute relaxation group reported much lower feelings of fatigue than individuals in the 9-minute break that changed work tasks.

The third major contribution from this study is that I explicitly tested if combinations of break durations, activities, and appraisals have a systematic difference in outcomes. This is a complex question that other scholars have asked before (e.g., Trougakos et al., 2014), and is especially interesting considering the conflicting results regarding microbreak durations. By using an experimental design with multiple break conditions, this study was able to tease apart the differences occurring from break activities and durations and compare the outcomes from each group. There are several general trends from this analysis. The 9-minute detachment condition was the only group that was consistently better than the control group regarding subjective measures, as these individuals reported lower fatigue, higher vigor, and higher attention, highlighting that this could be one of the best microbreak recovery strategies. In addition, the outcomes from the 1-minute work change condition was surprising in that this group reported lower fatigue than the control group and individuals also reported paying more attention after this break than in almost all other break and control conditions. If only a short amount of time is available, it may be best to complete another small task and then return to the
previous task. Another trend is that, in general, all of the relaxation conditions had almost no statistically different outcomes than other groups or the control group. It could be that the benefits of mindfulness mediation found in other research studies did not occur because this may have been the first time an individual was experiencing mindfulness meditation. In other words, mindfulness meditation or any other form of meditation may require practice or a willingness to engage in meditation to reap the potential benefits of meditating during work breaks. It is also possible that a shorter duration of mindfulness mediation may not have a direct impact on recovery processes. In this way, the findings from this experiment align with recent findings from a mindfulness meditation intervention study showing that individuals participating in a short (average of 10.5 minutes) mindfulness activity in the morning for 10 consecutive workdays had improved sleep, but no changes in psychological detachment experiences compared to a control group (Hülsheger, Feinholdt, & Nübold, 2015).

Research Question 1 also helped explore general trends occurring with the performance variables. The group that changed work tasks for 9-minutes had the highest Orienting RT but also the highest Executive Control RT. This likely occurred because the individuals who worked on another attention-demanding task (Stroop) for a long period had faster responses when an orienting cue appeared when compared to when one did not because they were already more fatigued or paying less attention. The Executive Control RT value seems to indicate that this was happening, as these individuals had the largest delay in response when an incongruent arrow was present in the flanker task. These performance findings require additional explanation to make sense in the context of a work environment. As described earlier, occupations such as truck drivers, lifeguards, nurse anesthetists, and air traffic controllers all require use of attentional resources to successfully complete work tasks. Using a task like the ANT in a computer lab is
not exactly like the job tasks that individuals experience in these occupations. However, all three attentional networks assessed by the ANT are vital components of these jobs, and response time on the ANT can translate to the use of attentional resources on the job. For example, an air traffic controller uses executive control to stay vigilant and continuously watch the computer monitors, utilizes the alerting component to notice when a change has occurred such as a signal flashing, and uses the orienting component to place where in space on the monitor the change occurred. Faster responses when an alerting cue and orienting cue occur are beneficial in this environment, and fewer delays in the Executive Control RT variable (a lower value) indicate that an individual was more vigilant during the trials, which is also beneficial in this type of job.

**Research Contributions.** Components of this experimental research contribute more to how scholars conduct research than contributing to theory or improved knowledge of resource recovery from work breaks. In cognitive and developmental psychology, there are ongoing debates about the ability and usefulness of training to improve attention and working memory (e.g., Rapport, Orban, Kofler, & Friedman, 2013). Results from the performance outcomes of this study indicate that training effects could appear based on the design of the training assessments. For example, when examining group differences with the ANT, participants frequently have several 5-minute rounds of the ANT with a break in between (e.g., Matthews & Zeidner, 2012). This research suggests that what an individual does during that break period could impact outcomes, and standardizing break activities as well as times could potentially clarify the inconsistencies within the literature. An additional benefit of this research design is that I separated the constructs of low energy (fatigue) and high energy (vigor). One debate in the employee stress and well-being literature is whether these are two distinct but related constructs (Demerouti et al., 2012) or if they opposite poles of the same construct (Cole et al., 2012).
Including both measures and graphing both at the same points in time in Figure 7 show that specific break activities may be better at reducing fatigue and others may be better at increasing vigor. Lastly, this study used multiple, related yet distinct dependent variables. For example, higher levels of fatigue or slower responses times may indicate that attentional resources have been depleted. The bivariate relationships between outcome variables are statistically significant in many instances, but are not too highly correlated, indicating that these are similar yet unique constructs.

**Practical Implications**

There are multiple practical implications stemming from this study, although all must be interpreted with caution as the experimental design, while enhancing control and allowing for more causal claims, may limit the generalizability of the findings to individuals in the workplace. One general finding from this study was that individuals who engaged in a detachment activity (watching a funny video) reported lower fatigue, higher vigor, and increased attention than the individuals who did not have a break, whereas individuals who changed work activities only reported higher levels of attention, and individuals who engaged in a relaxation activity saw no statistical changes versus individuals in the control (no break) condition. Thus, when one does take a break, doing something that helps one briefly mentally disengage such as watching a video, playing a game, or reading a story or news article could help.

An additional practical implication is more time-related. If an individuals is provided a 10-minute break period, such as what occurs by law in some industries, the results from this study would recommend mentally detaching from work, perhaps by watching a funny video or engaging in something else that one finds enjoyable. However, there many individuals that may feel they do not have time to take a 10-minute break at work. For example, lawyers typically
track billable hours in 6-minute increments, and taking a 10-minute break is a financially significant amount of time to not work during a work period. In these instances, it still appears that a shorter, 1-minute break can be helpful. The results from this study found that changing work tasks for a 1-minute period is actually as good as taking a 1-minute detachment break in terms of increasing attention and reducing fatigue. Thus, if an individual feels exhausted by a current attentionally-demanding task, a short 1-minute break or just changing tasks (and perhaps, still billing the same client) will still be beneficial. For these individuals, building into one’s schedule an intentional 1-minute activity every hour could help reduce overall exhaustion at the end of the day.

Individuals in some workplaces may not have a formal work break period, or may feel like they cannot take a work break because of the perception that the break is a counterproductive work behavior (Robinson & Bennett, 1995; Rodell & Judge, 2009). The results of this study highlight that managers should consider short breaks beneficial and allow for minor periods when an employee may take personal phone calls or e-mails. In a workplace in which an individual still feels he or she cannot take a break by detaching from the work task, these results show that changing tasks could also be beneficial. In other words, a beneficial break does not have to be viewed as something that is considered counterproductive, but rather it can be something such as doing paperwork or responding to an e-mail for a few minutes before returning to an attentionally demanding task.

The results from the ANT also provide practical implications. In the context of one workplace, a nurse anesthetist assess the patient’s physical cues as well as visual changes on a monitor that reports patient medial information. The monitor has text that flashes or blinks when a value changes (e.g., heart rate increasing or decreasing), which is both an alerting and orienting
cue. In this way, higher ANT alerting and orienting scores indicate that the employee responded quicker when the cue was present. Comparing group mean scores in this study, experiment groups with higher mean values for Alerting RT and Orienting RT indicates that these individuals responded faster from their experimental condition than the comparison group. A nurse anesthetist will also have to notice if the value on the monitor is within an acceptable range (a congruent condition) or not within an acceptable range (an incongruent condition). The Executive Control RT value indicates that the length of delay in an incongruent condition, and thus a lower value is better (the delay is shorter). Comparing group mean scores, the group with the lower value performs better because the delay is shorter when an incongruent condition exists. From a practical standpoint, these performance values matter, as faster time-critical responses could have a significant impact on health outcomes.

**Limitations**

This study is not without limitations. As highlighted when discussing practical implications, the use of an experiment provides a great amount of control and helps rule out other factors that could impact the results, allowing for greater causal inference by the nature of the design. Nonetheless, this limits the external validity of the findings, meaning that I cannot claim that the findings of this study are directly useful in a workplace without these controlled conditions. The use of the ANT also helped gain a better understanding of the use of attentional processing and attentional resources with each specific attention network, but this task is not exactly the same as what individuals do at work. Thus, caution must be used when examining task performance. Using the ANT as a work task also means that the results from this study are more applicable to individuals who have high visual attention demands at their job. For
occupations that require other resources like physical strength, emotion regulation, or verbal working memory, the breaks that were helpful in this study may not have the same benefit.

The use of students rather than employees can also be considered by some to be a limitation. However, because I was studying the basic human processes of resource depletion and recovery, the sample itself was less important as long as all individuals are expected to undergo this process. In other words, examining human behaviors and processes would be the same in a student or nonstudent sample, making this less of a concern (Dobbins, Lane, & Steiner, 1988). In addition, a meta-analysis by Podsakoff, LePine, and LePine (2007) examining stress appraisals and outcomes found no statistically significant difference in the results utilizing an employee sample or a student sample, providing evidence that college students are not different from other working adults in how they appraise and handle work stress. This potential limitation is further minimized when considering that 66.3% of the sample worked on average 25.2 hours each week.

Regarding research design, this experiment controlled what break activity each individual engaged in and also focused only on the effects of one break period. This limits the generalizability of the findings because in most instances, employees will be able to decide what they do during the break. Feelings of control during non-work time longer than breaks have been linked to a multitude of improved well-being outcomes (e.g., Davidson et al., 2010; Hahn, Binnewies, Sonnentag, & Mojza, 2011; Sonnentag & Fritz, 2007). Thus, allowing individuals a choice in break activities is an avenue for future research. In addition, employees may have multiple breaks during a work period, leading to a cumulative effect of multiple recovery processes. Initial research has found that individuals utilize multiple break strategies each day (Fritz et al., 2011). This study was useful to disentangle the effects of recovery activities and
appraisals over one time period, but future research should consider multiple breaks during a work period. An additional research limitation was the use of a general fatigue measure. Only recently has a scale been validated that separates physical, mental, and emotional fatigue at work (Frone & Tidwell, 2015), and including these conceptualizations would provide a stronger understanding how attention-demanding tasks impact employee energy.

Future Directions

Given these limitations, there are many avenues available for future research. One main aspect that should be considered is to examine how each microbreak impacted individuals over time. Analyzing the variance in outcomes within each person would provide a much better causal understanding of how microbreak activities and appraisals of these activities help individuals replenish resources. Examining resources after the final round of tasks could also show if resources were recovered after the break, but once again were depleted at the same rate as individuals who had no break. Could it be that individuals in the control (no break) condition actually have higher levels of resources at the end of the experiment because they finished all of their work trials faster? Overall, a more nuanced examination of the experimental results would allow for increased causal inferences about changes over time within each person.

Future research should also explore the interaction of emotions, social interactions, and attention (for more information, see: Federico, Marotta, Adriani, Maccari, & Casagrande, 2013; Morillas-Romero, Tortella-Feliu, Balle, & Bornas, 2014; Pessoa, 2009). It would be interesting to examine how social interactions during breaks impact individuals, as well as how having control over a break activity impacts resource recovery. Expanding the study of breaks to an environment that requires emotion regulation and attentional processes, such as a customer service job, is an area that also should be explored.
Lastly, future research should take these findings and attempt to directly replicate them (Kepes & McDaniel, 2013), as well as utilize a quasi-experimental design to enhance the generalizability of the findings. In a recent study, not only did individuals with greater executive control have improved task performance, this effect was stronger in an organizational setting with employees than a similar study with a student sample (Bosco, Allen, & Singh, 2015). Replicating this experiment could be practically significant to organizations too. For example, the visual attention of truck and car drivers has been a major topic of interest (e.g., Charlton & Starkey, 2011), especially since some vehicle manufacturers are considering adding ways to assess driver fatigue and attentiveness and have the vehicle automatically adapt (Doheny, 2012).

Understanding how breaks can improve attention and reduce fatigue has great practical importance in this context, and future studies should continue to explore this area.

**Conclusion**

With increasing interest in how employees recover cognitive and psychological resources during non-work time, this study focused on microbreaks. Although employees report spending approximately 10% of their time on non-work activities, there has been relatively little research about how work breaks impact individuals in jobs that require more cognitive resources rather than physical resources. Overall, taking a break between work tasks allowed individuals to feel less fatigued, more energized, and more attentive. Although some of these findings may make sense to general public, it is important to test if and when our notions about breaks at work are actually true. In some instances, conducting these tests also help us recognize when common knowledge might be untrue. For example, this study found that taking a longer break of 5 or 9 minutes might not be any more helpful than taking a 1-minute break. In other words, the notion that “more is better” when it comes to short breaks during work time may not be true. Another
surprising finding was that working on a different task for a short period rather than disengaging from work was the best at improving attention. This study also found that to increase feelings of energy at work, it may be best to change one’s appraisal of the situation (finding something enjoyable) rather than take a break. In other words, changing tasks could even be helpful if one finds enjoyment in a different work task.
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Appendix

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Appendix A: Instructions to participants

This experiment studies work effectiveness. You will be placed into a working condition simulating a work task within a Fortune 500 company that involves monitoring changes to a computer screen. During this time, the instructions on the screen will tell you what to observe and how to use your mouse and keyboard. You will be asked to work as quickly as possible while maintaining accurate responses.

During the work period, you may be provided instructions to take a break or change tasks. These instructions may be different for each participant. Please follow the instructions provided only to you, and do not follow what individuals near you may be doing.

Following a set of work tasks, you will be asked questions to rate your appraisal of a situation or of yourself. At the end of the work period, you will also be asked questions about you in general, not about how you felt during the work period.

Participation in this experiment is completely voluntary. If you choose not to participate, your instructor will provide you with additional ways to receive course credit or extra credit.

If you have any questions, please raise your hand now.

Thank you for your participation!
Appendix B: Microbreak manipulation conditions

<table>
<thead>
<tr>
<th>Recovery activity</th>
<th>Time</th>
<th>Details</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological detachment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 minute</td>
<td>0:52</td>
<td>Saturday Night Live: Weekend Update</td>
<td><a href="http://www.hulu.com/watch/544688">http://www.hulu.com/watch/544688</a></td>
</tr>
<tr>
<td>5 minutes</td>
<td>5:39</td>
<td>Saturday Night Live: Schweddy Balls</td>
<td><a href="http://www.youtube.com/watch?v=z9t5AJNF0so">http://www.youtube.com/watch?v=z9t5AJNF0so</a></td>
</tr>
<tr>
<td>Relaxation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 minute</td>
<td>1:00</td>
<td>Guided Mindfulness Meditation</td>
<td><a href="http://www.youtube.com/watch?v=0fcdv0kFVMs">http://www.youtube.com/watch?v=0fcdv0kFVMs</a></td>
</tr>
<tr>
<td>5 minutes</td>
<td>5:19</td>
<td>Guided Mindfulness Meditation</td>
<td><a href="http://www.youtube.com/watch?v=dEzbdLn2bJc">http://www.youtube.com/watch?v=dEzbdLn2bJc</a></td>
</tr>
<tr>
<td>9 minutes</td>
<td>8:57</td>
<td>Guided Mindfulness Meditation</td>
<td><a href="http://www.youtube.com/watch?v=YW-TDOgstSE">http://www.youtube.com/watch?v=YW-TDOgstSE</a></td>
</tr>
<tr>
<td>Task change</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1 minute</td>
<td>0:56</td>
<td>Stroop task</td>
<td></td>
</tr>
<tr>
<td>5 minutes</td>
<td>5:29</td>
<td>Stroop task</td>
<td></td>
</tr>
<tr>
<td>9 minutes</td>
<td>9:08</td>
<td>Stroop task</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C: Microbreak recovery appraisal items

Instructions: Below are several statements about you with which you may agree or disagree. Using the response scale below, indicate your agreement or disagreement with each item about the previous task (video).

Please use the following scale to record your responses. (1 = “strongly disagree;” 2; 3 = “neutral;” 4; 5 = “strongly agree”).

**Psychological detachment.** Items adapted from Recovery Experience Questionnaire (Sonnentag & Fritz, 2007) with item wording changed for momentary, state-level assessments (Bakker, Sanz-Vergel, Rodríguez-Muñoz, & Oerlemans, 2014) and context wording for use with breaks (Trougakos, Hideg, Cheng, & Beal, 2014).

1. During the break, I forgot about work
2. During the break, I don’t think about work at all
3. During the break, I distanced myself from my work
4. During the break, I got a break from the demands of work

**Relaxation.** Items adapted from Recovery Experience Questionnaire (Sonnentag & Fritz, 2007) with item wording changed for momentary, state-level assessments (Bakker, Sanz-Vergel, Rodríguez-Muñoz, & Oerlemans, 2014) and context wording for use with breaks (Trougakos, Hideg, Cheng, & Beal, 2014).

1. During the break, I kicked back and relaxed
2. During the break, I did relaxing things
3. During the break, I used the time to relax
4. During the break, I took time for leisure

**Enjoyment.** Items from Reinecke, Klatt, and Kramer (2011).

1. The break was enjoyable
2. I am glad the break did not last longer (R)
3. The break was fun
4. I liked the break
Appendix D: Energy items

Instructions: Please indicate the extent to which you feel the following right now. (1 = “not at all;” , 2 = “a little”; 3 = “moderately;”; 4 = “quite a bit;” 5 = “extremely”).

High energy. Items are the vigor-activity subscale from Profile of Mood States (POMS; McNair et al., 1971).

1. Lively
2. Active
3. Energetic
4. Cheerful
5. Alert
6. Full of pep
7. Carefree
8. Vigorous

Low energy. Items are the fatigue-inertia subscale from Profile of Mood States (POMS; McNair et al., 1971).

1. Worn out
2. Listless
3. Fatigued
4. Exhausted
5. Sluggish
6. Weary
7. Bushed
Appendix E: Attentional resource items

Instructions: Please rate the extent to which you agree with the following. (1 = “strongly disagree;” 2 = “disagree;” 3 = “slightly disagree;” 4 = “neutral;” 5 = “slightly agree;” 6 = “agree;” 7 = “strongly agree”).

Attentional resources. Items adapted from self-assessed attention during a training video (Davis, 2004). The wording was changed from “during the video demonstration” or “during the previous task”.

1. I paid close attention during the previous task
2. I was able to concentrate during the previous task
3. The previous task held my attention
4. During the previous task, I was absorbed in the work
Appendix F: Control variables and demographic items

**Sleep quality.** Item from the Pittsburg Sleep Quality Index (Buysse et al., 1989).

**Instructions:** Please rate your sleep quality last night with the following scale. (1 = “very bad”, 2 = “fairly bad”, 3 = “fairly good”, 4 = “very good”)

1. How would you rate your sleep quality overall?

**Caffeine intake.**

**Instructions:** Please indicate the number of caffeinated beverages you have consumed in the past four hours. (sliding scale of whole numbers from 0 to 10).

1. Coffee beverage (e.g., 8oz of caffeinated coffee; 12oz of iced coffee beverage)
2. Tea beverage (e.g., 8oz of black or green tea)
3. Highly caffeinated soda (e.g., one can / 12 oz of Mountain Dew)
4. Other caffeinated soda (e.g. one can / 12 oz of Coke, Pepsi)

**Personality.** Items from the Big Five Shortened Scale (Gosling, Rentfrow, & Swann, 2003).

**Instructions:** Please rate the extent to which you agree with the following words about yourself. (1 = “strongly disagree;” 2 = “disagree;” 3 = “slightly disagree;” 4 = “neutral;” 5 = “slightly agree;” 6 = “agree;” 7 = “strongly agree”).

I see myself as:
1. Extraverted, enthusiastic
2. Reserved, quiet (reversed)
3. Critical, quarrelsome (reversed)
4. Sympathetic, warm
5. Dependable, self-disciplined
6. Disorganized, careless (reversed)
7. Anxious, easily upset
8. Calm, emotionally stable (reversed)
9. Open to new experiences, complex
10. Conventional, uncreative (reversed)

**Attentional focusing.** Items from the focusing subscale of the Attentional Control Scale (Derryberry & Reed, 2002).

**Instructions:** Please rate the extent to which the following describes you. (1 = “almost never;” 2 = “sometimes;” 3 = “often;” 4 = “always”). (R) signifies a reverse-scored item.

1. It’s very hard for me to concentrate on a difficult task when there are noises around. (R)
2. When I need to concentrate and solve a problem, I have trouble focusing my attention. (R)
3. When I am working hard on something, I still get distracted by events around me. (R)
4. My concentration is good even if there is music in the room around me.
5. When concentrating, I can focus my attention so that I become unaware of what’s going on in the room around me.
6. When I am reading or studying, I am easily distracted if there are people talking in the same room. (R)
7. When trying to focus my attention on something, I have difficulty blocking out distracting thoughts. (R)
8. I have a hard time concentrating when I’m excited about something. (R)

**Demographic characteristics.**

Instructions: Please indicate the following about yourself.

1. Female / Male / Prefer not to answer
2. Black / Native American / Hispanic or Latino / White / Asian / Other or prefer not to answer
3. Age (enter number using keyboard)
4. Major (enter string using keyboard)
5. GPA (enter number using keyboard)
6. Average number of hours worked per week (if employed)
7. Job title (if employed)
Vita

Andrew Alan Bennett was born May 11, 1982 in Henrico County, Virginia and is an American citizen. He graduated from Douglas Freeman High School, Richmond, Virginia in 2000. He received his Bachelor of Science in Mechanical Engineering from Clemson University, Clemson, South Carolina in 2004 and his Master of Arts in Organizational Leadership from Gonzaga University, Spokane, Washington in 2008.