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Does dispositional mindfulness predict perceived stress in daily life?

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Abstract

Chronic stress in the mind-body system leads to frequent activation of the hypothalamic-pituitary-adrenal and sympathetic-adreno-medullar axes, creating excessive inflammation. This in turn increases a person's vulnerability for a host of conditions that take root in the "common soil" of inflammation including anxiety disorders, cardiovascular diseases, neurodegenerative diseases, major depressive disorder, obesity, asthma, and even the common cold. Mindful awareness, a purposeful, present moment awareness that is non-judgmental, likely serves as a protective factor against perceived stress. According to the mindfulness-to-meaning theory, open attention and awareness, a component of mindfulness, allows a person to dis-identify from a difficult situation and flexibly reappraise the event, interrupting default schemas to interpret the potential stressor within a fuller context. Previous studies have found a negative relationship between open attention and awareness and perceived stress. However, yet to be thoroughly tested is the theory that open attention and awareness can prospectively predict lower perceived stress in natural settings. The current study examined a sample of 73 undergraduate students using a daily diary design to better understand and predict perceived stress in response to difficult events. Participants completed a baseline survey capturing their demographics, levels of open attention and awareness, self-compassion, and neuroticism. Then, participants completed one week of daily surveys in which they indicated their levels of perceived stress and the number of difficult events they experienced that day. Regression analysis showed that open attention and awareness negatively predicted average perceived stress prospectively over the course of the week, even controlling for neuroticism. Using a multilevel modeling approach, several

significant between- and within-subject variables were shown to predict daily fluctuations in perceived stress. The number of difficult events that a participant reported, relative to their own average, was a positive predictor of perceived stress. Open attention and awareness negatively predicted daily fluctuations in perceived stress, controlling for the effects of time, number of difficult events, and neuroticism. To test the theory that open attention and awareness may protect against the impact of difficult events in daily life on perceived stress, the interaction between open attention and awareness and daily difficult events was tested but proved non-significant. Visual analysis showed modest support for the moderation hypothesis. Finally, to better understand the relationship between open attention and awareness and perceived stress, self-compassion was tested as a possible mediator, this also proved non-significant. Results add to the mounting evidence that open attention and awareness is a significant predictor of perceived stress, including in natural settings and with a prospective time course. Findings presented here support the use of interventions that increase open attention and awareness, such as MBSR and MBCT, in clinical settings to lower perceived stress. Other healthcare professionals who are concerned about a patient's stress-related health conditions, or physical conditions that are adversely impacted by stress, should consider administering measures of open attention and awareness and referring those with lower scores to mindfulness-based interventions including MBSR.

Dedication

I dedicate this work to Laura Szoke,

my family, my friends, and my teachers.

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Does dispositional mindfulness predict perceived stress in daily life?

A full coffee spilled onto a shiny new laptop, a fender bender on the way to work, a loved one receives difficult news at the doctor's office - a day in the life of a human being. In 2019, the American Psychological Association asked a group of over three thousand adults across the U.S. to rate both what they believed to be a "healthy stress level" and their own current level of stress. As in years past, Americans rated their level of perceived stress as higher than where they believe a healthy level falls (American Psychological Association, 2019). Stress occurs when an individual is forced to adapt to an ever-changing landscape of both internal and external stimuli (Selye, 1976). Continuous exposure to stress has been linked to increased risk for cardiovascular disease, anxiety and mood disorders, as well as decreased functioning of the immune system (Schneiderman, Ironson, & Siegel, 2005).

Mindfulness, a purposeful, non-judgmental awareness of the present moment, is the center piece of one of the most empirically supported stress-reduction programs, Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 2013). Indeed, those who participate in MBSR consistently report lower levels of stress, exhibited a reduced post-stress inflammatory response, and had better overall physical and mental health (Grossman, Niemann, Schmidt, & Walach, 2004; Khoury, Sharma, Rush, & Fournier, 2015; Rosenkranz, et al., 2013). Each individual has a unique, naturally occurring, dispositional level of mindful awareness, regardless of their experience with meditation practice or formal training such as MBSR. However, the question of whether a person's dispositional level of mindfulness impacts their perceived stress in natural settings has yet to be thoroughly explored. The current study describes an ecologically valid way to test

the hypothesis that baseline dispositional mindfulness will predict lower perceived stress in response to a naturally occurring stressors throughout the span of one week.

Stress in the Mind-Body System

Despite each individual's best efforts to create permanence, predictability, and control in their life, an impermanent world demands constant adaptation. Hans Selye (1950) referred to this process of reacting to nocuous agents as General Adaptation Syndrome; the efforts of a organism to adapt itself to new conditions. Three stages were elucidated: 1. An alarm phase in which the organism becomes aware of a threat and mobilizes resources, 2. a resistance stage in which the organism fights against the invasive agent, eventually leading to, 3. exhaustion (Selye, 1950). The term stressor is used to encompass the infinite list of agents that force an organism to adapt (Selye, 1976).

Adaptation to a change in the environment implies a baseline from which the change occurs. Cannon (1932) termed this baseline level homeostasis. Allostasis is an active process of reestablishing or maintaining homeostasis in the face of a changing internal and/or external environment, what Selye referred to as stress. When a person steps into the crosswalk and realizes that an approaching car is failing to slow down, they experience elevated heart rate, a rush of cortisol, and perform a behavioral response: leaping back to safety. Allostasis is the process that allowed for the continuation of essential, life maintaining physiology in spite of oncoming traffic (McEwen & Gianaros, 2011). Allostatic overload occurs when an organism's level of energy is weaker than the amount needed to maintain essential physiological functioning. Allostatic overload often results from an accruement of allostatic load, or the sum of multiple efforts to re-establish

or maintain homeostasis. When an individual is unable to adapt to allostatic overload, wear and tear occurs on the body, which in the long run causes physiological breakdown.

While Selye, trained in organic chemistry and medicine, studied biological noxious agents and the biological response in a reported 15,000 laboratory animals, Lazarus and Folkman (1984) expanded the understanding of stress to human psychology, describing what they referred to as psychological stress. They stated, "psychological stress is a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being," (p.19). The key here in defining psychological stress is that it is caused by a person's appraisal of the situation. A person's judgement determines whether something is psychologically stressful, rather than the characteristics of the stressor itself. Two individuals can experience the exact same event, say a performance review at work with multiple pages of constructive feedback, and have entirely different appraisals of the stressor. One may see the constructive feedback as helpful, and eagerly begin applying the suggestions, saying, "it is a lot to change, but I am up for the task." Another may see that their position at the company is in danger and begin thinking, "I am probably going to lose my job."

Whether a stressor begins in a part of the physical body, for example an abrasion from a sharp object, or starts as a thought, such as thinking about failing at work, the mind-body system responds by activating the sympathetic nervous system (SNS) in an attempt to respond to the stressor. These attempts to re-establish homeostasis function without causing harm in the short run, but the build-up from countless adaptations over many years causes undue harm to the mind-body system (McEwen, 1998; Selye, 1950).

Chronic physiological responding to stress via allostatic load involves chronic activation of the SNS. Two systems are involved in stress reactivity, the hypothalamic-pituitary-adrenocortical axis (HPA) and the sympathetic-adrenal-medullary (SAM) axis, both of which create inflammation in the body to respond to changes, real or perceived, in the internal and external environment (Cohen, Janicki-Deverts, & Miller, 2007).

High levels of perceived stress lead to frequent activation of the HPA and SAM axes, creating excessive inflammation and increasing a person's vulnerability for a host of conditions that take root in the "common soil" of inflammation including type 2 diabetes, anxiety disorders, cardiovascular diseases, neurodegenerative diseases, major depressive disorder, obesity, cancer, asthma, and the common cold (Dowlati et al., 2010; Ye, Baldwin, & Hou, 2021; Scrivo, Vasile, Bartosiewicz, & Valesini, 2011). Across multiple studies, stress has been linked to poorer health in the mind-body system (Black & Garbutt, 2002; Dimsdale, 2008; Faravelli & Pallanti, 1989; Hughes, et al. 2017; McEwen, 1998; Miller, Chen, & Cole, 2009; Rozanski, Blumenthal, & Kaplan, 1999). Additionally, stress can result in negative health behaviors such as poor nutritional habits, smoking, and low physical activity, which in turn cause health problems (Clark et al., 2016). Stress reactivity causes activation of the immune system response even when there is no biological threat present, leaving the immune system suppressed when a real threat enters the body (Cohen, Janicki-Deverts, & Miller, 2007; Cohen, Tyrrell, & Smith, 1991).

Highly stressful events in childhood and adolescence such as abuse or neglect, termed adverse childhood experiences, have also been linked to a greater number of health problems and greater premature mortality (Hughes, et al. 2017). Consistent

findings also support the positive association between stressful life events and the onset of major depressive disorder (MDD) and anxiety disorders (Faravelli & Pallanti, 1989; Finlay-Jones & Brown, 1981; Kendler, Karkowski, & Prescott, 1999). Kendler and colleagues (1999) assessed for the occurrence of stressful life events and the onset of depression in over 1,500 individuals every month for 15 months, resulting in 24,648 observations. Results showed that experiencing a stressful life event, such as going through serious financial problems, substantially increased the risk of onset for a depressive episode. Post (1992) presented the kindling hypothesis, claiming that first episodes of depression are more likely to be preceded by psychological stressors than subsequent episodes. This hypothesis was supported across 13 studies in meta-analysis of the relationship between stressors and first onset unipolar depression (Stroud, Davila, & Moyer, 2008). Previous studies have also linked stressful life events to the onset of panic disorder (Faravelli & Pallanti, 1989). Finlay-Jones and Brown (2009) found that stressful events related to loss tended to predict depressive onset, while stressful events related to danger were closer tied to the onset of anxiety disorders.

Stress in Development

While perceived stress occurs throughout an individual's lifespan, one unique period of stress occurs during emerging adulthood, usually described as occurring from ages 18-25. Jeffery Arnett (2000) posited that emerging adulthood is distinguished from other periods in life by the sudden independence and freedom to explore different directions. Arnett described this period as critical in the formation of one's life direction and identity. Some experiences unique to this developmental window include more intimate and serious explorations of dating, educational decisions, work, and an

individual worldview. Each exploration can lead to suffering, for example, experiencing rejection in the search for a romantic partner, or the discomfort accompanied by the rejection of a worldview acquired in childhood. Further, emerging adults spend more time alone than any other age group, with the exception of senior citizens, and more time focused on school and work than any other group under 40 (Arnett, 2000; Larson, 1990). In the most recent American College Health Association National College Health Assessment which included 96,489 students, 53% scored positive for loneliness and 80% of the student sample rated their stress in the moderate to high range (American College Health Association, 2021).

This period of high stress and long, lonely hours spent working ultimately results in habits that individuals carry with them for the rest of their lives. These foundational years of independence coincide with the neurobiological development that leads to the ability to self-regulate, including the ability to practice health-promoting behaviors (Casey, Getz, & Galvan, 2008; Sirois, 2015). Reducing risk factors for poor health-behaviors in this age group will allow for better health behaviors to take root, potentially leading to better health outcomes throughout the rest of the developmental lifespan.

Mindfulness and Stress

Jon Kabat-Zinn (2013), creator of MBSR, described a distinction between two categories of response stereotypies, what he termed "reacting to stress" and "responding to stress." Reacting to stress is the habitual process of experiencing heightened arousal and attempting to cope with the arousal, often by engaging in health damaging behaviors such as overworking, social isolation, and substance use that actually led to greater vulnerability to stressors and eventually a breakdown of the mind-body system. Kabat-

Zinn considers "responding to stress" an alternative option to a person's unhealthy response stereotypy in which a person becomes aware that they have made contact with a stressor and that they are experiencing arousal related to the contact. He explained that holding the physiological arousal in awareness in the absence of judgement allows a person to notice the full context of the situation, use either emotions-focused or problem-focused regulation strategies, and ultimately return to equilibrium more efficiently than the maladaptive coping strategies described above.

In response to a psychological stressor, a person is able to use mindful awareness to notice automatic reactivity, such as an elevated heart rate, sweaty palms, and possibly even initial appraisals such as "I am probably going to lose my job." Holding these reactions with mindful awareness means observing them as they arise and pass away, without fully believing the thoughts. With mindfulness, a person is able to notice that their heart rate has increased, but also notices how it begins to decrease and perhaps increase again, noticing fluctuations as a curious first-person observer rather than a neurotic mind engulfed and driven by the experience. The person takes in the situation as a whole, using a problem-focused regulation strategy such as coming up with ways to implement the constructive feedback that they received from their boss into their current project. In contrast, without training in mindfulness, that same person may be out having a cigarette after receiving similarly detailed feedback had they not brought mindful awareness to the situation.

Mindful awareness does not necessarily reduce the occurrence of difficult circumstances, rather it allows a person to change their relationship with the stressor, allowing for coping which buffers the impact of the stressors on their overall level of

perceived stress. Without training in mindfulness, each difficult event that a person experiences is likely to lead to greater overall perceived stress. With training in mindfulness, an individual is able to be less reactive to stressors, meaning that the number of difficult events that a person experiences is less likely to lead to higher perceived stress.

Benefits of Cultivated Mindfulness

The practice of mindfulness meditation has achieved robust empirical support in the reduction of negative states, as well as increases in positive states and health (Goleman & Davidson, 2005; Greeson, 2008; Schreiner & Malcolm, 2008). Benefits of meditation that are supported by research include the following: decreased depression, anxiety, stress, anger, worry, psychological distress, and rumination, as well as increases in well-being and attentional processes in the brain (Baer, 2003; Carmody & Baer, 2008; Brown, Ryan, & Creswell, 2007; Greeson, 2008; Grossman, Niemann, Schmidt, & Walach, 2004; Jha, Krompinger, & Baime, 2007; Jain et al., 2007; Tang et al., 2007).

In their book *Altered Traits: Science Reveals How Meditation Changes Your Mind, Brain, and Body*, Goleman and Davidson wrote that the pleasant states, and reduction in unpleasant states, encountered through the practice of meditation can result in lasting changes in the traits of the practitioner. The title of their work refers to new dispositions that surface through the practice of meditation; these altered traits can also be found in the brain images of practitioners of mindfulness meditation (Tang, Holzel, & Posner, 2015). Goleman and Davidson claimed that their theory represents a paradigm shift for the field of psychology, where traits have been long thought of as stable patterns of being. Several of these cultivated dispositions reviewed in their work include

selflessness, impartial compassion, equanimity, a compassionate presence, and the trait of mindfulness itself.

Mindfulness Based Stress Reduction. Ahead of the abundance of empirical studies concerning meditation, Jon Kabat-Zinn's theory of mindfulness and meditation provided support for the creation of his stress reduction intervention, Mindfulness-Based Stress Reduction (MBSR), an 8-week group intervention originally designed for suffers of chronic pain or illness (Kabat-Zinn, 2013). Kabat-Zinn ran his first stress reduction groups at a hospital affiliated with the University of Massachusetts Medical School. After seeing the results in the patients that they were treating, doctors, nurses, and other medical staff became interested in the effects of the program. A recent meta-analysis confirms what those doctors and nurses observed over 30 years ago: MBSR reduces stress, improves psychological health, and builds empathy for health care providers (Lamothe, Rondeau, Malboeuf-Hurtubise, Duval, & Sultan, 2016). Reviews of randomized control trials (RCTs) of regular participants in MBSR confirm that the program significantly improves mental health, with a medium effect size (d = 0.54), and significantly improves physical health for participants with a medium effect size (d=0.53; Grossman, Niemann, Schmidt, & Walach, 2004). Reviews also show that MBSR indeed reduces perceived stress in healthy individuals compared to waitlist conditions across seven RCTs (Chiesa & Serretti, 2009).

Further, MBSR has been compared to an active control intervention designed for the purposes of testing the unique effects of MBSR. Compared to the matched 8-week "Health Enhancement Program" (HEP), participants in the MBSR reported greater reductions in the pain they experienced during a thermal pain stimulus task (MacCoon et

al., 2012). Additionally, while both MBSR and HEP participants experienced similar levels of stress-evoked cortisol responses, those in the MBSR group had significantly smaller inflammatory responses compared to those in the HEP group (Rosenkranz et al., 2013). These findings lend support to the theory that mindfulness, as cultivated by practice and formal training, is an essential tool in the reduction of stress and has unique effects on physiological responses to stress.

Dispositional Mindfulness and Stress

While those with training in the area of mindfulness and stress reduction reported lower levels of stress, researchers have turned their attention to the question of whether those without formal training or even informal experiences with mindfulness meditation reap similar benefits from a naturally occurring level of mindfulness, or dispositional mindfulness. In an attempt to establish a well-validated measure of mindfulness, Brown and Ryan (2003) created and tested the Mindful attention Awareness Scale (MAAS) which is, "focused on the presence or absence of attention to and awareness of what is occurring in the present moment…foundational to mindfulness" (p. 824). Researchers found that the MAAS was able to distinguish between meditation-naive individuals and students of Zen who practiced being attentive and aware of the present moment. MAAS scores also increased in a group of participants after attending MBSR and were positively correlated with several measures of well-being.

Bilevicius, Smith, and Kornelsen (2018) explored the relationship between MAAS scores and functional connectivity patterns in the resting-state network of the brain. The MAAS predicted differences in the functional connectivity in all four areas that researchers examined, namely the default mode network (DMN), the salience

network (SN), and the left and right central executive network (lCEN and rCEN). MAAS scores were negatively correlated with functional connectivity in key nodes of the DMN, an area that has been linked to mind wandering. In the SN, MAAS scores were positively correlated with functional connectivity in the area related to attentional control, replicating a finding concerning changes in the brain that occur through the practice of meditation (Tang et al., 2007). In both the lCen and rCen, the MAAS was positively correlated to connectivity in the middle frontal gyrus, an area related reorienting of attention. In sum, these neuroscientific findings support the validity of the MAAS, showing positive relationships in the areas of the brain related to attentional control and the reorienting of attention, and a negative relationship with mind wandering.

Studies in laboratory settings confirm that dispositional mindfulness, as measured by the MAAS, is related to lower physiological stress reactivity during and after stressful tasks (Brown, Weinstein, & Creswell, 2012; Kadziolka, Di Pierdomenico, & Miller, 2016). Kadziolka, Di Pierdomenico, and Miller (2016) administered the MAAS before having participants vividly describe a personal example of a stressful event. While undergoing the recall of a stressful event, participants' heart rate variability (HRV) was measured using an electrocardiogram (ECG) and their skin conductance response (SCR) was measured using galvanic skin response finger electrodes. Participants with higher MAAS scores showed lower sympathetic nervous system activation, as measured by their SCR, and greater parasympathetic nervous system responding, as measured by their HRV and their return to a neutral state. Brown and colleagues (2012) also found that higher MAAS scores have a buffering effect against stress as measured by cortisol and affective

responding following participation in the Trier Social Stress Test, a laboratory protocol involving several stress inducing tasks.

Dispositional mindfulness and neuroticism. Weinstein, Brown, and Ryan (2009) found that MAAS scores prospectively predicted a person's perceived level of stress on the Perceived Stress Scale one month later. This was true even after controlling for neuroticism, a personality trait related to the tendency to experience emotional instability. Robert McCrae, co-creator of the Big Five Personality Inventory, described that because neuroticism is closely related to an individual's tendency to perceive events as stressful, it is necessary to control for neuroticism in the measurement of perceived stress (McCrae, 1990). The finding that dispositional mindfulness predicted an individual's level of perceived stress one month later over and above the predictive ability of neuroticism provides strong evidence that dispositional mindfulness is an important factor in describing unique variance in an individual's overall level of perceived stress.

Neuroticism has been found to be positively associated with over-identification, or the tendency to, "become carried away with, wrapped up in, (or) completely absorbed by their own feelings" (Neff, 2003, p.88; Neff, Tóth-Király, & Colosimo, 2018). Neff (2003) conceptualized over-identification as the antithesis of mindful awareness in relation to one's own emotional experiences. Over-identification has been found to lead to a downward spiral of more negative experiences across multiple studies and levels of analysis (Kross & Ayduk, 2011).

Beyond the negative implications for neuroticism, those with higher dispositional mindfulness are less likely to over-identify with each experience. One who is dis-

identified from their thoughts and emotions experiences a liberation of awareness from

typical schemas about the self, the world, and others. This decentering and dis-

identification with negative experiences triggers what Garland and colleagues (2014)

termed an "upward spiral" of emotion regulation. The upward spiral is derived from the

mindfulness-to-meaning theory, which posits that engaging mindful awareness allows for

decentering and therefore greater flexibility in cognitive appraisal and reappraisal of

situations, such that default schemas are interrupted and stimuli can be re-interpreted with

acknowledgement of the full context in which the stimulus occurred (Garland, Farb,

Goldin, & Fredrickson, 2015). In sum, those with lower neuroticism may be less likely to

interpret events as stressful in part due to a lesser identification with the difficult

stimulus; engaging mindful awareness may predict an even further reduction in perceived

stress as it allows for decentering and activates dis-identification resulting in a positive

spiral of emotion regulation. Controlling for neuroticism in statistical analyses will lead

to a greater understanding of the unique role of dispositional mindfulness in the reduction

of perceived stress.

Open Attention and Awareness and Daily Stress

Outside of laboratory settings, Weinstein, Brown, & Ryan (2009) also confirmed

a negative relationship between open attention and awareness and daily perceived levels

of stress. Daily measures bring an advantage to the study of stress; they allow researchers

to capture real, *in vivo*, experiences of stress and stress reactivity without depending on a

potentially biased retrospective self-report. Additionally, daily monitoring studies allow

researchers to observe participants ideographically as they react to meaningful, authentic

life stressors which maximizes ecological validity (Bolger, Davis, & Rafaeli, 2003).

While laboratory tasks are designed elicit psychological and physiological stress responses from the broadest group of people who may participate in a study, real difficult events in life act as naturally occurring "stress tasks" that are, by definition, perfectly capable of evoking stress in the participant. This approach also allows participants themselves to report what they perceive as a difficult or stressful event, which reflects Lazarus and Folkman's (1984) conceptualization of psychological stress.

Daily stress measures also help distinguish between participants who may have the same average level of perceived stress, but with differing daily experiences of perceived stress. For example, assessing for an overall average perceived stress level over the span of one week would mean that an individual who experiences a moderate level of perceived stress every day would be indistinguishable from an individual who experiences extremely low stress for four days and extremely high stress for three days. Daily measures of perceived stress provide researchers with the precision to test whether dispositional traits, such as dispositional mindfulness, predict daily fluctuations in perceived stress (Bolger & Zuckerman, 1995).

Weinstein, Brown, and Ryan (2009) collected data from a sample of 70 participants who reported their demographic information and completed the MAAS upon enrolling in the study. Following baseline measures, participants received notifications at three random times throughout the day concerning their state level of mindfulness, conceptualized as momentary fluctuations in open attention and awareness and measured by a five-item version of the MAAS. At the end of the day, participants were asked to report on the most stressful event they experienced each day and then to rate how stressful the event was on a 1-7 scale, as well as their overall level of stress on a 1-7

scale. The question asking participants to name the most stressful event experienced assumed that at least one stressful event occurred each day, without assessing for the number of stressful events experienced. Kabat-Zinn's (2013) theory rests on the idea that difficult events happen, regardless of one's level of dispositional mindfulness. According to Kabat-Zinn, a person who has cultivated mindfulness through practice responds adaptively to difficult events, leading in turn to lower overall perceived stress. Therefore, capturing the relationship between number of difficult events and level of perceived stress is essential to testing whether Kabat-Zinn's theory extends to dispositional mindfulness, as conceptualized by the MAAS. A study is needed first to determine whether the daily number of difficult events experienced is linked to daily perceived stress, and to test whether MAAS scores moderate that relationship.

Weinstein and colleagues (2009) found that MAAS scores predicted intra-individual fluctuations in perceived stress, such that those with a higher MAAS score at baseline reported lower daily perceived stress, both when asked about stress in response their identified "most stressful event" and their overall level of stress with beta weights of -0.34 and -0.29, respectively. However, one limitation to these findings is that participants responded to single item, unvalidated questions about their level of perceived stress. While researchers likely avoided participant burnout by using single item questions instead of psychometrically validated measures of perceived stress, their decision strongly limits the conclusions that can be drawn from this study. Researchers who have explored the relationship between mindful awareness and perceived stress, including studies of MBSR outcomes, tend to use the Perceived Stress Scale (PSS), which has strong empirical support in the measurement of perceived stress (Cohen,

Kamarck, & Mermelstein, 1983; Lee, 2012). Additionally, this study did not control for the predictive ability of neuroticism, which is closely tied to an individual's tendency to perceive events as stressful (McCrae, 1990). Weinstein and colleagues' study provides cursory evidence for the conclusion that depositional mindfulness buffers against daily perceived stress. Yet, further research is needed to build on these findings, using both an empirically validated measure of perceived stress, controlling for neuroticism, and capturing the number of stressful events experienced.

Self-Compassion

While researchers have explored the negative relationship between mindful awareness and stress, missing is an explanation of why the negative association between the two exists. The relational component of mindfulness may help to answer this mediation question. In his book, *The Wise Heart: A Guide to the Universal Teachings of Buddhist Psychology,* author Jack Kornfield emphasizes the inseparability of mindfulness and a way of relating to all beings and experiences with openness and compassion (Kornfield, 2009). Kindness is a necessary element to understand what the Buddha meant when he spoke of *sati*, the Pali word that is translated in English as "mindfulness." As Kabat-Zinn (2013) points out, in most Asian languages, the words for "heart" and "mind" are actually the same. He wrote, "So if you are not hearing or feeling the word heartfulness when you encounter or use the word mindfulness, you are in all likelihood missing its essence" (p. xxxv). The ways in which compassion is related to mindfulness and the stress process is yet to be thoroughly investigated.

When it comes to responding internally to stressful life events, the way in which one relates to oneself is highly relevant. Kindness towards oneself has been

conceptualized as self-compassion (Neff, 2003). Self-compassion is a practice from Buddhist traditions that has been integrated into mindfulness trainings including Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT). Kristen Neff (2003) described self-compassion as three interacting parts of a whole. The first piece is self-kindness which involves providing oneself with benevolence and goodwill, especially in response to mistakes and parts of one's personality that are displeasing. Self-kindness stands in contrast to self-judgement, or the tendency to be disapproving, judgmental, and intolerant towards one's mistakes and difficult personality features. The second piece is known as common humanity which is the recognition that all humans experience suffering; no one person is alone in their experience of pain. Common humanity is the opposite of what Neff describes as isolation, or the tendency to believe that others are happier and rarely fail. The final piece of self-compassion is a mindful relationship to experiences of suffering. A mindful relationship is one in which painful experiences are neither avoided nor over-indulged; simply recognized as part of the present moment. Mindfulness stands opposite to over-identification or fixating and becoming consumed by emotional experiences (Neff, 2003).

In her seminal paper, Neff (2003) describes the important distinction between mindfulness, on its own, and self-compassion. Neff states that mindful awareness is a necessary precursor for a person to then approach difficult emotions with "kindness, understanding and a sense of shared humanity" (Neff, 2003, p. 92). In this way, she described self-compassion as an emotions-focused regulation strategy in which a person can transform their experiences of negative emotions to a more positive feeling state. First, mindful awareness of a difficult situation allows a person to see clearly what is in

front of them. Then, self-compassion allows the person to respond to their own suffering with kindness. While previous studies have shown that greater open attention and awareness of difficult events leads to lower reported stress, an attitude of self-kindness may explain how mindful awareness leads to a lower perception of stress.

Self-compassion has been found to have a moderate, positive relationship with mindful awareness in both meditators and non-meditators (Baer, Lykins, & Peters, 2012). To date, no daily monitoring studies have explored the relationship between dispositional mindfulness, self-compassion, and perceived stress. If there is a true, negative effect of mindful awareness on perceived stress, a study is needed to determine whether that negative association is partially mediated by self-compassion.

Current Study

The current study aimed to answer five questions. First, does a person's level of open attention and awareness prospectively predict average levels of perceived stress across the span of one week, even when controlling for neuroticism? Second, when stressful events occur, do people report higher perceived stress? Third, does open attention and awareness predict daily fluctuations in perceived stress, even when controlling for neuroticism? Fourth, does open attention and awareness moderate the relationship between stressful events and perceived stress? Fifth, does self-compassion partially mediate the relationship between open attention and awareness and average perceived stress? The hypotheses for the current study are as follow:

1. Those with higher levels of open attention and awareness will experience less perceived stress over the span of one week than those with lower levels of

open attention and awareness, even when controlling for the predictive ability of neuroticism.

2. People will rate their perceived stress as higher on days in which they report experiencing a greater number of difficult events.

3. Open attention and awareness will significantly predict daily fluctuations in perceived stress, even when controlling for neuroticism, such that higher open attention and awareness will be related to lower daily reports of perceived stress.

4. The relationship between the number of difficult events experienced and perceived stress, controlling for neuroticism, will be moderated by open attention and awareness.

5. The relationship between open attention and awareness and average perceived stress, controlling for neuroticism, will be partially mediated by self-compassion.

In order to answer these research questions with maximum ecological validity, a daily diary study was conducted. After enrolling in the study and consenting to participate, participants reported on their level of self-compassion and open attention and awareness as well as their level of neuroticism, age, gender, and socioeconomic status. Participant then received instructions from trained research assistants concerning the monitoring portion of the study. During the daily diary monitoring portion of the study, participants reported how many difficult events they experienced in the since their last daily assessment, using the Daily Inventory of Stressful Events, and their overall level of perceived stress, using the Perceived Stress Scale.

Methods

Participants

A sample of 73 undergraduate students was collected using the psychology subject pool SONA system. Cohen and colleagues (1987) described that the life and developmental transitions occurring in the lives of undergraduate students make this population highly vulnerable to high levels of stress, and additional studies have continually found high levels of stressful events and perceived stress in undergraduate students (D'Zurilla & Sheedy, 1991; Ross, Niebling, & Heckert, 1999; Towbes & Cohen, 1996). One weakness of using an undergraduate sample is the risk to external validity and the ability to generalize results to a larger population. In an attempt to gather a diverse set of participants, no exclusion criteria were used.

Measures

There were 8 timepoints in which data was collected from each participant. The first timepoint occurred via videoconference with one participant and one research assistant on a Zoom video call. Data was collected via electronic survey. The remaining 7 time points occurred in 24-hour increments, starting the day immediately following the participant's baseline data collection in the study.

Demographics

Participants reported their gender identity, age, and socio-economic status (SES). Following best practice recommendations in the assessment of socio-economic status (Diemer, Mistry, Wadsworth, Lopez, & Reimers, 2013), and specifically SES assessment in college student populations (Rubin, et al., 2014), one objective measure (selecting a family annual income bracket; Diemer et al., 2013) and one subjective measure

(MacArthur Scales of Subjective Social Status) were employed. The MacArthur Scales of Subjective Social Status allow participants to select which rung on an actual picture of a ladder they believe best represents their overall social status and then their social status in their current community (Cundiff, Smith, Uchino, & Berg, 2011). No analyses were planned a priori for these data.

Difficult Events

The number of difficult events that each participant encountered was measured using a self-report version of the Daily Inventory of Stressful Events (DISE; Almeida, Wethington, & Kessler, 2002). Almeida and colleagues (2002) created a telephone interview in order to capture daily stressful events for a large epidemiological study aimed at understanding the types of daily stressors the average American experienced.

Categories of stressful events include having an argument/disagreement, work or school related event, experiences of discrimination, and a close friend or relative related event since filling out their previous survey. These wide categories allow participants to reflect on each category and then select a number of how many individual events they experienced that fall into each category. Inherent to the hypotheses in the current study, we altered text in the measure instructions to omit the word "stressors" in order to capture the number of difficult events that participants experienced, even if they choose not to label them as "stressors." Additionally, because we removed the word stressors from the stem, we altered the following categories: "event related to work or school that other people would consider stressful," "event with a close friend or relative that other people would consider stressful," and, "anything else that other people would consider stressful." Participants received training and additional instructions reminding them to count each

event once, and if it falls into multiple categories, to select the category that best fits the event. The total number of events was tallied, and their sum constituted the number of difficult events that occurred.

Perceived Stress

In line with other dispositional mindfulness and stress studies, participants' appraisal of stress was measured using Cohen and colleagues (1983) Perceived Stress Scale (PSS). Specifically, the ten-item scale was used, which was developed and validated by Cohen and Williamson in 1988. The ten-item scale consistently achieved internal reliability between $\alpha = 0.74$ and $\alpha = 0.91$, evaluated across six studies (Lee, 2012).

Open Attention and Awareness

Participants reported their experiences of attention and forgetting in daily living using the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003). This 15-item scale includes items such as, "I drive places on 'automatic pilot' and then wonder why I went there" and "I find myself doing things without paying attention". Participants will respond on a 6-point scale ranging from "almost always" to "almost never". Higher scores are indicative of higher mindful awareness and have been linked to certain neuropsychological variables, including smaller amygdala size and lower neuroendocrine responses to stressful situations (Brown, Weinstein, & Creswell, 2012; Taren, Creswell, & Gianaros, 2013). The scale was recently reevaluated to confirm its strong internal reliability ($\alpha = 0.89$; MacKillop & Anderson, 2007).

Self-compassion

Participants completed the Self-Compassion Scale (SCS) to report their level of self-compassion (Neff, 2003). This scale consists of 26 items to measure each of the six domains of self-compassion, as conceptualized and reported by Neff in 2011, self-kindness, self judgement, common humanity, isolation, mindfulness, and over-identification. This measure demonstrated good internal reliability in previous studies (α = 0.92; Neff, 2003).

Neuroticism

Participants' level of neuroticism was measured using the neuroticism subscale from the Big Five Inventory (John, Donahue, & Kentle, 1991). This subscale includes 8 items such as, "I am someone who worries a lot" and "I am someone who can be moody". Previous studies have reported strong internal consistency for this measure, with an average Cronbach's alpha of .80 (John, Naumann, & Soto, 2008; John & Srivastava, 1999).

Experience with Meditation and Yoga

Participants' experience with meditation and/or yoga was captured using questions from Baer and colleagues 2008 study. All participants were asked whether they had experience with meditation, and if so, if they meditate regularly, and if so, how many times per week they meditate. Additionally, participants were asked whether they had experience with yoga, and if so, if they practice yoga regularly, and if so, how many times per week they practice yoga.

Facets of Mindfulness

Participants completed the Five Facet Mindfulness Questionnaire to gauge their levels of observing, describing, acting with awareness, nonjudging, and nonreactivity

(Baer et al., 2006). The acting with awareness subscale items are identical to the items contained in the Mindful Attention Awareness Scale; participants were instructed that they may see duplicate items in the survey to reduce potential confusion. The measure and each of the five facets have been found to have strong internal reliability (Total: α = .89; Nonjudging: α = .90; Describing: α = .89; Nonreactivity: α = .69; Acting with awareness: α = .81; and Observing: α = .74; Truong et al., 2020). No analyses were planned a priori for this measure.

Procedure

Time Point 1

After consenting to participate in the study, participants completed electronic survey measures of open attention and awareness, self-compassion, neuroticism, experience with yoga and meditation, and demographic information. Participants were compensated with two research participation credits after attending the baseline survey session. After completing the baseline survey, participants received verbal instructions from a research assistant about completing their remaining daily diaries. Participants were reminded to separate out their feelings of overall stress from the number of difficult events they experienced using the following language:

> Remember, each daily survey will ask about two related but separate things: first, your overall level of stress and second, how many difficult events you encountered in the previous day. We are trying to understand two different aspects of the stress you experience in your life. First, we want to know about your feelings – how stressed you've been feeling over the course of the day including at the time you are taking the survey. Second, we want to know about the number of actual difficult events that happened that day.

Research assistants used a standardized script and were trained to answer questions that participants may have about the daily surveys. Research assistants used the Gmail add-on "Boomerang" to automate messages with survey links to each participant, set to arrive in nightly, 24-hour increments at a time of the participant's choosing, between 7:00 P.M. and 11:00 P.M. In order to maximize data collection and minimize missing data, research assistants requested the participants do one or more of the following to ensure daily survey participation: turn on email notifications, set a daily alarm, tie filling out the daily survey with a regular nighttime behavior (e.g., brushing teeth), and/or add the daily survey to their daily task lists.

Time Points 2-8

Participants completed daily surveys using the links e-mailed to them each day. Daily surveys included measures of difficult events and perceived stress. Participants received one additional research participation credit upon completion of each daily survey.

Results

Descriptive Statistics

Participants predominately identified as white (69%) and female (72%). The average family income bracket was $60,000 – $69,000 and the rung on the overall social status ladder was 6 and social status within their current community was 5. A total of 26 participants reported having tried meditation and yoga at least once in the past. Of the regular practitioners, one participant reported meditating and practicing yoga 5-6 times per week, each. Visual analysis of participants with a regular practice did not yield any indication of outliers in the dataset. Full demographic information is presented in Table 1.

Table 1. Demographic Information.	% of sample (n)
Gender Identity	
Woman	72% (53)
Man	27% (20)
Prefer to self-identify	0% (0)
Race	
White	69% (50)
Asian	26% (19)
Hispanic or Latino/a	18% (13)
Black or African American	11% (8)
Native Hawaiian or Pacific Islander	3% (2)
American Indian or Native American	0% (0)
Other (self-identified as "Middle Eastern" and "Arab")	3% (2)
Family income	
Less than $10,000	6% (4)
$10,000 to $19,999	8% (6)
$20,000 to $29,999	8% (6)
$30,000 to $39,999	6% (4)
$40,000 to $49,999	10% (7)
$50,000 to $59,999	8% (6)
$60,000 to $69,999	10% (7)
$70,000 to $79,999	7% (5)
$80,000 to $89,999	1% (1)
$90,000 to $99,999	6% (4)
$100,000 to $149,999	16% (12)
$150,000 or more	15% (11)
Experience with meditation	
Tried meditation at least once	45% (33)
Regular meditation practice	45% (15)
Meditate 1-2 times per week	14% (10)
Meditate 3-4 times per week	3% (2)
Meditate 5-6 times per week	4% (3)
Meditate 7+times per week	0% (0)
Experience with yoga	
Tried yoga at least once	56% (41)
Regular yoga practice	34% (14)
Practice yoga 1-2 times per week	14% (10)
Practice yoga 3-4 times per week	3% (2)
Practice yoga 5-6 times per week	3% (2)
Practice yoga 7+ times per week	0% (0)

Participants in this sample reported an average daily perceived stress score of 1.96 on the PSS-10, which is consistent with previous studies involving college students (Roberti, Harrington, & Storch, 2006). The internal reliability of the PSS-10 was good (α = 0.89). The average of the MAAS scores was 3.4, which is slightly lower than previous

studies involving undergraduate students (m = 4.0: Mackillop & Anderson, 2007); this measure also achieved good internal reliability ($\alpha = 0.87$). Self-compassion scores averaged to 2.97, which is comparable to previous studies conducted with undergraduates (Neff & Pommier, 2013). The Self-compassion Scale had good internal reliability ($\alpha = 0.92$). The participants' average level of neuroticism was 3.1, consistent with previous studies conducted with undergraduate students (Extremera & Fernández-Berrocal, 2005). The BFI-N had good internal reliability ($\alpha = 0.80$). Means, standard deviations, and correlations can be found in Table 2.

Table 2. Means, standard deviations, and correlations of baseline data. (N = 73)

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. Average perceived stress	2.0	0.7	1							
2. MAAS	3.4	0.8	-0.4*	1						
3. Self-compassion	3.0	0.7	-0.4*	0.4*	1					
4. BFI-N	3.1	0.7	0.5*	-0.4*	-0.6*	1				
5. FFMQ Observing	3.3	0.6	-0.2	0.3*	0.3*	-0.3*	1			
6. FFMQ Describing	3.1	0.8	-0.3*	0.3*	-0.4*	-0.4*	0.4*	1		
7. FFMQ Acting with Awareness	2.9	0.8	-0.4*	0.8*	0.3*	-0.5*	0.2	0.5*	1	
8. FFMQ Nonjudging	3.1	0.9	-0.3*	0.4*	0.6*	-0.4*	0.1	0.3*	0.4*	1
9. FFMQ Nonreactivity	2.8	0.7	-0.2	0.2	0.5*	-0.6*	0.4*	0.2	0.1	0.1

Note: * indicates $p < .05$.

The average number of daily difficult events that each participant reported was 2.87. The most common category of stressful event was an event related to work or school and the least common category was discrimination on the basis of race, sex, or age. To see a full break down of the categories of difficult events reported each day, as well as daily averages of perceived stress, see Table 3.

Table 3. Daily survey data: Average perceived stress and number of difficult events per participant.

	Day 1 N = 73	Day 2 N = 73	Day 3 N = 73	Day 4 N = 73	Day 5 N = 72	Day 6 N = 70	Day 7 N = 61
PSS-10	2.1	2.1	1.9	1.9	1.8	1.9	1.9
Total difficult events	3.6	3.1	2.9	2.3	2.7	2.7	2.4
Argument/ disagreement	0.6	0.6	0.6	0.5	0.6	0.6	0.5
Event related to work or school	1.5	1.2	1.2	1.2	1.2	1.5	1.1
Discrimination	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Event with close friend or relative	0.6	0.5	0.4	0.5	0.5	0.4	0.4
Other difficult event	0.9	0.6	0.6	0.4	0.5	0.6	0.5

Regression Analysis

Hypothesis 1 stated that those with higher levels of open attention and awareness would negatively predict average perceived stress over the span of one week, even when controlling for the predictive ability of neuroticism. Attention to, and awareness of, what is occurring in the present moment, was operationalized as participant Mindful Attention

Awareness Scale scores. Average perceived stress was operationalized as the average of participants' daily reports on the Perceived Stress Scale. Neuroticism was operationalized as participants' scores on the Big Five Inventory - Neuroticism subscale.

Data met all assumptions for multiple linear regression. The regression was run using the lme4 package in R (Bates, Mächler, Bolker, & Walker, 2015). The model was significant, ($R^2 = .27$, $F(2,70) = 13.40$, p < .05). Both variables in the model were significant predictors of average perceived stress. MAAS scores were a significant predictor ($\beta = -0.23$, $p < .05$) when controlling for neuroticism, such that higher scores on the MAAS predicted lower average perceived stress. Hypothesis 1 was supported. Neuroticism was also significant predictor of average perceived stress, such that higher neuroticism predicted higher average perceived stress ($\beta = 0.39$, $p < .05$) when controlling for MAAS scores (Table 4).

Table 4. Multiple regression results: Predictors of average perceived stress.

|	*B*	*SE B*	*β*
MAAS	-0.20*	0.10	-0.23*
BFI-N	0.37*	0.11	0.39*
R^2	.27		
F	13.40*		

*p < .05.

Multilevel Model Analysis

Hypothesis 2 stated that participants would rate their perceived stress as higher on days in which they reported experiencing a greater number of difficult events (Figure 1, B_{1j}). Hypothesis 3 stated that participants' level of open attention and awareness would significantly predict daily fluctuations in perceived stress, even when controlling for neuroticism, such that higher open attention and awareness would be related to lower daily reports of perceived stress (Figure 1, γ_{01}). Hypothesis 4 stated that the relationship between the number of difficult events experienced and perceived stress, controlling for neuroticism, would be moderated by open attention and awareness (Figure 1, γ_{11}).

This analysis consisted of 73 (subjects) X 7 (days) = 511 possible observations. Participants completed an average of 6.8 daily surveys, amounting to a total of 17 missing observations across all participants (96.67% completion rate) and an actual total observation of 494 points. We created an unconditional means model to calculate an interclass correlation (ICC) for the outcome, daily perceived stress. The ICC, 0.56,

Figure 1 Multilevel Model
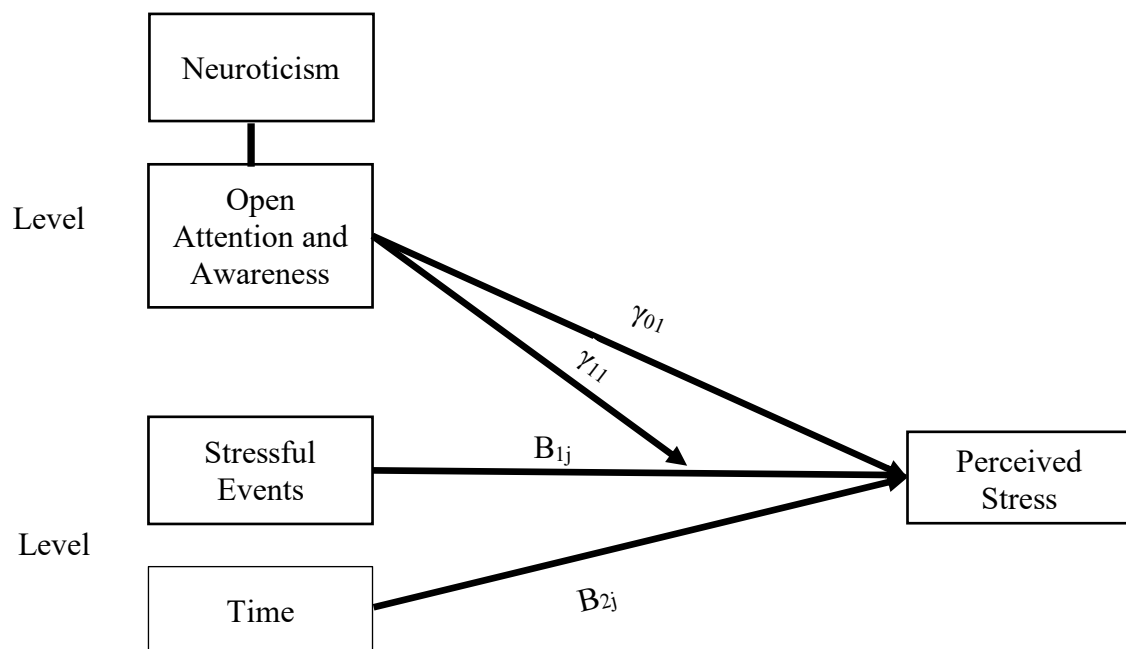
indicated that 56% of the total variance in perceived stress is attributable to between-person variation and the remaining 44% is attributable to within-person variation.

We analyzed our data using a multilevel model specified by the lme4 package in R (Bates, Mächler, Bolker, & Walker, 2015; Finch, W. H., Bolin, J. E., & Kelley, K., 2019). Data met all assumptions for the analysis Daily perceived stress was operationalized as participants' daily scores on the PSS. Within-Daily Difficult Events was operationalized as a participants' number of stressful events subtracted from their own average number of difficult events. Time was operationalized as the numbered day of the participant's response, centered at the midpoint of the study. Open attention and awareness was operationalized as MAAS scores and centered at the group mean for this analysis. Neuroticism was operationalized as participants' BFI-N scores, centered at the group mean for this analysis. Following conservative recommendations from Bolger & Laurenceau (2013), we based degrees of freedom off of the number of subjects, rather than the number of observations.

For results of the statistical test of the multilevel model hypotheses, we can review Table 5, specifically the upper portion labeled *fixed effects*. Hypothesis 2 can be examined by reviewing the significant within-Daily Difficult Events estimate of 0.17, meaning that at the midpoint of the study, a participant with average MAAS and BFI-N scores reported higher perceived stress on days in which they reported experiencing more difficult events. Note that because the model included time, results for the focal hypothesis cannot be artifacts of temporal chances over the daily survey period. Hypothesis 2 was supported. Hypothesis 3 can be examined by reviewing the significant MAAS estimate of -0.20, meaning that at the midpoint of the study, a participant with an

average BFI-N score and an average number of within-Daily Difficult Events reported lower perceived stress than those with lower MAAS scores. Hypothesis 3 was supported. Hypothesis 4 can be examined by reviewing Model 2 in Table 5, specifically the estimate labeled MAAS score by within-Daily Difficult Events interaction. The estimate was not significant. Our moderation hypothesis, hypothesis 4, was not supported.

Visual analysis of the moderation hypothesis was planned *a priori* due to the lack of power to assess for moderation given the size of this sample. Figure 2 compares the differences in average slopes between the high and low MAAS score groups and all observations are presented visually in Figures 3 and 4 to show the raw data used to obtain regression lines for each subject. Visual inspection of the two average regression lines in Figure 2 provides support for our moderation hypothesis: the slope for the low MAAS score group is steeper than it is for the high MAAS score group. Visual inspection comparing individual patterns in Figure 2 and Figures 3 and 4 also provide support for our hypothesis: the individual slopes of regression lines appear to be steeper in the low MAAS score group than in the high MAAS score group. It is important to note that these graphs fail to control for neuroticism, although it should also be noted that the statistical analysis continued to report a non-significant estimate of the interaction term MAAS score by within-Daily Difficult Events when neuroticism was removed from the model. In sum, the moderation hypothesis was not supported by statistical analysis, possibly because the null hypothesis is true or possibly because the analysis was under powered to detect a true effect. Visual analysis appears to provide modest support for the moderation hypothesis but fails to account for the role of neuroticism.

The random effects model in the bottom panel of Table 5 shows that there were significant between-subject differences in the average level of perceived stress at the midpoint of the study, with a variance of .32, or an SD of .56. At a 95% confidence interval, we can assume that perceived stress scores at the midpoint spread around the group mean by ± 1.1 units (± 2 * .56 = ± 1.1 units). There were also significant, between-subject differences in the average within-subject association between daily stressful events and daily perceived stress. The variance of the slopes of .01 corresponds to an SD of .1; we can assume that 95% of participants slopes fall between ± .2 units of the typical slope in this sample. While significant, both estimates of spread are small. At the bottom of Table 5 is an estimate of the size of the residual variance at level 1. This represents the deviations of the actual daily perceived stress scores at level 1 from the predicted values obtained from the model. A common value is assumed regardless of the number of daily stressful events for all participants. This value shows that there is significant unexplained variance in the model (B = 0.29, p < .05) Finally, as shown by the p-value of the coefficient, there is evidence of autocorrelation in the level-1 residuals. (See table notes.)

Table 5. Parameter estimates for multilevel model of daily perceived stress. (N = 73)

	Model 1, df(69)			Model 2, df(68)		
Fixed effects	**B**	**SE B**	**p**	**B**	**SE B**	**p**
Intercept	1.96*	0.07	< 0.01*	1.96*	.07	< 0.01*
Time (B_{2j})	-0.02	0.01	0.16	-0.02	0.01	.16
MAAS (γ_{01})	-0.20*	0.09	0.03*	-0.20*	0.10	.04*
BFI-N	0.37*	0.10	< 0.01*	0.36*	0.10	< 0.01*
Within-Daily Difficult Events (B_{1j})	0.17*	0.02	< 0.01*	0.17*	0.02	< 0.01*

	B	SE B	p	B	SE B	p
MAAS by Within-Daily Difficult Events(γ_{11})				-0.01	0.01	0.98
Random effects ([co]variances)	***B***	***SE B***	***p***	***B***	***SE B***	***p***
Level 2 (between-person)						
Intercept	0.32*	0.07	< 0.01*	0.32*	0.07	< 0.01*
Within-Daily Difficult Events	0.01*	0.01	0.03*	0.01*	0.01	0.03*
Intercept & within-Daily Difficult Events	-0.02	0.01	0.11	-0.02	0.01	0.11
Level 1 (within-person)						
Residual	0.29*	0.03	< 0.01*	0.29*	0.03	< 0.01*
Autocorrelation	0.28*[a]	0.06	< 0.01*	0.29[a]*	0.06	< 0.01*

[a] We created a model with lag-1 daily perceived stress due to significant autocorrelation of residuals in the model presented. The lag-1 model had the same pattern and significance of effects and removed the significant autocorrelation of residuals.

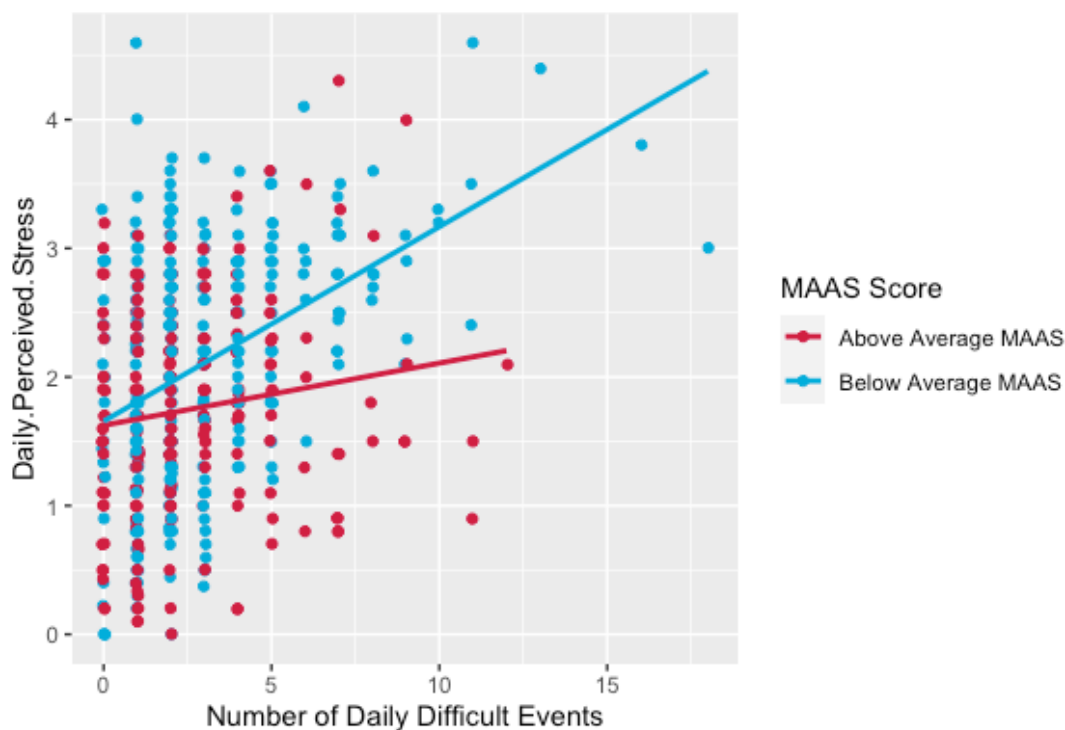*Figure 2 Daily perceived stress and daily difficult events by MAAS score*

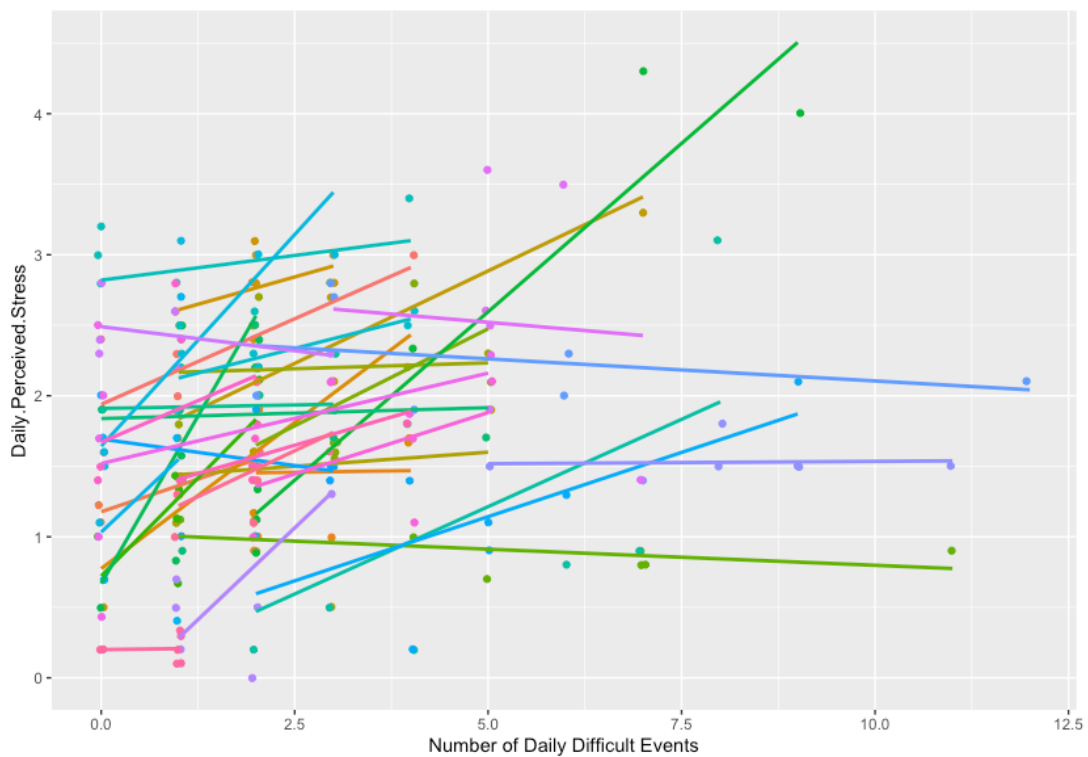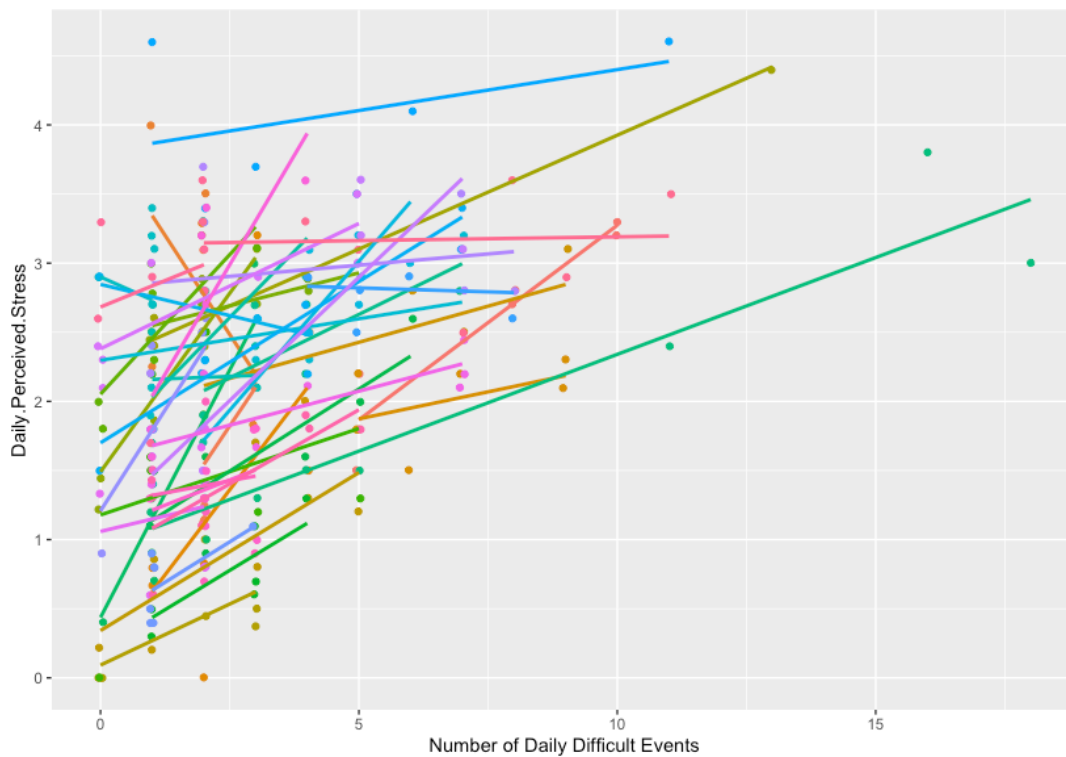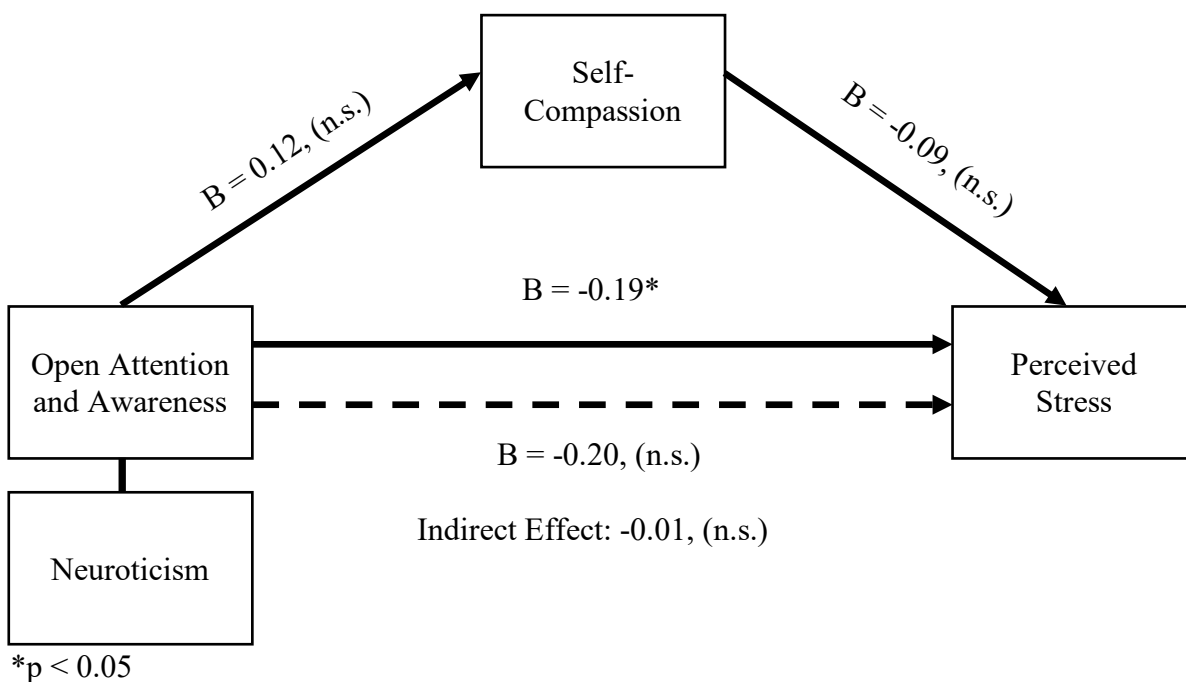*Figure 3 Above average MAAS: Daily perceived stress by daily difficult events*

Figure 4 Below average MAAS: Daily perceived stress by daily difficult events

Mediation Analysis

We used the R package lavaan (Rosseel, 2012) to create a structural equation model to examine hypothesis 5, which stated that the relationship between dispositional mindfulness and average perceived stress, controlling for neuroticism, will be partially mediated by self-compassion. Self-compassion was operationalized as participants' scores on the Self-Compassion Scale. All other variables were operationalized in the same manner as the regression analysis presented above. The full results are presented in Figure 5.

Figure 5 Mediation Model

Self-Compassion

B = 0.12, (n.s.)

B = -0.09, (n.s.)

B = -0.19*

Open Attention and Awareness

Perceived Stress

B = -0.20, (n.s.)

Neuroticism

Indirect Effect: -0.01, (n.s.)

*p < 0.05

MAAS scores significantly predicted average perceived stress controlling for neuroticism and self-compassion scores. MAAS scores did not significantly predict Self-Compassion Scale scores when controlling for neuroticism. Self-compassion Scale scores did not predict perceived stress scores. Because the mediator, Self-compassion Scale

scores did not predict the outcome, there is no evidence of mediation; accordingly, the indirect effect was not significant (p = 0.53). Because this portion of the analysis was planned as exploratory *a priori,* we ran a separate model that excluded neuroticism as a controlling variable. While MAAS scores significantly predicted both average perceived stress and Self-compassion Scale scores, and Self-compassion Scale scores significantly predict perceived stress, the indirect effect remained non-significant (p = 0.07). Hypothesis 5 was not supported.

Discussion

The current study aimed to glean new information about the relationships between open attention and awareness, self-compassion, neuroticism, daily occurrences of difficult events, and perceived stress. Stress, and specifically a person's perception of how much stress they experience, has been linked to numerous negative physical and mental health outcomes, ranging from heart disease to major depressive disorder (Black & Garbutt, 2002; Dimsdale, 2008; Faravelli & Pallanti, 1989; Finlay-Jones & Brown, 1981; Kendler, Karkowski, & Prescott, 1999; Miller, Chen, & Cole, 2009; Rozanski, Blumenthal, & Kaplan, 1999). Open attention and awareness, as cultivated by practice of mindfulness meditation, has been shown over multiple studies to be related to lower rates of perceived stress (Chiesa & Serretti, 2009; Grossman, Niemann, Schmidt, & Walach, 2004; Khoury, Sharma, Rush, & Fournier, 2015). However, an *in situ* test of whether a naturally occurring level of open attention and awareness protects against perceived stress has yet to be thoroughly conducted.

Findings in the current study supported our first hypothesis; open attention and awareness, as measured by the MAAS, negatively predicted participants' average level of

perceived stress over the span of one week. Further, MAAS scores were a significant predictor even when controlling for the predictive ability of neuroticism, a personality construct that measures, in part, a person's disposition to strongly identify with difficult events and to view events as stressful. MAAS scores were captured prospectively, establishing temporal precedence, and participants were exposed to naturally occurring difficult events in their lives rather than a laboratory task, maximizing the ecological validity of this finding.

This finding lends support to the value of analyzing a naturally occurring component of dispositional mindfulness, open attention and awareness. Items on this measure ask about attention to the present moment and forgetfulness when leaving the house or hearing someone's name for the first time; these items continue to appear as significant predictors of other important variables, in this case, perceived stress across the span of one week. This finding further affirms the theories of Brown and Ryan (2003), which posited the value of open attention and awareness on perceived stress and psychological well-being.

Baseline reports of traits combined with daily reports of difficult events and perceived stress allowed us to examine the data using a multilevel modeling approach in which both between-person and within-person processes are modeled simultaneously. In this sample, the ICC showed that 56% of the total variance in perceived stress is attributable to between-person variation, with the remaining 44% attributable to within-person variation.

The specific within-person variables in the model presented included time, to control for any confounding temporal changes, and a within-person number of daily

difficult events. The latter variable allowed for each participant to serve as their own control in regard to the number of daily difficult events they reported experiencing. Intraindividual increases in within-person daily difficult events predicted intraindividual increases in participants' levels of daily perceived stress, when controlling for time and the between-persons traits of interest, supporting our second hypothesis. This finding provides validation for the methods used in this study. We are unaware of any other study that has altered the DISE in such a way to capture the frequency difficult events, with specific instructions for participants to consider difficult events separately from their feeling of stress about the events.

The between-persons variables of interest were participants' trait levels of open attention and awareness and, to serve as a control, neuroticism. In support of our third hypothesis, interindividual increases in open attention and awareness were related to intraindividual decreases in daily perceived stress, controlling for the level of trait neuroticism, time, and the within-person number of daily difficult events. The predictive ability of open attention and awareness to predict daily fluctuations in perceived stress in the current study lends support to Weinstein, Brown, and Ryan's (2009) similar finding, with an empirically validated measure of perceived stress. Again, Brown and Ryan's (2003) theory concerning the negative relationship between open attention and awareness and perceived stress is affirmed, in this case, with daily, *in situ* data collected following a baseline measure of open attention and awareness.

Hypothesis 4 stated that open attention and awareness would moderate the relationship between within-person daily difficult events and perceived stress. We planned, *a priori,* to investigate this hypothesis through both statistical and visual

analysis due to a lack of statistical power to answer this question. The statistical analysis was non-significant. The visual analysis yielded modest support for the role of open attention and awareness as a moderator of the relationship between within-person daily difficult events and perceived stress. We believe that this evidence provides support for a future study involving a larger number of subjects with a greater number of observations to provide the necessary power to answer this question statistically. A significant finding in regard to this hypothesis would directly support Kabat-Zinn's (2013) theory of mindfulness and stress reduction; that mindfulness does not reduce the number of difficult events a person experiences, but rather reduces their stress reactivity to difficult events in daily life. A significant moderation effect using MAAS scores with a mostly meditation naive sample would imply that his theory extends to those with a higher, naturally occurring level of open attention and awareness.

The final hypothesis concerned self-compassion, specifically stating that self-compassion would serve as a partial mediator of the relationship between open attention and awareness and average perceived stress, controlling for neuroticism. However, the results of the meditation analysis did not prove significant, specifically due to the lack of predictive ability of self-compassion on perceived stress. It is likely that we were under powered for this analysis, but it is also possible that self-compassion does not mediate the relationship between open attention and awareness and perceived stress. Self-compassion may play a role throughout the entire process of experiencing a difficult event. It may impact whether the person even attends to the difficult event in the first place, whether they appraise the event as stressful, how they react to the difficult event, and how they respond to their own reaction. A review of Kabat-Zinn's (2013) theory of Mindfulness-

based Stress Reduction points to self-compassion as one of several responses to a difficult event once it occurs. Perhaps self-compassion is a helpful response for the mindfulness-practitioner in the face of higher perceived stress, which implies that self-compassion is a tool used to cope with perceived stress once it arises, rather than a protection against the occurrence of perceived stress. A future study examining this question could benefit from daily diary reports of how participants coped with difficult events and perceived stress if and when they arose within the day. A structural equation model could also further explore order effects of engaging with self-compassion in the fact of difficult events.

The mediation model also included neuroticism as a controlling variable, and when neuroticism was removed from the model, self-compassion did predict lower perceived stress, however the indirect effect remained non-significant. Kandler and colleagues (2017) suggested that high neuroticism may be indicative of an "uncompassionate self" and therefore questioned whether self-compassion was a useful construct, calling the self-compassion "old wine in a new bottle." Using a confirmatory factor analysis across two samples, Kandler and colleagues found that self-compassion failed to predict life satisfaction above and beyond neuroticism. Their argument, if correct, could explain why self-compassion did not significantly predict perceived stress when neuroticism was also controlled for in the model. However, in two subsequent responses in 2018 and 2019, Neff and colleagues used twenty samples and an exploratory structural equation modelling approach to show that self-compassion does in fact explain unique variance in life satisfaction, depression, anxiety, and emotion regulation when controlling for neuroticism.

This examination included a sample of undergraduate students, a population that experiences a sudden increase in independence and exploration as they develop life-long habits (Arnett, 2000). Simultaneously, this group is undergoing the neurobiological development of self-regulatory processes, including those related to practicing health-promoting behaviors (Casey, Getz, & Galvan, 2008; Sirois, 2015). Understanding factors that may enable this group to experience lower perceived stress and in turn experience better mind-body health as they develop either health promoting or destructive health behaviors could be essential to upstream health care. At the same time, findings from this study are limited in scope and researchers should use caution when attributing the results presented here to other populations.

Missing from the current study is an experimental manipulation, therefore, we are careful not to make any causal claims about the observed data. However, as Bolger and Laurenceau (2013) described, intensive longitudinal designs can build confidence that casual processes investigated in laboratory settings actually occur in nature. The findings in this paper build on previous empirical work that has shown the causal ability of mindfulness-based interventions to increase open attention and awareness and in turn decrease perceived stress and physiological stress responses, and laboratory studies showing the negative relationship between MAAS scores and physiological stress responding (Brown, Weinstein, & Creswell, 2012; Chiesa & Serretti, 2009; Kadziolka, Di Pierdomenico, & Miller, 2016; Rosenkranz et al., 2013). A future study could explore an experimental manipulation with intensive longitudinal data. For example, researchers could follow a control group and a group of students before, during, and after participating in MBSR. The collection of daily reports of difficult events and perceived

stress along with weekly measures of open attention and awareness would allow researchers to better understand the growth of open attention and awareness through a mindfulness-based intervention, and the impacts on the relationship between daily occurrences of difficult events and perceived stress. A comparison to a control group would also allow for stronger causal claims.

One possible limitation to the current study is that daily monitoring of stressful events and perceived stress levels may have increased participant's level of awareness throughout the week. If participants became more aware throughout the week, our findings concerning awareness and perceived stress may be biased. However, in the multilevel model, time was controlled for and proved non-significant in analysis. Future studies should be cautious around this potential confound and consider measuring open attention and awareness at the beginning and end of the study to check for an incidental manipulation.

Another limitation of the current study is presented by the significant unexplained variance left at both levels of analysis in the model. While prioritizing parsimony, researchers can continue to build on the models presented in the current study with both between- and within-person variables to explain more of the variance in individuals' daily perceived stress. Other variables of interest could include the role that social support, coping skills, and emotion regulation play in perceived stress (Boyle et al., 2017; Chao, 2012; Wright, 1999) Additionally, the current study specifically hypothesized about and tested the role of open attention and awareness, a component of mindful awareness. Missing from open attention and awareness is the relational component of mindfulness; the element that is non-judgmental, compassionate, and accepting. While

analysis showed significant correlations between open attention and awareness and several components of the Five Facet Mindfulness questionnaire, including the Observing, Describing, and Nonjudging subscales, a future study should explore more fully the role of mindful awareness in reducing perceived stress. Findings in the current study are specifically limited to open attention and awareness and should not be mistake for the construct "mindfulness".

We also believe that an added measure of physiological arousal, specifically heartrate variability captured throughout the day on a heartrate monitor or smart watch, could further increase the measurement validity of perceived stress (Kim et al., 2018). The addition of an important physiological marker would help capture a more holistic picture of the impact of open attention and awareness on the mind-body system. The current study infers that reductions in perceived stress will result in improved immune system function and reduced stress-induced neurogenic inflammation; adding physiological measures of these functions will allow researchers to directly observe the phenomenon if it is in fact occurring.

Limitations and suggestions for future research thus far have focus on increasing the *intensity* of the possible intensive longitudinal methods, but it is also possible to increase the time course of the methods, in order to increase the *longitudinality*. The ultimate goal of understanding individuals' perceived stress concerns the mitigation of chronic stress, and ultimately illness in the mind-body system. Brining a wider lens to this investigation, perhaps by tracking individuals' open attention and awareness along with mind-body health over several years, would allow researchers to explore the relationship between open attention and awareness and long-term health outcomes.

Understanding the reach of these between-subject variables combined with yearly periods of weekly monitoring could best combine these methods and capture both between- and within-person variables at play.

Taken together, the findings in the current study validate a method of exploring daily difficult events and perceived stress and provide further evidence of the prospective predictive ability of a component of mindfulness, open attention and awareness, on daily perceived stress. This further affirms the use of interventions, such as MBSR and MBCT, in clinical settings to increase open attention and awareness and lower perceived stress. Clinicians who seek to reduce the level of perceived stress that a client experiences should target open attention and awareness as a mechanism of change and use the MAAS to provide measurement-based care for these types of interventions. Physicians who are concerned about a patient's stress-related health conditions, or physical conditions that are adversely impacted by stress, should consider administering the MAAS and referring those with lower scores to mindfulness-based interventions including MBSR.

Trait neuroticism also negatively predicted daily perceived stress, and burgeoning evidence concerning cutting edge psychotherapies shows modest reductions in levels of neuroticism directly following a 16-week mindfulness and CBT intervention called the Unified Protocol (Barlow et al., 2017; Sauer-Zavala et al., 2020). While we wait for follow-up studies concerning the longevity of these neuroticism reductions and studies conducted with larger community samples, open attention and awareness is a trait that is both inexpensive and amenable to change. Mindfulness meditation remains a free and accessible way to change an individual's level of open attention and awareness, and in turn, reduce the individual's level of psychological and physiological stress (Chiesa &

Serretti, 2009; Goleman & Davidson, 2005; Rosenkranz et al., 2013). Future studies can

explore the impact of mindfulness meditation using similar methods presented here.

Findings presented in the current study will allow researchers to continue to build an

understanding of significant factors that may lead to lower perceived stress, and in turn,

better health in the mind-body system.

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