DISPOSITIONAL MINDFULNESS AND STRESS RESILIENCE: SELF-REGULATORY CAPACITY, AFFECTIVE STABILITY, AND PRESLEEP AROUSAL IN DAILY LIFE

by

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ABSTRACT

Mindfulness training appears to promote healthy and adaptive functioning by enhancing self-regulatory capacity and stress resilience. Less is known about whether *dispositional* mindfulness (DM) is similarly associated with self-regulatory capacity and stress resilience. Fifty-six healthy adults completed a self-report DM questionnaire and performance-based measures of executive function (EF) prior to daily life experience sampling of affect, self-regulation, presleep arousal, and sleep quality. DM was not associated with objective measures of EF but was significantly associated with self-reported cognitive, emotional, and behavioral self-regulation. Further, although DM was not associated with *average* affect levels (i.e., across positive/negative valence, low/high arousal domains), dispositionally high-mindful individuals exhibited less extreme changes in negative/low arousal affect (e.g., sad, bored) and negative/high arousal affect (e.g., stressed, angry) and evidenced less variability in positive/low arousal affect (e.g., relaxed, serene). Higher DM was also associated with lower presleep arousal and higher sleep quality. At the facet-level, mindful *awareness* was associated with daily self-reported EF and predicted cognitive presleep arousal and sleep quality; conversely, mindful *acceptance* was associated with greater stability across negatively valenced and low arousal affect states, and more strongly predicted somatic presleep arousal. Results indicate that mindful *awareness* and mindful *acceptance,* two distinct yet complementary processes, appear uniquely associated with components of self-regulation.

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INTRODUCTION

Mindfulness – defined as "nonjudgmental, present-moment awareness" (Kabat-Zinn, 1994) – has become increasingly recognized as a possible protective factor against stress exposure and a moderator of the ill effects of stress. For example, mindfulness-based interventions (e.g., Mindfulness-Based Stress Reduction, MBSR; Kabat-Zinn, 1991) are linked to better emotional and physical health outcomes, including increased subjective well-being (Shapiro, Oman, Thoresen, Plante, & Flinders, 2008; Siegel, 2007), reduced psychological symptoms (Carmody & Baer, 2008; Chiesa & Serretti, 2010; Grossman, Niemann, Schmidt, & Walach, 2004; Keng, Smoski, & Robins, 2011), improved immune functioning (Davidson et al., 2003; Solberg, Halvorsen, Sundgot-Borgen, Ingjer, & Holen, 1995), and attenuated psychophysiological stress reactivity (Brewer et al., 2009; Epel, Daubenmier, Moskowitz, Folkman, & Blackburn, 2009). The general consensus is that mindfulness training promotes healthy and adaptive functioning by enhancing self-regulatory capacity and stress resilience (Brown & Ryan, 2003; Chiesa & Serretti, 2009; E. L. Garland, Gaylord, & Fredrickson, 2011; Goldin & Gross, 2010). What is less known is whether self-regulatory capacity and stress resilience are similarly associated with variations in *dispositional* mindfulness (DM). Beneficial associations between DM and emotional and physical health mirror those observed with mindfulness-based interventions (e.g., Coffey & Hartman, 2008; Creswell, Way, Eisenberger, & Lieberman, 2007; Howell, Digdon, Buro, & Sheptycki, 2008;

Lakey, Campbell, Brown, & Goodie, 2007), and several individual difference factors related to self-regulatory capacity are conceptually and empirically linked to DM. Thus, prior research suggests that DM may also promote stress resilience via improved stress regulation, although the exact mechanisms remain unclear. The purpose of the current study, therefore, was to examine the relationship between DM, self-regulatory capacity, and stress regulation in the context of everyday life.

DISPOSITIONAL MINDFULNESS

Mindfulness was introduced to Western medicine as an individual difference factor—a "basic human quality" characterized by the tendency to attend to and accept present moment experiences (Kabat-Zinn, 1994; Santorelli & Kabat-Zinn, 2013). Although the vast majority of mindfulness research has examined the efficacy of mindfulness-based interventions (MBIs), important issues concerning the nature, structure, and measurement of dispositional mindfulness (DM) have emerged over the past two decades and can be used to guide current research (see Rau & Williams, 2015 for review).

First, DM is a distinct construct within the broader theoretical framework of mindfulness. Specifically, high self-reported mindfulness has different implications depending on exposure to mindfulness training. Different response patterns have been observed between samples trained versus untrained in mindfulness (Baer et al., 2008; Christopher, Charoensuk, Gilbert, Neary, & Pearce, 2009). For example, the association between the *Observe* facet from the Five Facet Mindfulness Questionnaire (FFMQ: Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) and measures of psychological adjustment is positive in meditating samples but nonsignificant or negative in nonmeditating samples (Baer et al., 2008). Further, the type of mindfulness experienced during meditation appears unrelated to the type of mindfulness experienced in everyday life (Carmody, Reed, Kristeller, & Merriam, 2008; Thompson & Waltz, 2007). These distinctions suggest that DM is an independent construct from trained mindfulness and should be informed by empirical investigations of DM per se rather than extrapolating from the more extensive MBI evidence base.

Second, DM appears to be a multidimensional construct represented by a 2-factor model. The 2-factor model was first proposed during a consensus meeting designed to operationally define mindfulness:

> The first component involves the self-regulation of attention so that it is maintained on immediate experience, thereby allowing for increased recognition of mental events in the present moment. The second component involves adopting a particular orientation toward one's experiences in the present moment, an orientation that is characterized by curiosity, openness, and acceptance. (Bishop et al., 2004, p. 232)

Since this definition was proposed, support for the 2-factor model has been well documented. Despite differences in measurement and descriptive language, reported 2-factor solutions have striking conceptual similarities: *presence* and *acceptance* (Brown & Ryan, 2003; Kohls, Sauer, & Walach, 2009), *awareness* and *acceptance* (Cardaciotto, Herbert, Forman, Moitra, & Farrow, 2008), *observing* and *nonjudging* (Evans & Segerstrom, 2011), and *decentering* and *curiosity* (Lau et al., 2006). Collectively, these findings indicate that DM should be examined as a multidimensional construct consisting of both the *focus* and the *quality* of attention.

MECHANISMS FOR DISPOSITIONAL MINDFULNESS ASSOCIATIONS WITH STRESS REGULATION

Associations between dispositional mindfulness (DM) and stress regulation processes reveal patterns of fewer and less extreme stress appraisals (e.g., Ciesla, Reilly, Dickson, Emanuel, & Updegraff, 2012; Evans & Segerstrom, 2011; Heppner et al., 2008; Marks, Sobanski, & Hine, 2010), attenuated stress reactivity (e.g., Arch & Craske, 2010; Barnes et al., 2007; Brown & Ryan, 2003; Brown, Goodman, & Inzlicht, 2013; Brown, Weinstein, & Creswell, 2012; Daubenmier, Hayden, Chang, & Epel, 2014; Holt, 2012), faster stress recovery (e.g., Arch & Craske, 2010; Drach-Zahavy & Marzuq, 2013; Holt, 2012), and better stress restoration (i.e., sleep; e.g., Allen & Kiburz, 2012; S. N. Garland, Campbell, Samuels, & Carlson, 2013; Murphy, Mermelstein, Edwards, & Gidycz, 2012). Further, these associations have been found with both subjective and objective measures (e.g., psychological, cognitive, neurobiological, and physiological), suggesting that DM elicits salutary effects through dynamic, interactive processes that are both "top-down" and "bottom-up." Based on these findings, we propose three potential mechanisms by which DM may confer stress resilience.

Executive Functioning

The term *executive functioning* (EF) refers to cognitive and behavioral control abilities that allow for purposeful, goal-directed behavior in everyday life (Cummings & Miller, 2007; Suchy, 2009). EF abilities support adaptive functioning by allowing the individual to regulate behavior as needed to achieve short- and long-term goals. Importantly, individual differences in EF are linked to stress regulation (see Williams, Suchy, & Rau, 2009 for review) and believed to promote the stress-buffering effects of DM.

From a neuroanatomical standpoint, EF relies on neural networks involved with processing and responding to stress, including the prefrontal cortex (i.e., monitoring and regulating behavior), the limbic system (i.e., emotional processing), and the brain stem (i.e., autonomic arousal and control). Even mild disruptions to these networks, for example following mild traumatic brain injury, can produce behavioral, emotional, and physiological dysregulation (Alexander, 1995; Marschark, Richtsmeier, Richardson, Crovitz, & Henry, 2000) that undermines effective stress regulation. Similarly, certain psychiatric populations characterized by poor stress regulation evidence poor EF abilities (e.g., borderline personality disorder: Fertuck, Lenzenweger, & Clarkin, 2005; obsessive-compulsive disorder: Olley, Malhi, & Sachdev, 2007; major depressive disorder: Paelecke-Habermann, Pohl, & Leplow, 2005). Patterns of executive dysfunction and impaired stress regulation are believed to generalize beyond clinical populations, such that individual differences in EF in neuropsychiatrically healthy adults (Friedman et al., 2008; Kane & Engle, 2002; Miyake et al., 2000) may confer stress risk or resilience (Williams et al., 2009).

Numerous studies report positive associations between mindfulness and EF following mindfulness training (e.g., mindfulness meditation; see Chiesa, Calati, & Serretti, 2011 for a review), as well as between DM and brain regions subserving EF (Modinos, Ormel, & Aleman, 2010). The handful of studies that have examined *behavioral* markers of EF show consistent positive associations between DM and performance on experimental cognitive tasks measuring controlled attention (e.g., Black, Semple, Pokhrel, & Grenard, 2011; Cheyne, Carriere, & Smilek, 2006; Oberle, Schonert-Reichl, Lawlor, & Thomson, 2011; Ostafin, Kassman, & Wessel, 2013) as well as self-report inventories of self-regulatory capacity (Black et al., 2011; Lakey et al., 2007). Future research is needed to substantiate preliminary support for the link between DM and EF. Combining more direct measures of EF – such as standardized neuropsychological tests and in vivo (i.e., experience sampling) reports – with multidimensional assessments of DM may reveal important insights about the mechanisms linking DM to stress regulation.

Affective Stability

The range and degree of variability in mood states fall under the domain of affective stability, also referred to as emotional equanimity, emotional lability, and affective instability. Variations in mood have been examined as alternations between positive and negative affect (Ebner-Priemer et al., 2007), momentary shifts in affective states (Koenigsberg et al., 2002), and changes in mood across hours or days (Cowdry, Gardner, O'Leary, Leibenluft, & Rubinow, 1991). Because affective changes often occur secondary to stressful encounters (Fabes & Eisenberg, 1997), affective stability is an important marker of stress regulation and may be one mechanism by which DM promotes stress resilience.

The link between emotions and regulatory capacity is well documented. Disruption to regulatory networks (i.e., prefrontal cortex, limbic system, brainstem regions) can interfere with emotion regulation and increase emotional lability (King &

Reiss, 2013; Morris, Robinson, & Raphael, 1993). Similarly, affective instability is associated with psychiatric symptomatology (e.g., borderline personality features: McConville & Cooper, 1998; Trull et al., 2008; depressive states: McConville & Cooper, 1998; Peeters, Berkhof, Delespaul, Rottenberg, & Nicolson, 2006) and linked to risk factors for developing psychopathology (e.g., neuroticism: Eid & Diener, 2004; Kuppens, Oravecz, & Tuerlinckx, 2010; Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007; low self-esteem: Rhodewalt, Madrian, & Cheney, 1998; Zeigler-Hill & Abraham, 2006). These findings suggest that affective *stability* may be a protective factor against stress-related illness and may reflect greater regulatory capacity more generally.

Evidence of emotional equipoise has been documented in dispositionally high-mindful individuals. Neuroimaging studies indicate that DM modulates neural responses during early phases of affective processing, especially for emotionally evocative stimuli (Brown et al., 2013), and is associated with decreased volume of the amygdala (Creswell et al., 2007; Taren, Creswell, & Gianaros, 2013) – a brain region involved with detecting and responding to threat. Consistent with these findings, higher reports of DM are associated with less emotional reactivity to experimentally induced stressors (Arch & Craske, 2010; Barnes et al., 2007; Brown et al., 2013) and fewer retrospective reports of perceived stress in daily life (Araas, 2008; Black, Milam, Sussman, & Johnson, 2012). Similarly, in daily life, DM predicts less frequent and less intense reports of negative affect (Brown & Ryan, 2003) and less variability in affective intensity over time (Hill & Updegraff, 2012).

Additional research is needed to disentangle the relationship between DM and affective stability. Although the first study of DM and affective stability (Brown & Ryan, 2003) utilized an ideal methodological approach that combined experience sampling data with multilevel modeling techniques to determine between-subjects variability in affect, the use of a unidimensional measure of DM limited the generalizability of these findings to multidimensional models of DM. A similar and more recent study (Hill & Updegraff, 2012) did use a multidimensional measure of DM (i.e., FFMQ) but relied on less sophisticated statistical approaches which addressed variability in affect (i.e., mean of within-subject standard deviations) but not necessarily the degree of change in affect over time. Combining the benefits of these two studies (i.e., multidimensional measurement of DM, experience sampling of affect, multilevel approach) while simultaneously examining indices of regulatory capacity could address previous limitations and test predicated relationships between DM, affective stability, and stress resilience.

Presleep Arousal

Stress resilience is often conceptualized as the ability to maintain balance and stability over time (Lukey & Tepe, 2008). Thus, the ability to successfully recover from a stressful experience – cognitively, emotionally, and physiologically – is an important marker of stress resilience. Conversely, the inability to restore balance and stability can prolong arousal and diminish regulatory capacity needed to manage future stressors. Along these lines, one important index of prolonged arousal – presleep arousal (PSA) – can be viewed as both a measure of stress recovery and a predictor of stress restoration.

PSA refers to both cognitive and physiological/somatic arousal experienced during the presleep period (Nicassio, Mendlowitz, Fussell, & Petras, 1985). Cognitive

PSA, including presleep mental activity and ruminative cognitions, is associated with subjective disruptions in sleep (Broman & Hetta, 1994; Lichstein & Rosenthal, 1980; Nicassio et al., 1985; Ohayon, Caulet, & Guilleminault, 1997) and greater sleep onset latency (Borkovec, Grayson, O'Brien, & Weerts, 1979; Kuisk, Bertelson, & Walsh, 1989), and differentiates good sleepers from insomniacs (Robertson, Broomfield, & Espie, 2007). Physiological/somatic PSA refers to autonomic nervous system arousal – indexed via self-report and objective measurement (i.e., electrocardiography, electromyography, and electroencephalography) – that interferes with sleep onset and maintenance. Recent models suggest that somatic PSA emerges from more pervasive hyperarousal processes indicative of impaired regulatory capacity (Bastien, Guimond, St-Jean, & Lemelin, 2008; Bonnet & Arand, 2010; Riemann et al., 2010). In sum, daytime stress regulation bears directly on PSA and subjective sleep quality (Winzeler et al., 2014). How well an individual manages stress during the day can therefore function as a protective factor in the development of stress-related disorders, such as clinical insomnia (Morin, Rodrigue, & Ivers, 2003).

Dispositionally high-mindful individuals evidence effective stress recovery across both emotional and physiological parameters following laboratory-induced stressors (Arch & Craske, 2010; Holt, 2012). Generalized to daily life, this suggests that DM promotes rapid recovery from everyday stressors and decreases instances of prolonged arousal, such as PSA. Consistent with this hypothesis, higher DM is associated with lower self-reported PSA (Howell et al., 2008) as well as better self-reported sleep quality (Allen & Kiburz, 2012; S. N. Garland et al., 2013; Howell, Digdon, & Buro, 2010; Murphy et al., 2012).

Preliminary evidence suggests that DM promotes more effective daytime stress regulation, protects against prolonged arousal, and facilitates restorative processes (i.e., sleep). However, additional research is needed to expand and build upon these findings. For example, examining the relative contribution of DM to cognitive versus somatic PSA may clarify mechanisms linking mindfulness to decreased arousal. Incorporating measures of daytime stress regulation could provide additional insights into the relationship between DM and self-regulatory depletion (i.e., PSA), especially when examined in the context of daily life (e.g., experience sampling, sleep study).

THE CURRENT STUDY

The purpose of the current study was to examine the relationship between dispositional mindfulness (DM), self-regulatory capacity (i.e., executive functioning), and stress regulation (i.e., affective stability, presleep arousal) in everyday life. We combined objective assessments (i.e., neurocognitive testing) and first-person reports (i.e., daily diary, nighttime ratings of executive functioning and presleep arousal, morning sleep diary) in the context of everyday life to examine three primary hypotheses.

First, because dispositionally high-mindful individuals are expected to respond to everyday experiences in a regulated yet flexible manner, we predicted that DM would be positively associated with *self-regulatory capacity* – measured via behavioral and self-reported executive functioning – and *stress regulation* – operationalized as affective stability throughout the day. Second, because moment-to-moment self-regulation is believed to promote more effective *stress recovery* and restorative processes, we predicted that DM would be negatively associated with presleep arousal and positively associated with sleep quality. Third, if DM is associated with executive functioning, affective stability, and restorative processes (i.e., presleep arousal, sleep quality), we predicted that executive functioning and affective stability would mediate the relationship between DM and restorative processes.

METHODS

Participants

Participants included 79 healthy adults (32% male; mean age = 27 years, *SD* = 6.5) recruited from University of Utah undergraduate psychology courses and the greater Salt Lake City community. The race composition of the sample was 91% Caucasian, 5% Asian Pacific, 4% unspecified. Exclusionary criteria included age beyond 20-45 years; primary language other than English; left hand dominant; symptoms indicative of clinical insomnia; visual impairments that could interfere with reading or computerized tasks; arm impairments that could interfere with cognitive task performance; current pregnancy; current use of tobacco; history of brain trauma, seizures, brain tumor, stroke or aneurysm, brain surgery, heart surgery, Multiple Sclerosis, major orthopedic surgery, hypertension, pulmonary disorder, or renal failure; and current use of cardiovascular, neuroleptic, or hypnotic medications (e.g., beta blockers).

Procedures

Following informed consent and eligibility screening, participants completed a 4-day protocol. On Day 1, participants completed a laboratory assessment that included self-reported dispositional mindfulness and executive cognitive functioning. On Days 2-3, participants completed first-person reports of daily functioning that included multiple daytime ratings of affect acquired through electronic diary, nighttime ratings of executive functioning and presleep arousal, and morning ratings of sleep quality. On

Day 4, participants provided final sleep ratings, returned laboratory equipment, and underwent debriefing and compensation procedures.

Baseline Assessment Measures

Five Facet Mindfulness Questionnaire

The Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) is a 39-item multidimensional measure of dispositional mindfulness. Items are rated on a 5-point Likert scale from 1 (never or vary rarely true) to 5 (very often or always true). Scores are calculated across five facets, with higher scores reflecting higher levels of dispositional mindfulness: *Observe* (8 items; e.g., "I pay attention to sensations, such as the wind in my hair or sun on my face."), *Describe* (8 items; e.g., "I can easily put my beliefs, opinions, and expectations into words."), *Act with awareness* (8 items; e.g., "I find it difficult to stay focused on what's happening in the present." reverse-scored), *Nonjudge* (8 items; e.g., "I tell myself I shouldn't be feeling the way I'm feeling." reverse-scored), and *Nonreact* (7 items; "I watch my feelings without getting lost in them.").

The FFMQ is the result of a large-scale factor analysis of five common self-report measures of mindfulness (Baer et al., 2006). This measure has a well-defined factor structure that corresponds to predicted criterion variables (e.g., openness to experience, self-compassion) and demonstrates good internal consistency across the five facets (alpha coefficients: *Observe* = .83; *Describe* = .91; *Act with awareness* = .87; *Nonjudge* = .87; *Nonreact* = .75). Importantly, however, *Observe* did not contribute to the overall mindfulness construct, and *Describe* and *Nonjudge* were only modestly correlated with the total score. From a theoretical perspective, these qualities appear the least related to general conceptualizations of mindfulness (Bishop et al., 2004; Brown, Ryan, &

Creswell, 2007; Gunaratana, 2002) and may better reflect learned skills than dispositional attributes. Conversely, *Act with awareness* and *Nonreact* provided the strongest association with the overall mindfulness construct, followed by *Nonjudge*.

To identify the best theoretical and empirical approach to operationalizing DM in this sample, we systematically examined the contribution of each FFMQ subscale. We first calculated the Chronbach's alpha for the total FFMQ score when all five subscales were included (α = .65). We then removed subscales, one by one, until the optimal fit of reliability and number of subscales was obtained. A total of three subscales was retained – *Act with Awareness, Nonreact,* and *Nonjudge.* This finding is consistent with the 2-factor model of DM (Bishop et al., 2004; Brown & Ryan, 2003; Cardaciotto et al., 2008; Evans & Segerstrom, 2011; Kohls et al., 2009; Lau et al., 2006) that considers both the *focus* of attention (i.e., *awareness* of present-moment experiences) and the *quality* of attention (i.e., *acceptance* of present-moment experiences). We therefore operationally defined DM as the sum of the FFMQ facets *Act with awareness* (i.e., representing *awareness* factor) and *Nonreact* and *Nonjudge* (i.e., together representing the *acceptance* factor). Chronbach's alphas were .88 for the DM composite score, .82 for the mindful awareness score, and .84 for the mindful acceptance score.

<u>Delis-Kaplan Executive Function System</u>

Assessment of executive cognitive functioning involved standard administration and scoring of four subtests from the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001). From these subtests, conditions that reflect components of executive attentional control and cognitive flexibility were selected: Trail Making (Letter Number Sequencing completion time), Color-Word Interference (Inhibition and

Inhibition/Switching completion times), Verbal Fluency (Letter and Category correct responses), and Design Fluency (number of correct responses across three conditions). An EF composite score was calculated by averaging the age-corrected scaled scores across the eight conditions, with higher scores indicating better performance.

Given the hierarchical organization of cognitive functions (Stuss, Picton, & Alexander, 2001), we controlled for lower order processes (e.g., working memory, processing speed) that are inherently assessed during cognitive testing. First, conditions that reflect lower order processes (i.e., psychomotor speed, scanning and sequencing abilities, naming and reading abilities) were selected, including four conditions from the Trail Making Test (Visual Scanning, Number Sequencing, Letter Sequencing, Motor Speed) and two conditions from the Color-Word Interference Test (Color Naming, Word Reading). Next, a nonexecutive composite score was calculated by averaging the age-corrected scaled scores across the six component process conditions. We then removed the lower order process variance from the EF composite and used the nonexecutive composite score to control for component process variance. The resulting unstandardized residual for the EF composite was used as the final measure.

Due to procedural modifications early in the study, the D-KEFS Trail Making Test was not included in the initial study protocol. Consequently, 12 participants received all D-KEFS measures except the Trail Making Test. We therefore imputed missing values by using scores obtained on the nine other test conditions included in the executive and nonexecutive composites, together with demographic variables (i.e., age, education, and gender), to predict the missing values. Chronbach's alphas were .75 for the executive composite and .81 for the nonexecutive composite.

Experience Sampling Measures

Daily Diary

The intensity and variability of affective states were assessed via PalmPilot. Participants were prompted at random approximately once per hour (i.e., 14 times per day) on Days 2 and 3 of the study protocol. Participants were encouraged to respond to as many prompts as possible but were also given the option to skip a prompt if unable to respond (e.g., driving, business meeting). Completion rates varied by participant and study day. On Day 2 of the protocol, 62 participants completed at least one diary (range 1-12; mean = 6.19, *SD* = 2.68). On Day 3 of the protocol, 54 participants completed at least one diary (range 1-11; mean = 5.67, *SD* = 2.74). Because participants completed significantly more diaries on Day 2 compared to Day 3 [t (53) = 2.24, $p < .05$], only Day 2 affect ratings were included in the analyses.

A total of 21 emotional descriptors were selected in an effort to represent a broad range of affective states across the affective circumplex (Russell, 1980), including positive valence/high arousal (i.e., excited, elated, in awe, sense of wonder), positive valence/low arousal (i.e., relaxed, calm, serene, contented, happy), negative valence/high arousal (i.e., stressed, tense, angry, worried, upset, nervous), and negative valence/low arousal (i.e., sad, lethargic, bored, depressed, distractible, fatigued). Each item was presented using the same stem question (e.g., “How SAD do you feel right now?”) and rated on a 5-point Likert scale from 1 (not at all) to 5 (very much). The order of affect items presented at each prompt was randomized to reduce careless or overlearned responding. Chronbach’s alphas, calculated using affect ratings obtained on the first day of experience sampling, were .84 for positive valence/high arousal ratings, .91 for positive valence/low arousal ratings, .96 for negative valence/high arousal ratings, and .88 for negative valence/low arousal ratings.

The construct "affective stability" has been examined using several different approaches. One common and relatively accessible approach involves computing an intraindividual variability (IIV) score, in which the degree of fluctuation around a central tendency (typically standard deviation around person-means) is examined (e.g., Castro-Schilo & Ferrer, 2013; Eid & Diener, 1999; Ferrer, Steele, & Hsieh, 2012; Jacobs, van Os, Derom, Thiery, Delespaul, et al., 2011; Komulainen et al., 2014; McConville & Cooper, 1998; Russell et al., 2007). Although the IIV metric addresses the degree of fluctuation or dispersion around an individual's average level of affect, this approach fails to account for the effect of time on changes in daily life affect. As stated by Ebner-Priemer and colleagues (2009) and demonstrated by multiple studies (e.g., Ebner-Priemer et al., 2007; Jahng, Wood, & Trull, 2010; Larsen, 1987; Trull et al., 2008), a major component of instability is temporal dependency.

The current study examined affective stability using multiple approaches. The first approach involved calculating a raw IIV score for each affect rating separately (i.e., SDs around person-means for each of the 21 affective descriptors), and then averaging the raw IIVs according to the four valence/arousal categories. The second approach involved assessing temporal dependence (i.e., fixed or random effect of time, via multilevel modeling), removing linear effects of time (i.e., "detrending;" Curran & Bauer, 2011), calculating a modified IIV score for each affect rating separately (i.e., SD of detrended residuals for each of the 21 affective descriptors), and averaging the modified IIVs according to the four valence/arousal categories. Both the raw and modified IIV scores were included in analyses to examine variability in affect with and without examining affect as a time-varying covariate. We also examined the *direction* of change in affect over time (i.e., raw regression slopes averaged within each valence/arousal affect group) as well as the *degree* of change in affect over time (i.e., absolute value of regression slopes averaged within each valence/arousal affect group).

Executive Functioning Log

At the end of each day (i.e., Days 2-3), participants completed a questionnaire assessing lapses in executive functioning experienced during the day. A total of 9 items were selected from well-validated self-report measures of EF, including the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) and the Conners' Adult ADHD Rating scales (CAARS; Conners, Erhardt, & Sparrow, 1996), in order to measure subjective difficulties in emotion regulation (e.g., "Thinking of today only, how often did you feel easily frustrated?"), cognitive regulation (e.g., "Thinking of today only, how often did you become distracted by things going on around you?"), and behavioral regulation (e.g., "Thinking of today only, how often did you say or do things without thinking?"). Items were rated on a 5-point Likert scale ranging from 0 (not at all) to 4 (constantly). Because affect ratings from Day 2 only were used in the current analyses, only nighttime EF ratings collected on Day 2 were included in the analyses. Chronbach's alphas were .64 for the global EF rating, .73 for the emotion regulation subscale, .65 for the cognitive regulation subscale, and .59 for the behavioral regulation subscale.

Presleep Arousal Scale

Before going to bed each night, participants rated levels of mental and physical arousal. The Presleep Arousal Scale (PSAS; Nicassio et al., 1985) consists of 16 items rated from 1 (not at all) to 5 (extremely), with questions evenly divided between a cognitive subscale, which asks about sleep- and nonsleep-related worry and overall cognitive arousal, and a somatic subscale, which asks about physical symptoms of arousal and anxiety before bed. Higher scores on the PSAS have been found to differentiate between clinical insomnia and normal sleepers (Robertson et al., 2007). In this study, Chronbach's alpha for the PSAS was .75.

Morning Sleep Diary

Upon waking each morning (i.e., Days 2-4), participants were asked to rate the previous night's sleep on four items measuring 1) global sleep quality, 2) satisfaction/dissatisfaction with sleep quality, (3) worry/distress about sleep quality, and (4) the degree to which participants felt rested or refreshed. Items were rated on a 4-point Likert scale ranging from 0 to 3. The total score was used to index sleep quality upon waking the morning of Day 3 (i.e., following Day 2 night's sleep). The Chronbach's alpha for the sleep quality composite was .84.

PRELIMINARY ANALYSES

Normality

To test the assumption of normality, basic descriptive statistics and Shapiro-Wilk test statistics were calculated for each measure (Table 1). All obtained values were within expected ranges, and no outliers were identified or removed. Variables flagged for possible non-normal distribution (Shapiro-Wilk $p < .05$) were subjected to additional assessment of normality, including examination of skewness, kurtosis, histogram graph, box plot, and Normal Q-Q Plots. Due to the generally healthy, nonclinical nature of the sample, several variables were positively skewed (i.e., scores concentrated at low end of distribution) but with skewness z scores less than 2.75 (greater than 3.29 indicates statistically significant skewness at $p<.05$). However, when examining the average affect ratings by valence/arousal group, most distributions were significantly positively skewed (i.e., scores concentrated at the low end of the distribution). Therefore, as suggested by Tabachnick and Fidell (2007) and Howell (2007), positive skewness was corrected. First, positively skewed scores were reflected, which involved subtracting the valence/arousal average rating from six (i.e., one greater than the largest possible score of five). We then log base-10 transformed the absolute value of the reflected score, which yielded modified scores with more acceptable ranges of skewness for conducting parametric tests.

Missing Data

Given the complexity of study procedures, missing data were expected. Using the six measures included in data analysis (i.e., FFMQ, executive composite, daily diary, EF log, PSAS, sleep quality composite), Little's Missing Completely at Random (MCAR) test was used to test the null hypothesis that data is missing at random. The resulting chi-square of 15.01 ($df = 12$; $p = .24$) indicates that data were missing at random and that no missing data techniques were needed. However, because approximately 29% of the sample either failed to respond to daily diary prompts or responded to less than three diary prompts, we took additional efforts to determine whether under-responders differed significantly from responders on any study measures. Results of independent t-tests revealed no significant differences ($ps > .05$) on measures of dispositional mindfulness, executive functioning (behavioral and self-reported), presleep arousal, and sleep quality when comparing non-responders (n=17) and low-responders (i.e., <3 diary responses; n=6) to responders (i.e., 3+ diary responses; n=56).

Sample Characteristics

Because daytime affect ratings were central to the current investigation, and because we were interested in variability across affect ratings, only participants with three or more affect ratings on Day 2 (i.e., first day of experience sampling) were included in the final analyses. The resulting sample included 56 healthy young adults (32% male; age range = 20-45, mean = 27.45, $SD = 6.24$) who completed between 14-23 years of education ($M = 16.30$, $SD = 2.11$). The race of the final sample was 91% Caucasian, 7% Asian, and 2% unspecified. Descriptive statistics for each measure using this modified subsample are provided in Table 2.

Daily Diary Affect Ratings

Five scores were calculated to examine affect ratings obtained during the first day of experience sampling.

Valence/arousal Composite

Ratings were averaged across each of the 21 affective descriptors, creating 21 affect composites per participant. These 21 affect composites were then averaged by valence/arousal group: negative valence/high arousal (i.e., stressed, tense, angry, worried, upset, nervous), and negative valence/low arousal (i.e., sad, lethargic, bored, depressed, distractible, fatigued), positive valence/high arousal (i.e., excited, elated, in awe, sense of wonder), positive valence/low arousal (i.e., relaxed, calm, serene, contented, happy). As indicated in Table 3, valence/arousal composites were consistently positively skewed. The majority of participants endorsed low to moderate levels of negative affect on average, with composite scores generally falling between one and two on a 5-point scale regardless of arousal. Positively valenced/high arousal affect was also positively skewed, although to a lesser extreme. Positively valenced/low arousal affect was normally distributed; however, the range was more restricted, with composite scores generally falling between 2 and 4.

Raw Intraindividual Variability Score

The first set of intraindividual variability (IIV) scores was calculated by first obtaining the standard deviations (SDs) around the mean for each affect rating separately. For each participant, the resulting 21 SDs were then averaged by valence/arousal group, producing four raw IIV scores. As indicated in Table 3, the raw IIV scores were normally distributed. Variability around the mean averaged .5 SDs for each of the valence/arousal affect ratings, with the exception of the positive/low arousal ratings, which averaged .77 SDs.

<u>Modified Intraindividual Variability Score</u>

Examination of individual fit lines across affect ratings revealed a high degree of variability in intercepts and slopes across participants, suggesting a linear trend for most affective descriptors. To examine the effect of time on affect ratings and determine whether affect represents a time-varying covariate, two types of unconditional multilevel models were conducted for each affective descriptor.

First, a series of unconditional means models were conducted. This type of multilevel model does not include level-1 or level-2 predictors. Rather, the purpose of this model is to partition variance and determine a) whether systematic variation in affect ratings exists, and b) whether systematic variation lies within or between participants. The following unconditional means model – in which no level-1 or level-2 predictors are included – was conducted, where AFFECT represents the affective descriptor, *j* represents the participant, and *i* represents the sequence of diary prompt:

L1: AFFECTij = β0j + rij

L2: β0j = γ00 + u0j

Intraclass correlation coefficients, which reflect the proportion of total variance that exists between participants, are listed in Table 4. For example, the ICC obtained for *WORRIED* was .60, indicating that 60% of the total variance was between participants (i.e., level-2 individual difference factors) and 40% of the variance was within participants, consistent with substantial variability observed across intercepts and slopes.

Second, a series of unconditional growth models was conducted, in which time is included as a level-1 predictor. This model allowed us to a) evaluate the presence of temporal dependence, and b) determine whether the effect of time is fixed (i.e., between-persons) or random (i.e., within-persons). The following unconditional growth model was conducted, where AFFECT represents the affective descriptor, TIME represents the sequence of diary prompts, *j* represents the participant, and *i* represents the diary prompt:

L1: $AFFECTij = \beta 0j + \beta 1j*(TIMEij) + rij$

L2: $\beta 0j = \gamma 00 + u0j$
$\beta 1j = \gamma 10 + u1j$

As indicated in Table 4, there was a significant random effect of time for the majority (i.e., 15) of affective descriptors included in this study, indicating significant variability in both participants' beginning levels of affect and participants' affect-time slopes. In other words, the overall significant effect of time reflects intercepts and slopes that vary randomly for each participant. In addition, there was a significant fixed effect of time for three low arousal ratings (i.e., lethargic, bored, serene), indicating that linear changes in these specific affect types are generalizable to the population being estimated.

Because there was a significant linear effect of time on affect ratings, modified IIV scores were calculated to examine variability in affect after removing the affect-time slope. That is, rather than examining standard deviations of affect ratings around the horizontal line (i.e., person-means), the process of "detrending" (e.g., Curran & Bauer, 2011) allowed us to examine standard deviations of *residualized* affect ratings around affect-time slopes. Given that temporal dependence was observed in the majority of affect ratings, and at least half of each valence/arousal group, we detrended each affect rating before computing modified IIV scores. First, we regressed each affect rating on time (i.e., sequence of diary prompts, grand-mean centered) for each participant using ordinary least squares (OLS) regression. We then subtracted the estimated affect rating produced by OLS regression at each observation for each participant to create a within-person component of the affect rating, and used the intercept from OLS regression as the between-person component of the affect rating. Consequently, the obtained residualized ratings reflect the degree of fluctuation in affect *without* the effect of time.

Modified IIV scores were then calculated using the standard deviations of residualized affect ratings, averaged by valence/arousal group. In general, modified IIV scores were normally distributed with average variability around .5 SDs (Table 3). The exception to this general finding occurred with positive/low arousal ratings, which were both positively skewed and less variable when compared to other modified IIV scores and when compared to the raw positive/low arousal IIV score.

<u>Affect-time Direction of Change</u>

To examine the *direction* of change in affect over time, the individual regression slopes for each affect rating were averaged by valence/arousal category. On average, participants exhibited only slight decreases in affect ratings over time (mean slopes range -.01 – -.03). Closer examination of the distribution of slopes revealed modest to strong (-.1– -.75) *decreases* in affect ratings over time for a subset of the sample: 20% for negative/low arousal, 16% for negative/high arousal, 21% for positive/low arousal, and 11% for positive/high arousal. With the exception of positive/high arousal ratings, substantially fewer participants exhibited modest to strong *increases* in affect ratings over time: 7% for negative/low arousal, 7% for negative/high arousal, 9% for positive/low arousal, and 13% for positive/high arousal.

Affect-time Rate of Change

To examine the *degree* of change in affect over time, regardless of direction, the absolute value of individual regression slopes for each affect rating were averaged according to valence/arousal affect group. In other words, rate of change over time can be used to index overall affective stability, with higher rates of change indicating decreased stability. As expected based on rates of directional changes observed with raw slopes, approximately one quarter of the sample exhibited modest to strong linear changes in any given affective quadrant.

Table 1.
Original sample (n=79): Descriptive statistics for predictor and outcome variables.

	N	**Range**	**Mean (*SD*)**	**Skew z**
Predictor Variable				
Dispositional Mindfulness	78	45-96	76.01 (11.07)	-0.67
Self-Regulatory Capacity Variables				
Executive Functioning				
Behavioral Composite	79	-3.31-2.62	0.00 (1.39)	-1.11
Evening Diary	68	0-13	5.32 (3.15)	2.16
Stress Regulation Variables				
Daytime Affective Stability	56			
Negative/low arousal composite^		1.15-4.69	1.98 (.79)	6.92
Negative/high arousal composite^		1.00-4.69	1.82 (.92)	6.60
Positive/low arousal composite		1.97-4.27	3.03 (.55)	0.77
Positive/high arousal composite^		1.00-4.50	1.92 (.80)	3.52
Presleep Arousal	68	11-46	25.96 (5.65)	2.67
Morning Sleep Quality Composite	69	0-12	4.62 (3.03)	1.70

^Indicates scores that were transformed prior to conducting parametric tests.

Table 2.
Modified sample (n=56): Descriptive statistics for predictor and outcome variables.

		Minimum	Maximum	Mean	*SD*
Predictor Variable					
Dispositional Mindfulness	56	58	96	77.30	10.40
Self-Regulatory Capacity					
Executive Functioning					
Behavioral Composite	56	-2.48	2.62	0.12	1.34
Evening Diary	52	0	13	5.08	3.11
Set Loss		0	5	2.08	1.56
Emotion Regulation		0	6	1.52	1.43
Behavior Regulation		0	7	1.48	1.51
Stress Regulation					
Daytime Affective Stability	56				
Negative/low arousal composite		1.15	4.69	1.98	0.79
Negative/high arousal composite		1.00	4.69	1.82	0.92
Positive/low arousal composite		1.97	4.27	3.03	0.55
Positive/high arousal composite		1.00	4.50	1.92	0.80
Presleep Arousal	52	11	46	25.58	5.85
Somatic Arousal		10	28	16.00	4.38
Cognitive Arousal		8	18	9.88	2.14
Morning Sleep Quality Composite	54	0	12	4.74	3.09

Table 3.

Modified sample (n=56): Descriptive statistics for daily diary affect metrics.

Valence Arousal Affect Group	**Min**	**Max**	**Mean**	***SD***	**Skewness z**
Negative/low arousal					
Valence/arousal composite^	1.15	4.69	1.98	0.79	6.92
Raw IIV score	.17	1.06	0.57	0.22	0.39
Modified IIV score	.09	1.02	0.45	0.21	1.64
Affect-time slope	-.56	.50	-.04	0.13	-.36
Affect-time slope (abs)	.01	.48	0.09	0.09	8.20
Negative/high arousal					
Valence/-arousal composite^	1.00	4.69	1.82	0.92	6.60
Raw IIV score	0	1.29	0.56	0.27	1.51
Modified IIV score	0	1.05	0.50	0.24	1.21
Affect-time slope	-.41	.19	-.03	0.10	-3.97
Affect-time slope (abs)	.00	.41	0.08	0.08	7.16
Positive/low arousal					
Valence/arousal composite	1.97	4.27	3.03	0.55	0.77
Raw IIV score	.35	1.48	0.77	0.22	1.64
Modified IIV score	.05	.62	0.26	0.12	4.30
Affect-time slope	-.87	.41	-.03	0.15	-7.82
Affect-time slope (abs)	.02	.41	0.11	0.07	6.48
Positive/high arousal					
Valence/arousal composite^	1.00	4.50	1.92	0.80	3.52
Raw IIV score	0	1.13	0.57	0.27	-0.04
Modified IIV score	0	1.00	0.49	0.25	0.35
Affect-time slope	-.75	.32	-.02	0.14	-8.61
Affect-time slope (abs)	.00	.75	0.10	0.12	11.64

^Indicates scores that were transformed prior to conducting parametric tests.

SD = standard deviation; IIV = intraindividual variability; Abs = absolute value.

Table 4.

Results of unconditional means models and unconditional growth models.

	Variance			Fixed effects			Random effects		
Affect Rating	**ICC**	**Between**	**Within**	***t***	***df***	***p***	**X2**	***df***	***p***
Negative/Low Arousal									
Sad	0.852	85.21	14.79	-0.50	55	0.62	103.45	55	<.001
Fatigued	0.501	50.08	49.92	1.66	55	0.10	88.54	55	0.00
Depressed	0.933	93.27	6.73	1.47	55	0.15	64.67	55	0.18
Lethargic	0.593	59.28	40.72	2.67	55	0.01	89.95	55	0.00
Bored	0.369	36.92	63.08	2.74	51	0.01	51.69	51	0.45
Distractible	0.244	24.39	75.61	-0.33	54	0.75	81.72	54	0.01
Negative/High Arousal									
Worried	0.603	60.34	39.66	-0.86	55	0.40	108.69	55	<.001
Tense	0.534	53.42	46.58	0.97	55	0.34	97.40	55	<.001
Stressed	0.423	42.27	57.73	0.69	55	0.49	7.88	55	0.04
Upset	0.707	70.68	29.32	0.22	55	0.83	65.66	55	0.15
Nervous	0.648	64.85	35.15	-0.71	55	0.48	59.71	55	0.31
Angry	0.652	65.15	34.85	1.52	51	0.13	100.86	51	<.001
Positive/Low Arousal									
Serene	0.404	40.39	59.61	2.70	55	0.01	101.37	55	<.001
Contented	0.257	25.66	74.34	1.94	55	0.06	89.75	55	0.00
Relaxed	0.254	25.44	74.56	-0.76	55	0.45	74.86	55	0.04
Calm	0.298	29.83	70.17	0.52	54	0.61	98.43	54	<.001
Happy	0.441	44.08	55.92	-0.39	55	0.70	78.52	55	0.02
Positive/High Arousal									
Excited	0.381	38.13	61.87	-1.70	55	0.09	96.05	55	<.001
Elated	0.574	57.43	42.57	0.51	55	0.61	103.77	55	<.001
Awe	0.636	63.63	36.37	-0.60	52	0.55	55.84	52	0.33
Wonder	0.656	65.56	34.44	0.58	52	0.56	61.96	52	0.16

ICC = Intraclass Correlation Coefficient; df = degrees of freedom

PRINCIPAL ANALYSES

Linear and Nonlinear Analyses

Simple regression was used to examine the relationship between the primary predictor (DM) and outcome variables. Linear associations were expected, such that higher levels of DM should predict greater executive functioning, higher affective stability, lower presleep arousal, and higher waking sleep quality. To further understand associations between variables and accommodate the possibility of nonparametric associations, nonlinear regression was also conducted. All regression analyses used mean-centered DM as the predictor; linear regressions used the mean-centered DM variable as the predictor, quadratic regressions used the *squared* mean-centered DM variable as the predictor, and *cubic* regressions used the cubed mean-centered DM variable as the predictor. Because no significant findings were observed for cubic or quadratic regressions, only linear associations are reported and discussed (Tables 5 and 6).

Self-regulatory Capacity

Objectively measured self-regulatory capacity (i.e., EF behavioral composite) was not significantly associated with DM or subjective measures of EF. Examination of EF composite scores (i.e., executive and nonexecutive processes) and subtests revealed a uniform lack of association ($ps > .05$) with self-reported DM. However, there was a significant association between DM and self-reported EF. Higher levels of mindful *awareness*, but not mindful *acceptance*, were associated with fewer EF difficulties in the context of daily life across domains: set maintenance (e.g., difficulty concentrating, forgetfulness), regulating emotions (e.g., reacting emotionally, becoming easily upset), and regulating behaviors (e.g., doing things without thinking, failing to think things through before acting). Of the self-reported EF subscales, emotion dysregulation was most strongly associated with indices of affective instability, including more extreme changes in negative/low arousal affect, higher levels of overall negative/high arousal affect, greater variability in negative/high arousal affect, and linear increases in negative/high arousal affect over the course of the day.

Daytime Affective Stability

The association between DM and daytime affective stability was assessed by examining stability in reported daytime affect ratings (Table 6). There was no association between DM and *average* affect levels across the four valence/arousal affect groups, and global ratings of DM were not significantly associated with affective stability metrics for *high* arousal affect ratings. However, DM was significantly associated with affective stability metrics for *low* arousal affect ratings. Higher DM was associated with variability in *negative*/low arousal affect (e.g., sad, lethargic, bored, depressed, distractible, fatigued) around average levels of negative/low arousal affect (i.e., not correcting for temporal dependence). When removing linear effects of time, the relationship between DM and variability in negative/low arousal affect was no longer significant. Examination of affect-time slopes revealed that lower self-reported DM was associated with greater rates of change in negative/low arousal affect throughout the day (i.e., absolute value of slopes), but this did not appear to be directional (i.e., raw value of slopes). In other words, variability in negative/low arousal affect (i.e., raw IIV score) associated with lower DM appear to reflect sharper increases or decreases in negative/low arousal affect over the course of the day rather than greater variability around a temporally stable average.

Conversely, higher DM was associated with less variability in *positive*/low arousal affect (i.e., relaxed, calm, serene, contented, happy) after controlling for temporal dependence. These findings indicate that dispositionally high-mindful individuals show less extreme changes in low arousal negative affect and less variability in low arousal positive affect over the course of the day, suggesting that DM may temper low arousal mood states. Examination of DM domains revealed that most associations with affective stability were driven by the mindful *acceptance* component; the one exception was the degree of change in negative/low arousal ratings over time, which was associated with mindful awareness *and* mindful acceptance. In addition, mindful acceptance was associated with degree of change across negatively valenced mood states, regardless of arousal, indicating that higher levels of acceptance correspond to less severe increases or decreases in negative affect.

<u>Stress Recovery and Restoration</u>

The association between DM and stress recovery and restoration was assessed by examining measures of presleep arousal (i.e., measured the night of experience sampling) and sleep quality / disturbance (i.e., measured the following morning). Higher reported DM was significantly associated with lower levels of subjective arousal prior to falling asleep, and higher levels of subjective sleep quality upon wakening. Examination of nighttime PSAS scores revealed an inverse relationship between DM and both somatic and cognitive presleep arousal. Although both mindful awareness and mindful acceptance were associated with somatic presleep arousal, only mindful *awareness* was associated with cognitive presleep arousal. Further, waking sleep quality was significantly better for individuals reporting greater mindful awareness and lower cognitive presleep arousal; sleep quality was not significantly associated with mindful acceptance or somatic presleep arousal.

Bootstrap Mediation

Bootstrapping techniques were used to estimate the indirect effect of DM on restorative processes (i.e., PSA) through a single mediator (i.e., executive functioning and affective stability, examined separately). Generally speaking, the bootstrapping procedure creates an empirical representation of the sampling distribution from which direct and indirect effects can be estimated. Once completed, inferences about the size of the indirect effect (i.e., mediation) can be made by examining 95% confidence intervals (CI). The null hypothesis of no indirect effect (i.e., no mediation) is rejected if zero does not lie within the CI. Compared to the traditional "Baron and Kenny" (1986) approach, bootstrapping techniques have higher power and better Type I error control (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002) and have become the preferred approach to mediation analyses (Hayes, 2009). The PROCESS macro for SPSS (Hayes, 2013) was used to test the simple mediation models.

As previously reported (Table 5), higher DM significantly predicted lower presleep arousal (b = -.34, 95% CI [-.47, -.22], t = -5.37, p < .001), accounting for 37% of the variance in PSAS scores. Results of linear regression revealed two possible mediators of this association: self-reported EF and rates of change in negative/low arousal affect. Mediation analyses were conducted with DM as the independent variable (X) and PSAS scores as the dependent variable (Y); cognitive and somatic PSA were examined separately in order to determine whether specific types of arousal were differentially influenced by executive functioning and affective stability.

We began by examining the indirect effect of self-regulatory capacity, indexed by reported EF difficulties. Higher self-reported DM was associated with fewer daytime EF difficulties (b = -.11, 95% CI [-.19, -.03], t = -2.7, p < .01); DM scores accounted for 13% of the variance in reported EF. In turn, greater difficulties with daytime EF were associated with greater cognitive PSA (b = .25, 95% CI [.07, .43], t = 2.79, p < .01) and greater somatic PSA (b = .49, 95% CI [.12, .87], t = 2.65, p =.01). The indirect effect of EF was significant for cognitive PSA (b = -.019, 95% BCa CI [-.054, -.00]), representing a relatively small effect size (K^2 = .09, 95% CBa CI [.01, .24]). However, there was no significant indirect effect of EF for somatic PSA (b = -.03, 95% BCa CI [-.09, .01]; K^2 = .08, 95% CBa CI [.01, .22]).

Next, we examined the indirect effect of affective stability, indexed by degree of change in negative/low arousal affect (i.e., absolute value of individually derived affect-time slopes). Higher self-reported DM was associated with less extreme changes in negative/low arousal affect (b = -.00, 95% CI [-.01, -.00], t = -2.49, p = .02), accounting for 10% of the variance in rates of change over time. Changes in negative/low arousal affect were significantly associated with somatic PSA (b = .01, 95% CI [.00, .01], t = 2.36, p = .02), but not cognitive PSA (b = .01, 95% CI [-.00, .02], t = 1.28, p = .21). Results of bootstrap mediation indicated that rate of change in negative/low arousal affect was not a significant indirect effect on the association between DM and somatic PSA (b =

-.01, 95% CBa CI [-.02, .00]).

To summarize, DM was significantly associated with reported self-regulatory capacity (i.e., EF), daytime stress regulation (i.e., variability in affect), and stress recovery (i.e., presleep arousal). Results of bootstrap mediation indicated that global, self-reported difficulty in daytime EF significantly mediated the relationship between DM and cognitive PSA. Further, although less extreme changes in negative/low arousal affect over the course of the day appear to be associated with both higher DM and lower somatic PSA, this particular index of affective stability did not emerge as a significant mediator.

Table 5.

Bivariate correlations between dispositional mindfulness, self-regulatory capacity, and stress recovery and restoration

	DM Composite	DM Awareness	DM Accept	FFMQ Total	FFMQ Observe	FFMQ Describe	FFMQ Awareness	FFMQ Nonjudge	FFMQ Nonreact
Self-Regulatory Capacity									
EF Behavioral Composite	-0.10	-0.12	-0.11	-0.03	0.26	-0.13	-0.10	-0.07	-0.05
EF Log Total Score	-.359**	-.490**	-0.15	-0.23	0.14	-0.01	-.519**	-0.21	-0.03
Set Maintenance Errors	-0.21	-.363**	0.02	-0.07	0.12	0.15	-.411**	-0.08	0.06
Emotion Dysregulation	-.325*	-.285*	-0.21	-0.25	0.10	-0.12	-.324*	-0.18	-.276*
Behavior Dysregulation	-0.21	-.362**	-0.13	-0.15	0.07	-0.05	-.335*	-0.19	0.13
Stress Recovery / Restoration									
PSAS Total Score	-.605**	-.448**	-.486**	-.501**	0.08	-0.23	-.498**	-.485**	-.392**
PSAS Cognitive Subscale	-.408**	-.380**	-0.27	-.388**	0.04	-.289*	-.420**	-.311*	-0.17
PSAS Somatic Subscale	-.510**	-.384**	-.396**	-.380**	0.12	-0.11	-.429**	-.392**	-.331*
Morning Sleep Disturbance	-.304*	-.281*	-0.17	-.291*	-0.03	-0.18	-.329*	-.281*	-0.03

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 6.

Bivariate correlations between dispositional mindfulness and affective stability.

	DM Composite	DM Awareness	DM Accept	FFMQ Total	FFMQ Observe	FFMQ Describe	FFMQ Awareness	FFMQ Nonjudge	FFMQ Nonreact
Negative/low arousal affect									
Composite^	0.14	-0.04	0.21	-0.02	-0.18	-0.20	-0.03	0.26	0.06
Raw IIV	-.287*	-0.20	-.268*	-0.18	-0.09	0.18	-0.21	-0.23	-0.23
Modified IIV	-0.21	-0.15	-0.18	-0.11	-0.09	0.22	-0.16	-0.19	-0.13
Slopes (raw)	0.08	0.15	0.07	0.03	-0.11	0.00	0.13	-0.03	0.13
Slopes (abs)	-.321*	-.290*	-.290*	-.279*	0.04	-0.16	-.284*	-0.22	-0.25
Negative/high arousal affect									
Composite^	0.05	-0.04	0.09	-0.13	-.332*	-0.21	-0.03	0.15	-0.03
Raw IIV	-0.23	-0.22	-0.24	-0.17	0.00	0.00	-0.20	-0.18	-0.13
Modified IIV	-0.21	-0.22	-0.19	-0.17	0.03	-0.07	-0.21	-0.15	-0.12
Slope (raw)	0.16	0.12	0.16	0.17	0.10	0.07	0.12	0.05	.265*
Slope (abs)	-0.21	-0.12	-.271*	-0.15	0.01	0.01	-0.10	-0.19	-0.21
Positive/low arousal affect									
Composite	-0.07	-0.07	-0.04	-0.08	-0.04	-0.07	-0.07	-0.05	-0.01
Raw IIV	-0.11	0.07	-0.17	-0.07	-0.04	0.06	0.06	-0.20	-0.09
Modified IIV	-.330*	-0.20	-.363**	-.337*	-0.11	-0.18	-0.19	-.381**	-0.14
Slope (raw)	-0.02	-0.02	-0.05	0.02	0.01	0.10	-0.01	0.01	-0.07
Slope (abs)	-0.13	0.02	-0.23	-0.13	0.02	-0.13	0.04	-0.12	-0.26
Positive/high arousal affect									
Composite^	-0.01	0.04	-0.03	-0.08	-0.23	-0.02	0.04	0.05	-0.16
Raw IIV	-0.18	-0.16	-0.16	-0.14	0.17	-0.20	-0.15	-0.09	-0.18
Modified IIV	-0.12	-0.12	-0.10	-0.06	0.19	-0.10	-0.12	-0.07	-0.08
Slope (raw)	0.08	0.10	0.03	0.10	0.01	0.11	0.11	0.13	-0.11
Slope (abs)	-0.19	-0.16	-0.18	-0.16	0.11	-0.17	-0.15	-0.11	-0.19

DISCUSSION

The current study examined associations between dispositional mindfulness (DM) and markers of stress resilience in the context of everyday life. To test whether DM is associated with self-regulatory capacity, daytime stress regulation, and stress recovery and restoration, this study incorporated objective measures of executive cognitive functioning with experience sampling reports of affect, daily life perceived executive difficulties, presleep arousal, and sleep quality. DM was examined using a multidimensional self-report measure – the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) – which allowed us to utilize facets most strongly associated with the overall mindfulness construct. Consistent with the empirically supported 2-factor model of mindfulness (i.e., Bishop et al., 2004), reliability analyses revealed three FFMQ facets representing both the *focus* and *quality* of present-moment attention (i.e., act with awareness, nonjudgment, nonreactivity).

Self-Regulatory Capacity

Contrary to predictions, self-reported DM was not associated with a performance measure of executive functioning (EF). This finding runs counter to the handful of studies reporting positive associations between DM and EF (i.e., controlled attention; Black, Semple, Pokhrel, & Grenard, 2011; Cheyne, Carriere, & Smilek, 2006; Oberle, Schonert-Reichl, Lawlor, & Thomson, 2011; Ostafin, Kassman, & Wessel, 2013). Differences in measurement instruments may explain the discrepancy in results.

Neurocognitive tests used in previous studies rely heavily on lower order cognitive processes (i.e., processing speed, working memory), rather than higher order executive processes (i.e., cognitive flexibility, problem solving, response inhibition). In addition, most studies used a unidimensional measure of DM that emphasizes mindful awareness, but not mindful acceptance. Therefore, previous findings support the notion that certain aspects of mindfulness (i.e., awareness) are associated with specific cognitive abilities (i.e., attentional control), but fail to address the broader range of features represented by both the DM and EF constructs. Consistent with previous findings, the current study – which included a multidimensional assessment of both DM and EF – found support for a link between *self-reported* EF and mindful awareness, but not mindful acceptance. Importantly, mindful awareness was associated with a broad range of daily life EF abilities, including cognitive, emotional, and behavioral self-regulation, suggesting that discrete features of mindfulness may support a broad range of regulatory functions.

There are several possible explanations for the lack of support for an association between DM and objective measures of EF. One possibility is that DM is not associated with behavioral indices of self-regulation, but instead reflects subjectively experienced self-regulation. Alternatively, it is possible that the measures used in this sample are either not sensitive enough to detect subtle differences in EF in relatively healthy young adults, or lack the ecological validity needed to capture functional differences in daily life self-regulation. Researchers interested in addressing these questions are encouraged to exercise care when selecting measurement instruments. There is currently a lack of sensitive, ecologically valid, and standardized neuropsychological tests for measuring EF in *nonclinical* populations. Similarly, experimental measures are suboptimal given their lack of normative data and heavy reliance on processing speed. Consequently, when attempting to detect subtle differences in EF in healthy young adults – especially if there are reasons to differentiate between specific executive abilities (e.g., cognitive flexibility, inhibition, attentional control, etc.) – future research may benefit from using a multimethod approach that combines standardized neuropsychological measures, experimental cognitive tests, and self-report questionnaires.

Daytime Stress Regulation

In this study, daytime stress regulation was indexed via affective stability. Affect ratings representing the affective circumplex (i.e., positive/negative valence, low/high arousal; Russell, 1980) were obtained at random intervals via electronic diary during a single day. Counter to previous research linking higher DM to greater tendencies toward positive affect (Branstrom, Duncan, & Moskowitz, 2011; Brown & Ryan, 2003; Jimenez et al., 2010) and lower tendencies toward negative affect (Barnhofer, Duggan, & Griffith, 2011; Frewen, Evans, Maraj, Dozois, & Partridge, 2008; McKee, Zvolensky, Solomon, Bernstein, & Leen-Feldner, 2007; Coffey & Hartman, 2008), self-reported DM was not signficantly associated with *average* daytime affect ratings in any of the valence/arousal quadrants. Interestingly, when variability in affect was taken into consideration, DM was primarily associated with variations in *low* arousal affect states. Within the low arousal affect ratings, patterns of variability were dissociated on the basis of valence. For dispositionally high-mindful individuals, ratings of *negatively* valenced low arousal affect (i.e., sad, lethargic, bored, depressed, distractible, fatigued) appeared to change less dramatically over the course of the day, whereas ratings of *positively* valenced low arousal affect (i.e., relaxed, calm, serene, contented, happy) were less variable throughout the day after removing the effect of time.

Examination of DM domains revealed that associations with low arousal affect ratings were primarily driven by mindful *acceptance*. Consistent with theoretical models of mindfulness, individuals reporting higher DM were more consistently calm and relaxed over the course of the day. Greater mindful acceptance was also associated with less dramatic change in all types of *negative* affect, including high arousal ratings (i.e., stressed, tense, angry, worried, upset, nervous). Based on research linking stability in negative affect to overall emotional stability and risk for mood disorders (e.g., Bagge et al., 2004; Kuppens, Mechelen, Nezlek, Dossche, & Timmermans 2007; Russell, Moskowitz, Zuroff, Sookman, & Paris, 2007), higher levels of mindful acceptance may promote emotional stability by protecting against dramatic shifts in negative affect over the course of the day. This also suggests, however, that initial levels of negative affect are less likely to change over the course of the day. While this may be protective for individuals with lower starting levels of negative affect, maintenance of higher starting levels of negative affect throughout the day could be disadvantageous. Future research may benefit from examining the association between initial affect levels, rates of affect change throughout the day, and end of day outcomes (i.e., presleep arousal, sleep quality).

Nighttime Stress Recovery and Restoration

Consistent with predictions, higher self-reported DM was associated with lower reported presleep arousal and higher reported waking sleep quality. Although global levels of presleep arousal were associated with both mindful awareness and mindful acceptance, cognitive presleep arousal was only associated with mindful *awareness*.

Importantly, mindful awareness refers to the ability to maintain present-moment attention, whereas cognitive presleep arousal is associated with tendencies to focus negative and unproductive attention on events from the past (i.e., rumination) and the future (i.e., worry) (Harvey, 2000, 2002). Thus, the general ability to focus attention on the present moment could protect against nighttime perseverative cognitions (see, e.g., Brosschot, Gerin, & Thayer, 2006; Brosschot, Pieper, & Thayer, 2005) that may lead to diminished sleep quality. Interestingly, both mindful awareness and cognitive presleep arousal predicted waking sleep quality, suggesting that the ability to stay in the present moment may promote stress restoration by facilitating stress recovery.

Models of Stress Resilience in Daily Life

A unified model of dispositional mindfulness (DM) and stress regulation can be directly informed by existing theory, including the Mindful Coping Model (MCM; Garland, Gaylord, & Park, 2009; Garland et al., 2011). Grounded in stress appraisal theory (Lazarus & Folkman, 1984), the MCM acknowledges that stressful events and negative stress appraisals are ubiquitous and unavoidable in daily life. The MCM further asserts that the stress response, once elicited, can be de-escalated and redirected via *reappraisal* processes, which involve reinterpreting contextual cues and meaning in a way that changes the trajectory of the initial response. Numerous studies have demonstrated beneficial effects of cognitive reappraisal, including reduced psychological and physiological responses to stress (e.g., Bower et al., 2008; Helgeson et al., 2006; Mauss, Cook, Cheng, & Gross, 2007). Importantly, rather than attempting to control or alter an emotional response, which can prolong or exacerbate psychological and physiological distress (Beevers, Wenzlaff, & Hayes, 1999; Gird & Zettle, 2009; Gross &

Levenson, 1997; Tull & Gratz, 2008), reappraisal involves re-examining one's relationship to events, beliefs, and emotions.

According to the MCM, the primary mechanism underlying positive reappraisal processes is mindful *decentering*. Described as a "transitory metacognitive state" characterized by broadened awareness and cognitive flexibility (Garland et al., 2011, p. 60), mindful decentering allows the individual to disengage from initial stress appraisals, consider a broader range of interpretations, reappraise stressors (i.e., benign, valuable, beneficial), and experience reduced stress and positive affect. Over time, the 'active ingredients' of the MCM – mindful decentering and positive reappraisal – are believed to promote an upward positive spiral that is reciprocal, self-perpetuating, and protective (Garland, Gaylord, Boettiger, & Howard, 2010; Garland et al., 2011).

Consistent with MCM theory, DM is associated with self-reported positive reappraisal tendencies across multiple samples (i.e., healthy adults, contemplative practitioners, college students, chronic pain outpatients, alcohol-dependent inpatients), even when controlling for related factors such as psychological well-being, positive affect, and positive refocusing (Hanley & Garland, 2014). Furthermore, DM is associated with cognitive abilities believed to be necessary precursors to reappraisal, including *decentering* (Coffey & Hartman, 2008; Hayes-Skelton & Graham, 2012; Pearson, Brown, Bravo, & Mitkiewitz, 2014) and *cognitive flexibility* (Anicha et al., 2012). In other words, broadened awareness afforded by mindful decentering may allow for less reactive and more flexible processing of information and facilitation of (low arousal) positive affective states.

Additional support for the link between mindfulness, reappraisal, and stress regulation is found in neuroimaging studies. Cognitive reappraisal is associated with increased activation in brain regions associated with reasoning and problem solving (i.e., dorsolateral PFC) and self-monitoring (i.e., mPFC, anterior cingulate cortex) (Levesque et al., 2003; Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner, Ray et al., 2004) and decreased activation of the amygdala (Ochsner et al., 2002; Ochsner, Ray eta l. 2004; Schaefer et al., 2002). Similar patterns of activation have been found with individuals reporting high DM (Modinos et al., 2010). These findings are consistent with a larger corpus of research linking PFC-amygdala circuitry to stress regulation (Davidson, Putnam, & Larson, 2000; Oschsner & Gross, 2005), suggesting that mindfulness and reappraisal processes work concomitantly to down-regulate the stress response.

Over time, frequent engagement of mindful decentering and reappraisal processes may alter the trajectory of the stress response altogether. Just as negative emotional states promote maladaptive stress appraisals via reduced tonic inhibition of the PFC-amygdala circuitry (McEwen, 2003b), positive emotional states can produce lasting neurobiological changes that perpetuate more adaptive stress appraisals (see E. L. Garland & Howard, 2009 for a review), perhaps by directly enhancing thought-action repertoires (i.e., broaden-and-build theory: Fredrickson, 2001). In other words, a predisposition toward low arousal positive affect, thought to characterize high-DM individuals (e.g., Branstrom et al., 2011; Brown & Ryan, 2003; Jimenez et al., 2010), may result from a combination of controlled and flexible processes that simultaneously serve as a buffer against negative stress appraisals (Tugade & Fredrickson, 2004; Tugade, Fredrickson, & Barrett, 2004) and the corresponding stress response.

Future Directions

Additional research is needed to replicate current findings and support existing theoretical models of mindfulness. To that end, several strengths and limitations of the present study can be used to inform directions for future research. The main strengths of the current study lie in the methodological approach to examining DM and daily life variability in affect. Consistent with mindfulness theory (Bishop et al., 2004) and related empirical findings (e.g., Brown & Ryan, 2003; Cardaciotto et al., 2008; Evans & Segerstrom, 2011; Kohls et al., 2009; Lau et al., 2006), this study examined a 2-factor model of dispositional mindfulness by identifying subscales from the FFMQ that yielded the highest statistical reliability and theoretical congruence with the mindfulness construct. The current study also employed experience sampling methodology to measure affect at multiple times throughout the day, presleep arousal prior to falling asleep, and subjective sleep quality upon waking. The increased reliability and validity of experience sampling methods compared to retrospective reports (i.e., Csikszentmihalyi & Larson, 1987; Reis & Gable, 2000; Scollon, Prieto, & Diener, 2009) lends additional weight to the current findings. Further, since we were particularly interested in affective stability, a strength of the present study was the use of affect ratings that comprehensively represented the affective circumplex. By parsing affect by valence and arousal, we were able to more closely understand nuanced relationships linking mindfulness to emotion regulation patterns in daily life. This approach also yielded important insights about the nature of affect in dispositionally high-mindful individuals, and future research should consider using similarly fine-grained approaches to understand associations between affect and dispositional style.

Despite the numerous methodological strengths of the current study, several weaknesses will need to be addressed in future research. First, although our approach to operationalizing DM was theoretically and empirically informed, additional research is needed to examine the validity and reliability of this relatively novel approach. Second, this study relied on a modestly sized, homogenous sample. Additional research is needed to determine whether the current findings can be generalized to more diverse groups on the basis of age, race, ethnicity, education, and culture. Further, given the established relationship between intelligence and executive functioning, future research should measure and control for general intelligence before interpreting findings. Additional related constructs should also be considered. For example, participants high or low in emotional intelligence may have very different profiles of affect ratings independent of self-reported levels of dispositional mindfulness. Alternatively, participants familiar with mindfulness – either through popular culture exposure or mindful behaviors, such as meditation or yoga – may have different response patterns. In addition to controlling for possible confounds, future research should obtain daily assessments for longer periods of time, consider dynamic associations between waking affect and affective trajectories, and examine lagged effects over time.

Conclusions

Results from the current study provide support for a 2-factor model of dispositional mindfulness consisting of both mindful awareness and mindful acceptance. Mindful *awareness* was associated with measures of self-regulation (i.e., reported cognitive, emotional, and behavioral regulation in daily life), stress recovery (i.e., cognitive presleep arousal), and stress restoration (i.e., waking sleep quality). In contrast, mindful *acceptance* was associated with markers of affective stability, with greater acceptance predicting less extreme changes in negatively valenced affect, greater stability across low arousal affect, and less variability in positively valenced/low arousal affect. These results suggest that DM may protect against stress and promote healthy, adaptive functioning via distinct yet complementary processes. In addition, these results support current models of mindfulness (e.g., Mindful Coping Model; Garland et al., 2011) emphasizing both the *focus* of attention (i.e., present-moment, broadband) and the *quality* of attention (i.e., acceptance, positive appraisal). Future research is needed to better understand dynamic processes linking DM to momentary stress regulation in daily life.

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