MECHANISMS OF MINDFULNESS ON ACUTE PSYCHOLOGICAL AND PHYSIOLOGICAL STRESS REACTIVITY IN STRESSED YOUNG ADULTS

by

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ABSTRACT

MARIA GRACE ALESSI. Mechanisms of Mindfulness on Acute Psychological and Physiological Stress Reactivity in Stressed Young Adults.
(Under the direction of DR. JEANETTE M. BENNETT)

Stressed young adults are at greater risk of lifetime higher morbidity and mortality, highlighting a need for feasible and effective approaches to improve stress management in this population. Mindfulness, defined as intentional awareness of the present with an attitude of nonjudgment, is a promising intervention to improve a host of physical and mental health outcomes. The stress-buffering hypothesis posits that mindfulness may mitigate harmful consequences of chronic stress through top-down modulation of stress perception as well as bottom-up regulation of stress response systems (Creswell & Lindsay, 2014). Further, Lindsay & Creswell's Monitor & Acceptance Theory (MAT; 2017) proposes that experiential acceptance is a key component of these effects, without which stress reactivity may be exacerbated. This study sought to investigate the stress-buffering mechanisms of mindfulness using a single session dismantling study comparing regulated breathing control, monitor-only, and monitor + accept conditions in a sample of 33 stressed young adults who completed an in-lab social evaluative stressor. A series of linear hierarchical regressions and multilevel models compared condition effects on physiological and psychological stress responsivity and reactivity, respectively. Individual-level predictors (e.g., trait mindfulness, self-compassion) that may moderate stress-buffering effects were also examined, and exploratory qualitative analysis of participants' perceptions was conducted. No hypotheses were supported by the study's findings, most likely due to the underpowered sample. Qualitative results further suggest that the study's active control was potentially equally efficacious to the mindfulness conditions, suggesting that the relative contribution of mindfulness skills to buffer stress reactivity may be negligible above and beyond the effects of regulated breathing in this short duration of practice. Future research directions include clarifying the minimal amount of mindfulness practice needed to observe stress-buffering effects as well as investigating how mindfulness is most effectively learned in stressed populations.

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BMI	body mass index
BO	breathing-only control
BP	blood pressure
ELISA	enzyme-linked immunosorbent assay
FFMQ	Five-Factor Mindfulness Questionnaire
HF-HRV	high-frequency heart rate variability
HPA	hypothalamic-pituitary-adrenal axis
HR	heart rate
HRV	heart rate variability
MA	monitor + accept condition
MAT	Monitor & Acceptance Theory
MLM	mixed linear model
MO	monitor-only condition
PNS	parasympathetic nervous system
RA	research assistant
RMSSD	root mean square of successive differences
SAM	sympathetic-adreno-medullar axis
SC	self-compassion
SDNN	standard deviation of the interbeat interval of normal sinus beats
SES	socioeconomic status
SNS	sympathetic nervous system
TSST	Trier Social Stress Task

V1	visit one
V2	visit two
VAS	visual analog scale

CHAPTER 1: INTRODUCTION

From a life course health development framework, early adulthood is an important developmental period with significant impacts on health trajectories across the lifespan (Halfon & Hochstein, 2002). Many health indicators among young adults ages 18-29 in the United States have improved little over the last few decades, however, holding implications for individual as well as population health and mortality rates for decades to come (Mulye et al., 2009; M. J. Park et al., 2014; White et al., 2020). Rates of suicide, depression, anxiety, obesity, and prediabetes are rising among young American adults, and increased stress is likely a significant contributor (Andes et al., 2020; Goodwin et al., 2020; Miron et al., 2019; Slavich & Irwin, 2014). Further, the COVID-19 pandemic exacerbated many of these existing trends as major societal disruptions increased stress and emotional distress, with some of the largest increases reported in young adults at pandemic onset (Hawes et al., 2021; Shanahan et al., 2022; Vahratian, 2021). Effective and feasible interventions to support more adaptive stress coping are critically needed to mitigate these negative impacts and reduce lifetime morbidity and mortality risks, particularly among this cohort of young adults. One such intervention with significant potential to ubiquitously improve mental and physical health outcomes caused or exacerbated by stress is the practice of mindfulness.

Mindfulness is defined as a distinct quality of clear and nonconceptual awareness of the present moment (Brown & Ryan, 2003), which involves increased concentration, clarity, and equanimity towards internal and external experiences (Young, 2016). Originating in ancient Eastern Buddhist practices and teachings, mindfulness was first formally studied by Western psychological science in the 1970s by Dr. Jon Kabat-Zinn as a practice of intentionally paying attention to the present moment with nonjudgment (Kabat-Zinn, 2006). An exponentially growing body of research has since demonstrated consistent evidence that mindfulness-based interventions can improve various mental and physical health outcomes across diverse patient populations.

Meta-analytic findings suggest that mindfulness reduces risk of depressive relapse (Teasdale et al., 2000) and decreases depressive symptoms among adolescents (g = .14, Reangsing, Punsuwun, et al., 2021) and older adults (g = .65; Reangsing, Rittiwong, et al., 2021), decreases negative symptoms of psychosis (g = .41; Khoury et al., 2013), improves chronic pain (d = .32) and mental health-related quality of life (d = .49; Hilton et al., 2017). Mindfulness-based interventions are demonstrated to reduce psychological distress and fatigue among cancer patients (g = .32 - .51; Cillessen et al., 2019), increase sleep quality in adults with sleep disturbances (g = .33 - .54; Rusch et al., 2019), improve eating behaviors in overweight and obese adults (g = 1.08; Rogers et al., 2017), decrease systolic blood pressure among adults with cardiovascular disease (d = .89; Scott-Sheldon et al., 2019), as well as lower blood pressure, cortisol, heart rate, and circulating levels of inflammatory markers in both clinical and non-clinical samples (Pascoe et al., 2017). These findings support the broad efficacy of mindfulness practice as a transdiagnostic intervention to improve psychological and physiological health.

Less well-understood is *how* mindfulness impacts such a wide range of mental and physical outcomes. Experimental evidence supports a moderating effect of mindfulness-based interventions to attenuate acute psychological and physiological stress reactivity, suggesting that mindfulness alters activation of the body’s stress response systems. (Morton et al., 2020; Nyklíček et al., 2013). However, neuroendocrine and cardiovascular effects of mindfulness-based interventions have been mixed across such large-format studies, possibly due to heterogeneity in populations studied, limited use of rigorous controls, and variable intervention dosages (Morton et al., 2020). Carefully designed and well-controlled intervention studies are needed to elucidate the mechanism(s) of mindfulness's salutatory effects.

Notably, a significant majority of mindfulness interventions investigated to date are delivered in 8-week long group-based formats (e.g., mindfulness-based stress reduction, mindfulness-based cognitive therapy), which also include components of psychoeducation about stress management, physical activity (e.g., yoga), and an intensive 1-day silent retreat in addition to mindfulness practice. This format involves several components that may all contribute to positive health outcomes, making it difficult to determine mechanistic conclusions about mindfulness per se. Further, the length of time and necessary degree of participation may create barriers to accessibility and acceptability of this practice across diverse settings and populations, highlighting the need for investigations of shorter and more feasible mindfulness interventions.

Brief mindfulness interventions have been demonstrated to significantly reduce negative affect (g = .21), with stronger effects in community-based settings (g = .41) compared to healthy undergraduate samples (g = .14; Schumer et al., 2018). While the majority of studies have focused on primarily psychological outcomes (Howarth et al., 2019), a handful of well-controlled trials additionally demonstrate decreases in resting heart rate as well as reduced blood pressure and sympathetic nervous system activity following brief mindfulness practice in both healthy and chronically ill populations (J. Park et al., 2014; Zeidan et al., 2010). This expansion of mindfulness research beyond intensive 8-week interventions increases the generalizability of findings to more diverse populations and clinical settings in which single-session brief interventions may be commonly employed (e.g., primary care).

1.1 A Stress-Buffering Account

Converging evidence that mindfulness practices, whether integrated and lengthy or simple and short, can improve stress-related mental and physical health outcomes is congruent with the stress-buffering hypothesis of mindfulness (Creswell & Lindsay, 2014). This hypothesis posits that nonjudgmentally paying attention to the present moment is beneficial for a diversity of health outcomes due to altering cognitive-affective perceptions and reactivity to stressors, thereby mitigating activation of physiological stress response systems which drive the development of mental and physical illness when dysregulated (Cattaneo & Riva, 2016; Kemeny & Schedlowski, 2007).

The two primary physiological stress response systems are the sympathetic-adreno-medullar (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis (Kemeny, 2003). The SAM axis enhances sympathetic activation, promoting the release of norepinephrine and epinephrine by the adrenal medulla to increase heart rate and send blood to muscles for action within seconds of activation. The comparatively slower HPA axis begins with stimulation of the pituitary gland by the hypothalamus via corticotropin-releasing hormone, which in turn stimulates the adrenal cortex via adrenocorticotropin hormone. Within minutes of stressor onset, the adrenal cortex produces the hormone cortisol to broadly mobilize the body for action and energy expenditure as well as increase blood flow to parts of the brain that govern alertness, focus, and executive function (S. Cohen et al., 2016; Ginty et al., 2017). Cortisol also enhances activation in the hippocampus and amygdala, brain regions primarily responsible for memory formation and emotional reactivity (McEwen, 1998). These physiological and neuropsychological effects of cortisol support an adaptive response to momentary stressors when responsive, resulting in an increase and a subsequent decrease in circulating blood levels of this stress hormone upon stressor resolution; thus, a well-regulated (i.e., healthy) system resets to baseline (Sturmberg et al., 2015).

However, with the accumulation of stressors and repeated activation of stress systems, chronic 'wear and tear' (i.e., increased allostatic load) on these systems impairs feedback regulation and resets the body's baseline over time (McEwen, 2004). Both exaggerated cortisol responses to stress as well as hypocortisolism are reported in a number of chronic conditions, including depression, posttraumatic stress disorder, bipolar disorder, irritable bowel syndrome, metabolic syndrome, and cardiovascular disease risk, suggesting that HPA axis dysregulation is a transdiagnostic correlate of both mental and physical illness (Sturmberg et al., 2017). According to the stress-buffering hypothesis, mindfulness may therefore mitigate the downstream risk of chronic illness development by decreasing activation of the SAM and HPA pathways (stress responsivity) and promoting faster recovery to baseline (stress recovery; Creswell & Lindsay, 2014).

Furthermore, the stress-buffering hypothesis predicts that the benefits of mindfulness will be most pronounced under conditions of stress (Creswell & Lindsay, 2014). This is supported by evidence that the health benefits of mindfulness-based interventions are most commonly observed in stress-related medical conditions, including depression, inflammatory disorders, and chronic pain (Crowe et al., 2016), and generally demonstrate greater positive effects on psychological outcomes in community-based than healthy undergraduate samples (Schumer et al., 2018). Thus, understanding how mindfulness works is likely best studied by paradigms of stress reactivity and within populations reporting higher levels of stress.

1.2 HRV as a Measure of the Mechanisms of Mindfulness

Additionally, the stress-buffering hypothesis predicts that mindfulness both strengthens top-down regulatory pathways and modulates bottom-up activation of stress responses systems to broadly support mental and physical health (Creswell & Lindsay, 2014). This proposed mechanism implicates the utility of measuring heart rate variability (HRV), or the beat-to-beat variation between heartbeats, in mindfulness research (Christodoulou et al., 2020). The timing between heartbeats arises from a complex interplay of multiple independent systems and is regulated in part by the autonomic nervous system, making cardiac function an important indicator of autonomic flexibility and health (Siegel, 1999; Shaffer & Ginsberg, 2017). Lower resting HRV is observed in many clinical disorders and predicts mortality risk, making this biomarker a transdiagnostic indicator of pathology (Beauchaine & Thayer, 2015). Conversely, higher resting HRV generally predicts better psychological functioning, including decreased anxiety and rumination as well as more adaptive coping (Chalmers et al., 2014; O'Connor et al., 2002; Ottaviani et al., 2016). Moreover, increasing HRV via biofeedback decreases anxiety and other symptoms of stress (g = .81; Goessl et al., 2017).

Adaptive functioning in response to dynamic environmental demands depends on rapid coordination between brain and body (Appelhans & Luecken, 2006). According to the neurovisceral integration theory, HRV reflects how efficiently central-peripheral feedback mechanisms are coupled to regulate autonomic, attentional, and affective reactivity to the environment (Thayer & Lane, 2000). Specifically, this theory posits that a central autonomic network regulates activation of the autonomic nervous system via inhibitory control. HRV is thus thought to quantify the self-regulatory capacity critical for behavioral adaptation to stressors (Thayer & Lane, 2000). This self-regulatory capacity is also a core process believed to be promoted by mindfulness practice (Christodoulou et al., 2020; Young, 2016).

During stress, HRV often decreases (i.e., becomes less variable) and can be accompanied by increased sympathetic and decreased parasympathetic input and, relatedly, elevated heart rate and faster respiration. Rapid changes in HRV between rest and under stress reflect an acute cardiovascular stress response which is appropriately responsive to stressors to activate and then inhibited via negative feedback loops to return to baseline. Acute changes in heart rate variability as well as cortisol thus reflect neuroendocrine (i.e., SAM and HPA axes) and cardiovascular stress reactivity, and are important outcomes to investigate the physiological stress-buffering effects of mindfulness.

Findings from several experimental studies generally support the stress-buffering hypothesis of mindfulness. Multiple randomized controlled trials within 4-8 week-long mindfulness-based interventions suggest that mindfulness increases parasympathetic regulation of cardiac responsivity to stress (specifically high-frequency or HF-HRV reactivity) within both clinical and non-clinical populations (Christodoulou et al., 2020). However, considerable heterogeneity across study methodology and measures limits the ability to draw clear conclusions about the stress-buffering hypothesis's predictions (Christodoulou et al., 2020), and fewer studies have investigated these relationships outside of lengthy interventions (Morton et al., 2020). Among brief and single-session intervention studies, stressor types vary widely and span a range of cognitive tasks, physiological stressors, and active social-emotional stressors.

For example, among studies examining cognitive stressors, 10 minutes of breathing-centered meditation increased an index of HRV associated with greater parasympathetic activity (high-frequency or HF-HRV) during a pattern recognition task in healthy young adults, relative to an educational listening control (Azam et al., 2015). This finding was replicated in a sample of undergraduates with and without tension headaches/migraines; however, the headache group exhibited significantly lower post-stress HRV while meditating compared to headache-free controls (Azam et al., 2016). Sympathetic activation (measured by galvanic skin response) in response to a defeating computer game was also buffered following 15-minute focused breathing meditation, though cortisol response was not significantly modulated (Singh et al., 2012). Additionally, single session mindfulness meditation of focused breathing with an orientation of nonjudgment (i.e., acceptance) buffered systolic and diastolic blood pressure reactivity to cognitive tasks compared to educational control (Larson et al., 2013; Steffen & Larson, 2015).

In response to physiological stress, brief mindfulness practice increases willingness to tolerate distress among healthy young adults (Carpenter et al., 2019) and increases HRV in nicotine deprived smokers during a hyperventilation challenge (Paz et al., 2017). Notably, the majority of these studies are conducted in non-clinical healthy college-aged samples, precluding investigation into the specific prediction that mindfulness may exert its strongest effects in higher stress populations. At least one study in young adults with a family history of hypertension found evidence that brief mindfulness practice predicts slower cardiovascular recovery following a cold pressor task (Grant et al., 2013), incongruent with the stress-buffering account. Nonetheless, these studies suggest that a single session of mindfulness practice may buffer cardiovascular reactivity in response to stress.

1.3 Ecological Validity of a Lab-Based Social Stressor

While preliminary evidence supporting the psychological and physiological stress-buffering effects of brief mindfulness practice in response to cognitive and physiological stressors is promising, the health benefits of mindfulness are perhaps most vigorously tested in paradigms involving an active social-emotional stressor. Given that social belonging is a fundamental survival need for human beings (Baumeister & Leary, 1995), the threat of social rejection is a major stressor. Moreover, social stressors, including social rejection and experiences of loneliness, are strongly predictive of poor mental and physical health and increased mortality risk (Holt-Lunstad et al., 2015; Slavich & Irwin, 2014). Thus, examining intervention efficacy in response to social stressors is especially salient.

The Trier Social Stress Task (TSST) is one well-validated lab-based social-evaluative stressor which reliably activates the HPA axis to produce cortisol and increase heart rate (Dickerson & Kemeny, 2004). Just a few studies have examined stress reactivity to the TSST following brief mindfulness practice, and methodology has varied widely with mixed findings. Compared to an active cognitive training control, a 3-session mindful hypnosis intervention reduced anticipatory anxiety as well as psychological distress to the TSST among stressed young adults; however, no physiological data was collected (Slonena & Elkins, 2021). In a within-subject intervention experiment conducted on adolescents at-risk of developing adult obesity, anxiety but not cardiovascular reactivity in response to the TSST was buffered by a 10-minute focused breathing practice relative to neutral-focus control (Miller et al., 2021). While this effect on reduced anxiety was greatest among those with less disordered eating behaviors, those who binge-ate experienced greater reductions in diastolic blood pressure (Miller et al., 2021), thus partially supporting the stress-buffering hypothesis. Following a 3-day mindfulness meditation training, young adults reported less stress but exhibited significantly higher cortisol response to the TSST relative to a cognitive training control; there was no difference in blood pressure changes between groups (Creswell et al., 2014). This evidence of reduced subjective stress and greater physiological stress reactivity also partially supports the stress-buffering account of mindfulness, albeit in the opposite direction reported by Miller and colleagues (2021). These findings overall highlight the need for additional research to clarify the physiological stress-buffering effects of brief mindfulness practice as well as the potential for incongruence between psychological and physiological stress reactivity, thus supporting the inclusion of both subjective and objective measures in mechanistic studies.

1.4 The Key Skill of Acceptance: Monitor & Acceptance Theory

One explanation for these mixed findings may be due to significant methodological heterogeneity across brief mindfulness protocols. Specifically, interventions vary widely in psychoeducational delivery about what acceptance is as well as how much acceptance may be emphasized within a practice (cf. Creswell et al., 2014; Miller et al., 2021), and some inductions do not explicitly include this skill at all (e.g., focused breathing only; cf. Grant et al., 2013; Singh et al., 2012). While the fundamental 'what' of mindful awareness is focused attention monitoring of present moment experiences, the 'how' of effective mindfulness practice necessitates an attitude of acceptance towards those experiences (Eisenlohr-Moul et al., 2012). Acceptance is a broad concept encompassing several interrelated emotion regulation skills, including the willingness to welcome experiences as they are without automatically changing, avoiding, or suppressing them, as well as the ability to allow ever-changing present moment experiences to pass without judgment as good vs. bad and subsequently, without further reactivity (e.g., rumination, perseveration; Lindsay & Creswell, 2017; Williams & Lynn, 2010). In sum, acceptance encompasses a stance of nonjudgement, openness, and equanimity towards both internal and external experiences.

According to Monitor & Acceptance Theory (MAT; Lindsay & Creswell, 2017), attention monitoring and acceptance are two active components of mindfulness which have unique and synergistic effects on health outcomes. Specifically, attention monitoring facilitates the cognitive benefits of mindfulness while acceptance is necessary for flexible emotional engagement and disengagement from passing stimuli. MAT predicts that awareness of momentary experiences without an accompanying attitude of acceptance heightens emotional experiences and stress reactivity, while attention monitoring with acceptance modulates reactivity to improve stress-related health outcomes as posited by the stress-buffering account.

Converging evidence largely supports MAT's predictions on mental and physical health outcomes in both non-clinical and clinical populations; however, most studies to date are correlational. Higher trait observing, as measured by the Five-Factor

Mindfulness Questionnaire (FFMQ), independently predicts increased drug and alcohol use as well as poorer physical health among college students (Bodenlos et al., 2015; Leigh et al., 2005; Leigh & Neighbors, 2009), but is protective against substance use when dispositional acceptance (e.g., nonreactivity FFMQ facet) is higher (Eisenlohr-Moul et al., 2012). Observing is associated with greater depressive and anxiety symptoms when nonreactivity is lower but not higher (Barnes & Lynn, 2010; Desrosiers et al., 2014; Pearson et al., 2015). Higher monitoring skills (e.g., acting with awareness FFMQ facet) also predict less anger rumination, fewer interpersonal difficulties, lower resting blood pressure, and reduced systemic inflammation (interleukin-6) only when trait acceptance (e.g., nonjudgment FFMQ facet) is also higher (Peters et al., 2013; Tomfohr et al., 2015). In contrast, habitual use of acceptance as a coping skill is associated with greater well-being, life satisfaction, fewer depressive and anxiety symptoms, and longitudinally predicts better psychological health among college students (Ford et al., 2018).

While fewer experimental or intervention designs have investigated the moderating effect of acceptance on mindful awareness and health outcomes, single-session acceptance practice predicted greater distress tolerance to a physiological stressor (CO_2-inhalation) relative to deep breathing and no-instruction control among highly anxious females, while the deep breathing only group exhibited greater behavioral avoidance (Eifert & Heffner, 2003). There were no differences between groups in heart rate or sympathetic activation (Eifert & Heffner, 2003). Additionally, explicit instruction to evaluate emotional responses to a personal stressor predicted higher heart rate response and slower recovery compared to instructions to accept emotional responses or attend to objective stressors details (Low et al., 2008). Habitual use of acceptance also buffered negative emotional reactivity to the TSST in healthy college students (Ford et al., 2018). One of the most rigorous tests of MAT to date conducted in a sample of healthy young adults demonstrated that a 3-week intervention emphasizing monitoring and acceptance skills decreased cortisol and systolic blood pressure reactivity to the TSST more than a monitoring-only intervention or reappraisal control (Lindsay et al., 2018).

Altogether, correlational and experimental evidence suggest that both trait-level and state changes in mindful acceptance predict the stress-buffering benefits of mindfulness interventions. These findings highlight the critical importance of facilitating the development of acceptance skills in clinical interventions. Emphasis on attention monitoring skills without concomitant training in acceptance may increase awareness of aversive experiences and intensify distress, thereby nullifying the benefits of mindfulness and likely increasing the likelihood of experiential avoidance and subsequent risk of psychopathology (Hayes et al., 1996). This potentially harmful effect may be most pronounced in brief interventions among those most vulnerable to common transdiagnostic correlates of psychopathology, including high self-judgment and criticism (Werner et al., 2019). Relatedly, low self-compassion may predict a greater likelihood of initially experiencing aversive experiences to mindfulness interventions and therefore greater stress reactivity. Self-compassion may be considered a “higher-order” mindfulness-based skill that includes components of present-moment awareness, the ability to be kind and nurturing to oneself when feeling distressed, and recognition that distress/pain is part of the shared human experience (Neff, 2003). This conceptualization of self-compassion has been described as a ‘connected loving presence’ (Bluth & Neff, 2018). Self-compassion may facilitate greater self-acceptance (Neff, 2003), and so is highly relevant to the development of emotional acceptance skills emphasized by mindfulness interventions.

Relatedly, trait self-compassion is associated with positive mental health. People who are highly self-compassionate report less negative affect and fewer symptoms of anxiety as well as greater equanimity, optimism, and life satisfaction (Barnard & Curry, 2011). Higher trait self-compassion also predicts higher resting HRV and buffers stress reactivity to lab-based stressors (Ceccarelli et al., 2019; Luo et al., 2018; Svendsen et al., 2016). A growing number of mindfulness interventions further suggest that mindfulness efficacy may depend on levels of dispositional self-compassion. For example, a 10-minute focused breathing meditation increased parasympathetic activation (higher HF-HRV) following a cognitive stressor in healthy young adults but had no buffering effect on physiological reactivity among maladaptive perfectionists (Azam et al., 2015). Additionally, those lowest in dispositional mindfulness exhibited the greatest cortisol reactivity to the TSST following a 3-day mindfulness training (Creswell et al., 2014). These findings suggest that individual-level differences in trait self-compassion may moderate the impact of mindfulness practice on stress reactivity, highlighting the need for further research to clarify who may be most harmed by interventions that inadequately emphasize the key skill of acceptance.

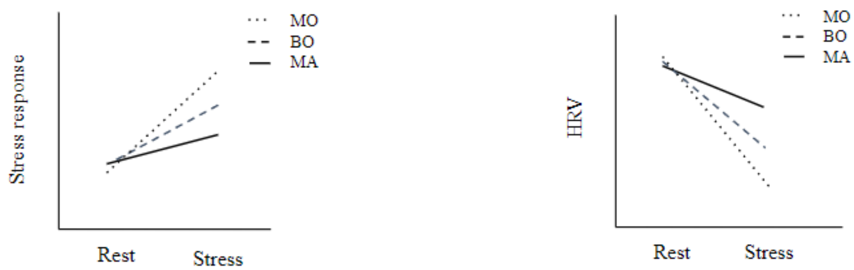
1.5 Study Aims

No investigations to date have examined the stress-buffering impacts of single-session mindfulness practice on the psychophysiological response to a social-emotional stressor, thus limiting conclusions about whether brief mindfulness interventions can buffer reactivity to the type of stressor most strongly linked to poor health via increased central-peripheral nervous system integration. Therefore, this dissertation aimed to test the stress-buffering effects posited by Lindsay & Creswell's Monitor & Acceptance Theory (2017) of a single session mindfulness intervention in stressed young adults. This investigation informs the efficacy of this intervention format within a population at elevated risk of lifetime mental and physical chronic illness, and for whom evidence-based prevention efforts to improve stress management are critically needed.

As secondary aims, this study also investigated whether levels of trait mindfulness, as well as self-compassion, moderated the efficacy of brief mindfulness practice on acute stress reactivity. Additionally, this study qualitatively explored participant's self-reported processes of utilizing mindfulness during practice and under stress to inform brief mindfulness interventions in clinical practice and generate further hypotheses about the mechanisms of mindfulness.

1.6 Hypotheses

H1. Relative to a regulated breathing-only (BO) control, monitor-only (MO) practice was expected to result in a greater increase from baseline to peak in psychological and physiological stress response measures during a social-evaluative stressor. Relative to control, monitor + accept (MA) practice was expected to attenuate psychological and physiological stress responses (see Figure 1).

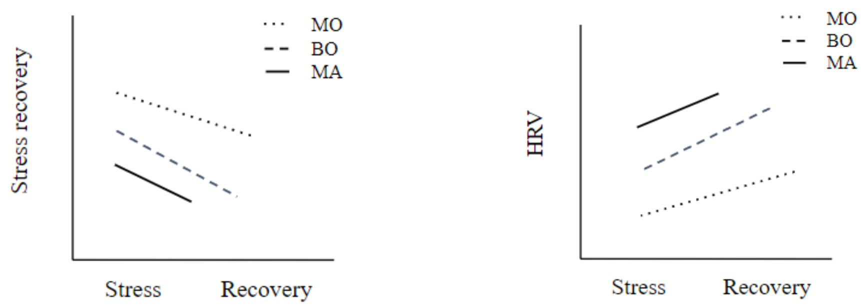


A. B.

Figure 1. Depiction of hypothesis 1 predictions on stress responsivity differences between experimental groups, including distress ratings, cortisol peak, heart rate, and blood pressure (A), as well as HRV (B). MA = monitor & accept condition, MO = monitor-only, BO = breathing-only.

Rationale: Replicating findings from Lindsay and colleague's (2018) seminal study, MA practice was expected to buffer psychological and physiological stress responses to the TSST relative to control which accounts for physiological regulation due to breathing alone (Bernardi et al., 2000; Conrad et al., 2007). This study involved a shorter period (single session vs. 15 sessions in Lindsay's 2018 study) of mindfulness practice which may be initially cognitively demanding among novice meditators, thereby exacerbating stress responses (Creswell et al., 2014; Wadlinger & Isaacowitz, 2011). Furthermore, monitoring without acceptance was expected to facilitate a greater stress response due to increased likelihood of negative self-judgment during practice (Neff, 2003).

H2. Relative to breathing-only control, participants in the MO condition were predicted to display a slower return to baseline on psychological and physiological measures between stress and recovery timepoints. Relative to the control, the MA condition was expected to return to baseline sooner on psychological and physiological measures between stress and recovery timepoints (see Figure 2).



A. B.

Figure 2. Depiction of hypothesis 2 predictions on stress recovery differences between experimental groups, including distress ratings, cortisol peak, heart rate, and blood pressure (A), as well as HRV (B). Simplified relationships from stressor until end of 60-minute recovery period are depicted; actual recovery trajectories are expected to be curvilinear. MA = monitor & accept condition, MO = monitor-only, MO = monitor-only, BO = breathing-only. HRV = heart rate variability, measured as RMSSD and SDNN.

Rationale: Brief mindfulness practice as well as emotional evaluation predicts slower recovery to baseline in some studies (Grant et al., 2013; Low et al., 2008). Monitoring without acceptance (MO) may enhance judgment of internal experiences, thereby increasing likelihood of rumination and prolonging stress response. Monitoring with acceptance (MA) was expected to enhance emotion regulation during present-moment awareness and reduce likelihood of negative self-judgment, thus facilitating faster recovery following stressor resolution.

H3A. Across all condition groups, those higher in trait mindful attention were expected to endorse less psychological and physiological stress reactivity relative to baseline than those with lower levels (see Figure 3).

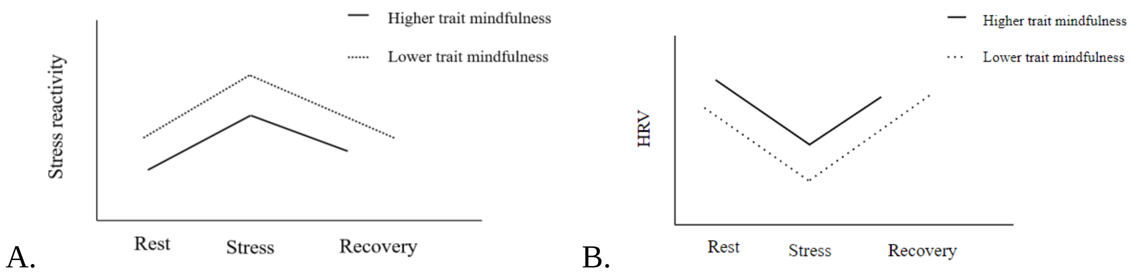
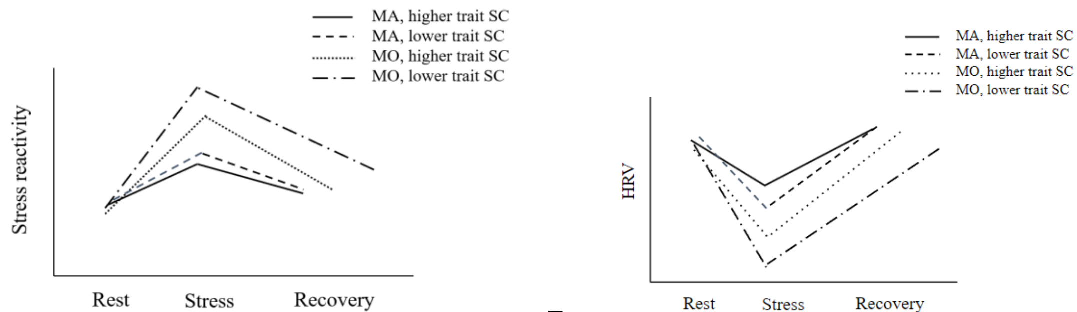


Figure 3. Depiction of hypothesis 3A predictions on stress reactivity differences between those lower and higher in trait mindfulness (measured by MAAS), including distress ratings, cortisol peak, heart rate, and blood pressure (A), as well as HRV (B).

Rationale: Higher trait mindfulness is broadly associated with better mental and physical health (Creswell & Lindsay, 2014), and relatedly may predict higher resting HRV (Sun et al., 2019). Under stress, lower trait mindfulness predicts higher cortisol response to the TSST following mindfulness training (Creswell et al., 2014), and higher trait mindfulness independently buffers cortisol and affective responses as well as sympathetic activity to social stressors (Brown et al., 2012; Kadziolka et al., 2016). Lower levels of trait mindfulness were thus expected to predict heightened stress reactivity as a main effect across conditions relative to those with higher trait mindfulness.

H3B. Within mindfulness conditions (MO, MA), those lower in trait self-compassion in the MO condition were predicted to exhibit the greatest psychological and physiological stress reactivity, relative to MA practice and those higher in trait self-compassion (see Figure 4).



A. B.

Figure 4. Depiction of hypothesis 3B predictions on stress reactivity differences between those lower and higher in trait self-compassion (measured by SCS-SF) by mindfulness condition (MO, MA), including distress ratings, cortisol peak, heart rate, and blood pressure (A), as well as HRV (B). MO = monitor-only. MA = monitor + accept condition. HRV = heart rate variability, measured as RMSSD and SDNN.

Rationale: Lower self-compassion is associated with greater negative affect and high avoidance/low acceptance (Barnard & Curry, 2011; Hayes et al., 2004). As the MO practice excluded experiential acceptance, likely enhancing judgment of internal experiences, this effect and therefore stress reactivity was expected to be enhanced among those who are most likely to be highly judgmental and rejecting of internal experiences.

CHAPTER 2: METHODS

2.1 Study Design

This brief intervention study utilized a 3-arm experimental design consisting of monitor + accept (MA) practice, monitor only (MO) practice, and breathing-only control group. Within- and between-subject effects of each condition on psychological and physiological stress reactivity were investigated. An *a priori* power analysis in G*Power 3.1 (Faul et al., 2009) for repeated measures ANOVA and within-between interactions with three groups, at least seven measurements (cortisol), and nonsphericity correction at one indicated that a total sample size of at least 84 was needed to detect a small effect size (.15) for an alpha level of .05 at 95% power. Participants were initially consented and completed baseline measures at visit one (V1) and if eligible, were randomized into one of the three experimental groups for visit two (V2) using block randomization procedures to equalize groups by sex at birth and use of psychiatric medications.

2.2 Participants

To sample a stressed population at-risk of poor mental and physical health, eligible participants needed to endorse current stress levels at or above the normative mean for college students on the Perceived Stress Scale (PSS ≥ 18; Roberti et al., 2006). Additional inclusion criteria were fluency in English, between ages 18 and 25, and not currently menstruating if female sex to account for well-established age and hormonal impacts on HPA axis function (Kudielka & Kirschbaum, 2004; Narvaez Linares et al., 2020). All female participants had a regular monthly menstrual cycle and were to be in luteal phase at time of TSST completion (e.g., within 5-14 days from ovulation) unless on hormonal birth control.

To minimize impact of moderators known to affect cardiovascular and neuroendocrine reactivity while maximizing external validity of the proposed study to diverse patient populations, exclusion criteria included: anticipating to become, currently, or within the past 12 month pregnant/breastfeeding, history of congenital or cardiovascular/heart disease like heart attack or stroke, past month major depressive episode or other mood episode, psychotic episode, or panic attack, current drug/alcohol misuse (defined as weekly use of any marijuana product, two or more binge drinking episodes, nicotine use greater than social use-only or more than 1x/week, or any other illicit drug use in the past month), body mass index (BMI) ≥ 35 kg/m^2, current daily use of psychotropics known to impact cardiac function (i.e., monoamine oxidase inhibitors, selective norepinephrine reuptake inhibitors, tricyclic antidepressants), current use of any steroid based medication (e.g., oral, inhaled, or injected corticosteroid), current use of hormonal supplementation other than hormonal birth control, any change in allowed psychotropic medications within the past month, or current use of beta-blockers (e.g., propranolol). Given inconsistent daily use of prescribed stimulant medications, participants diagnosed with Attention Deficit/Hyperactivity Disorder who had this prescription were eligible to complete the study experiment at V2 and randomized by psychiatric medication use in order to maximize study recruitment. Additionally, any participant with regular meditation practice (e.g., weekly or more than one hour/week mindfulness meditation) was ineligible, indirectly assessed in study screener by querying for typical stress coping methods and frequency to minimize expectation bias.

Participants were recruited through the University of North Carolina at Charlotte's SONA subject research pool as well as Internet-based sources (e.g., website, email, social media). Recruitment flyers and posted material described the study purpose broadly as relaxation training for stress management and the term ‘mindfulness’ or ‘meditation’ was not used in any study description to minimize potential expectancy effects. This study was approved by the Institutional Review Board (#22-1183) and all participants provided written, informed consent. Compensation for participation was offered as either psychology research course credits or up to $30 in Amazon gift cards, per participant preference.

Approximately 500 UNCC students, almost exclusively undergraduates, were screened for study eligibility; of these, 367 or 73.4% were determined ineligible through the study screener, primarily due to low PSS score (< 18) or recent levels of drug use (e.g., past month binge drinking > 1x in the past month, regular nicotine or cannabis use). Approximately 133 were eligible to be consented. A total of 65 participants were scheduled and consented at V1, completing baseline measures as well as the structured psychiatric interview. Among this recruited sample, 23 young adults were ineligible to complete V2 primarily due to past month psychiatric illness such as major depressive episode or panic attack (n = 16). Another three were ineligible because of menstrual or birth control-related reasons (e.g., irregular cycle, on an IUD, etc.), three more endorsed current drug use such as smoking cannabis at greater than eligibility criteria thresholds (though did not necessarily meet for current substance use disorder), and one was ineligible for other medical reasons.

Of those eligible to complete V2, eight were lost to follow up or uninterested/unavailable to schedule. Another participant was ineligible at V2 due to the current major depressive episode and did not complete the visit. One participant randomized to the breathing only control group (not included in these totals) withdrew consent from the study after experiencing an acute stress reaction during the TSST.

2.3 Protocol

Visit One

This study took place over two visits. The first visit (V1) was conducted in the lab to confirm study eligibility and minimize potential impacts of self-report questionnaires that may elicit emotional responses and otherwise affect outcomes of interest. At this initial in-lab visit, a trained research assistant (RA) reviewed informed consent procedures. Participants were told that the second visit will involve completion of a psychological task, but the TSST was not described until instructions were formally provided at V2 following guided practice and just prior to TSST onset to minimize expectation effects or anticipatory anxiety. Participants' height, weight, and temperature, and resting blood pressure (assessed via arm cuff on non-dominant arm) were collected by a study RA. The temperature check served as confirmation that the participant is not acutely ill, as an elevated body temperature of 99.6 °F or higher may indicate infection. Resting blood pressure (systolic and diastolic mmHg) was averaged across at least three readings to maximize accuracy. A sample of continuous blood pressure via finger cuff was also collected to assess participant fit to the equipment and allow for habituation to collection procedures in V2. To obtain resting HRV values controlling for known impacts of respiration, participants breathed along to a five minute paced breathing task at a rate of approximately 10 breaths per minute. Lastly, the RA conducted a brief structured psychiatric diagnostic interview to confirm study eligibility. Participants then completed self-report questionnaires via Qualtrics at home and were encouraged to complete them by the next day. Prior to V2, eligible participants were randomized to study conditions.

Visit 2

Please see Appendix B for diagram flowchart of study procedures during V2, which was completed on a separate day to maximize scheduling flexibility given necessary eligibility considerations in female participants' menstrual cycles. All second visits began between 12 and 4pm to control for diurnal hormone fluctuations due to circadian rhythms (Rohleder & Nater, 2009). Additionally, all participants were asked to refrain from using recreational drugs and alcohol or engaging in vigorous physical activity at least 24-hours prior as well as to refrain from eating, drinking other than water, or brushing/flossing their teeth for at least one hour prior to scheduled V2.

Upon arrival in the lab, participants were reminded that participation is voluntary, and they may withdraw consent at any time by informing the RA. Participants were instructed to place a Polar™ heart rate monitor (V800) under their shirt and across the sternum with the watch placed on their left wrist. See Appendix K for depiction of watch and band placement. An initial saliva sample was collected by salivette (Sarstedt, Cary, NC) to allow for habituation to collection procedures and was not used in final analyses. Resting blood pressure was collected via arm cuff on the non-dominant arm across three readings. Participants were then refitted with the finger cuff on their non-dominant hand for continuous blood pressure recording during the TSST and recovery period; a two-minute resting sample was initially collected prior to start of guided practice and data recording began immediately following the guided practice and prior to the TSST.

Following equipment set-up, the remainder of the visit was mostly conducted with the participant alone in the room in front of a lab computer to allow for COVID-19 social distancing precautions at time of study initiation as well as feasibility of coordinating multiple RA schedules to conduct the lab-based stressor (this stressor was originally validated for in-person administration; see Gunnar et al., 2021 for validation of virtual administration). HIPAA-compliant Zoom was utilized to protect participant identity. The study RA and principal investigator were also blinded to preassigned study conditions to minimize potential researcher expectancy bias.

To obtain resting HRV, participants breathed along to a five-minute paced breathing task that controlled for respiration impacts on HRV. Next, participants listened to an approximately 20-minute guided audio file that varied by condition group. Please see appendix A for detailed scripts. Following this practice, the RA instructed the participant via Zoom to provide a pre-TSST saliva sample to measure baseline cortisol as well as to complete VAS scales via tablet to assess current stress levels.

The RA via Zoom then provided instructions for the TSST, with additional instruction to apply the technique they just learned about to manage stress during the task. The RA then left the virtual room and a panel of two confederate judges, also blind to study conditions, joined to complete the TSST with the participant.

Following TSST completion, the main RA virtually assisted the participant in completing post-TSST measures, including saliva samples immediately following TSST completion and at 10-, 20-, 30-, 45- and 60-minutes during the recovery window. Distress ratings were measured immediately post-TSST as well as prior to saliva sample collection at 30- and 60-minutes. In between these measures, the main RA had their camera and microphone off. The RA briefly returned to the physical room at the 30-minute mark to stop and restart the equipment to allow for a potential bathroom break and minimize participant burden of the continuous blood pressure cuff.

Through the recovery period, participants did not have access to their phones and were provided with emotionally neutral activities (e.g., coloring pages, puzzles). After the final distress rating and saliva sample at 60-minutes post-TSST, participants were also asked, via open-ended written response, to describe their experiences with the audio practice and how they utilized this technique during the TSST and recovery phases.

Lastly, all participants were debriefed about the TSST protocol and study purpose and provided information about available supportive resources they may access as needed (e.g., UNCC's Counseling and Psychological Services Center) as well as online guided mindfulness meditations and other related resources before leaving the lab.

2.4 Intervention groups

The three conditions in this 3-arm brief intervention study included monitor + accept (MA) practice, monitor-only (MO) practice, and breathing only group to control for physiological impacts of regulated breathing as well as general study variables. Each condition involved listening to an approximately 20-minute guided audio clip that began with a brief psychoeducation describing the practice as helpful for stress management, followed by approximately 20 minutes of experiential practice. Each audio clip was recorded in the same female voice (Dr. Jeanette Bennett) and matched in tone, volume, rate, as well as roughly equivalent in time spent listening and in silent practice. The terms 'mindfulness' or 'meditation' were not used in any audio clip to minimize potential expectancy effects. The guided scripts were adapted from MBSR sitting and body scan meditation practices (Kabat-Zinn, 1982; Potter, n.d.) as well as from Lindsay and colleagues' seminal intervention study testing MAT (2018).

The audio clip for the control condition consisted of regulated breathing practice only and included prompts to continue breathing throughout the practice in between periods of silence. There was no specific instruction to focus attention to the sensation of breathing to maximize the likelihood of mind-wandering.

The audio clip for the MO group instructed participants to practice paying attention to current experiences by focusing on their breath, noticing current bodily sensations, and completing a full body-scan. This practice incorporated awareness of mental distractions with instruction to simply return the attention back to the breath whenever mind-wandering was noticed.

The audio clip for the MA group included additional instruction about the skill of acceptance and how to return attention back to the breath gently and without judgment whenever they notice themselves thinking during the practice. This guided practice was identical to the MO condition except for additional reminders to practice acceptance by allowing all experiences to be as they are, noting feelings and thoughts matter-of-factly and without judgment (e.g., 'this is thinking'), and returning the attention back to the current breath with an attitude of gentle kindness towards self.

2.5 Social-Evaluative Stressor

Following the guided audio practice, participants completed the Trier Social Stress Test (TSST), a standardized social-evaluative acute stressor (Kirschbaum et al., 1993). The TSST consists of a public speaking and mental arithmetic task conducted in front of a panel of confederate "judges" who provided minimal verbal and non-verbal feedback during task completion to elicit a stress response. As this task requires viewing full facial expressions while ongoing COVID-19 precautions were in effect (e.g., wearing face masks during any in-person close interactions) at the start of initial data collection, a validated virtual format was utilized (Fallon et al., 2021; Gunnar et al., 2021). Specifically, participants completed the TSST via Zoom during in-lab data collection to maximize both feasibility and standardization of safe data collection. They remained seated throughout the TSST to remain visible on camera as well as minimize movement that may impact measures of cardiovascular reactivity (Gunnar et al., 2021). Participants joined a Zoom room on a lab computer and were instructed that they have five minutes to prepare for a speech about why they are the best candidate for their dream job for two judges within the virtual room. This panel consisted of at least two trained RAs wearing white lab coats and equipped with clipboards to function as evaluation signifiers. Efforts were made to ensure each judge panel had at least one person of color and one male-presenting confederate to minimize potential differential race or sex/gender-based stress perceptions within this social-evaluative paradigm.

The TSST protocol also included specific instruction to implement the 'stress management technique' that was just practiced to manage stress during the task. Additionally, participants were informed that the task will be recorded for later analysis to maximize perception of evaluation. After a five-minute preparation period, the judges began recording via Zoom and participants each delivered the five-minute speech followed by a five-minute mental arithmetic challenge. The recording file was deleted immediately following the TSST. Please see Appendix C for further information about TSST protocol.

2.6. Self-Report Measures

Sociodemographic confounds

Confounds that have known associations with cardiovascular output or neuroendocrine function were assessed for use as sample descriptors and potential covariates in analyses. Sociodemographic variables (Appendix D) included self-reported age, sex at birth, gender identity, race, ethnic background, and socioeconomic status (SES). As perceived low social status correlates highly with objective measures such as family income (Tan et al., 2020), subjective SES was measured using the MacArthur Scale of Subjective Social Status (Adler et al., 2000). The MacArthur is a single-item measure capturing perceived social rank relative to similar others. It has good test-retest reliability and is a valid measure of subjective SES that has been positively associated with self-reported health (Operario et al., 2004). In this study's total sample with complete self-reports (n = 61), subjective social status on the MacArthur was significantly positively correlated with self-reported physical (r = .9, p = .025) and mental health (r = .27, p = .037).

Comorbidities

Psychiatric morbidities were assessed by the Mini-International Neuropsychiatric Interview (MINI; English version 7.0.2 for DSM-5), an approximately 20-minute structured diagnostic interview of the most common psychiatric diagnoses (Appendix E). The suicidality module was not administered. The MINI has good specificity (.72 - .97) and good inter-rater reliability (κ = .88 – 1.0; Lecrubier et al., 1997). As current acute psychiatric illness may blunt neuroendocrine and cardiovascular stress reactivity, past month major depressive episode, panic attack, and psychotic episode were ineligibility criteria for this study.

State & Trait Mindfulness

Baseline dispositional mindfulness was measured by the Mindful Attention Awareness Scale (MAAS; Appendix F), a widely used 15-item scale of trait present moment awareness (Brown & Ryan, 2003). Participants rated each item along a 6-point Likert scale ranging from 1 (almost always) to 6 (almost never), and scores were summed and averaged to produce a total score for which higher values indicate greater trait mindfulness. This measure demonstrates good internal consistency (α = .82 - .87 in college and non-college samples) and is considered a valid measure of unitary mindfulness (Brown & Ryan, 2003). Cronbach's α in this study's V2 sample ($n = 33$) was .81.

Changes in mindfulness induced by practice in this study were measured using the Toronto Mindfulness Scale (TMS; Appendix G), a 13-item two-factor scale of state present moment awareness with a quality of openness and curiosity (curiosity subscale) as well as the ability to allow experiences to come and go (decentering subscale; Lau et al., 2006). Participants rated each item along a 5-point Likert scale ranging from 0 (not at all) to 5 (very much), and items within each factor were summed to yield two composite scores. Both TMS factors encompass aspects of acceptance and therefore were utilized as a manipulation check of practice effects on mindful acceptance. The TMS is a reliable measure (α = .88 - .93 for curiosity, α = .84 - .91 for decentering) with good construct and criterion validity (Lau et al., 2006). Cronbach's α in this study's V2 sample ($n = 33$) was .84 for the curiosity subscale and .56 for the decentering subscale.

Trait self-compassion

Baseline levels of trait self-compassion were measured using the Self-Compassion Scale - Short Form (SCS-SF; Appendix H), a 12-item measure consisting of 6 subscales: self-kindness, self-judgment, common humanity, isolation, mindfulness, and over-identification (Neff, 2003; Raes et al., 2011). Participants indicated item responses using a 5-point Likert scale ranging from 1 (almost never) to 5 (almost always). The self-judgment, isolation, and over-identification scales were reverse-scored, and all subscales summed into a total score for which higher values indicate greater self-compassion. The SCS-SF is a reliable measure of total self-compassion ($\alpha = .86$) with established content and discriminant validity (Neff et al., 2007; Raes et al., 2011). Cronbach's α in this study's V2 sample ($n = 32$) was .50.

Perceived stress

Study eligibility was proposed as total score at least one standard deviation above the normative mean among college students, or at least 24 or higher on the Perceived Stress Scale (PSS-10; Appendix I), a popular 10-item scale assessing subjective appraisals of uncontrollability, unpredictability, and overload (S. Cohen & Williamson, 1988). Participants respond to each item using a 5-point Likert scale ranging from 0 (never) to 4 (very often) indicating how often they have felt or thought a specific way in the past month. Four positively stated items were reversed scores and then all item ratings were summed to create a total score for which higher values indicate greater perceived stress in the past month. The PSS-10 is demonstrated to have good convergent and divergent validity with good internal consistency ($\alpha = .89$; Roberti et al., 2006). Cronbach's α in this study's V2 sample ($n = 33$) was .674.

Distress ratings

State changes in distress was assessed by visual analog scales (VAS) at 5 timepoints during visit 2: before the TSST, immediately after the speech task, immediately after the math task, as well as at 30- and 60-minutes post-TSST (Hellhammer & Schubert, 2012), 2012). Participants rated via Qualtrics survey how anxious, emotionally insecure, and stressed they currently felt along three bipolar lines anchored from 0 (feeling not stressed/anxious/insecure at all) to 100 (feeling highly stressed/anxious/insecure). Ratings within each timepoint were averaged to create a composite measure of perceived distress. Ratings from the speech and math tasks were averaged together to capture stress during the TSST.

Qualitative responses

Using an open-ended written response format, participants were additionally asked to describe their experiences during intervention practice as well as how they utilized this technique during the stressor. Please see Appendix J for open-ended questions.

2.7 Physiological measures

Heart rate and HRV

Heart rate in beats per minute and HRV were assessed continuously using a H10 Polar® heart rate monitor watch and band, a reliable and valid measure comparable to commonly employed electrocardiograph (ECG) data collection (Tarvainen et al., 2014). Text data files were processed using Kubios v3.3 to correct artifacts and analyzed to provide R-R wave intervals. The same individual processed all samples to control for processor bias across selection of samples. All procedures followed recommendations of the Task Force of the European Society of Cardiology and the North American Society of Pacing Electrophysiology (Malik et al., 1996). The root mean square of successive differences (RMSSD) in the R-R interval as well as the standard deviation of the interbeat interval of normal sinus beats (SDNN) were calculated as time-domain indices of HRV. RMSSD and SDNN (measured in milliseconds) are reliable and valid measures of ventrally mediated HRV that are generally minimally affected by respiratory oscillations and therefore appropriately measured with a heart rate monitor band and watch (Hill et al., 2009). SDNN is affected by both the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS), while RMSSD is comparatively more influenced by the PNS (Shaffer & Ginsberg, 2017).

At least ten two-minute HRV samples were identified and processed for analysis with automatic beat correction and medium artifact correction. Timepoints included at baseline during the paced breathing task, at the end of guided audio practice, under stress during TSST speech task as well as serial subtraction, immediately following the TSST, and throughout recovery at 10-, 20-, 30-, 45- and 60-minutes just prior to each corresponding saliva collection timestamp to minimize movement effects. The average RMSSD and SDNN for each sample was used in analyses, and TSST stress samples were averaged to provide a single value. See Appendix M for a detailed timeline of stress measurements at V2.

Blood pressure

Resting blood pressure was measured by GE Carescape Dinamap V100 to collect systolic and diastolic blood pressure in millimeters Hg. Continuous blood pressure during stress and recovery was measured by a Human NIBP Nano monitoring system using a dual finger cuff system (ADInstruments, Inc., Colorado Springs, CO). Finger cuffs alternated pressure every 15-minutes of recording to minimize participant fatigue during the continuous recording.

Continuous blood pressure data was processed using LabChart. Three total baseline samples were averaged into a single baseline from a one minute recording collected prior to beginning of guided audio practice and another two one-minute samples at restart of recording prior to starting the TSST. The average systolic and diastolic blood pressure in one minute sample segments was then processed for each minute beginning at the start of TSST and through the first five minutes of the recovery (as blood pressure was expected to recover quickly after resolution of the stressor), and then every five minutes through the end of recovery for a total of 32 samples of the stress trajectory.

Cortisol

As an index of HPA axis stress reactivity, circulating cortisol was estimated by saliva sample using a salivette (Sarstedt, Cary, NC). A total of eight saliva samples were collected, with the first habituation sample not used in data analysis. Baseline cortisol was measured following guided audio practice and prior to delivery of TSST instructions. Subsequent saliva samples were collected immediately following TSST completion and 10-, 20-, 30-, 45- and 60-minutes during recovery. See Appendix K for a detailed timeline of stress measurements at V2.

Following completion of the visit, each salivette was weighed and immediately frozen in -80°C freezer. Samples were later analyzed via a commercially available Enzyme-Linked Immunosorbent Assay (ELISA) kit (Salimetrics, State College, PA). All samples were run twice by the same individual (Dr. Jeanette Bennett) to minimize measurement error. Any sample with a coefficient of variation (CV) higher than 10% was also re-run for reliability. Please see Appendix L for further details about the assay protocol.

2.8 Data Analysis

All statistical analyses were conducted in IBM SPSS Statistics Version 28 (Armonk, NY, USA) and at a two-tailed significance level of $\alpha = 0.05$. Categorical variables were dummy coded as 0 or 1 and continuous independent variables mean-centered for ease of interpretation (J. Cohen et al., 2003). Cortisol and HRV values were natural log transformed to reduce skewness.

Sample characteristics were summarized using mean and standard deviation for continuous variables. Count and percentage were used to summarize categorical variables. To evaluate successful randomization, one-way analysis of variance (ANOVA) for continuous variables and chi-squared analyses for categorical variables were conducted to assess for significant differences in characteristics between experimental groups prior to guided practice. Pearson's correlation coefficient assessed linear associations among variables. Significant correlations confirmed relevant confounds to include as potential covariates in analyses.

Quantitative analyses

To examine H1, individual hierarchical linear regressions were utilized to predict stress responses to the TSST for outcomes of interest to the TSST, controlling for significant covariates and respective baseline measures. Covariates that were either significantly different between groups or significantly correlated with key variables of interest were examined as potential confounds and if significant in the model, kept as covariates in the final models for best fit. These same covariates were kept consistent in models of the same dependent variable across hypotheses to compare findings more easily by outcome.

To examine H2, mixed linear modeling (MLM) was utilized for all outcomes to predict stress reactivity trajectories (i.e., change from stress through end of recovery period) of post-stress measures. Time, condition, time*condition, and significant covariates were entered as fixed effects and baseline measures entered as random effects given their propensity to vary randomly across individuals. MLM is preferred over other analyses with three or more timepoints and continuous predictors (e.g., repeated measures ANOVA) as it is more robust to missing data. Restricted maximum likelihood estimation was utilized in all MLMs as this approach yields unbiased estimates of variance and covariance parameters.

To examine H3A, MLM was also utilized to predict stress reactivity trajectories of post-stress measures from trait mindfulness. Significant covariates, presence/absence of manipulation (BO control coded as 0 and MO/MA conditions coded as 1), trait mindfulness (total MAAS score), time, and mindfulness*time were entered as fixed effects and baseline measures as random effects.

For H3B, MLM were conducted within mindfulness groups only to investigate whether trait self-compassion moderates condition effects across time in a three-way interaction. Specifically, stress reactivity trajectories of post-stress measures were outcomes of interest with trait self-compassion (SC; total SCS-SF score), time, mindfulness condition (MO or MA), time*condition, SC*time*condition, and significant covariates as fixed effects. Baseline measures (i.e., before TSST) were included as random effects.

Exploratory qualitative analysis

Categorical themes of qualitative responses to open-ended questions were analyzed by reflexive thematic analysis (Braun & Clarke, 2006, 2021). Given that this exploratory aim is to generate hypotheses about how and for whom mindfulness approaches may be most effective and acceptable, this theoretically flexible approach allows for a data-driven analysis within the context of existing theories and perspectives of mindfulness. This approach thus assumes researcher subjectivity and relies on reiterative and inductive-based identification by this researcher of major semantic themes, or patterns of shared meaning, of individual written responses. A response to an open-ended question could encompass multiple themes. In accordance with Braun and Clarke's analytic strategy (2006), this analysis involved six recursive phases: 1) familiarization with the data, 2) systematic coding of response content meanings and patterns over at least two rounds by this researcher, 3) generating initial themes, 4) developing and reviewing themes, 5) refining and naming themes, and finally, 6) analysis write-up.

CHAPTER 3: RESULTS

3.1 V1 Participant Descriptives

Demographic descriptives for participants who were ineligible (n = 23) and eligible for V2 (n = 42) as well as completers (n = 33) are summarized in-text below (see Table 1).

Table 1. Demographics of all consented participants

Variable		Ineligible for V2 (n = 23)	Eligible for V2 (n = 42)	Completed V2 (n = 33)
Age (years)		21.0 (2.0)	20.3 (2.1)	20.2 (2.1)
Sex at birth	*Female*	78.3% (n = 18)	69.0% (n = 29)	63.6% (n = 21)
Gender identity	*Cisgender Female*	73.9% (n = 17)	59.5% (n = 25)	51.5% (n = 17)
	Cisgender Male	17.4% (n = 4)	28.6% (n = 12)	33.3% (n = 11)
	Non-binary/ transgender	8.7% (n = 2)	11.9% (n = 5)	15.1% (n = 5)
Ethnoracial identity	*White, non-Hispanic*	26.1% (n = 6)	40.5% (n = 17)	42.4% (n = 14)
	White, Hispanic	8.7% (n = 2)	4.8% (n = 2)	6.1% (n = 2)
	Asian	21.7% (n = 5)	21.4% (n = 9)	24.2% (n = 8)
	Black/African-Am.	26.1% (n = 6)	11.9% (n = 5)	6.1% (n = 2)
	Multiracial	17.4% (n = 4)	14.3% (n = 6)	18.2% (n = 6)
U.S. born		65.2% (n = 15)	76.2% (n = 32)	81.8% (n = 27)
1st generation college student		17.4% (n = 4)	33.3% (n = 14)	36.4% (n = 12)
Subjective social status		5.1 (1.6)	5.0 (1.7)	5.0 (1.7)

Note. Means and standard deviations or percentages reported. Subjective social status is per MacArthur Subjective Social Status ladder relative to others in the United States; higher scores on scale 1-10 indicate higher perceived social status.

Ineligible participants were not significantly different from eligible participants on any demographic variables ($p > .05$). Overall, the recruited V1 sample was predominantly female sex with some diversity in gender identity (5 non-binary, 1 male-to-female transgender, 1 female-to-male transgender). Per study criteria, no participants were on hormone replacement therapy and all participants of female sex at birth had regular monthly menstrual cycles. Participants were majority non-white and non-

Hispanic, U.S. born, and of middle-class socioeconomic status, as subjectively reported. Among participants who completed V2, a total of 5 (15.2%) participants identified as non-binary or transgender, 6 (18.2%) reported being born outside of the US, 5 (15.2%) identified as Hispanic, and 6 (18.2%) self-identified as bi- or multi-racial. An additional 12 (36.4%) reported being a first-generation college student.

Self-reported mental and physical health descriptive data for participants ineligible for V2, eligible, and completers are summarized in-text below (see Table 2).

Table 2. Lab-measured and self-reported health variables at visit 1

Variable		Ineligible for V2 (n = 23)	Eligible for V2 (n = 42)	Completed V2 (n = 33)
BMI (kg/m^2)		26.0 (5.6)	23.8 (4.2)	23.7 (4.4)
V1 resting blood pressure (mmHg)	*Systolic*	107.5 (8.3)	105.1 (9.5)	105.4 (9.1)
	Diastolic	63.4 (6.1)	62.1 (5.8)	62.4 (6.0)
Screener PSS		25.1 (4.2)	23.5 (3.3)	23.6 (3.3)
No physical health comorbidities		60.9% (n = 14)	69% (n = 29)	66.7% (n = 22)
Self-reported physical health		13.2 (2.8)	13.9 (2.2)	13.7 (2.2)
Self-reported mental health		10.8 (3.1)	12.3(2.6)	12.3 (2.4)
Depressive symptoms		27.7 (11.8)	17.4 (10.4)	18.4 (10.7)
At least 1 psychiatric diagnosis		95.7% (n = 22)*	71.4% (n = 30)	75.8% (n = 25)
On psychiatric medication		17.4% (n = 4)	14.3% (n = 6)	15.2% (n = 5)
In mental health treatment now		26.1% (n = 6)	26.2% (n = 11)	27.3% (n = 9)

Note. Means and standard deviations or percentages reported. * $p < .05$ indicates group difference between ineligible and eligible for V2. BMI = body mass index. PSS = Perceived Stress Scale. Self-reported health is from average global physical and mental health scores on Patient-Reported Outcomes Measurement Information System (PROMIS) Global Health Short Form. Depressive symptoms are from Center for Epidemiological Studies – Depression (CES-D) scale; a total of 16 or greater suggests risk of major depressive episode.

Most of the recruited sample met for at least 1 psychiatric diagnosis on the MINI (most commonly Major Depressive Disorder and/or an anxiety disorder), though most were not currently on psychiatric medication or in mental health treatment. Those ineligible for V2 were not significantly different from eligible participants on perceived stress at screening, PROMIS self-reported physical or mental health, BMI, resting blood pressure at V1, depressive symptoms, use of psychiatric medication, or participation in current mental health treatment ($p > .05$). Ineligible participants were more likely to meet criteria for a psychiatric diagnosis [χ^2 (1, N = 65) = 5.45, $p = .02$]. Additionally, those who were eligible but did not complete V2 (n = 9) were not significantly different from those who completed V2 (n = 33) on any demographic variable or health-related variables. Overall, these descriptive findings suggest that eligibility screening procedures were successful in parsing out participants who were likely generalizable to the study population of interest (stressed young adults) from those who were more acutely ill with clinically significant psychiatric symptoms in the past month.

3.2 V2 Participant Descriptives

Participants who completed V2 (n = 33) were randomized to one of three guided practice groups by sex and current use of any psychiatric medication to equalize expected confound effects. A total of 11 participants were in the breathing control condition, 10 were in the monitor-only condition, and 12 were in the monitor + accept condition. TSST judge panels were balanced with respect to confederate gender and racial presentations for over half of participants (73.7% control, 90% MO, and 58.3% MA). One participant in the monitor-only group was systematically missing all HRV data due to equipment error at time of data collection. Please see table 3 in-text below for a summary of demographic variables by study group and table 4 for health-related variables and predictors of interest.

Table 3. Demographics of participants who completed V2 by study condition

Variable		BO (n = 11)	MO (n = 10)	MA (n = 12)
Age (years)		20.0 (2.4)	20.6 (2.4)	20.1 (1.8)
Sex at birth	*Female*	63.6% (n = 7)	60% (n = 6)	66.7% (n = 8)
Gender identity	*Cisgender Female*	45.5% (n = 5)	60% (n = 6)	50% (n = 6)
	Cisgender Male	36.4% (n = 4)	40% (n = 4)	25% (n = 3)
	Non-binary/ transgender	18.2% (n = 2)	0% (n = 0)	25% (n = 3)
Ethnoracial identity	*White, non-Hispanic*	45.5% (n = 5)	30% (n = 3)	50% (n = 6)
	White, Hispanic	0% (n = 0)	20% (n = 2)	0% (n = 0)
	Asian	27.3% (n = 3)	20% (n = 2)	25% (n = 3)
	Black/African-Am.	18.2% (n = 2)	0% (n = 0)	0% (n = 0)
	Multiracial	9.1% (n = 1)	20% (n = 2)	25% (n = 3)
Hispanic ethnicity		0% (n = 0)	40% (n = 4)*	8.3% (n = 1)
U.S. born		90.9% (n = 10)	60% (n = 6)	91.7% (n = 11)
1^{st} generation college student		9.1% (n = 1)*	60% (n = 6)	41.7% (n = 5)
Subjective social status		6.0 (1.2)	4.3 (1.9) †	4.6 (1.7)

Note. Means and standard deviations or percentages reported. * $p < .05$, † $p < .1$ BO = breathing only control. MO = monitor-only condition. MA = monitor + accept condition. Subjective social status is per MacArthur Subjective Social Status ladder relative to others in the United States; higher scores on scale 1-10 indicate higher perceived social status.

Table 4. Lab-measured and self-reported health variables for V2 completers

Variable	BO (n = 11)	MO (n = 10)	MA (n = 12)
BMI (kg/m^2)	24.2 (4.3)	23.4 (4.8)	23.5 (4.5)
Females on birth control	28.6% (n = 2)	0% (n = 0)	62.5% (n = 5)*
Screener PSS	24.3 (3.0)	23.5 (4.0)	23.2 (4.0)
No physical health comorbidities	72.7% (n = 8)	80% (n = 8)	50% (n = 6)
Self-reported physical health	13.5 (1.3)	13.1 (3.0)	14.5 (2.0)
Self-reported mental health	12.0 (2.9)	11.6 (2.5)	13.3 (1.7)
Depressive symptoms	17.5 (10.3)	23.1 (13.9)	15.3 (6.9)
At least 1 psychiatric diagnosis	90.9% (n = 10)	60% (n = 6)	75% (n = 9)
On psychiatric medication	9.1% (n = 1)	20% (n =2)	26.7% (n = 2)
In mental health treatment now	18.2% (n = 2)	30% (n = 3)	33.3% (n = 4)
Trait mindfulness	3.3 (.7)	3.6 (.7)	3.6 (.7)
Trait self-compassion	2.5 (.5)	2.8 (.4)	2.6 (.5)

Note. Means and standard deviations or percentages reported. * $p < .05$, † $p < .1$. BO = breathing only control. MO = monitor-only condition. MA = monitor + accept condition. BMI = body mass index. BP = blood pressure. PSS = Perceived Stress Scale. Self-reported health is from average global physical and mental health scores on Patient-Reported Outcomes Measurement Information System (PROMIS) Global Health Short Form. Depressive symptoms are from Center for Epidemiological Studies – Depression (CES-D) scale; a total of 16 or greater suggests risk of major depressive episode.

Regarding psychiatric and physical health comorbidities, 18 (54.5%) of those who completed V2 met diagnostic criteria on the MINI for Major Depressive Disorder and 12 (36.4%) of these reported recurrent (2+) major depressive episodes. An additional three participants met criteria for another mood disorder (bipolar type I or other bipolar related). Three (9.1%) endorsed a history of panic disorder as well as social anxiety disorder. Two (6.1%) met criteria for a mild Alcohol Use Disorder within the past 12 months (though were eligible to complete V2 due to below cutoff threshold of <1x/month binge drinking in past three months). Another five (15.2%) additionally reported a diagnosis of Attention Deficit/Hyperactivity Disorder by a physician and were either previously or currently on stimulant medications to treat this condition. Current use of psychiatric medication at time of V2 included antidepressants (n = 1; sertraline, mirtazapine), anti-psychotics (n = 2; aripiprazole), mood stabilizers (n = 1; lamotrigine), and stimulants (n = 2; lisdexamfetamine). Thus, while the majority of participants who completed the study experiment met diagnostic criteria for at least one mental health disorder in their lifetime, most (n = 28) were not on psychiatric medication at V2.

Additionally, no participant reported a medical history of heart attack/failure, stroke, diabetes, cancer, other major organ disease (e.g., renal, liver), or HIV/AIDS. Twenty-two (66.7%) of the V2 sample did not report any other comorbid disorder, and 8 (24.2%) reported one, most commonly allergies. Two (3%) reported 2 physical health comorbidities. Thus, the majority of the V2 sample was in relatively good physical health with little to no chronic physical health issues.

3.3 Group Differences

Group differences between the three study conditions were examined using one-way ANOVAs for continuous variables and Chi-square for categorical variables. The groups were significantly different in subjective social status (F[2, 30) = 3.41, p = .046), with the breathing only control group endorsing marginally higher subjective social status (6.0) relative to the MO (4.3) or MA (4.6) groups, as revealed by a post-hoc Tukey's HSD test for multiple comparisons (p = .066, 95% CI = -3.49, .09; p = .066, 95% CI = -.090, 3.49, respectively). The breathing only control group also had significantly fewer 1st generation college students (n = 1) compared to the MO (n = 6) or MA groups (n = 5) [χ^2 (2, N = 33) = 6.10, p = .047]. The MO group had a significantly higher number of

Hispanic/Latine participants (n = 4) relative to the control (n = 0) or MA (n = 1) groups [χ^2 (2, N = 33) = 7.20, p = .027].

Additionally, females by study condition significantly differed in use of birth control [χ^2(2, N = 21) = 6.13, p = .047]. A majority (62.5%, n = 5) of female participants in the MA group were on birth control and therefore completed V2 at any time (other than during menstruation) in their cycle, compared to just two female participants (28.6%) in the breathing only control and none in the MO group.

There were no other significant group differences in demographic variables, including age, sex, gender identity, ethnoracial identity, or U.S. birth (see Table 3). There were no other significant differences between groups in self-reported or lab-measured health-related variables, including perceived stress, self-reported physical or mental health, depressive symptoms, trait mindfulness, trait self-compassion, number of physical health comorbidities, presence of psychiatric diagnosis, use of psychiatric medication or current mental health treatment, resting blood pressure, body mass index, or mean heart rate during the paced breathing task or at the end of the guided practice (see Tables 4 and 5; p's > .05). There were no significant differences in outcome variables of interest prior to the TSST (see Table 5 below).

Table 5. Pre-TSST outcomes of interest for V2 completers

Variable		BO (n = 11)	MO (n = 10)	MA (n = 12)
pre-TSST VAS		15.0 (11.3)	8.3 (9.3)	11.9 (7.7)
pre-TSST mean cortisol (ug/dL)		.15 (.055)	.26 (.21) †	.16 (.10)
PBT HR (bpm)		81.9 (17.3)	91.1 (14.5)	85.3 (12.1)
PBT SDNN (ms)		70.9 (43.0) †	40.4 (20.7)	47.1 (26.9)
PBT RMSSD (ms)		64.3 (49.5) †	27.8 (18.6)	36.8 (26.0)
End GA HR (bpm)		69.4 (12.8)	76.4 (12.6)	75.4 (13.7)
End GA SDNN (ms)		94.2 (28.2)	66.0 (20.2)	70.5 (44.1)
End GA RMSSD (ms)		76.3 (40.8)	48.5 (23.4)	57.3 (40.4)
V2 resting BP (mmHg)	*Systolic*	105.7 (6.9)	101.9 (9.0)	105.6 (7.9)
	Diastolic	62.1 (3.1)	60.2 (7.6)	61.3 (4.3)

Note. Means and standard deviations or percentages reported. † $.05 < p < .1$. BO = breathing only control. MO = monitor-only condition. MA = monitor + accept condition. TSST = Trier Social Stress Test. VAS = visual analog scale, measured from 0-100 on sliding scale. ug/dL = micrograms per deciliter. PBT = 5-min paced breathing task. bpm = beats per minute. GA = guided audio. HR = heart rate. SDNN = Standard deviation of all normal-to-normal R-R intervals. ms = millisecond. RMSSD = root mean square of successive differences between normal heartbeats. BP = blood pressure. mmHg = millimeters of mercury.

There was a trending difference in mean cortisol, measured just after the guided audio practice and prior to TSST initiation, between groups ($F[2, 30) = 2.64$, $p = .088$), with the MO group exhibiting non-significantly higher average cortisol relative to the other groups. There were also trending differences in heart rate variability (SDNN $F[2, 29) = 2.60$, $p = .092$); RMSSD $F[2, 29) = 3.14$, $p = .058$) during the paced breathing task (though not at the end of the guided audio practice) between groups, such that the BO group exhibited non-significantly higher HRV during the paced breathing task relative to the other groups.

3.4 Correlations

Please see table 6 in appendix M for a summary of correlations of model variables. Correlational relationships between variables of interest and possible confounds were examined using Pearson's r for continuous variables and binary dichotomous variables (point biserial correlation). Resting blood pressure values measured by arm cuff are reported for correlational relationships given better accuracy of readings with this measure compared to continuous finger cuff measurement. Additionally, paced breathing task HRV values are described here as a purer measure of HRV due to the effect of respiration being controlled for. Given very small subsample sizes (n < 5), ethnoracial identity was recoded into 0 for non-Hispanic white and 1 for all other minority status identities to allow for multiple comparisons of significant relationships and simple detection of effects that may be related to minority stress status (in the US).

Significant and nearly significant associations with predictors (trait mindfulness, self-compassion) and outcomes of interest (cortisol, HRV, resting blood pressure, heart rate, distress ratings) are described below.

Participants on psychiatric medication endorsed significantly lower trait self-compassion [r_{pb} (31) = -.44, p = .011]. There was a trending negative correlation between self-compassion and perceived stress (r = -.33, p = .064), and a trending positive correlation between self-compassion and baseline cortisol following the guided audio practice (r = .33, p = .065).

Higher trait mindfulness was associated with higher BMI (r = .36, p = .040), and higher baseline cortisol following the guided audio practice (r = .38, p = .029). There was a trending negative correlation between trait mindfulness and perceived stress (*r* = -.31, *p* = .076) as well as baseline distress ratings prior to the TSST (*r* = -.33, *p* = .057).

Participants on psychiatric medication displayed significantly lower SDNN (*r* = -.38, *p* = .034) and near significantly lower RMSSD (*r* = -.35, *p* = .050) on the paced breathing task. Better sleep quality was significantly correlated with higher SDNN (*r* = .38, *p* = .037) and RMSSD (*r* = .370, *p* = .044) during the paced breathing task.

Those on psychiatric medication also displayed significantly higher heart rate during the paced breathing task [r_{pb} (31) = .50, *p* = .004]. Higher heart rate during paced breathing was significantly associated with lower levels of physical activity over the past week (*r* = -.46, *p* = .013; *r* = -.51, *p* = .006).

Older age was significantly associated with higher resting systolic blood pressure (*r* = .346, *p* = .049). Sex at birth was significantly associated with resting blood pressure; participants of female sex displayed lower resting systolic [r_{pb} (31) = -.480, *p* = .005] and diastolic [r_{pb} (31) = -.37, *p* = .034] blood pressure relative to males. Ethnoracial minorities also exhibited significantly lower resting systolic blood pressure (*r* = -.37, *p* = .036). Higher resting systolic blood pressure was significantly positively correlated with higher BMI (*r* = .390, *p* = .026).

Baseline distress as measured by average VAS score prior to the TSST was significantly negatively correlated with age (*r* = -.44, *p* = .010), such that older participants endorsed lower distress. Distress was also significantly positively associated with SDNN (*r* = .39, *p* = .032) and RMSSD (*r* = .40, *p* = .028) during the paced breathing task.

3.5 Outliers

In accordance with study protocols, no participant who completed V2 reported past 24-hour nicotine, caffeine, or recreational drug use. No participant reported eating or drinking liquids other than water within one hour prior to the start of V2. One participant in the MO group reported past 24-hour alcohol use of up to five beers the night prior as well as brushing and flossing his teeth in the hour prior to the visit start. Examination of this participant's data for outliers revealed very high cortisol values greater than 2.5 standard deviations from the group mean. Another participant, in the MA group, reported strenuous exercise the morning of the study visit and displayed very low cortisol values more than -2.5 standard deviations from the group mean. Both participants were flagged to exclude in sensitivity analyses in cortisol models to determine if results differed based on these potential confounds. No other potential outliers in study variables of interest were identified.

3.6 Data Missingness

One participant in the V2 sample had no HRV or heart rate data due to data collection failure associated with the Polar equipment throughout the visit. Another participant was also missing the SCS due to noncompletion of self-reports. Additionally, data collection for the continuous blood pressure monitor at V2 could not be completed for 22 individuals for whom the finger cuff either never successfully switched or recording terminated prematurely for analyzable data, most likely due to poor cuff fit size. Thus, blood pressure through stress and recovery could only be processed for 11 participants, with one group including just three participants. A *post-hoc* power analysis in G*Power 3.1 (Faul et al., 2009) for repeated measures ANOVA and within-between interactions with three groups, 32 measurements, and nonsphericity correction at 1 indicated that a total sample size of at least 36 would have been needed to detect a small effect size (.15) for an alpha level of .05 at 95% power. Given this lack of power to detect a significant effect in conjunction with very low number of participants in each group to validly conduct group comparisons, it was determined that analyses using the proposed methods in this dissertation could not be validly completed. Please see figure 9 and figure 10 in Appendix N for raw systolic and diastolic blood pressure values over time, respectively.

3.7 Manipulation checks

As a manipulation check of whether study conditions differentially impacted state mindfulness, participants completed the Toronto Mindfulness Scale (TMS) immediately following the guided practice and prior to the TSST. One-way ANOVAs revealed that there were no significant differences in group average scores on either the curious or decenter subscales of the TMS ($p > .05$). Of note, the MA group did endorse on average the highest state mindfulness on both subscales relative to the other groups.

Following completion of the experiment and all other study measures, participants were asked explicitly about lifetime frequency of prior mindfulness meditation experience, if any. This had been previously asked indirectly within a stress coping question on the screener to mitigate risk of expectation bias and to exclude prior to consent those who reported regular meditation practice from a list of multiple stress coping methods (e.g., exercise, distraction, etc.). A total of five (45.5%) participants in the breathing only control endorsed prior meditation experience at the end of the study, with four participants reporting approximately 3-10x in lifetime and one endorsing ‘very rare’ weekly practice. A total of seven (70%) of participants in the MO condition endorsed meditation experience, with five reporting 3-10x in lifetime and two reporting 1-3x in lifetime. A total of six (50%) of participants in the MA condition reported lifetime meditation experience, specifically three participants endorsing 3-10x in lifetime, two reporting 1-3x in lifetime, and one reporting 'sometimes' engaging in weekly practice. Thus, while the screening process was somewhat successful at recruiting meditation- naïve participants, no participants who completed the study experiment were regular or highly experienced meditators.

3.8 H1: Stress response by condition

To investigate whether the stress response to the TSST differed by study condition, data was analyzed using hierarchical linear regression models. Continuous predictors were mean centered for ease of interpretation. Cortisol as well as HRV variables were log transformed due to skewed raw distributions. All models controlled for baseline values to assess change from baseline to stress. Figures of raw data are in Appendix N.

Cortisol. For each participant, peak cortisol value in response to the lab stressor was identified and used as the dependent variable. There was no significant difference between either mindfulness conditions and the BO condition on the cortisol stress response, controlling for sex at birth and preTSST cortisol (see Table 6 below). Findings did not change when either cortisol outliers (n = 2) or those on psychiatric medication (n = 5) were excluded from the analysis.

Table 6. Summary of the hierarchical linear regression predicting cortisol peak

Step	Variable	B	S.E.	β	R^2	ΔR^2
1	preTSST cortisol	.65	.19	.48**	.42	.42
	Sex at birth	-.24	.10	-.34*		
2	MO	.04	.12	.06	.42	.003
	MA	.03	.11	.04		

Note. N = 33. ** *p* < .01, * *p* < .05. TSST = Trier Social Stress Test. Sex is coded 0 = male, 1 = female. *B* = unstandardized beta coefficient. β = standardized beta coefficient. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

RMSSD. Controlling for presence of psychiatric medication, subjective social status, and RMSSD at the end of guided audio practice, there was no significant difference between either mindfulness conditions and the BO condition on RMSSD stress response (see Table 7).

Table 7. Hierarchical linear regression predicting RMSSD at stress

Step	Variable	*b*	S.E.	β	R^2	ΔR^2
1	preTSST RMSSD	.63	.14**	.59	.70	.70
	Psychiatric medication	-.22	.11†	-.25		
	SSS	.070	.02**	.34		
2	MO	-.01	.10	-.10	.70	.002
	MA	-.04	.09	-.06		

Note. N = 32. ** *p* < .01, † *p* < .10. TSST = Trier Social Stress Test. Psychiatric medication is coded 0 = absence, 1 = presence at V2. SSS = subjective social status, as measured by the MacArthur. *B* = unstandardized beta coefficient. β = standardized beta coefficient. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

SDNN. There was also no significant difference between either of the mindfulness conditions and the BO condition on SDNN stress response, controlling for presence of psychiatric medication, subjective social status, and SDNN at the end of guided audio practice (see Table 8).

Table 8. Hierarchical linear regression predicting SDNN at stress

Step	Variable	*b*	S.E.	β	R^2	ΔR^2
1	preTSST SDNN	.50	.14	.48**	.63	.63
	Psychiatric medication	-.22	.09	-.33*		
	SSS	.05	.05	.33*		
2	MO	.01	.08	.02	.63	.001
	MA	.01	.08	.01		

Note. N = 32. ** *p* < .01, * *p* < .05. TSST = Trier Social Stress Test. SDNN = Standard deviation of all normal-to-normal R-R (NN) intervals. Psychiatric medication is coded 0 = absence, 1 = presence at V2. SSS = subjective social status, as measured by the MacArthur. *B* = unstandardized beta coefficient. β = standardized beta coefficient. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

HR. Controlling for sex at birth, subjective social status, and HR at the end of the guided audio practice, there were no significant difference between of the mindfulness conditions and the BO condition on HR stress response (see Table 9).

Table 9. Hierarchical linear regression predicting HR at stress

Step	Variable	*b*	S.E.	β	R^2	ΔR^2
1	preTSST HR	.67	.15	.56**	.61	.61
	Sex at birth	6.3	4.2	.18		
	SSS	-3.9	1.11	-.42**		
2	MO	-.66	5.35	-.02	.61	.00
	MA	-.36	4.97	-.01		

Note. N = 32. ** $p < .01$. TSST = Trier Social Stress Test. HR = heart rate, in bpm. Sex is coded 0 = male, 1 = female. SSS = subjective social status, as measured by the MacArthur. β = standardized beta coefficient. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

Subjective distress. Controlling for self-reported distress prior to the TSST, there was no significant difference between either of the mindfulness conditions and the BO condition on self-reported stress response (see Table 10).

Table 10. Hierarchical linear regression predicting VAS at stress

Step	Variable	*b*	S.E.	β	R^2	ΔR^2
1	preTSST VAS	.68	.47	.25	.06	.06
2	MO	-4.6	11.6	-.09	.10	.04
	MA	6.8	10.7	.13		

Note. N = 33. TSST = Trier Social Stress Test. VAS = visual analogue scale. β = standardized beta coefficient. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

3.9 H2: Stress reactivity by condition

Mixed linear models were used to examine whether stress reactivity through recovery differed by study condition. Baseline values were included as random effects in the models. All outcomes other than cortisol appeared to vary little following the end of the stressor, not demonstrating variations across recovery timepoints. Some fluctuations were observed around the 30-minute mark, however, these appeared likely related to engagement in data collection procedures (i.e., when the RA re-entered the physical room at the 30-min mark to briefly stop equipment and offer a potential bathroom break before restarting) rather than in response to the lab stressor of study interest (see figures). Accordingly, data from all recovery time points (10-, 20-, 30-, 45-, and 60-minutes) were averaged together for HRV, HR, and distress ratings to improve model fit.

Cortisol. Controlling for sex at birth, there was a significant time effect on cortisol reactivity, such that salivary cortisol increased from baseline to stressor and decreased from the stressor through recovery ($p < .001$). There was no significant main effect of condition or interaction effect of condition by time. Please see table 11 in-text below for summary statistics. Results did not change when the two cortisol outliers or those on psychiatric medication (n = 5) were excluded from the sample.

Table 11. Estimates of random and fixed effects of mixed linear model (MLM) examining condition by time effects on cortisol recovery from the TSST

Variables	Estimate	S.E.
Random Effects		
preTSST cortisol	.46	.65
Fixed Effects		
Intercept	-.09	.09
Sex	-.14**	.03
MO condition	.04	.09
MA condition	.02	.08
Time	-.03**	.02
MO condition*Time	.006	.02
MA condition*Time	.001	.02

Note. N = 33. ** denotes p < .01. TSST = Trier Social Stress Test. Sex is coded 0 for male, 1 for female. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

RMSSD. There was a significant time effect on RMSSD reactivity ($p = .002$; see Table 12), such that RMSSD decreased from baseline to stressor and increased from stressor to recovery. There was no significant effect of condition or condition by time, controlling for subjective social status and psychiatric medication.

Table 12. Estimates of random and fixed effects of MLM examining condition by time effects on RMSSD recovery from the TSST

Variables	Estimate	S.E.
Random Effects		
preTSST RMSSD	.50	.72
Fixed Effects		
Intercept	.05	.20
SSS	.04*	.01
Psychiatric medication	-.11	.08
MO condition	-.07	.19
MA condition	-.11	.18
Time	.05**	.11
MO condition*Time	.02	.12
MA condition*Time	.05	.11

Note. N = 32. ** denotes p < .01, * denotes .01 ≤ *p* < .05. TSST = Trier Social Stress Test. RMSSD = root mean squared of successive differences. SSS = subjective social status, as measured by the MacArthur. Psychiatric medication is coded 0 = absence, 1 = presence at V2. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

SDNN. There were no significant time, condition, or condition by time effects on SDNN reactivity, controlling for the same covariates (*p*'s > .05, see table 13).

Table 13. Estimates of random and fixed effects of MLM examining condition by time effects on SDNN recovery from the TSST

Variables	Estimate	S.E.
Random Effects		
preTSST SDNN	.25	.37
Fixed Effects		
Intercept	.53*	.20
SSS	.02*	.01
Psychiatric medication	-.19**	.06
MO condition	-.06	.16
MA condition	-.07	.15
Time	.03	.07
MO condition*Time	.03	.10
MA condition*Time	.05	.03

Note. N = 32. ** denotes p < .01, * denotes .01 ≤ *p* < .05. TSST = Trier Social Stress Test. SDNN = Standard deviation of all normal-to-normal R-R (NN) intervals. SSS = subjective social status, as measured by the MacArthur. Psychiatric medication is coded 0 = absence, 1 = presence at V2. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

HR. Controlling for sex at birth and subjective social status, there was a significant time effect on HR reactivity, such that HR increased from baseline to stressor and decreased from the stressor through recovery ($p < .001$, see table 14). There was no significant main effect of condition or interactive effect between condition by time.

Table 14. Estimates of random and fixed effects of MLM examining condition by time effects on HR recovery from the TSST

Variables	Estimate	S.E.
Random Effects		
preTSST HR	.62	.88
Fixed Effects		
Intercept	47.42**	8.65
SSS	-1.98**	.55
Sex at birth	-2.43	1.82
MO condition	2.70	10.66
MA condition	4.21	9.90
Time	-14.42**	3.80
MO condition*Time	-1.42	5.67
MA condition*Time	-2.58	5.26

Note. N = 32. ** denotes p < .01. TSST = Trier Social Stress Test. HR = heart rate, in bpm. SSS = subjective social status, as measured by the MacArthur. Sex is coded 0 for male, 1 for female. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

Subjective distress. There was a significant time effect on distress reactivity, such that distress increased from baseline to stressor and decreased from the stressor through recovery ($p < .001$, see table 15). There was no significant main effect of condition or interactive effect between condition by time.

Table 15. Estimates of random and fixed effects of MLM examining condition by time effects on self-reported distress recovery from the TSST

Variables	Estimate	S.E.
Random Effects		
preTSST VAS	.16	.28
Fixed Effects		
Intercept	86.22**	15.73
MO condition	-10.16	22.47
MA condition	14.15	21.44
Time	-38.33**	8.30
MO condition*Time	3.67	12.03
MA condition*Time	-8.33	11.49

Note. N = 33. ** denotes p < .01. S.E. = standard error. TSST = Trier Social Stress Test. VAS = visual analogue scale. MO = monitor-only condition. MA = monitor + accept condition.

3.10 H3A: Effect of trait mindfulness

Mixed linear models examined whether trait mindfulness had a main effect on stress reactivity across groups. Presence of manipulation (coded 0 = breathing only control, 1 = either MO or MA condition) was controlled for in all models as a fixed effect, and baseline values of outcome included as a random effect.

Additionally, data quality checks in self-report data suggested evidence that at least some participants' data may be unreliable across at least two measures. Three participants total (two in the MO group and one in the MA group) were flagged for possible unreliable self-report data and excluded from the sample in sensitivity analyses.

Cortisol. Controlling for sex at birth and manipulation presence, there was a significant time effect, such that salivary cortisol increased from baseline to stressor and decreased from the stressor through recovery ($p < .001$; see table 16 in-text below). There was no significant main effect of trait mindfulness or interactive effect between mindfulness by time. Results held whether cortisol outliers (n = 2) or those on psychiatric medication (n = 5) or those flagged for unreliable self-report data (n = 3) were excluded from the sample.

Table 16. Estimates of random and fixed effects of MLM by trait mindfulness on cortisol reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST cortisol	.41	.59
Fixed Effects		
Intercept	-.12	.08
Sex	-.13**	.03
Manipulation	.03	.03
Trait mindfulness	.06	.05
Time	-.03**	.01
Trait mindfulness*Time	-.003	.01

Note. N = 33. ** denotes p < .01. TSST = Trier Social Stress Test. Sex is coded 0 for male, 1 for female. Manipulation coded as 0 = control, 1 = MO or MA condition. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

RMSSD. There was a significant time effect on RMSSD reactivity, such that RMSSD decreased from baseline to stressor and increased from the stressor through recovery (p = .001; see Table 17). There was no significant effect of trait mindfulness or interactive effect between mindfulness by time, controlling for subjective social status, psychiatric medication, and manipulation presence. Results did not change if those flagged for unreliable self-report data (n = 3) were excluded from the sample.

Table 17. Estimates of random and fixed effects of MLM by trait mindfulness on RMSSD reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST RMSSD	.50	.72
Fixed Effects		
Intercept	.02	.17
SSS	.04*	.01
Psychiatric medication	-.11	.07
Manipulation	-.03	.05
Trait mindfulness	.13	.11
Time	.15**	.04
Trait mindfulness*Time	-.09	.07

Note. N = 32. ** denotes p < .01, * denotes .01 ≤ *p* < .05. TSST = Trier Social Stress Test. RMSSD = root mean square of successive differences. SSS = subjective social status, as measured by the MacArthur. Psychiatric medication is coded 0 = absence, 1 = presence at V2. Manipulation coded as 0 = control, 1 = MO or MA condition. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

SDNN. There were no significant time, condition, or condition by time effects on SDNN reactivity, controlling for subjective social status, psychiatric medication, and manipulation presence (*p*'s > .05, see table 18). Results did not change if those flagged for unreliable self-report data (n = 3) were excluded from the sample.

Table 18. Estimates of random and fixed effects of MLM by trait mindfulness on SDNN reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST SDNN	.24	.36
Fixed Effects		
Intercept	.50**	.18
SSS	.02*	.01
Psychiatric medication	-.19**	.06
Manipulation	-.003	.05
Trait mindfulness	.11	.10
Time	.05	.04
Trait mindfulness*Time	-.08	.06

Note. N = 32. ** denotes p < .01, * denotes .01 ≤ *p* < .05. TSST = Trier Social Stress Test. SDNN = standard deviation of normal RR intervals. SSS = subjective social status, as measured by the MacArthur. Psychiatric medication is coded 0 = absence, 1 = presence at V2. Manipulation coded as 0 = control, 1 = MO or MA condition. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

HR. Controlling for sex at birth, subjective social status, and manipulation presence, there was a significant time effect on HR reactivity, such that HR increased from baseline to stressor and decreased from the stressor through recovery (*p* < .001, see table 19 in-text below). There was no significant main effect of trait mindfulness or interactive effect between mindfulness by time. Results did not change if those flagged for unreliable self-report data (n = 3) were excluded from the sample.

Table 19. Estimates of random and fixed effects of MLM by trait mindfulness on HR reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST HR	.62	.88
Fixed Effects		
Intercept	50.02**	6.73
SSS	-1.99**	.55
Sex at birth	-2.41	1.89
Manipulation	-.30	2.00
Trait mindfulness	-1.58	6.24
Time	-15.77**	2.21
Trait mindfulness*Time	.94	3.33

Note. N = 32. ** denotes p < .01. TSST = Trier Social Stress Test. HR = heart rate, in bpm. SSS = subjective social status, as measured by the MacArthur. Sex is coded 0 for male, 1 for female. Manipulation coded as 0 = control, 1 = MO or MA condition. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

Subjective distress. Controlling for manipulation presence, there was a significant time effect on distress reactivity, such that distress increased from baseline to stressor and decreased from the stressor through recovery (*p* < .001, see table 20). There was no significant trait mindfulness or interactive effect between mindfulness by time. Results did not change if those flagged for unreliable self-report data (n = 3) were excluded from the sample.

Table 20. Estimates of random and fixed effects of MLM by trait mindfulness on self-reported distress reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST VAS	.19	.33
Fixed Effects		
Intercept	89.21	9.77
Manipulation	-2.14	3.97
Trait mindfulness	-3.08	13.58
Time	-40.25**	4.81
Trait mindfulness*Time	2.10	7.25

Note. N = 33. ** denotes p < .01. TSST = Trier Social Stress Test. VAS = visual analogue scale. Manipulation coded as 0 = control, 1 = MO or MA condition. S.E. = standard error. MO = monitor-only condition. MA = monitor + accept condition.

3.11 H3B: Effect of trait self-compassion by mindfulness condition

Mixed linear models also investigated whether levels of trait self-compassion moderated stress reactivity by mindfulness intervention condition. Those in the breathing only control group were therefore excluded from these analyses. Covariates were included as fixed effects and baseline values of outcome included as a random effect.

Cortisol. Controlling for sex at birth, mindfulness condition, and trait self-compassion, there was a significant time effect on cortisol reactivity in the total sample of 21, such that salivary cortisol increased from baseline to stressor and decreased from the stressor through recovery ($p = .022$; see table 21). There was no significant effect of trait self-compassion by mindfulness condition by time. Results did not change if either cortisol outliers (n = 2) or those on psychiatric medication (n = 5) or those flagged for unreliable self-report data (n = 3) were excluded from analysis.

Table 21. Estimates of random and fixed effects of MLM examining self-compassion by mindfulness condition interaction on cortisol reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST cortisol	.60	.86
Fixed Effects		
Intercept		
Sex	-.13**	.04
Mindfulness condition	.04	.10
SC	-.17	.17
Time	-.04*	.12
Condition*Time	-.02	.02
Condition*SC	-.28	.23
SC*Time	.02	.04
Condition*SC*Time	.06	.06

Note. N = 21. ** denotes p < .01, * denotes .01 ≤ *p* < .05. TSST = Trier Social Stress Test. Sex is coded 0 = male, 1 = female. Mindfulness condition coded as 0 = monitor-only, 1 = monitor + accept. SC = trait self-compassion.

RMSSD. There was a significant time effect on RMSSD reactivity in the total sample of 20 (*p* = .01; see Table 22), controlling for subjective social status, psychiatric medication, mindfulness condition, and trait self-compassion. RMSSD decreased from baseline to stressor and increased from the stressor through recovery. There was no significant effect of trait self-compassion by mindfulness condition by time. Results did not change if those flagged for unreliable self-report data (n = 3) were excluded from the sample.

Table 22. Estimates of random and fixed effects of MLM by self-compassion as moderator of RMSSD reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST RMSSD	.31	.47
Fixed Effects		
Intercept	.17	.21
SSS	.05**	.02
Psychiatric medication	-.20	.12
Mindfulness condition	-.01	.21
SC	.03	.36
Time	.15*	.08
Condition*Time	-.02	.12
Condition*SC	-.08	.48
SC*Time	-.05	.20
Condition*SC*Time	.13	.27

Note. N = 20. ** denotes p < .01, † *p* < .10. TSST = Trier Social Stress Test. RMSSSD = root mean square of successive differences. SSS = subjective social status, as measured by the MacArthur. Psychiatric medication is coded 0 = absence, 1 = presence at V2. Mindfulness condition coded as 0 = monitor-only, 1 = monitor + accept. S.E. = standard error. SC = trait self-compassion. MO = monitor-only condition. MA = monitor + accept condition.

SDNN. In the total sample of 20, there was no significant time or trait self-compassion by mindfulness condition by time effect on SDNN reactivity, controlling for subjective social status, psychiatric medication, mindfulness condition, and trait self-compassion (*p*'s > .05, see table X). Results did not change if those flagged for unreliable self-report data (n = 3) were excluded from the sample.

Table 23. Estimates of random and fixed effects of MLM by self-compassion as moderator of SDNN reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST SDNN	.25	.38
Fixed Effects		
Intercept	.46*	.19
SSS	.04**	.01
Psychiatric medication	-.21**	.08
Mindfulness condition	.00	.17
Trait self-compassion	.13	.27
Time	.06	.06
Condition*Time	-.02	.09
Condition*SC	-.19	.36
SC*Time	.06	.15
Condition*SC*Time	.21	.20

Note. N = 20. ** denotes p < .01, * denotes .01 ≤ *p* < .05. TSST = Trier Social Stress Test. SDNN = standard deviation of all normal RR intervals. SSS = subjective social status, as measured by the MacArthur. Psychiatric medication is coded 0 = absence, 1 = presence at V2. Mindfulness condition coded as 0 = monitor only, 1 = monitor + accept. S.E. = standard error. SC = trait self-compassion. MO = monitor-only condition. MA = monitor + accept condition.

HR. Controlling for sex at birth, subjective social status, mindfulness condition, and trait self-compassion, there was a significant time effect on HR reactivity, such that distress increased from baseline to stressor and decreased from the stressor through recovery ($p < .001$, see table 24). There was no significant effect of trait self-compassion by mindfulness condition by time. Results did not change if those flagged for unreliable self-report data (n = 3) were excluded from the sample.

Table 24. Estimates of random and fixed effects of MLM by self-compassion as moderator of HR reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST HR	.55	.79
Fixed Effects		
Intercept	52.93**	10.68
SSS	-2.29**	.64
Sex at birth	-3.38	2.43
Mindfulness condition	-1.04	2.43
Trait self-compassion	-5.92	20.26
Time	-16.22**	4.20
Condition*Time	.28	6.38
Condition*SC	2.31	27.50
SC*Time	1.64	10.66
Condition*SC*Time	-3.74	14.50

Note. N = 20. ** denotes p < .01. TSST = Trier Social Stress Test. HR = heart rate, in bpm. SSS = subjective social status, as measured by the MacArthur. Sex is coded 0 = male, 1 = female. Mindfulness condition coded as 0 = monitor only, 1 = monitor + accept. S.E. = standard error. SC = trait self-compassion. MO = monitor-only condition. MA = monitor + accept condition.

Subjective distress. Controlling for mindfulness condition and trait self-compassion, there was a significant time effect on distress reactivity ($p < .001$, see table 25). There was no significant effect of trait self-compassion by mindfulness condition by time. Results did not change if those flagged for unreliable self-report data (n = 3) were excluded from the sample.

Table 25. Estimates of random and fixed effects of MLM by self-compassion as moderator of self-reported distress reactivity

Variables	Estimate	S.E.
Random Effects		
preTSST VAS	.32	.61
Fixed Effects		
Intercept	89.63**	15.01
Mindfulness condition	9.89	21.70
Trait self-compassion	52.58	36.98
Time	-41.98**	7.96
Condition*Time	-5.07	11.86
Condition*SC	84.83	49.89
SC*Time	-32.44	20.19
Condition*SC*Time	-47.55	27.27

Note. N = 21. ** denotes p < .01. TSST = Trier Social Stress Test. VAS = visual analogue scale. Mindfulness condition coded as 0 = monitor only, 1 = monitor + accept. S.E. = standard error. SC = trait self-compassion. MO = monitor-only condition. MA = monitor + accept condition.

3.12 Exploratory Qualitative Analysis and Post-Recovery Questions

Participant experiences with and perceptions of the ‘stress management’ techniques during practice (i.e., at rest) and during stress were investigated using a data-driven qualitative exploratory thematic analysis of open-ended responses. Categorical themes were iteratively identified and coded by the study investigator in two rounds approximately two months apart and while blinded to study conditions. A written response could be coded in multiple categories if more than one major theme was identified in the text, and subcategories within a major theme could be additionally identified if appropriate. Additionally, simple descriptive statistics were calculated for Likert-scale items of post-recovery questions.

What were participants’ experiences like with the guided practice?

Participants were first asked to describe in writing their experiences with learning the guided practice at rest. See table 27 in appendix O for summary of thematic categories and subcategories identified by qualitative analysis, and table 29 in appendix O for a complete listing of participant responses.

In the breathing only control group, a total of six (54.5%) responses described the guided practice as relaxing or calming, four (36.4%) as enjoyable or interesting, and five (45.5%) as helpful or useful. The helpful/useful categorical included responses noting that the practice facilitated mind-body awareness, present moment awareness (described as "center[ing] myself") and distancing oneself from thoughts. The latter response described that the practice "allowed me to distance myself from my anxieties". One response (9.1%) also described the practice as simple and easy to learn, while another (9.1%) reported it was at least initially more difficult. One response (9.1%) reported that the practice increased drowsiness. Another (9.1%) was neutral, describing the practice only as "fine".

In the monitor only (MO) group, a total of five (55.6%) responses described the practice as relaxing or calming, two (22.3%) as enjoyable or interesting, and four (44.5%) as helpful or useful. Within the latter category, one (11.2%) response appeared to describe reduced rumination, writing that "the technique really helped minimize my stress as I was thinking about the stressors I currently have". Two responses (22.3%) noted that the practice increased drowsiness and one (11.2%) endorsed needing more time to practice the technique. One participant in the MO condition did not directly answer the question prompt, describing instead feeling stressed during the TSST.

In the monitor + accept (MA) group, a total of five (45.5%) responses described the practice as relaxing or calming, four (36.4%) as enjoyable or interesting, and three (27.3%) as helpful or useful with one response endorsing increased mind-body awareness and another noting increased acceptance of sensations and feelings. Two responses (18.2%) reported needing more time to practice, another two endorsed the practice as simple or easy to learn, and another two reported that the practice was at least initially more difficult to engage with. One response (9.2%) described the practice as “boring” and another reported increased drowsiness. One participant in the MA condition also did not directly answer the question prompt, describing instead feeling stressed during the TSST.

How did participants utilize the technique during stress?

When asked specifically about how they used the technique to manage stress during the TSST (see Table 28 in appendix O for summary of thematic categories and subcategories), a total of seven responses (63.6%) in the BO group endorsed the technique as helpful, with five (45.5%) reporting that it facilitated relaxation or reduced stress/feelings of overwhelm. Additionally, two responses (18.2%) described that practicing this technique during the TSST gave them time to think or refocus, another (9.1%) described increased mind-body awareness, and another (9.1%) reported increased present moment awareness, described as ‘centering’. Five responses (45.5%) endorsed the technique as not helpful or difficult to use, more specifically while talking ($n = 1$, 9.1%), because it was hard to remember to use during the task ($n = 1$, 9.1%), because of feeling too stressed/anxious ($n = 1$, 9.1%), or because they needed more practice to effectively use (n = 1, 9.1%). Another two (18.2%) responses described minimally using the technique from the guided practice during the TSST.

In the MO group, a total of six responses in (60%) endorsed the technique as helpful, with three of these responses (30%) specifically mentioning that use of the focused breathing gave them time to think or refocus on the task, one response (10%) describing that it reduced rumination, and another describing present moment awareness, or 'grounding'. A total of five responses (50%) in the MO group endorsed the technique as difficult to use while talking during the task (n = 2, 20%) and/or because they felt too stressed/anxious to effectively use (n = 3, 30%). Another three (30%) responses described employing a different strategy to manage stress other than the guided practice that they were instructed to use; specifically, two responses (20%) described cognitive reframing-based strategies (e.g., "I would have been too anxious to make a real career sales pitch, so I just made up a fun one instead", "[I tried] to realize it was not a serious situation and of course figure out that anyone can make mistakes"). Another described that he "took [his] time" without clear indication that this was related to intentional use of the study strategy.

In the MA group, a total of six (50%) responses described the technique as helpful. Specifically, three (25%) reported that it allowed time to think or refocus, two (16.7%) endorsed increased present moment awareness, one (8.3%) described reduced rumination, and another described reduced anxiety. Another 2 (16.7%) responses described using acceptance, writing, "when I started to feel stressed I would accept the hard things around me then focus on my breathing and try again" and "[I] told myself that 'this is what it is' a few times to accept the task ahead of me". A total of three responses (25%) described the technique as difficult to use while talking or focused on the task (n =

1, 8.3%) or because of feeling too stressed/anxious to effectively use (n = 2, 16.7%). Two responses (16.7%) reported using the technique only minimally. Another described using cognitive reframing to manage stress, writing, “I reminded myself that it was a research study, and not an actual interview and attempted to remind myself the quality of what I say wasn’t as important”.

How helpful was the technique to manage stress?

In addition to the open-ended written response questions above, participants were also asked to rate on a 5-point Likert scale how helpful the technique they had practiced was to manage stress during the TSST. In the BO control, six participants (54.5%) rated the technique as unhelpful, three (27.3%) were neutral, and two (18.2%) endorsed it as helpful. In the MO condition, three participants (30%) rated the technique as unhelpful, three (30%) were neutral (i.e., neither unhelpful or helpful), and four (40%) endorsed it as helpful. In the MA condition, four participants (33.4%) endorsed it as unhelpful, four (33.4%) were neutral, and four (33.4%) rated it as helpful. Thus, breathing only was proportionally more likely to be rated as unhelpful relative to the mindfulness conditions. No participant rated any of the experimental conditions as ‘very unhelpful’ or ‘very helpful’.

How was the technique utilized during recovery?

Participants were next asked whether they employed the technique during the 60-minute recovery period (though they had not been instructed to do so), and if so, to describe how. Responses were summarized generally as follows (see table Y for complete listing): 10 participants (100%) in the breathing only control reported utilizing focused or controlled breathing to calm down and to “ground”, in addition to reframing or “thinking positive” about the situation and focusing on the recovery activities for distraction. Seven participants (70%) in the MO group described utilizing awareness of the breath to calm down and to “ground”. A total of nine participants (75%) in the MA group also described utilizing awareness of the breath and other sensations as well as acceptance of thoughts and feelings, in addition to controlling “negative thoughts” and focusing on the recovery activities for distraction.

How likely are participants to utilize the technique again?

Participants were also asked to rate on a 5-point Likert scale how likely they are to utilize the technique they learned again with a real-world stressor. In the breathing only control group, one (9.1%) participant reported unlikely, two were neutral (i.e., neither unlikely or likely), four (36.4%) rated as likely, and another four (36.4%) rated as very likely. In the MO group, one (10%) participant reported unlikely, two (20%) were neutral, six (60%) rated likely and one (10%) rated as very likely. In the MA group, one (8.3%) participant rated as very unlikely to use again, one (8.3%) was neutral, six endorsed as likely, and four rated as very likely to utilize this technique again to manage stress.

CHAPTER 4: DISCUSSION

This mechanistic investigation sought to test the stress-buffering effects of a single session mindfulness practice in stressed young adults, a population at elevated risk of lifetime mental and physical chronic illness, and for whom evidence-based prevention efforts to improve stress management are critically needed. To identify individual-level characteristics that might predict intervention efficacy, this study also investigated the moderating effect of trait mindfulness as well as trait self-compassion on physiological and psychological stress responses. Lastly, participants' perceptions of mindfulness practices following study completion were examined through qualitative analysis of open-ended written responses to inform future mindfulness investigations. Overall, H1 - H3B hypotheses were not supported by any of the quantitative analyses. Themes identified from qualitative analysis of participants' perceptions of and experiences with the three study conditions illuminate possible reasons for the lack of significant quantitative findings and suggest directions for future research, described below.

Results from this investigation were inconsistent with prior research that supported Lindsay & Creswell's Monitor & Acceptance Theory (MAT, 2017), which posits that present moment awareness may exacerbate stress reactivity when stripped of experiential acceptance skills. Lindsay and colleagues' seminal dismantling study (2018) demonstrated monitoring and acceptance was more effective than monitor-only in lowering cortisol and systolic blood pressure stress reactivity to the TSST. However, this study conducted a 3-week intervention. It may be that a single session, as investigated in our study, is insufficient time to effectively utilize mindfulness skills to modulate stress reactivity, and a longer duration of practice is needed to observe significant differences.

Additionally, Lindsay and colleagues (2018) utilized a cognitive reappraisal and coping skills intervention as the active control group in their study, thus distinguishing the effects of mindfulness-based approaches from a different kind of metacognitive rather than physiologically based stress management tool. Similar studies supporting the stress-buffering hypothesis have also utilized meta-cognitive active controls such as cognitive training (cf. Slonena & Elkins, 2021) or guided audio to focus on mental phenomena (cf. Miller et al., 2021). In the present study, regulated breathing was chosen as the control to account for the known physiological relaxation effects of altered breathing alone. This allowed us the potential to parse out the meta-cognitive effects attributed to mindfulness from physiological relaxation effects, and so examine mechanisms of mindfulness as a distinct quality of consciousness that may modulate stress appraisals and downstream stress reactivity, consistent with the stress buffering hypothesis (Creswell & Lindsay, 2014). Despite these theoretical distinctions, the lack of statistically significant differences in the present study suggests that regulated breathing practice and active components of mindfulness meditation may have comparable effects on relaxation and state mindfulness, perhaps especially in a single session format. That is, a deeper and slower rate of breathing (which is itself a commonly employed relaxation technique) and increased awareness of body sensations, whether explicitly or implicitly instructed, may be common factors across these conditions, thus making any differences in impacts on stress reactivity between conditions negligible when controlling for breathing alone. The lack of significant differences between groups in state mindful awareness following guided practice supports this. Moreover, all three groups exhibited lower heart rate and higher heart rate variability following the guided practice (see Table 5), suggesting that all conditions were physiologically calming. Moreover, the stress buffering effects of regulated breathing common across conditions may have been especially potent as a stress-buffering intervention particularly for this study's high stress participants, given their increased disposition toward stress vulnerability.

Further, participant descriptions of their experiences during guided practice suggest that all conditions were perceived favorably and as having a calming or relaxing effect for most participants. Interestingly, at least three responses in the breathing-only control included descriptions of increased present moment and mind-body awareness as well as increased distance from thoughts as internal mechanisms despite the breathing-only practice's repetitious instruction of regulated counting of the breath throughout the 20-minute guided audio (see script in appendix A), which had been expected to likely generate feelings of boredom and elicit mind-wandering over time. These responses further support the idea that regulated breathing may have increased mindful awareness for at least some participants.

Relatedly, different participants' interpretations of the guided audio practice likely played a role in how they responded to and implemented the various techniques. Assessment of participants' degree of meditation experience and practice at the end of V2 (only implicitly assessed on the online study screener prior to consent to mitigate expectation bias) revealed that most participants did have some exposure to mindfulness previously. Though no participants were regular practitioners, the study sample overall was not naïve to the study intervention. As such, participants' mindful awareness during study participation may have been influenced by prior conceptualizations of and experiences with mindfulness. This prior exposure will likely continue to be a factor to account for in future mindfulness investigations, given the increasing popularity of and ubiquitous incorporation of mindfulness as a stress management tool in Western culture at large.

Alternatively, null findings may be explained by a lack of power to detect significant group differences. For example, and counter to some of the evidence described above suggesting similar effects of conditions, regulated breathing was quantitatively rated as ‘unhelpful’ under stress by a higher proportion of participants in the BO group compared to either mindfulness condition, despite comparative endorsements of both helpfulness and unhelpfulness across conditions in qualitative data. Further, while state mindfulness scores between conditions were not statistically different at the end of guided practice, the MA group displayed the highest mean, followed by the MO group and then the BO group. These data suggest that a larger sample size may have revealed meaningful differences between conditions.

Restriction of study eligibility was a significant contributor to this study’s small sample size. A high number of exclusionary criteria were needed to investigate a physiological outcome like cortisol to control for known confounds that would otherwise have obscured detection of any study-related effects due to biological heterogeneity. Additionally, exclusion based on acute psychiatric distress was necessary for both ethical and investigatory reasons, as the potential for extreme reactions to the lab-based stressor could be harmful to a vulnerable participant and may also compromise data integrity by introducing significant outliers in the physiological data. While increasing internal validity, these eligibility restrictions notably limited the sample size.

Despite multiple efforts to recruit participants within and outside of the university as well as high interest in study participation, roughly one in every three of the 500 students who completed the study screener was not eligible to schedule a lab visit. Of those initially eligible and consented, approximately one-third were not eligible to participate in V2, primarily due to endorsement of a major depressive episode or panic attack within the past month. The necessary restrictions to study eligibility and subsequent difficulties with study enrollment highlight both the significant barriers to, and enormous importance of, conducting this type of investigation in an at-risk population of stressed young adults. Furthermore, the majority of participants who completed the study, despite high stress levels and lifetime prevalence of at least one psychiatric disorder, were not currently in psychiatric treatment. As such, this population may be more likely to seek and practice self-directed stress management tools outside of the context of formal psychological treatment, underscoring the need for translational investigations into preventative approaches that can be feasibly employed in diverse settings (e.g., primary care, stress management workshops, first-year experience seminars, etc.).

Additionally, a minority of participants across all conditions also endorsed increased drowsiness during practice, initial difficulty engaging in the practice, and desiring more time to practice. These responses underscore the importance of identifying individual-level characteristics that may predict intervention efficacy, particularly in brief settings, as well as a patient-centered focus in clinical practice (e.g., normalizing the discomfort of learning a new skill, processing experiences with mindfulness practice, identifying barriers to practice, integrating patient preferences, etc.). Overall, the heterogeneity in perceptions suggests that both acceptability of and skill with mindfulness practice varied across participants, potentially influencing responses when they were tasked to implement the practice under stress.

Another consideration is that the single session practice may have been too short to observe distinct meta-cognitive effects between monitoring alone and monitoring with acceptance, especially under the challenge of social stress. Though the stress-buffering hypothesis suggests a high stress context may be the most useful condition for the salutary effects of mindfulness, it is also highly demanding to employ a new or unfamiliar skill, particularly in this stress-vulnerable sample. Employing any novel emotion regulation skill, especially one as complex as experiential acceptance, in this context potentially increased cognitive load and further exacerbated stress reactivity.

For example, participants in all three conditions commented that the stress management technique was difficult to effectively employ while feeling stressed and specifically while talking or focused on task performance. Effective stress management training, regardless of specific intervention, may be strengthened with psychoeducation about and practice with employing a given technique in the context of stress. In other words, the skill of mindfulness in a neutral setting under quiet conditions of (as is often done in clinical practice), may differ considerably during active stress or under duress, particularly when the skill is new. Future research can further inform clinical practice by clarifying how at-risk populations learn and practice mindful awareness and acceptance under stress, particularly in the context of *in vivo* real-world stressors.

Additionally, descriptive findings from this study that those with more severe psychopathology, indexed by use of psychiatric medication, were significantly less self-compassionate support the investigation of trait mindfulness and trait self-compassion as relevant individual characteristics that may explain heterogeneity in responses to mindfulness interventions. This association may indicate that vulnerable populations who are likely most helped by present moment awareness and experiential acceptance (congruent with the stress-buffering hypothesis of mindfulness) may also struggle the most to learn and effectively implement mindfulness strategies to manage stress. While the absence of significant findings in this study cannot support this hypothesis, it does not preclude its possibility. Moreover, research to date suggests that many individuals experience at least one adverse effect during mindfulness meditation, including increased symptoms of anxiety, depression, and even psychosis (Dobkin et al., 2012; Lomas et al., 2015; Shapiro, 1992). Additional research examining individual-level predictors of mindfulness efficacy and acceptability is needed to clarify who may be most helped by mindfulness interventions and how to maximize benefits vs. mitigate potential harms.

The present study has several notable strengths, including the well-controlled 3-arm study dismantling design in this mechanistic investigation. The validated lab-based stressor also allows for comparison of study findings to other similar studies while controlling for potential confounds. Further, the comparison of an active control to isolate physiological regulation from breathing alone as well as comparison between active ingredients of mindfulness meditation (present moment awareness, acceptance) are important methodological approaches to clarify how mindfulness as a metacognitive construct may buffer stress. Approximately half of all randomized controlled trials to date have used passive or waitlist controls to investigate mindfulness-based investigation (Goldberg et al., 2022), resulting in considerable heterogeneity in statistically significant effect sizes. When active controls have been used as the basis for comparison, they often vary in their similarity to meditation, thus limiting conclusions about their unique effects (Farias & Wikholm, 2016). For instance, both attentive listening to psychoeducational material (Sleimen-Malkoun et al., 2023) and progressive muscle relaxation (Somaraju et al., 2023) have been described as active controls in recent brief mindfulness investigations. Relatedly, this present study's theoretically driven hypothesis testing is a relative strength, as this is often lacking in mindfulness research, which is still in a nascent stage of investigation (*Nature Mental Health*, 2023).

Other strengths include the relative diversity of this sample with respect to both demographic and clinical characteristics, supporting the potential generalizability of any study findings. In contrast to the majority of psychological research conducted in US undergraduate samples (Henrich et al., 2010), this study was relatively diverse with respect to race/ethnicity, gender identity, socioeconomic, and immigration status, despite its small sample size. Additionally, significant efforts were made to minimize potential differential racial and gendered perceptions of this study's lab-based social evaluative stressor by balancing and tracking the racial and gender composition of confederate judge panels, an intersectional consideration that is rarely if ever incorporated into TSST study designs.

Further, the inclusion of a diverse range of psychiatric comorbidities (e.g., history of bipolar disorder, substance use disorder) which are excluded in many acute biobehavioral lab stressor investigations offers potential translational implications of study findings to real-world clinical settings in which a diversity of comorbid clinical presentations is the norm rather than the exception. Here, we sought to balance the methodological necessity of restricting physiological heterogeneity while also maximizing external validity as much as possible. For example, we included individuals with a history of bipolar disorder who were on psychiatric medication and currently in a euthymic phase because meta-analytic findings suggest non-significant differences in cortisol levels between non-psychiatric controls and those with bipolar disorder meeting those criteria (medicated, euthymic phase), and especially in the afternoon which was when V2 was completed (Belvederi Murri et al., 2015).

Conversely, our findings may have been limited by the selection of a highly stressed sample in context of a single session practice, which may have been too high of a stress acuity and in too short of a time frame to observe significant differences. Other limitations include our exclusively undergraduate sample as efforts to recruit in the larger community were unfortunately not fruitful. Undergraduate college students are incentivized to participate in research studies in part to fulfill required course credit and are thus potentially less intrinsically invested in study participation. Relatedly, evidence of lower reliability in study self-report measures (e.g., self-compassion scale) may reflect a limitation of allowing undergraduate participants to complete select self-reports at home following V1, when they were likely more distracted with other demands. The reliability of these measures would likely have been strengthened by completing all self-reports in the more controlled lab environment. Additionally, respiration rate at rest was not measured in this study, which would have strengthened the HRV analyses by parsing out known impacts of respiration.

4.1 Implications for Clinicians

This study offers several potential implications for clinical practice, particularly health psychologists addressing stress as a key target for health behavior change and managing chronic conditions (e.g., smoking cessation, chronic pain, etc.). If regulated breathing alone is comparable to the stress buffering effects of mindfulness-based approaches, this approach should be introduced first as a stress management tool, as it will likely be more acceptable to a diverse population and indirectly facilitate mindful awareness without explicitly incorporating a meditation practice. Further, the wide variety of patient reactions to mindfulness meditation must be considered in context of patient-centered practice that incorporates patient preferences to maximize the efficacy of psychological interventions. Mindfulness interventions cannot be a one-size fit approach, and given the potential for adverse experiences, informed consent about the potential risks as well as benefits in conjunction with empowering patient autonomy to stop the practice at any point should always precede introduction to mindfulness.

Additionally, a single mindfulness practice conducted in a neutral setting may be too little time to be demonstrably effective for stress management, especially in those most at-risk of developing stress-related disorders. However, this may be the only amount of time available to deploy the intervention, such as in primary care settings or brief psychoeducational group formats (e.g., smoking cessation group). Providers may boost the efficacy of mindfulness as a stress management tool by discussing and ideally, practicing mindfulness with patients when stress or discomfort arises, to bridge patients' learning gap between neutral practice and real-world use more effectively. Relatedly, providers should collaboratively work with patients to identify specific behavioral goals to practice mindfulness, whether formally through guided meditation or informally in everyday life (e.g., while walking, doing dishes, etc.).

4.2 Implications for Mindfulness-Based Research

This study also underscores the importance of studying feasible stress management interventions in stressed young adults who are at risk of developing both chronic mental and physical illnesses over their lifetime. Additional research to clarify who is most vulnerable to adverse reactions to mindfulness interventions, and under what conditions, will also support greater acceptability of this popular tool as well as expand scientific conceptualization of mindfulness as a metacognitive construct.

Despite its lack of significant findings, this study also underscores the importance of considering the inseparable mind-body connection in mindfulness research. Our attempt to compare a presumably "bottom-up" control based in physiological relaxation with a meta-cognitive mindfulness practice did not yield meaningful differences between breathing alone and mindfulness practice on stress reactivity, possibly due in part to the "top-down" effects that were associated with regulated breathing alone. The relative contribution of mindfulness skills may be negligible above and beyond regulated breathing and its physiological as well as likely metacognitive effects that buffer stress reactivity. Future mindfulness research, conducted in a larger and adequately powered sample to detect a small effect size, would be strengthened by inclusion of clear rationale for the selection of a particular active control, and what non-specific effects it is expected to account for.

4.3 Conclusion

In summary, this mechanistic investigation of the physiological and psychological stress-buffering effects of brief mindfulness meditation offers directions for future research in stress-vulnerable young adults for whom feasible evidence-based prevention efforts to improve stress management are needed. Research questions and hypotheses generated from this study include clarifying the amount and context of mindfulness practice (i.e., under rest vs. stress) that is minimally needed to observe stress-buffering effects as well as investigating how mindfulness is most effectively learned in stressed populations to modulate stress reactivity. Additionally, investigating to what extent mindful awareness is a key component in stress management interventions such as regulated breathing can inform both mindfulness research methodology (i.e., use of active controls) and clinical practice.

REFERENCES

Adler, N., Epel, E., Castellazzo, G., & Ickovics, J. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy white women. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association*, *19*(6). https://doi.org/10.1037//0278-6133.19.6.586

Andes, L. J., Cheng, Y. J., Rolka, D. B., Gregg, E. W., & Imperatore, G. (2020). Prevalence of Prediabetes Among Adolescents and Young Adults in the United States, 2005-2016. *JAMA Pediatrics*, *174*(2), e194498. https://doi.org/10.1001/jamapediatrics.2019.4498

Appelhans, B. M., & Luecken, L. J. (2006). Heart rate variability as an index of regulated emotional responding. *Review of General Psychology*, *10*(3), 229–240. https://doi.org/10.1037/1089-2680.10.3.229

Azam, M. A., Katz, J., Fashler, S. R., Changoor, T., Azargive, S., & Ritvo, P. (2015). Heart rate variability is enhanced in controls but not maladaptive perfectionists during brief mindfulness meditation following stress-induction: A stratified-randomized trial. *International Journal of Psychophysiology: Official Journal of the International Organization of Psychophysiology*, *98*(1), 27–34. https://doi.org/10.1016/j.ijpsycho.2015.06.005

Azam, M. A., Katz, J., Mohabir, V., & Ritvo, P. (2016). Individuals with tension and migraine headaches exhibit increased heart rate variability during post-stress mindfulness meditation practice but a decrease during a post-stress control condition – A randomized, controlled experiment. *International Journal of Psychophysiology*, *110*, 66–74. https://doi.org/10.1016/j.ijpsycho.2016.10.011

Barnard, L. K., & Curry, J. F. (2011). Self-Compassion: Conceptualizations, Correlates, & Interventions. *Review of General Psychology*, *15*(4), 289–303. https://doi.org/10.1037/a0025754

Barnes, S., & Lynn, S. (2010). Mindfulness Skills and Depressive Symptoms: A Longitudinal Study. *Imagination, Cognition and Personality*, *30*, 77–91. https://doi.org/10.2190/IC.30.1.e

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*(3), 497–529.

Beauchaine, T. P., & Thayer, J. F. (2015). Heart rate variability as a transdiagnostic biomarker of psychopathology. *International Journal of Psychophysiology*, *98*(2, Part 2), 338–350. https://doi.org/10.1016/j.ijpsycho.2015.08.004

Belvederi Murri, M., Prestia, D., Mondelli, V., Pariante, C., Patti, S., Olivieri, B., Arzani, C.,

Masotti, M., Respino, M., Antonioli, M., Vassallo, L., Serafini, G., Perna, G., Pompili, M., & Amore, M. (2016). The HPA axis in bipolar disorder: Systematic review and meta-analysis. *Psychoneuroendocrinology*, *63*, 327–342. https://doi.org/10.1016/j.psyneuen.2015.10.014

Bernardi, L., Wdowczyk-Szulc, J., Valenti, C., Castoldi, S., Passino, C., Spadacini, G., & Sleight, P. (2000). Effects of controlled breathing, mental activity and mental stress with or without verbalization on heart rate variability. *Journal of the*

American College of Cardiology, *35*(6), 1462–1469. https://doi.org/10.1016/S0735-1097(00)00595-7

Berntson, G. G., Bigger, J. T., Eckberg, D. L., Grossman, P., Kaufmann, P. G., Malik, M., Nagaraja, H. N., Porges, S. W., Saul, J. P., Stone, P. H., & Molen, M. W. V. D. (1997). Heart rate variability: Origins, methods, and interpretive caveats. *Psychophysiology*, *34*(6), 623–648. https://doi.org/10.1111/j.1469-8986.1997.tb02140.x

Bluth, K., & Neff, K. D. (2018). New frontiers in understanding the benefits of self-compassion. *Self and Identity*, *17*(6), 605–608. https://doi.org/10.1080/15298868.2018.1508494

Bodenlos, J. S., Wells, S. Y., Noonan, M., & Mayrsohn, A. (2015). Facets of Dispositional Mindfulness and Health Among College Students. *The Journal of Alternative and Complementary Medicine*, *21*(10), 645–652. https://doi.org/10.1089/acm.2014.0302

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, *18*(3), 328–352. https://doi.org/10.1080/14780887.2020.1769238

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*(4), 822–848. https://doi.org/10.1037/0022-3514.84.4.822

Brown, K. W., Weinstein, N., & Creswell, J. D. (2012). Trait mindfulness modulates neuroendocrine and affective responses to social evaluative threat. *Psychoneuroendocrinology*, *37*(12), 2037–2041. https://doi.org/10.1016/j.psyneuen.2012.04.003

Carpenter, J. K., Sanford, J., & Hofmann, S. G. (2019). The Effect of a Brief Mindfulness Training on Distress Tolerance and Stress Reactivity. *Behavior Therapy*, *50*(3), 630–645. https://doi.org/10.1016/j.beth.2018.10.003

Cattaneo, A., & Riva, M. A. (2016). Stress-induced mechanisms in mental illness: A role for glucocorticoid signalling. *The Journal of Steroid Biochemistry and Molecular Biology*, *160*, 169–174. https://doi.org/10.1016/j.jsbmb.2015.07.021

Ceccarelli, L. A., Giuliano, R. J., Glazebrook, C. M., & Strachan, S. M. (2019). Self-Compassion and Psycho-Physiological Recovery From Recalled Sport Failure. *Frontiers in Psychology*, *10*, 1564. https://doi.org/10.3389/fpsyg.2019.01564

Chalmers, J. A., Quintana, D. S., Abbott, M. J.-A., & Kemp, A. H. (2014). Anxiety Disorders are Associated with Reduced Heart Rate Variability: A Meta-Analysis. *Frontiers in Psychiatry*, *5*. https://doi.org/10.3389/fpsyt.2014.00080

Charlson, M., Szatrowski, T. P., Peterson, J., & Gold, J. (1994). Validation of a combined comorbidity index. *Journal of Clinical Epidemiology*, *47*(11), 1245–1251. https://doi.org/10.1016/0895-4356(94)90129-5

Christodoulou, G., Salami, N., & Black, D. S. (2020). The Utility of Heart Rate Variability in Mindfulness Research. *Mindfulness*, *11*(3), 554–570. https://doi.org/10.1007/s12671-019-01296-3

Cillessen, L., Johannsen, M., Speckens, A. E. M., & Zachariae, R. (2019). Mindfulness-based interventions for psychological and physical health outcomes in cancer patients and survivors: A systematic review and meta-analysis of randomized controlled trials. *Psycho-Oncology*, *28*(12), 2257–2269. https://doi.org/10.1002/pon.5214

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences, 3rd ed* (pp. xxviii, 703). Lawrence Erlbaum Associates Publishers.

Cohen, S., Gianaros, P. J., & Manuck, S. B. (2016). A Stage Model of Stress and Disease. *Perspectives on Psychological Science: A Journal of the Association for Psychological Science*, *11*(4), 456–463. https://doi.org/10.1177/1745691616646305

Cohen, S., & Williamson, G. (1988). Perceived stress in a probability sample of the United States. In *The social psychology of health* (pp. 31–67). Sage Publications, Inc.

Conrad, A., Müller, A., Doberenz, S., Kim, S., Meuret, A. E., Wollburg, E., & Roth, W. T. (2007). Psychophysiological Effects of Breathing Instructions for Stress Management. *Applied Psychophysiology and Biofeedback*, *32*(2), 89–98. https://doi.org/10.1007/s10484-007-9034-x

Creswell, J. D., & Lindsay, E. K. (2014). How Does Mindfulness Training Affect Health? A Mindfulness Stress Buffering Account. *Current Directions in Psychological Science*, *23*(6), 401–407. https://doi.org/10.1177/0963721414547415

Creswell, J. D., Pacilio, L. E., Lindsay, E. K., & Brown, K. W. (2014). Brief mindfulness meditation training alters psychological and neuroendocrine responses to social evaluative stress. *Psychoneuroendocrinology*, *44*, 1–12. https://doi.org/10.1016/j.psyneuen.2014.02.007

Crowe, M., Jordan, J., Burrell, B., Jones, V., Gillon, D., & Harris, S. (2016). Mindfulness-based stress reduction for long-term physical conditions: A systematic review. *Australian & New Zealand Journal of Psychiatry*, *50*(1), 21–32. https://doi.org/10.1177/0004867415607984

Desrosiers, A., Vine, V., Curtiss, J., & Klemanski, D. H. (2014). Observing nonreactively: A conditional process model linking mindfulness facets, cognitive emotion regulation strategies, and depression and anxiety symptoms. *Journal of Affective Disorders*, *165*, 31–37. https://doi.org/10.1016/j.jad.2014.04.024

Dickerson, S. S., & Kemeny, M. E. (2004). Acute Stressors and Cortisol Responses: A Theoretical Integration and Synthesis of Laboratory Research. *Psychological Bulletin*, *130*(3), 355–391. https://doi.org/10.1037/0033-2909.130.3.355

Dobkin, P. L., Irving, J. A., & Amar, S. (2012). For whom may participation in a mindfulness-based stress reduction program be contraindicated?. *Mindfulness*, *3*, 44-50.

Eifert, G. H., & Heffner, M. (2003). The effects of acceptance versus control contexts on avoidance of panic-related symptoms. *Journal of Behavior Therapy and Experimental Psychiatry*, *34*(3), 293–312. https://doi.org/10.1016/j.jbtep.2003.11.001

Eisenlohr-Moul, T. A., Walsh, E. C., Charnigo, R. J., Lynam, D. R., & Baer, R. A. (2012). The “What” and the “How” of Dispositional Mindfulness: Using Interactions Among Subscales of the Five-Facet Mindfulness Questionnaire to Understand Its Relation To Substance Use. *Assessment*, *19*(3), 276–286. https://doi.org/10.1177/1073191112446658

Fallon, M. A., Riem, M. M. E., Kunst, L. E., Kop, W. J., & Kupper, N. (2021). Multi-modal responses to the Virtual Reality Trier Social Stress Test: A comparison with standard interpersonal and control conditions. *International Journal of Psychophysiology*, *161*, 27–34. https://doi.org/10.1016/j.ijpsycho.2021.01.010

Farias, M., & Wikholm, C. (2016). Has the science of mindfulness lost its mind? *BJPsych Bulletin*, *40*(6), 329–332. https://doi.org/10.1192/pb.bp.116.053686

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160. https://doi.org/10.3758/BRM.41.4.1149

Ford, B. Q., Lam, P., John, O. P., & Mauss, I. B. (2018). The psychological health benefits of accepting negative emotions and thoughts: Laboratory, diary, and longitudinal evidence. *Journal of Personality and Social Psychology*, *115*(6), 1075–1092. https://doi.org/10.1037/pspp0000157

Ginty, A. T., Kraynak, T. E., Fisher, J. P., & Gianaros, P. J. (2017). Cardiovascular and autonomic reactivity to psychological stress: Neurophysiological substrates and links to cardiovascular disease. *Autonomic Neuroscience: Basic & Clinical*, *207*, 2–9. https://doi.org/10.1016/j.autneu.2017.03.003

Goessl, V. C., Curtiss, J. E., & Hofmann, S. G. (2017). The effect of heart rate variability biofeedback training on stress and anxiety: A meta-analysis. *Psychological Medicine*, *47*(15), 2578–2586. https://doi.org/10.1017/S0033291717001003

Goldberg, S. B., Riordan, K. M., Sun, S., & Davidson, R. J. (2022). The Empirical Status of Mindfulness-Based Interventions: A Systematic Review of 44 Meta-Analyses of Randomized Controlled Trials. *Perspectives on Psychological Science, 17*(1), 108–130. https://doi.org/10.1177/1745691620968771

Goodwin, R. D., Weinberger, A. H., Kim, J. H., Wu, M., & Galea, S. (2020). Trends in anxiety among adults in the United States, 2008–2018: Rapid increases among young adults. *Journal of Psychiatric Research*, *130*, 441–446. https://doi.org/10.1016/j.jpsychires.2020.08.014

Grant, C., Hobkirk, A., Persons, E., Hwang, V., & Danoff-Burg, S. (2013). Cardiovascular reactivity to and recovery from stressful tasks following a mindfulness analog in college students with a family history of hypertension. *Journal of Alternative and Complementary Medicine (New York, N.Y.), 19*(4), 341–346. https://doi.org/10.1089/acm.2011.0880

Gunnar, M. R., Reid, B. M., Donzella, B., Miller, Z. R., Gardow, S., Tsakonas, N. C., Thomas, K. M., DeJoseph, M., & Bendezú, J. J. (2021). Validation of an online version of the Trier Social Stress Test in a study of adolescents. *Psychoneuroendocrinology*, *125*, 105111. https://doi.org/10.1016/j.psyneuen.2020.105111

Halfon, N., & Hochstein, M. (2002). Life Course Health Development: An Integrated Framework for Developing Health, Policy, and Research. *The Milbank Quarterly*, *80*(3), 433–479. https://doi.org/10.1111/1468-0009.00019

Hawes, M. T., Szenczy, A. K., Klein, D. N., Hajcak, G., & Nelson, B. D. (2021). Increases in depression and anxiety symptoms in adolescents and young adults during the COVID-19 pandemic. *Psychological Medicine*, 1–9. https://doi.org/10.1017/S0033291720005358

Hayes, S. C., Strosahl, K., Wilson, K. G., Bissett, R. T., Pistorello, J., Toarmino, D., Polusny, M. A., Dykstra, T. A., Batten, S. V., Bergan, J., Stewart, S. H., Zvolensky, M. J., Eifert, G. H., Bond, F. W., Forsyth, J. P., Karekla, M., & McCurry, S. M. (2004). Measuring experiential avoidance: A preliminary test of a working model. *The Psychological Record*, *54*(4), 553–578. https://doi.org/10.1007/BF03395492

Hayes, S. C., Wilson, K. G., Gifford, E. V., Follette, V. M., & Strosahl, K. (1996). Experiential avoidance and behavioral disorders: A functional dimensional approach to diagnosis and treatment. *Journal of Consulting and Clinical Psychology*, *64*(6), 1152–1168. https://doi.org/10.1037/0022-006X.64.6.1152

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behav Brain Sci*, *33*(2–3), 61–83.

Hellhammer, J., & Schubert, M. (2012). The physiological response to Trier Social Stress Test relates to subjective measures of stress during but not before or after the test. *Psychoneuroendocrinology*, *37*(1), 119–124. https://doi.org/10.1016/j.psyneuen.2011.05.012

Hill, L., Siebenbrock, A., Sollers, J. J. I., & Thayer, J. F. (2009). All are measures created equal? Heart rate variability and respiration. Biomed Sci Instrum, 45, 71-76. *Biomedical Sciences Instrumentation*, *45*, 71–76.

Hilton, L., Hempel, S., Ewing, B. A., Apaydin, E., Xenakis, L., Newberry, S., Colaiaco, B., Maher, A. R., Shanman, R. M., Sorbero, M. E., & Maglione, M. A. (2017). Mindfulness Meditation for Chronic Pain: Systematic Review and Meta-analysis. *Annals of Behavioral Medicine*, *51*(2), 199–213. https://doi.org/10.1007/s12160-016-9844-2

Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and Social Isolation as Risk Factors for Mortality: A Meta-Analytic Review. *Perspectives on Psychological Science*, *10*(2), 227–237. https://doi.org/10.1177/1745691614568352

Howarth, A., Smith, J. G., Perkins-Porras, L., & Ussher, M. (2019). Effects of Brief Mindfulness-Based Interventions on Health-Related Outcomes: A Systematic Review. *Mindfulness*, *10*(10), 1957–1968. https://doi.org/10.1007/s12671-019-01163-1

Kabat-Zinn, J. (1982). An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: Theoretical considerations and preliminary results. *General Hospital Psychiatry*, *4*(1), 33–47.

Kabat-Zinn, J. (2006). Mindfulness-Based Interventions in Context: Past, Present, and Future. *Clinical Psychology: Science and Practice*, *10*(2), 144–156. https://doi.org/10.1093/clipsy.bpg016

Kadziolka, M. J., Di Pierdomenico, E.-A., & Miller, C. J. (2016). Trait-Like Mindfulness Promotes Healthy Self-Regulation of Stress. *Mindfulness*, *7*(1), 236–245. https://doi.org/10.1007/s12671-015-0437-0

Kemeny, M. E. (2003). The Psychobiology of Stress. *Current Directions in Psychological Science*, *12*(4), 124–129. https://doi.org/10.1111/1467-8721.01246

Kemeny, M. E., & Schedlowski, M. (2007). Understanding the interaction between psychosocial stress and immune-related diseases: A stepwise progression. *Brain, Behavior, and Immunity*, *21*(8), 1009–1018. https://doi.org/10.1016/j.bbi.2007.07.010

Khoury, B., Lecomte, T., Gaudiano, B. A., & Paquin, K. (2013). Mindfulness interventions for psychosis: A meta-analysis. *Schizophrenia Research*, *150*(1), 176–184. https://doi.org/10.1016/j.schres.2013.07.055

Kirschbaum, C., Pirke, K.-M., & Hellhammer, D. (1993). The 'Trier Social Stress Test' – A Tool for Investigating Psychobiological Stress Responses in a Laboratory Setting. *Neuropsychobiology*, *28*, 76–81. https://doi.org/10.1159/000119004

Kudielka, B. M., & Kirschbaum, C. (2004). Sex differences in HPA axis responses to stress: A review. *Biological Psychology*, *69*, 113–132.

Larson, M. J., Steffen, P. R., & Primosch, M. (2013). The impact of a brief mindfulness meditation intervention on cognitive control and error-related performance monitoring. *Frontiers in Human Neuroscience*, *7*. https://doi.org/10.3389/fnhum.2013.00308

Lau, M. A., Bishop, S. R., Segal, Z. V., Buis, T., Anderson, N. D., Carlson, L., Shapiro, S., Carmody, J., Abbey, S., & Devins, G. (2006). The toronto mindfulness scale:

Development and validation. *Journal of Clinical Psychology*, *62*(12), 1445–1467. https://doi.org/10.1002/jclp.20326

Lecrubier, Y., Sheehan, D., Weiller, E., Amorim, P., Bonora, I., Sheehan, K. H., Janavs, J., & Dunbar, G. (1997). The Mini International Neuropsychiatric Interview (MINI). A short diagnostic structured interview: Reliability and validity according to the CIDI. *European Psychiatry*, *12*(5), 224–231. https://doi.org/10.1016/S0924-9338(97)83296-8

Leigh, J., Bowen, S., & Marlatt, G. A. (2005). Spirituality, mindfulness and substance abuse. *Addictive Behaviors*, *30*(7), 1335–1341. https://doi.org/10.1016/j.addbeh.2005.01.010

Leigh, J., & Neighbors, C. (2009). Enhancement Motives Mediate the Positive Association Between Mind/Body Awareness and College Student Drinking. *Journal of Social and Clinical Psychology*, *28*(5), 650–669. https://doi.org/10.1521/jscp.2009.28.5.650

Lindsay, E. K., & Creswell, J. D. (2017). Mechanisms of mindfulness training: Monitor and Acceptance Theory (MAT). *Clinical Psychology Review*, *51*, 48–59. https://doi.org/10.1016/j.cpr.2016.10.011

Lindsay, E. K., Young, S., Smyth, J. M., Brown, K. W., & Creswell, J. D. (2018). Acceptance lowers stress reactivity: Dismantling mindfulness training in a randomized controlled trial. *Psychoneuroendocrinology*, *87*, 63–73. https://doi.org/10.1016/j.psyneuen.2017.09.015

Lomas, T., Cartwright, T., Edginton, T. (2015). A Qualitative Analysis of Experiential Challenges Associated with Meditation Practice. *Mindfulness 6*, 848–860. https://doi.org/10.1007/s12671-014-0329-8

Low, C. A., Stanton, A. L., & Bower, J. E. (2008). Effects of acceptance-oriented versus evaluative emotional processing on heart rate recovery and habituation. *Emotion*, *8*(3), 419–424. https://doi.org/10.1037/1528-3542.8.3.419

Luo, X., Qiao, L., & Che, X. (2018). Self-compassion Modulates Heart Rate Variability and Negative Affect to Experimentally Induced Stress. *Mindfulness*, *9*(5), 1522–1528. https://doi.org/10.1007/s12671-018-0900-9

Malik, M., Bigger, J. T., Camm, A. J., Kleiger, R. E., Malliani, A., Moss, A. J., & Schwartz, P. J. (1996). Heart rate variability: Standards of measurement, physiological interpretation, and clinical use. *European Heart Journal*, *17*(3), 354–381. https://doi.org/10.1093/oxfordjournals.eurheartj.a014868

McEwen, B. S. (1998). Protective and damaging effects of stress mediators. *The New England Journal of Medicine*, *338*(3), 171–179. https://doi.org/10.1056/NEJM199801153380307

McEwen, B. S. (2004). Protection and damage from acute and chronic stress: Allostasis and allostatic overload and relevance to the pathophysiology of psychiatric disorders. *Annals of the New York Academy of Sciences*, *1032*, 1–7. https://doi.org/10.1196/annals.1314.001

Miller, R. L., Lucas-Thompson, R. G., Sanchez, N., Smith, A. D., Annameier, S. K., Casamassima, M., Verros, M., Melby, C., Johnson, S. A., & Shomaker, L. B. (2021). Effects of a mindfulness-induction on subjective and physiological stress response in adolescents at-risk for adult obesity. *Eating Behaviors*, *40*, 101467. https://doi.org/10.1016/j.eatbeh.2020.101467

Miron, O., Yu, K.-H., Wilf-Miron, R., & Kohane, I. S. (2019). Suicide Rates Among Adolescents and Young Adults in the United States, 2000-2017. *JAMA*, *321*(23), 2362–2364. https://doi.org/10.1001/jama.2019.5054

Morton, M. L., Helminen, E. C., & Felver, J. C. (2020). A Systematic Review of Mindfulness Interventions on Psychophysiological Responses to Acute Stress. *Mindfulness*, *11*(9), 2039–2054. https://doi.org/10.1007/s12671-020-01386-7

Mulye, T. P., Park, M. J., Nelson, C. D., Adams, S. H., Irwin, C. E., & Brindis, C. D. (2009). Trends in Adolescent and Young Adult Health in the United States. *Journal of Adolescent Health*, *45*(1), 8–24. https://doi.org/10.1016/j.jadohealth.2009.03.013

Narvaez Linares, N. F., Charron, V., Ouimet, A. J., Labelle, P. R., & Plamondon, H. (2020). A systematic review of the Trier Social Stress Test methodology: Issues in promoting study comparison and replicable research. *Neurobiology of Stress, 13*, 100235. https://doi.org/10.1016/j.ynstr.2020.100235

Nature Mental Health. (2023). Mindfulness research needs an intervention. *Nature Mental Health*, *1*(7), 437–438. https://doi.org/10.1038/s44220-023-00100-5

Neff, K. (2003). Self-Compassion: An Alternative Conceptualization of a Healthy Attitude Toward Oneself. *Self and Identity*, *2*(2), 85–101. https://doi.org/10.1080/15298860309032

Neff, K., Rude, S. S., & Kirkpatrick, K. L. (2007). An examination of self-compassion in relation to positive psychological functioning and personality traits. *Journal of*

Research in Personality, *41*(4), 908–916. https://doi.org/10.1016/j.jrp.2006.08.002

Nyklíček, I., Mommersteeg, P. M. C., Van Beugen, S., Ramakers, C., & Van Boxtel, G. J. (2013). Mindfulness-based stress reduction and physiological activity during acute stress: A randomized controlled trial. *Health Psychology*, *32*(10), 1110–1113. https://doi.org/10.1037/a0032200

O'Connor, M.-F., Allen, J. J. B., & Kaszniak, A. W. (2002). Autonomic and emotion regulation in bereavement and depression. *Journal of Psychosomatic Research*, *52*(4), 183–185.

Operario, D., Adler, N. E., & Williams, D. R. (2004). Subjective social status: Reliability and predictive utility for global health. *Psychology & Health*, *19*(2), 237–246. https://doi.org/10.1080/08870440310001638098

Ottaviani, C., Thayer, J. F., Verkuil, B., Lonigro, A., Medea, B., Couyoumdjian, A., & Brosschot, J. F. (2016). Physiological concomitants of perseverative cognition: A systematic review and meta-analysis. *Psychological Bulletin*, *142*(3), 231–259. https://doi.org/10.1037/bul0000036

Park, J., Lyles, R. H., & Bauer-Wu, S. (2014). Mindfulness meditation lowers muscle sympathetic nerve activity and blood pressure in African-American males with chronic kidney disease. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *307*(1), R93–R101. https://doi.org/10.1152/ajpregu.00558.2013

Park, M. J., Scott, J. T., Adams, S. H., Brindis, C. D., & Irwin, C. E. (2014). Adolescent and Young Adult Health in the United States in the Past Decade: Little

Improvement and Young Adults Remain Worse Off Than Adolescents. *Journal of Adolescent Health*, *55*(1), 3–16. https://doi.org/10.1016/j.jadohealth.2014.04.003

Pascoe, M. C., Thompson, D. R., Jenkins, Z. M., & Ski, C. F. (2017). Mindfulness mediates the physiological markers of stress: Systematic review and meta-analysis. *Journal of Psychiatric Research*, *95*, 156–178. https://doi.org/10.1016/j.jpsychires.2017.08.004

Paz, R., Zvielli, A., Goldstein, P., & Bernstein, A. (2017). Brief mindfulness training de-couples the anxiogenic effects of distress intolerance on reactivity to and recovery from stress among deprived smokers. *Behaviour Research and Therapy*, *95*, 117–127. https://doi.org/10.1016/j.brat.2017.05.017

Pearson, M. R., Lawless, A. K., Brown, D. B., & Bravo, A. J. (2015). Mindfulness and emotional outcomes: Identifying subgroups of college students using latent profile analysis. *Personality and Individual Differences*, *76*, 33–38. https://doi.org/10.1016/j.paid.2014.11.009

Peters, J. R., Eisenlohr-Moul, T. A., Upton, B. T., & Baer, R. A. (2013). Nonjudgment as a moderator of the relationship between present-centered awareness and borderline features: Synergistic interactions in mindfulness assessment. *Personality and Individual Differences*, *55*(1), 24–28. https://doi.org/10.1016/j.paid.2013.01.021

Potter, D. (n.d.). *MBSR Manual*. Palouse Mindfulness: Mindfulness-Based Stress Reduction. Retrieved April 16, 2022, from https://palousemindfulness.com/MBSR/manual.html

Raes, F., Pommier, E., Neff, K. D., & Van Gucht, D. (2011). Construction and factorial validation of a short form of the Self-Compassion Scale. *Clinical Psychology & Psychotherapy*, *18*(3), 250–255. https://doi.org/10.1002/cpp.702

Reangsing, C., Punsuwun, S., & Schneider, J. K. (2021). Effects of mindfulness interventions on depressive symptoms in adolescents: A meta-analysis. *International Journal of Nursing Studies*, *115*, 103848. https://doi.org/10.1016/j.ijnurstu.2020.103848

Reangsing, C., Rittiwong, T., & Schneider, J. K. (2021). Effects of mindfulness meditation interventions on depression in older adults: A meta-analysis. *Aging & Mental Health*, *25*(7), 1181–1190. https://doi.org/10.1080/13607863.2020.1793901

Roberti, J. W., Harrington, L. N., & Storch, E. A. (2006). Further Psychometric Support for the 10-Item Version of the Perceived Stress Scale. *Journal of College Counseling*, *9*(2), 135–147. https://doi.org/10.1002/j.2161-1882.2006.tb00100.x

Roffman, C. E., Buchanan, J., & Allison, G. T. (2016). Charlson Comorbidities Index. *Journal of Physiotherapy*, *62*(3), 171. https://doi.org/10.1016/j.jphys.2016.05.008

Rogers, J. M., Ferrari, M., Mosely, K., Lang, C. P., & Brennan, L. (2017). Mindfulness-based interventions for adults who are overweight or obese: A meta-analysis of physical and psychological health outcomes. *Obesity Reviews*, *18*(1), 51–67. https://doi.org/10.1111/obr.12461

Rohleder, N., & Nater, U. M. (2009). Determinants of salivary α-amylase in humans and methodological considerations. *Psychoneuroendocrinology*, *34*(4), 469–485. https://doi.org/10.1016/j.psyneuen.2008.12.004

Rusch, H. L., Rosario, M., Levison, L. M., Olivera, A., Livingston, W. S., Wu, T., & Gill, J. M. (2019). The effect of mindfulness meditation on sleep quality: A systematic review and meta-analysis of randomized controlled trials. *Annals of the New York Academy of Sciences*, *1445*(1), 5–16. https://doi.org/10.1111/nyas.13996

Schumer, M. C., Lindsay, E. K., & Creswell, J. D. (2018). Brief Mindfulness Training for Negative Affectivity: A Systematic Review and Meta-Analysis. *Journal of Consulting and Clinical Psychology*, *86*(7), 569–583. https://doi.org/10.1037/ccp0000324

Scott-Sheldon, L. A. J., Gathright, E. C., Donahue, M. L., Balletto, B., Feulner, M. M., DeCosta, J., Cruess, D. G., Wing, R. R., Carey, M. P., & Salmoirago-Blotcher, E. (2019). Mindfulness-Based Interventions for Adults with Cardiovascular Disease: A Systematic Review and Meta-Analysis. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine*, *54*(1), 67–73. https://doi.org/10.1093/abm/kaz020

Shanahan, L., Steinhoff, A., Bechtiger, L., Murray, A. L., Nivette, A., Hepp, U., Ribeaud, D., & Eisner, M. (2022). Emotional distress in young adults during the COVID-19 pandemic: Evidence of risk and resilience from a longitudinal cohort study. *Psychological Medicine*, *52*(5), 824–833. https://doi.org/10.1017/S003329172000241X

Shapiro, D. H. (1992). Adverse effects of meditation: A preliminary investigation of long-term meditators. *International Journal of Psychosomatics*, *39*(1–4).

Siegel, D. (1999). *The Developing Mind: How Relationships and the Brain Interact to Shape Who We Are*. Guilford Publications.

Singh, Y., Sharma, R., & Talwar, A. (2012). *Immediate and Long-term Effects of Meditation on Acute Stress Reactivity, Cognitive Functions, and Intelligence*. *18*(6), 46–53.

Slavich, G. M., & Irwin, M. R. (2014). From Stress to Inflammation and Major Depressive Disorder: A Social Signal Transduction Theory of Depression. *Psychological Bulletin*, *140*(3), 774–815. https://doi.org/10.1037/a0035302

Sleimen-Malkoun, R., Devillers-Réolon, L., & Temprado, J.-J. (2023). A single session of mindfulness meditation may acutely enhance cognitive performance regardless of meditation experience. *PLOS ONE*, *18*(3), e0282188. https://doi.org/10.1371/journal.pone.0282188

Slonena, E. E., & Elkins, G. R. (2021). Effects of a Brief Mindful Hypnosis Intervention on Stress Reactivity: A Randomized Active Control Study. *International Journal of Clinical and Experimental Hypnosis*, 1–15. https://doi.org/10.1080/00207144.2021.1952845

Somaraju, L.H., Temple, E.C., Bizo, L.A. (2023). Brief mindfulness meditation: Can it make a real difference?. *Curr Psychol 42*, 5530–5542. https://doi.org/10.1007/s12144-021-01897-z

Steffen, P. R., & Larson, M. J. (2015). A Brief Mindfulness Exercise Reduces Cardiovascular Reactivity During a Laboratory Stressor Paradigm. *Mindfulness*, *6*(4), 803–811. https://doi.org/10.1007/s12671-014-0320-4

Sturmberg, J. P., Bennett, J. M., Martin, C. M., & Picard, M. (2017). “Multimorbidity” as the manifestation of network disturbances. *Journal of Evaluation in Clinical Practice*, *23*(1), 199–208. https://doi.org/10.1111/jep.12587

Sturmberg, J. P., Bennett, J. M., Picard, M., & Seely, A. J. E. (2015). The trajectory of life. Decreasing physiological network complexity through changing fractal patterns. *Frontiers in Physiology*, *6*. https://www.frontiersin.org/article/10.3389/fphys.2015.00169

Sun, S., Hu, C., Pan, J., Liu, C., & Huang, M. (2019). Trait Mindfulness Is Associated With the Self-Similarity of Heart Rate Variability. *Frontiers in Psychology*, *10*. https://www.frontiersin.org/article/10.3389/fpsyg.2019.00314

Svendsen, J. L., Osnes, B., Binder, P.-E., Dundas, I., Visted, E., Nordby, H., Schanche, E., & Sørensen, L. (2016). Trait Self-Compassion Reflects Emotional Flexibility Through an Association with High Vagally Mediated Heart Rate Variability. *Mindfulness*, *7*(5), 1103–1113. https://doi.org/10.1007/s12671-016-0549-1

Tan, J. J. X., Kraus, M. W., Carpenter, N. C., & Adler, N. E. (2020). The association between objective and subjective socioeconomic status and subjective well-being: A meta-analytic review. *Psychological Bulletin*, *146*(11), 970–1020. https://doi.org/10.1037/bul0000258

Tarvainen, M. P., Niskanen, J.-P., Lipponen, J. A., Ranta-Aho, P. O., & Karjalainen, P. A. (2014). Kubios HRV--heart rate variability analysis software. *Computer Methods and Programs in Biomedicine*, *113*(1), 210–220. https://doi.org/10.1016/j.cmpb.2013.07.024

Teasdale, J. D., Segal, Z. V., Williams, J. M., Ridgeway, V. A., Soulsby, J. M., & Lau, M. A. (2000). Prevention of relapse/recurrence in major depression by mindfulness-based cognitive therapy. *Journal of Consulting and Clinical Psychology*, *68*(4), 615–623.

Thayer, J. F., & Lane, R. D. (2000). A model of neurovisceral integration in emotion regulation and dysregulation. *Journal of Affective Disorders*, *61*(3), 201–216. https://doi.org/10.1016/S0165-0327(00)00338-4

Tomfohr, L. M., Pung, M. A., Mills, P. J., & Edwards, K. (2015). Trait mindfulness is associated with blood pressure and interleukin-6: Exploring interactions among subscales of the Five Facet Mindfulness Questionnaire to better understand relationships between mindfulness and health. *Journal of Behavioral Medicine*, *38*(1), 28–38. https://doi.org/10.1007/s10865-014-9575-4

Vahratian, A. (2021). Symptoms of Anxiety or Depressive Disorder and Use of Mental Health Care Among Adults During the COVID-19 Pandemic—United States, August 2020–February 2021. *MMWR. Morbidity and Mortality Weekly Report*, *70*. https://doi.org/10.15585/mmwr.mm7013e2

Wadlinger, H. A., & Isaacowitz, D. M. (2011). Fixing our focus: Training attention to regulate emotion. *Personality and Social Psychology Review: An Official Journal of the Society for Personality and Social Psychology, Inc*, *15*(1), 75–102. https://doi.org/10.1177/1088868310365565

Werner, A. M., Tibubos, A. N., Rohrmann, S., & Reiss, N. (2019). The clinical trait self-criticism and its relation to psychopathology: A systematic review – Update. *Journal of Affective Disorders*, *246*, 530–547. https://doi.org/10.1016/j.jad.2018.12.069

White, A. M., Castle, I.-J. P., Hingson, R. W., & Powell, P. A. (2020). Using Death Certificates to Explore Changes in Alcohol-Related Mortality in the United

States, 1999 to 2017. *Alcoholism: Clinical and Experimental Research*, *44*(1), 178–187. https://doi.org/10.1111/acer.14239

Williams, J. C., & Lynn, S. J. (2010). Acceptance: An Historical and Conceptual Review. *Imagination, Cognition and Personality*, *30*(1), 5–56. https://doi.org/10.2190/IC.30.1.c

Young, S. (2016). What Is Mindfulness? A Contemplative Perspective. In K. Schonert-Reichl & R. Roeser (Eds.), *Handbook of Mindfulness in Education*. Springer. https://link.springer.com/chapter/10.1007/978-1-4939-3506-2_3

Zeidan, F., Johnson, S. K., Gordon, N. S., & Goolkasian, P. (2010). Effects of Brief and Sham Mindfulness Meditation on Mood and Cardiovascular Variables. *The Journal of Alternative and Complementary Medicine*, *16*(8), 867–873. https://doi.org/10.1089/acm.2009.0321

APPENDIX A: INTERVENTION CONDITION SCRIPTS

Relaxation control	Monitor only	Monitor + accept
Welcome to relaxation practice. Today, you will learn about and practice how to use breathing to relax the body and mind. *[pause].* Breathing is a simple but powerful technique to consciously take back control over the body's stress response and return you to a state of calmness and ease. *[pause].* When you breath in and out, you activate the body's autonomic nervous system, impacting how fast your heart beats and helping to regulate the body. This also helps to regulate and calm the mind so that you are less reactive when stressors occur. For the next 20 minutes, you will practice breath relaxation. Please do not do anything else during this time. This audio guide will remind you relax and continue to breath throughout the 20 minutes, as well as let you know when time is nearly up. Are you ready? *[pause].* To begin this breathing relaxation practice, you are invited to sit in a comfortable upright posture, with your back straight and both feet on the floor. You may sit with your eyes open or eyes closed for this practice, though most people find this practice easier to complete with their eyes closed. *[pause].* Beginning to relax, breathe in *[4 sec]* and breathe out. *[4 sec]* Inhaling again, breathe in *[4 sec]* and breathe out. *[4 sec]* For this next breath, breathe in *[4 sec]* and breath out. *[4 sec]* Now continue to breathe and relax on your own. *[30 sec]* Continue to breathe. Inhaling, breathe in *[4 sec]* and exhaling, breathe out. *[4 sec]* Inhaling again, breathe in *[4 sec]* and breathe out. *[4 sec]*	Welcome to relaxation practice. Today, you will learn about and practice how to focus on present moment bodily sensations to relax the mind. *[pause].* This involves practicing skills of concentration and clarity. Concentration is the ability to focus on what you want, when you want, and for as long as you want. Clarity is the ability to know exactly what you're experiencing at any given moment. When you can purely focus on what you feel in each moment, the mind is calmer and less reactive when stressors occur. For the next 20 minutes, you will practice paying attention to the present moment. Please follow along closely to this audio guide. Are you ready? *[pause].* You are invited to sit in a comfortable upright posture, with your back straight and both feet on the floor. You may sit with your eyes open or eyes closed for this practice, though most people find it easier to focus with their eyes closed. *[pause].* We'll begin focusing on the sensation of breathing to anchor the mind in the present moment. Breathing in through the nose, feel your belly rise *[4 sec]* Breathing out through the nose, feel your body relax *[4 sec]* Inhaling again, breathe in *[4 sec]* and breathe out. *[4 sec]* *[pause]* And this next breath, breathe in *[4 sec]* and breath out. *[4 sec]* *[pause]* As you continue to breathe, notice where you feel your breath *[4 sec]* Feel your belly and chest rise as you breathe in *[4 sec]* And breathing out, release. *[4 sec]* Pay attention to the rhythm of your breath as it moves your belly. *[4 sec]*	Welcome to relaxation practice. Today, you will learn about and practice how to focus on and accept present moment bodily sensations to relax the mind. *[pause].* This involves practicing skills of concentration, clarity, and acceptance. Concentration is the ability to focus on what you want, when you want, and for as long as you want. Clarity is the ability to know exactly what you're experiencing at any given moment. Acceptance is a kind of openness to experience, allowing it all to be just as it is, without judgment as good or bad/wanted or unwanted, and with a gentle and kind attitude. When you can welcome all experiences as they are and remain curious about each new moment that comes and goes, the mind is calmer and less reactive when stressors occur. For the next 20 minutes, you will practice paying gentle and open attention to the present moment. Please follow along closely to this audio guide as best you can. Are you ready? *[pause].* You are invited to sit in a comfortable upright posture, with your back straight and both feet on the floor. You may sit with your eyes open or eyes closed for this practice, though most people find it easier to focus with their eyes closed. *[pause].* We'll begin by allowing the mind to settle on the sensation of breathing as an anchor to notice each new moment. With each new breath, welcome this next moment, whatever it may contain. Breathing in through the nose, feel your belly rise *[4 sec]*

And the next breath, breathe in *[4 sec]*
and breathe out.
[30 sec]

As you relax, continue to breathe.
Inhaling again, breathe in *[4 sec]*
and breathe out. *[4 sec]*
For this next breath, breathe in *[4 sec]*
and breathe out. *[4 sec]*
And the next one, breathe in *[4 sec]*
and breathe out.
[30 sec]

Continue to breathe.
Inhaling, breathe in *[4 sec]*
and exhaling, breathe out. *[4 sec]*
Inhaling again, breathe in *[4 sec]*
and breathe out. *[4 sec]*
And the next breath, breathe in *[4 sec]*
and breathe out.
[30 sec]

As you relax, remember to breathe.
Inhaling, breathe in *[4 sec]*
and exhaling, breathe out. *[4 sec]*
For this next breath, breathe in *[4 sec]*
and breathe out. *[4 sec]*
And the next, breathe in *[4 sec]*
and out. *[4 sec]*
Now continue to breathe and relax on your own.
[60 sec]

As you relax, breathe in [4 *sec]*
and breathe out. *[4 sec]*
Inhaling again, breathe in *[4 sec]*
and breathe out. *[4 sec]*
And again, breathe in *[4 sec]*
and breathe out. *[4 sec]*
[30 sec]

As you relax, remember to breathe.
Inhaling, breathe in *[4 sec]*
and exhaling, breathe out. *[4 sec]*
For this next breath, breathe in *[4 sec]*
and breathe out. *[4 sec]*
And the next, breathe in *[4 sec]*
and out.
[30 sec]

Continue to breathe.
Inhaling, breathe in *[4 sec]*
and exhaling, breathe out. *[4 sec]*
Inhaling again, breathe in *[4 sec]*
and breathe out. *[4 sec]*
And the next breath, breathe in *[4 sec]*

Notice how the air feels as it enters your nose,
Travels down your throat,
And into your lungs. *[4 sec]*
Breathing out, feel the release. *[4 sec]*
Continue to focus on where you feel the breath. If you catch yourself losing focus or thinking, just simple bring your attention back to the breath. Each new inhale and exhale will bring you back to this present moment.
[60 sec]

As you continue to breathe, notice any sounds you may hear in the room at this moment. *[pause]*
Note these experiences and again return your attention back to the sensation of breathing. Where do you feel the breath the most? *[30 sec]*

Breathing in, feel your body expanding *[4 sec]*
And breathing out, feel your body release *[4 sec]*
Remember to stay focused on the sensation of breathing and bring your attention back to the body when you notice yourself thinking.
Continue to focus on breathing on your own.
[60 sec]

Now bring your attention to the feeling of your body in the chair. *[pause]*
Notice where your feet make contact with the floor. *[pause]*
Feel the sensation of pressure in your feet *[pause]*
Remember to breathe. *[pause]*
Slowly scanning up your body, bring your attention to your calves, *[pause]*
And upper legs, *[pause]*
Feeling all the sensations of pressure and touch against the chair. *[pause]*
And breathe.
[30 seconds]
Continuing to scan up the body,
Notice the sensations in your
Thighs, *[pause]*
Back of your legs, *[pause]*
Buttocks, *[pause]*
and pelvis as you sit in the chair.
[pause]
And the rise and fall of your belly as you breathe in *[pause]*
And out.
[30 seconds]
Breathing in,
feel your ribcage and chest expand *[pause]*
And breathing out,

Breathing out through the nose,
feel your body relax *[4 sec]*
Inhaling, breathe in *[4 sec]*
And out. *[4 sec]*
[pause]
And again, breathe in *[4 sec]*
and out. *[4 sec]*
[pause]
Notice how you feel, allowing your experience to be just as it is. There is no one way you should or should not be feeling right now.
[30 sec]

As you breathe, notice where you feel your breath with curiosity *[4 sec]*
Feel your belly and chest rise as you inhale *[4 sec]*
And breathing out, feel the release. *[4 sec]*
Pay attention to the rhythm of your breath as it moves your belly. *[4 sec]*
Notice how the air feels as it enters your nose,
Travels down your throat,
And into your lungs. *[4 sec]*
Breathing out, feel the release. *[4 sec]*
Note any new sensations or thoughts matter-of-factly and gently return the attention to the next breath. You might simply note to yourself, 'This is thinking'.
And then return your focus to the sensation of the next breath.
[pause]
Each new inhale and exhale will bring you back to this present moment.
[60 sec]

As you breathe, notice any sounds you may hear in the room at this moment. *[4 sec]*
Note these experiences without judgment as good or bad, wanted or unwanted. *[pause]*
Allow what is here to be here, just as it is. *[pause]*
And if you notice any judgment, simply make note of that matter-of-factly,
And gently return your focus to the breath.
Where do you feel the breath the most? *[30 sec]*

and breathe out.
[30 sec]

As you relax, remember to breathe.
Inhaling, breathe in [4 sec]
and exhaling, breathe out. [4 sec]
For this next breath, breathe in [4 sec]
and breathe out. [4 sec]
And the next, breathe in [4 sec]
and out.
[30 sec]

Continue to breathe.
Inhaling, breathe in [4 sec]
and exhaling, breathe out. [4 sec]
Inhaling again, breathe in [4 sec]
and breathe out. [4 sec]
And the next breath, breathe in [4 sec]
and breathe out.
Now continue to breathe and relax on your own.
[90 sec]

As you relax, breathe in [4 sec]
and breathe out. [4 sec]
Inhaling again, breathe in [4 sec]
and breathe out. [4 sec]
And again, breathe in [4 sec]
and breathe out. [4 sec]
[30 sec]

As you relax, remember to breathe.
Inhaling again, breathe in [4 sec]
and breathe out. [4 sec]
For this next breath, breathe in [4 sec]
and breathe out. [4 sec]
And the next, breathe in [4 sec]
and out.
[60 sec]

Continue to breathe.
Breathe in [4 sec]
And out [4 sec]
Inhaling again, breathe in [4 sec]
and breathe out. [4 sec]
And again, breathe in [4 sec]
And out. [4 sec]
[30 sec]

As you relax, remember to breathe.
Inhaling, breathe in [4 sec]
and exhaling, breathe out. [4 sec]
For this next breath, breathe in [4 sec]
and breathe out. [4 sec]
And the next, breathe in [4 sec]
and out.
[30 sec]

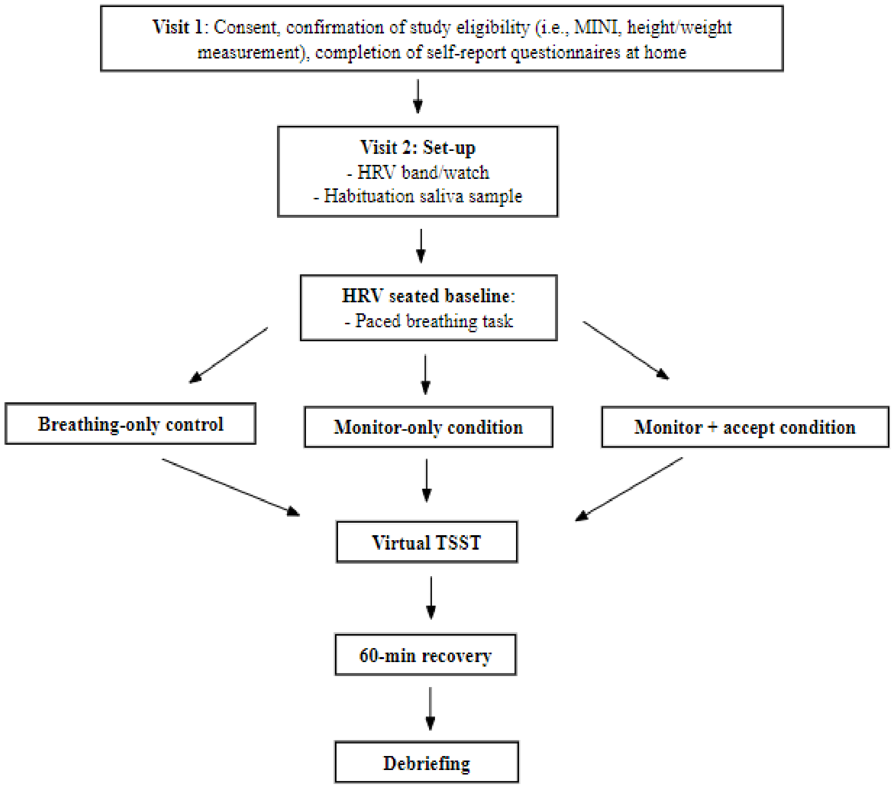
Feel your body release and relax.
And if you notice your mind thinking again, just return the attention to this breath.
[30 seconds]
Continuing to scan,
Notice the sensations in your hands, [pause]
Wrists, [pause]
forearms, [pause]
upperarms, [pause]
And shoulders. [pause]
Notice how the shoulders move with each new breath. [pause]
Can you feel your heart beating? What does it feel like?
[30 seconds]
Now bringing the attention to the throat and neck,
Note any sensations of tightness or relaxation, keeping the mind anchored on the breath. [pause]
Notice where you may feel any movement. [pause]
Remember to breathe.
[30 seconds]
Continuing to scan, pay attention to your jaw, [pause]
And the muscles in your lower face and cheeks. [pause]
Shifting the attention to your lips [pause] and mouth,
notice any sensations you may have in the interior of your mouth or on your tongue. [pause]
And when you catch yourself thinking, simply return the attention to this next new breath. [pause]
[30 seconds]
Shifting the attention to the nostrils,
Notice where you feel your next inhale [pause]
And exhale [pause]
[30 seconds]
Continuing to scan, next pay attention to the muscles around your eyes [pause]
corner of the eyes [pause]
and brow region.
Remember to breath. [pause]
And now feel the entire scalp area
From across the top of the head [pause]
And all the way to the ears. [pause]
Breathe.
[30 seconds]
When you're ready, begin to expand your awareness to include the entire body as you sit in the chair.
[10 seconds]
Scanning from the top of your head to your feet,

Now bring your attention to the feel of your body in the chair.
[pause]
Notice where your feet make contact with the floor. [pause]
Feel the sensation of pressure in your feet [pause]
Remember to breathe. [pause]
Slowly scanning up your body, bring your attention to your calves, [pause]
And upper legs, [pause]
Feeling all the sensations of pressure and touch against the chair, exactly as they are, without changing anything. [pause]
Breathe.
[30 seconds]
Continuing to scan up the body,
Notice the sensations in your
Thighs, [pause]
Back of your legs, [pause]
Buttocks, [pause]
and pelvis as you sit in the chair. [pause]
And the rise and fall of your belly as you breathe in [pause]
And out.
[10 seconds]
Breathing in,
feel your ribcage and chest expand [pause]
And breathing out,
Feel your body release and relax.
When you notice your mind thinking again, just gently make note and return to the breath.
Allow what's here to be here, anchoring the mind on the sensation of breathing.
[30 seconds]
Continuing to scan,
Notice the sensations in your hands, [pause]
Wrists, [pause]
forearms, [pause]
upperarms, [pause]
And shoulders. [pause]
Notice how the shoulders move with each new breath. [pause]
Can you feel your heart beating? What does it feel like?
[30 seconds]
Now bringing the attention to the throat and neck,
Note any sensations of tightness or relaxation, keeping the mind anchored on the breath. [pause]
No need to change or control anything. [pause]
Allow your experience to be just as it is. What do you feel?

Continue to breathe. Breathe in *[4 sec]* And out *[4 sec]* Inhaling again, breathe in *[4 sec]* and breathe out. *[4 sec]* And again, breathe in *[4 sec]* And out. *[4 sec]* *[30 sec]* As you relax, remember to breath. Inhaling, breathe in *[4 sec]* and exhaling, breathe out. *[4 sec]* For this next breath, breathe in *[4 sec]* and breathe out. *[4 sec]* *[pause]* And the next, breathe in *[4 sec]* and out. Now continue to breathe and relax on your own. *[30 sec]* Continue to breathe. Breathe in *[4 sec]* And out *[4 sec]* Inhaling again, breathe in *[4 sec]* and breathe out. *[4 sec]* And again, breathe in *[4 sec]* And out. *[4 sec]* *[30 sec]* Now closing this practice, inhale again *[4 sec]* And exhaling *[4 sec]* Again, inhaling *[4 sec]* And exhaling. *[4 sec]* One last time, breathing in *[4 sec]* And out. *[4 sec]* Whenever you are ready, you may open your eyes.	Notice any sensations *[pause]* Are there areas of relaxation or tightness? *[pause]* Places that feel hot or cold? *[pause]* Pleasant or unpleasant? *[pause]* *[10 seconds]* And remember to breathe. When you catch yourself thinking, simply return the attention back to the sensation of the breath. The breath will always bring your back to this new moment. *[60 sec]* As you continue to breath with focused awareness, you may focus the mind by beginning to count the breaths. *[pause]* Counting 1 on the inhale *[pause]* And 2 on the exhale. *[pause]* All the way up to 10. *[pause]* If you lose count, simply start over again from 1. *[60 sec]* As you breathe with awareness, notice all the sensations you may feel. *[pause]* Notice how each new inhale *[pause]* And exhale *[pause]* Is subtlety different from the next. *[60 sec]* Continuing to breathe, remain focused on present moment by continuing to count the breaths. *[pause]* Counting 1 on the inhale *[pause]* And 2 on the exhale. *[pause]* All the way up to 10. *[pause]* If you lose count, simply start over again from 1. Focus on the sensations of your heart beating as you may continue to count each inhale and exhale. *[60 sec]* As you breathe, bring your awareness again to any sounds you may hear in the room at this moment. *[4 sec]* Note these experiences and again return your attention back to the sensation of breathing. Where do you feel the breath the most? *[30 sec]* When you catch yourself thinking, simply return the attention back to the sensation of the breath. The breath will always bring your back to this new moment. *[90 sec]* Closing this practice, bring your attention to the sensations of the inhale	*[30 seconds]* Continuing to breathe, notice your jaw, *[pause]* And the muscles in your lower face and cheeks. *[pause]* Shifting the attention to your lips *[pause]* and mouth, notice any sensations you may have in the interior of your mouth or on your tongue. *[pause]* And when you catch yourself thinking, gently return the attention to the sensation of this next breath. *[30 seconds]* Shifting the attention to the nostrils, Notice where you feel your next inhale *[pause]* And exhale *[pause]* *[30 seconds]* Continuing to scan, next pay attention to the muscles around your eyes *[pause]* corner of the eyes *[pause]* and brow region. Remember to breath. *[pause]* And now feel the entire scalp area From across the top of the head *[pause]* And all the way to the ears. *[pause]* Breathe. *[30 seconds]* When you're ready, begin to expand your awareness to include the entire body. Allow your experience to be just as it is, without judgment as good or bad, wanted or unwanted. What do you feel? *[30 seconds]* Scanning from the top of your head to your feet, Notice any sensations *[pause]* Are there areas of relaxation or tightness? *[pause]* Places that feel hot or cold? *[pause]* Pleasant or unpleasant? *[pause]* *[30 seconds]* And remember to breathe. When you catch yourself thinking or judging any experience, simply make note matter-of-factly, *This is judgment. [pause]* And gently return the attention back to the sensation of the breath. The breath will always bring your back to this new moment. With each new breath,

	and breathe in through your nose *[4 sec]* And exhale through your mouth. *[4 sec]* Again, in through your nose *[4 sec]* and exhale, out through the mouth. *[4 sec]* One last time, breathing in through the nose, *[4 sec]* and exhale, out through the mouth. *[4 sec]* And whenever you are ready, you may open your eyes.	welcome this next moment, whatever it may contain. *[90 sec]* As you breath, you might focus the mind by beginning to count the breaths. *[pause]* Counting 1 on the inhale *[pause]* And 2 on the exhale. *[pause]* All the way up to 10. *[pause]* If you lose count, simply and with kindness start over again from 1. *[60 sec]* Continuing to breathe, let each new moment be exactly as is. *[pause]* Focus on the sensations of your heart beating as you may continue to count each inhale and exhale. *[60 sec]* As you breathe, bring your awareness again to any sounds you may hear in the room at this moment, without judgment as good or bad. *[4 sec]* Note these experiences matter-of-factly and gently return to the breath. Where do you feel the breath the most? *[30 sec]* Closing this practice, bring your attention to the sensations of the inhale and breathe in through your nose *[4 sec]* And exhale through your mouth. *[4 sec]* Again, in through your nose *[4 sec]* and exhale, out through the mouth. *[4 sec]* One last time, breathing in allow yourself to expand, *[4 sec]* and breathing out, let it all go. *[4 sec]* Whenever you are ready, you may open your eyes.

APPENDIX B: FLOWCHART OF STUDY PROCEDURES



APPENDIX C: ONLINE TRIER SOCIAL STRESS TEST (TSST) PROTOCOL

TSST Instructions to Participant

Main RA: *We will now begin the psychological task. For this task, you will give a speech about why you are the best candidate for your dream job to the judges who will analyze your performance. Imagine you have applied for your ideal job, and you must convince the committee members why you are the perfect candidate. The judges will not ask or answer questions during your speech. Make sure that you define your dream job for the judges. You should speak for the entire five-minute period. Before you start the task, the camera will begin recording so that your performance can be further analyzed later. Please remain looking at the screen throughout the entirety of the task once it starts. Do you have any questions?*

You have just learned about and practiced a relaxation technique. Throughout this task, please utilize this practice to manage stress. Once the task is complete, we will measure your perceptions and body's response to this task for the remainder of the visit. Do you have any questions?

I will leave the room now and you will have five minutes to prepare your speech. The judges will turn their video and audio on when 5 minutes have passed. You may write notes to prepare but will be asked to put any notes aside once the task begins. After the preparation period, the judges will instruct you when to give your speech while remaining seated. Please remain looking at the screen throughout the entirety of the task. Do you have any questions?

You may begin your preparation now.

Main RA leaves Zoom room and enters separate breakout room until judge B messages that TSST is completed.

Preparatory Period

Judge 1: Set timer on phone for **5 minutes**. Begin timer when V2 main RA states "*You can begin your preparation now.*" Then turn video and audio off.

Time for 5 minutes.

__________PM Prep period begin time

- During the prep period, all judges should watch the participant and make notes. Do not speak to the participant or respond to any verbal or non-verbal attempts at social engagement during any portion of the TSST.

Speech Task

After the 5-minute prep time is up…

Judges turn cameras and audio on.

Judge 1: "*The preparation period is now over. Please put away any notes.*"

Judge 1: After resetting the timer for **5 minutes**, say *"We will now begin recording. A prompt will appear on your screen about this, please select 'got it' to accept this."* Hit start record on Zoom and begin time. "*You may now begin your speech.*"

Time for 5 minutes.

__________PM Speech period begin time

- Throughout the speech and math portions, judges should maintain eye contact with participants and refrain from providing nonverbal feedback, including nodding or making emotional facial expressions, especially positive expressions. Only scripted verbal feedback is allowed, unless the participant states that she wants to discontinue the study.
- Throughout the speech and math portions, the participant should also remain looking at the screen. If the participant looks away or shuts eyes for more than 5 seconds, prompt the participants to redirect attention back to screen.

Prompts for speech continuation for Judge 1

If participant is silent for more than 5 seconds:

"*Your time is not up. Please continue.*" "*You need to continue speaking.*"

"*You still have time remaining.*" "*The task isn't finished yet.*"

If participant looks away or closes eyes for more than 5 seconds:

"*You must look at the screen during this task.*"

If participant asks a question:

"*We can't answer that. Please continue.*"

Math Task

After the 5-minute speech task time is up…

Judge 1: "*Thank you. The speech task is finished. Now you will begin the final five-minute math portion of this task, during which you will sequentially subtract 13 from 1,022. You will be asked to start over from 1,022 if a mistake is made. Please subtract 13 from 1,022 and keep going until you are instructed to stop. Please remain looking at the screen throughout this portion of the task.*"

NOTE: 1,022 to be pronounced "one thousand twenty two"

Judge 1: After resetting the timer for **5 minutes**, say "*You may now begin*" and start the timer.

Time for 5 minutes.

__________PM Math period begin time

Judge 2: Track participant's progress through the numbers. If the participant makes a mistake, say "*That is incorrect. Please start over from 1,022.*"

Judge 1: Halfway through the math period, say "*You are not going fast enough. Please pick up the pace.*"

Prompts for speech continuation for Judge 2

If participant is silent for more than 5 seconds:

"*Your time is not up. Please continue.*" "*You need to continue speaking.*"

"*You still have time remaining.*" "*The task isn't finished yet.*"

If participant looks away or closes eyes for more than 5 seconds:

"*You must look at the screen during this task.*"

If participant asks a question:

"We can't answer that. Please continue."

After the 5-minute math task is up…

Judge 1 stops recording. Judge 2 messages main RA that TSST is complete.

Judge 1: "*Thank you. You are now finished with the tasks. You will now join the research assistant to complete the rest of the study.*

__________PM TSST stop time

All judges may now leave Zoom.

Upon exit from Zoom, Judge 1 selects 'cancel' on the 'downloading recording' option.

APPENDIX D: SOCIODEMOGRAPHIC QUESTIONS

Please answer the following:

1. What is your date of birth? ____
2. What sex were you assigned at birth?
   Male____ Female____ Intersex____
3. What gender do you identify as?
   Man____ Woman____ Non-binary____ Other, please specify: ________
4. What race do you identify as (you may select multiple)?
   _____ Black or African American
   _____ White
   _____ Asian
   _____ Native American or Alaskan Native
   _____ Native Hawaiian or Other Pacific Islander
   _____ Other, please specify: _________________________
5. What cultural background/heritage do you identify as? For example, European-American, Caribbean-American, Cuban-American, Punjabi, Cantonese, Chinese-American, etc. You may list more than group/cultural identity.
   ____
6. Do you identify as Hispanic, Latino/a/x, or of Spanish descent?
   Yes____ No____
7. Think of this as a ladder representing where people stand in the United States:

At the **top** of the ladder are the people who are best off -- those who have the most money, the most education, and the most respected jobs. At the **bottom** are the people who are the worst off -- who have the least money, least education, and the least respected jobs or no job. The higher up you are on this ladder, the closer you are to the people at the very top; the lower you are, the closer you are to the people at the bottom.

Where would you place yourself on this ladder? Please indicate a number, 1-10, where you think you stand at this time in your life, relative to other people in the United States.

1 2 3 4 5 6 7 8 9 10

APPENDIX E: MINI INTERNATIONAL NEUROPSYCHIATRIC INTERVIEW (MINI) INSTRUCTIONS

The MINI English Version 7.0.2 for DSM-5 was purchased and utilized to screen for the following common psychiatric diagnoses as part of study exclusion criteria and for generalizability purposes: major depression disorder, bipolar disorder, social anxiety disorder, generalized anxiety disorder, panic disorder, posttraumatic stress disorder, and psychotic disorder. Modules on suicidality, agoraphobia, obsessive-compulsive disorder, eating disorders, and antisocial personality disorder were not included given lower base rates of these disorders and time constraints. Clinical interviews were conducted by the study principal investigator or trained research assistant and audio recorded for later case consensus by the clinical research team for reliability and validity. All questions were rated by the clinical interviewers. Clarifying examples and questions were asked as needed, per assessment instructions. Please see https://harmresearch.org/ for more information.

APPENDIX F: MINDFUL AWARENESS & ATTENTION SCALE (MAAS)

Reference:

Brown, K.W. & Ryan, R.M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84*, 822-848.

Instructions:

Below is a collection of statements about your everyday experience. Using the 1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every other item.

1	2	3	4	5	6
Almost always	Very frequently	Somewhat frequently	Somewhat infrequently	Very infrequently	Almost never

1. I could be experiencing some emotion and not be conscious of it until some time later.
2. I break or spill things because of carelessness, not paying attention, or thinking of something else.
3. I find it difficult to stay focused on what's happening in the present.
4. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.
5. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.
6. I forget a person's name almost as soon as I've been told it for the first time.
7. It seems I am "running on automatic," without much awareness of what I'm doing.
8. I rush through activities without being really attentive to them.
9. I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.
10. I do jobs or tasks automatically, without being aware of what I'm doing.
11. I find myself listening to someone with one ear, doing something else at the same time.
12. I drive places on 'automatic pilot' and then wonder why I went there.
13. I find myself preoccupied with the future or the past.
14. I find myself doing things without paying attention.
15. I snack without being aware that I'm eating.

Scoring:

To score the scale, calculate average of all 15 items.

APPENDIX G: TORONTO MINDFULNESS SCALE (TMS)

Reference:

Lau, M. A., Bishop, S. R., Segal, Z. V., Buis, T., Anderson, N. D., Carlson, L., Shapiro, S., Carmody, J., Abbey, S., & Devins, G. (2006). The toronto mindfulness scale: Development and validation. *Journal of Clinical Psychology*, *62*(12), 1445–1467. https://doi.org/10.1002/jclp.20326

Instructions:

We are interested in what you just experienced. Below is a list of things that people sometimes experience. Please read each statement. Please indicate the extent to which you agree with each statement. In other words, how well does the statement describe what you just experienced, just now?

0	1	2	3	4
Not at all	A little	Moderately	Quite a bit	Very much

1. I experienced myself as separate from my changing thoughts and feelings.
2. I was more concerned with being open to my experiences than controlling or changing them.
3. I was curious about what I might learn about myself by taking notice of how I react to certain thoughts, feelings, or sensations.
4. I experience my thoughts more as events in my mind than as a necessarily accurate reflection of the way things ‘really’ are.
5. I was curious to see what my mind was up to from moment to moment.
6. I was curious about each of the thoughts and feelings that I was having.
7. I was receptive to observing unpleasant thoughts and feelings without interfering with them.
8. I was more invested in just watching my experiences as they arose, than in figuring out what they could mean.
9. I approached each experience by trying to accept it, no matter whether it was pleasant or unpleasant.
10. I remained curious about the nature of each experience as it arose.
11. I was aware of my thoughts and feelings without overidentifying with them.
12. I was curious about my reactions to things.
13. I was curious about what I might learn about myself by just taking notice of what my attention gets drawn to.

Scoring:

Add respective items into Curiosity factor: 3 + 5 + 6 + 10 + 12 + 13
Add respective items into Decentering factor: 1 + 2 + 4 + 7 + 8 + 9 + 11
*all items are positively keyed

APPENDIX H: SELF-COMPASSION SCALE – SHORT FORM (SCS-SF)

<u>Reference:</u>

Raes, F., Pommier, E., Neff, K. D., & Van Gucht, D. (2011). Construction and factorial validation of a short form of the Self-Compassion Scale. *Clinical Psychology & Psychotherapy*. *18*, 250-255.

<u>Instructions:</u>

Please read each statement carefully before answering. Indicate how often you behave in the stated manner, using the following scale:

1	2	3	4	5
Almost Never				Almost Always

1. When I fail at something important to me I become consumed by feelings of inadequacy
2. I try to be understanding and patient towards those aspects of my personality I don't like.
3. When something painful happens I try to take a balanced view of the situation.
4. When I'm feeling down, I tend to feel like most other people are probably happier than I am.
5. I try to see my failings as part of the human condition.
6. When I'm going through a very hard time, I give myself the caring and tenderness I need.
7. When something upsets me I try to keep my emotions in balance.
8. When I fail at something that's important to me, I tend to feel alone in my failure.
9. When I'm feeling down I tend to obsess and fixate on everything that's wrong.
10. When I feel inadequate in some way, I try to remind myself that feelings of inadequacy are shared by most people.
11. I'm disapproving and judgmental about my own flaws and inadequacies.
12. I'm intolerant and impatient towards those aspects of my personality I don't like.

<u>Scoring:</u>

Self-Kindness Items: 2, 6
Self-Judgment Items (Reverse Scored): 11, 12
Common Humanity Items: 5, 10
Isolation Items (Reverse Scored): 4, 8
Mindfulness Items: 3, 7
Over-identification Items (Reverse Scored): 1, 9
To reverse score items (1=5, 2=4, 3=3, 4=2, 5=1).
To compute a total self-compassion score, first reverse score the negative subscale items - self judgment, isolation, and over-identification. Then take the mean of each subscale and compute a total mean (the average of the six subscale means).

APPENDIX I: PERCEIVED STRESS SCALE (PSS-10)

Reference:

Cohen, S., & Williamson, G. (1988). Perceived stress in a probability sample of the United States. In *The social psychology of health* (pp. 31–67). Sage Publications, Inc.

Instructions:

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate with a check how often you felt or thought a certain way.

0	1	2	3	4
Never	Almost never	Sometimes	Fairly often	Very often

1. In the last month, how often have you been upset because of something that happened unexpectedly?
2. In the last month, how often have you felt that you were unable to control the important things in your life?
3. In the last month, how often have you felt nervous and "stressed"?
4. In the last month, how often have you felt confident about your ability to handle your personal problems?
5. In the last month, how often have you felt that things were going your way?
6. In the last month, how often have you found that you could not cope with all the things that you had to do?
7. In the last month, how often have you been able to control irritations in your life?
8. In the last month, how often have you felt that you were on top of things?
9. In the last month, how often have you been angered because of things that were outside of your control?
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

Scoring:

To calculate a total PSS score, responses to the four positively stated items (items 4, 5, 7 and 8) first need to be reversed (i.e. 0 => 4; 1 => 3; 2 => 2; 3 => 1; 4 => 0).

The PSS score is then obtained by summing across all items. Higher scores indicate higher levels of perceived stress.

APPENDIX J: POST-RECOVERY QUESTIONS

1. Please describe your experiences practicing the relaxation technique today. What was this practice like for you? [open-ended]

2. How did you utilize this practice during the psychological task? [open-ended]

3. How helpful was it to use this practice to manage stress during the psychological task?

   Very unhelpful   Unhelpful   Neither   Helpful   Very helpful

4. Did you utilize this practice after the psychological task?

   Yes/No

      If yes, how? [open-ended]

5. How likely are you to use this practice again?

   Very unlikely   Unlikely   Neither   Likely   Very likely

6. Is there anything that would have made this practice more effective for you? Please describe your specific recommendations.

APPENDIX K: VISIT 2 STRESS REACTIVITY MEASUREMENT TIMELINE

Visit preparation (~15 minutes) | **Guided practice** (30 minutes)

Review visit health questions

Saliva sample 0

Set-up HR, BP equipment

Paced breathing task

Guided audio practice

HRV R-R baseline recording begins

Baseline measures (< 5 minutes) | **Virtual TSST** (~20 minutes) | **Recovery** (60 minutes)

VAS 1

Baseline BP

Saliva sample 1

TSST begin

Prep period

Speech task

Math task

VAS 2

VAS 3

Saliva sample 2

Saliva sample 3

Saliva sample 4

HRV R-R baseline recording ends, stress recording begins

HRV R-R stress recording ends, recovery recording begins

Recovery, cont. | **Closing** (~15 minutes)

Saliva sample 5

VAS 4

Saliva sample 6

Saliva sample 7

VAS 5

Remove HR, BP monitors

Debriefing, compensation

HRV R-R recovery recording ends

APPENDIX L: SALIVARY CORTISOL ELISA ASSAY

High sensitivity salivary cortisol enzyme immunoassay kits (protocol version 02.12.21) purchased from Salimetrics were utilized to analyze cortisol samples. Bound cortisol enzyme conjugate is measured by the reaction of peroxidase enzyme to tetramethylbenzidine to yield a blue color reaction that is stopped by an acid, turning the solution yellow. The density is then read on a standard plate reader at a wavelength of 450nm to determine the amount of cortisol present (inverse of enzyme conjugate). Please see https://salimetrics.com/assay-kit/salivary-cortisol-elisa-kit/ for further information and https://salimetrics.com/wp-content/uploads/2018/03/salivary-cortisol-elisa-kit.pdf for most up to date protocol.

APPENDIX M: CORRELATION TABLE

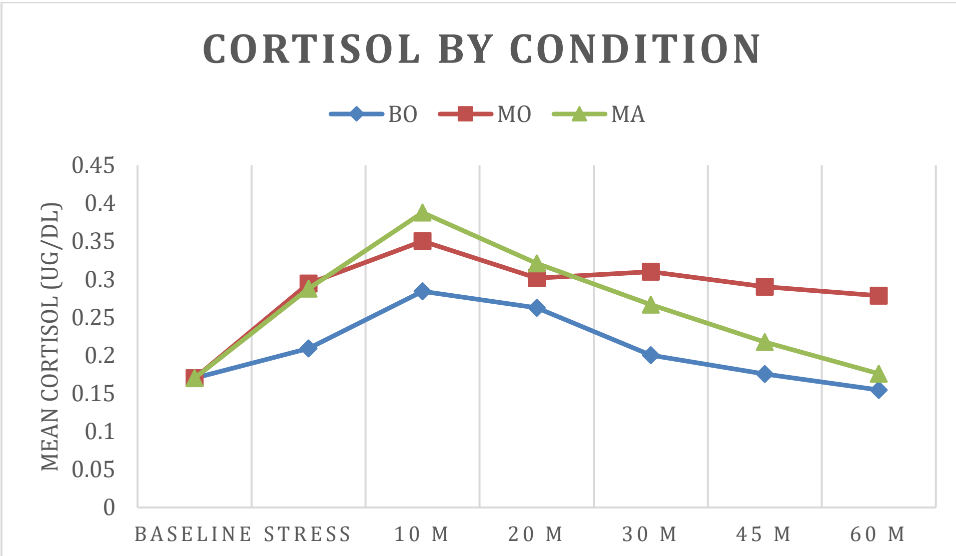
Table 26. Correlations for V2 completers

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Age	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2. Sex	-.10	1	--	--	--	--	--	--	--	--	--	--	--	--	--
3. Ethnoracial st.	-.17	.07	1	--	--	--	--	--	--	--	--	--	--	--	--
4. SSS	-.27	-.20	.09	1	--	--	--	--	--	--	--	--	--	--	--
5. Screener PSS	.14	.13	.16	-.02	1	--	--	--	--	--	--	--	--	--	--
6. SCS	.18	-.29	.02	-.01	-.33†	1	--	--	--	--	--	--	--	--	--
7. MAAS	.21	-.18	.05	-.13	-.31†	.16	1	--	--	--	--	--	--	--	--
8. Psych. med.	.16	.32†	.22	-.09	.02	-.44*	.20	1	--	--	--	--	--	--	--
9. BMI	.23	-.18	-.11	.14	-.14	-.05	.36*	-.03	1	--	--	--	--	--	--
10. BL VAS	-.44*	.16	.15	.11	.24	-.05	-.33†	-.27	-.20	1	--	--	--	--	--
11. Systolic BP	.35*	-.48**	-.37*	.13	-.24	.12	.08	-.06	.39*	-.16	1	--	--	--	--
12. Diastolic BP	.27	-.37*	.25	.29	-.15	.11	.15	.08	.26	-.11	.63**	1	--	--	--
13. PBT HR	.23	-.06	.11	-.05	-.10	.03	.20	.50**	.06	-.28	.09	.38*	1	--	--
14. PBT SDNN	-.33†	.04	-.11	.09	.29	-.17	-.22	-.38*	-.14	.39*	-.05	-.25	-.74**	1	--
15. PBT RMSSD	-.29	.04	-.10	.12	.26	-.17	-.20	-.35†	-.10	.40*	.02	-.17	-.74**	.99**	1
16. BL cortisol	-.02	-.22	.33†	.17	-.23	.33†	.38*	.11	-.12	-.08	-.16	.23	.39*	-.26	-.26

Note. N = 33 for all except SCS, PSQI, HRV, N = 32; IPAQ, N = 29. Pearson's r is reported for continuous variables and point biserial correlation r is reported for binary dichotomous variables. ** $p < .01$, * $p < .05$, † $p < .10$. Sex is coded 0 for male, 1 for female. Ethnoracial status (st.) is coded 0 for non-Hispanic white, 1 for any ethnoracial minority. Psychiatric medication (psych. med.) and diagnosis are coded 0 for no, 1 for yes. SSS = subjective social status per MacArthur Subjective Social Status ladder relative to others in the United States. PSS = Perceived Stress Scale. SCS = Self-Compassion Scale. MAAS = Mindful Attention Awareness Scale. BP = blood pressure. BMI = body mass index. TSST = Trier Social Stress Test. BL = baseline. VAS = Visual Analog Scale. PBT = Paced Breathing Task, HR = heart rate. SDNN = standard deviation of the interbeat interval of normal sinus beats. RMSSD = root mean square of successive differences.

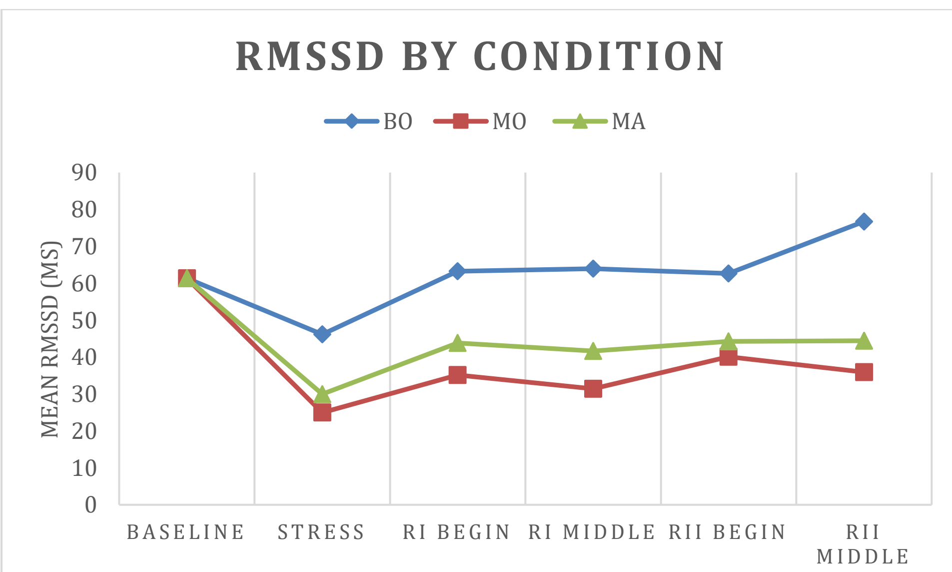
APPENDIX N: RAW GRAPHS OF OUTCOME STRESS REACTIVITY TRAJECTORIES

Figure 5. Cortisol reactivity by condition



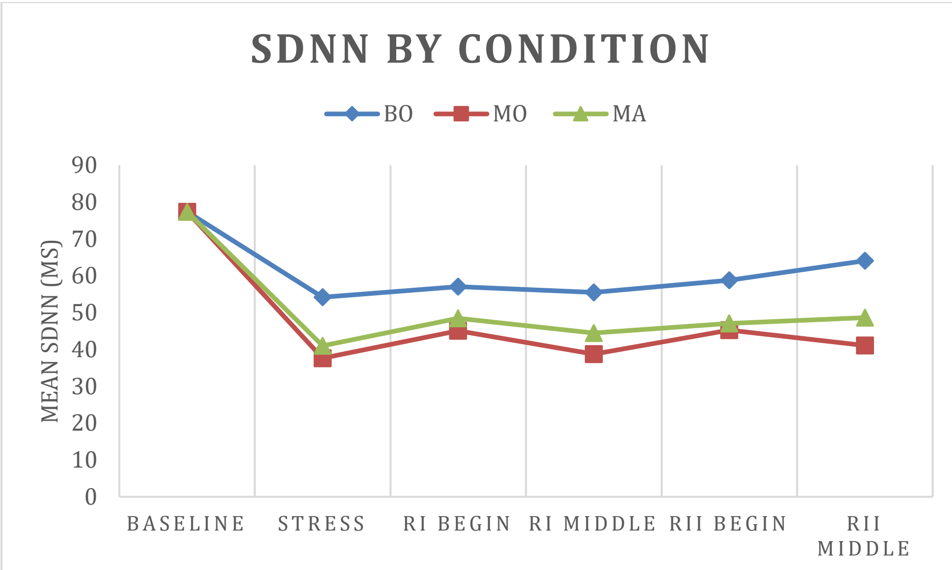
Note. N = 31 (2 outliers excluded). BO = breathing-only control, MO = monitor-only condition, MA = monitor + accept condition. M = minute.

Figure 6. RMSSD by condition



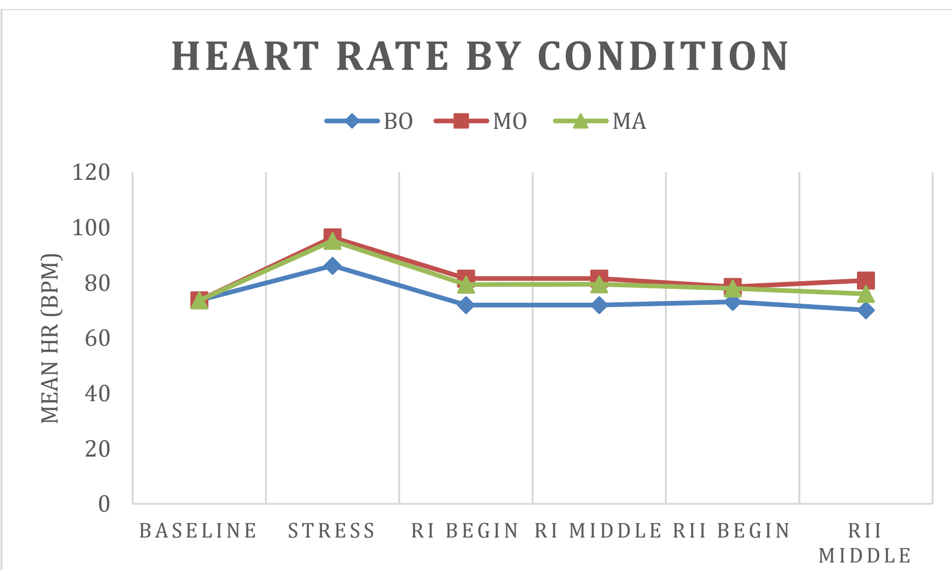
Note. N = 32. RMSSD = Root mean square of successive differences. BO = breathing-only control, MO = monitor-only condition, MA = monitor + accept condition. MS = milliseconds.

Figure 7. SDNN by condition



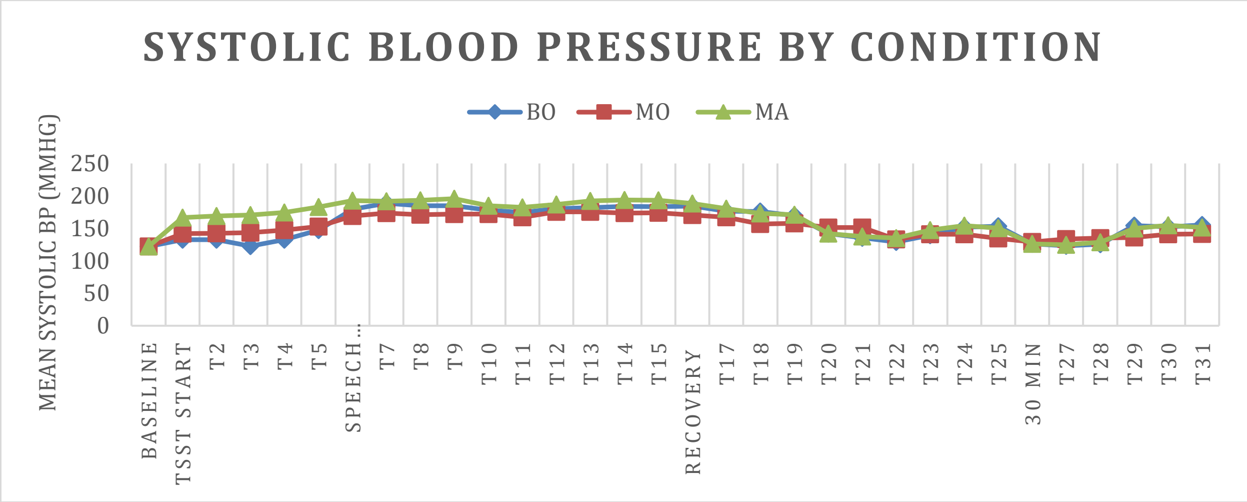
Note. N = 32. SDNN = Standard deviation of the interbeat interval of normal sinus beats. BO = breathing-only control, MO = monitor-only condition, MA = monitor + accept condition. MS = milliseconds.

Figure 8. Heart rate by condition



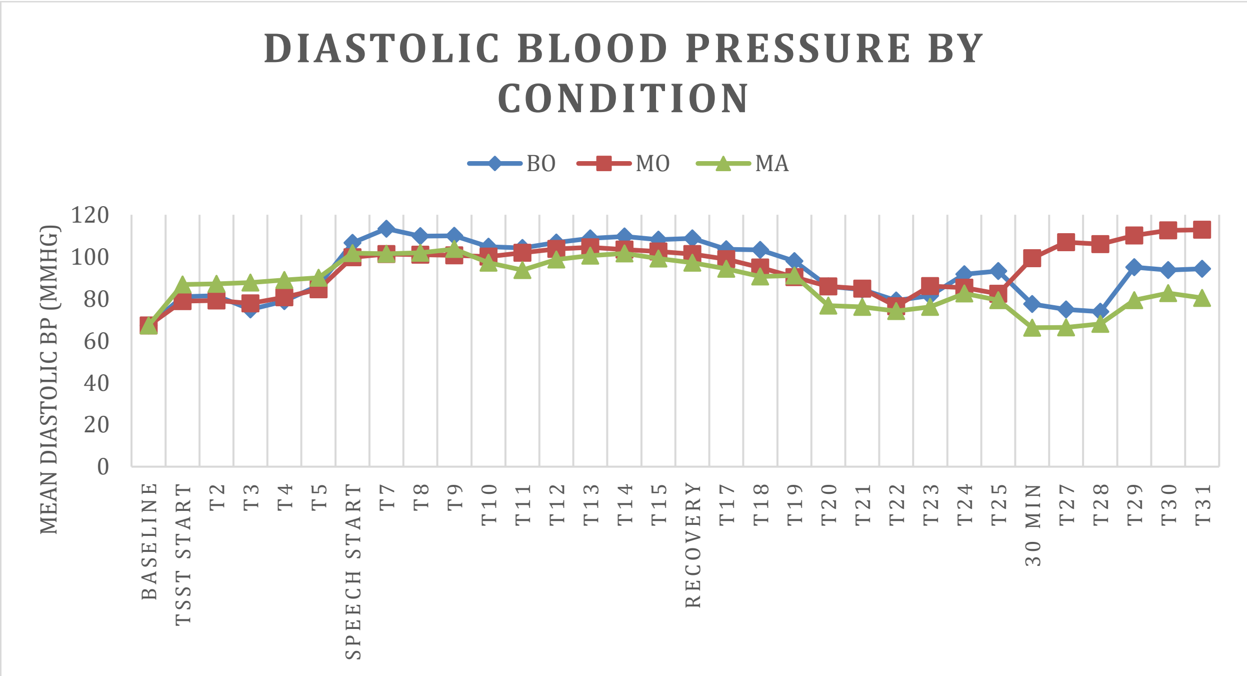
Note. N = 32. BO = breathing-only control, MO = monitor-only condition, MA = monitor + accept condition. BPM = beats per minute.

Figure 9. Systolic blood pressure by condition



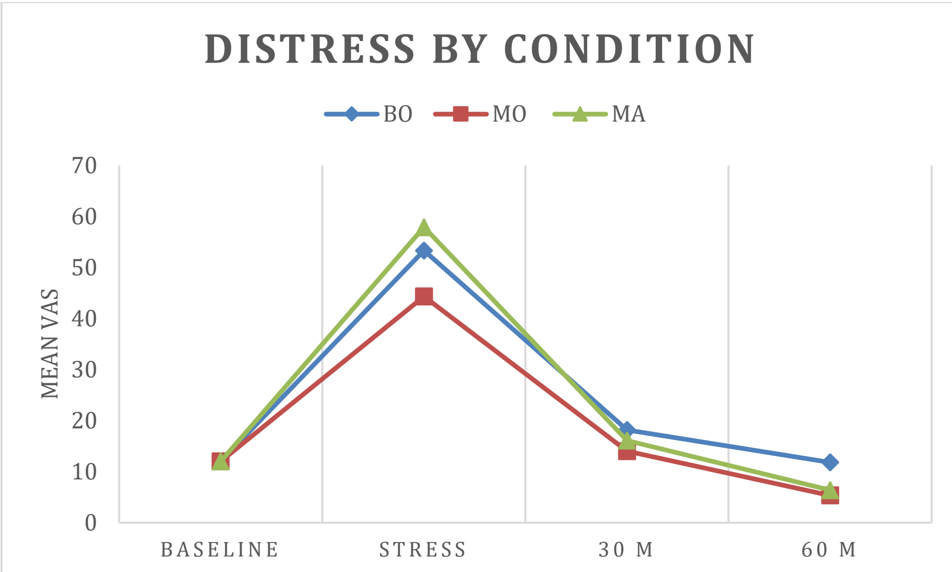
Note. N = 11. BO = breathing-only control, MO = monitor-only condition, MA = monitor + accept condition. mmHG = millimeters mercury.

Figure 10. Diastolic blood pressure by condition



Note. N = 11. BO = breathing-only control, MO = monitor-only condition, MA = monitor + accept condition. mmHG = millimeters mercury.

Figure 11. Distress ratings by condition



Note. N = 33. BO = breathing-only control, MO = monitor-only condition, MA = monitor + accept condition. M = minute. VAS = visual analog scale.

APPENDIX O: QUALITATIVE RESPONSE SUMMARY TABLES

Table 27: Thematic analysis of participants' experiences with guided practice at rest

Condition	Category	Subcategory
BO	Relaxing/calming (6)	--
	Enjoyable/interesting (4)	--
	Helpful/useful (5)	Facilitated mind-body awareness (1) Facilitated present moment awareness (1) Facilitated distance from thoughts (1)
	Neutral (1)	--
	Simple/easy to learn (1)	--
	Increased drowsiness (1)	--
	Initially more difficult (1)	--
MO	Relaxing/calming (5)	--
	Enjoyable/interesting (2)	--
	Helpful/useful (4)	Reduced thinking about stressors (1)
	Increased drowsiness (2)	--
	Needed more time/practice (1)	--
MA	Relaxing/calming (5)	--
	Enjoyable/interesting (4)	--
	Helpful/useful (3)	Facilitated mind-body awareness (1) Facilitated acceptance of sensation/feelings (1)
	Increased drowsiness (1)	--
	Need more time/practice (2)	--
	Simple/easy to learn (2)	--
	Initially more difficult (2)	--
	Boring (1)	--

Note: BO = breathing only control, MO = monitor only condition, MA = monitor + accept condition.

Table 28: Thematic analysis of participants' process of using technique to manage stress

Group	Category	Subcategory
BO	Focused breathing helped performance (7)	Facilitated relaxation/reduced stress/overwhelm (5) Facilitated mind-body awareness (1) Facilitated present moment awareness (1) Allowed time to think/refocus (2)
	Difficult to use (5)	Hard to remember to use during task (1) While talking (1) Needed more practice (1) Felt very stressed/anxious (1)
	Used only minimally (2)	--
MO	Focused breathing helped performance (6)	Reduced rumination (1) Allowed time to think/refocus (3) Facilitated present moment awareness (1)
	Difficult to use (5)	Felt very stressed/anxious (3) While talking (2)
	Used other strategy (3)	Reframing – changed task, used compassion (2) Allowed for pacing (1)
MA	Focused breathing helped performance (6)	Allowed time to think or slow down/refocus (3) Facilitated present moment awareness (2) Facilitated acceptance (2) Reduced rumination (1) Reduced anxiety (1)
	Difficult to use (3)	While talking or focused on task (1) Felt very stressed/anxious (2)
	Used other strategy (1)	Reframing (1)
	Used only minimally (2)	--

Note: BO = breathing only control, MO = monitor only condition, MA = monitor + accept condition.

Table 29: Participant open-ended responses to post-recovery questions

Condition	Experiences with practice	Process during stress	Process during recovery
BO	While learning the exercise with the voice, it was very relaxing and did make me feel more tired.	While under a stressful situation it was hard to remember to use it since my thoughts were on the situtation. It was harder to use it during the task since my mind was clouded trying to think of the answers to the questions	Breathing deeper and more controlled calmed me down after from the stress I was feeling
	The technique was really nice when I was doing the practice. I felt super calm and relaxed after it. It took a while for my body to get used to the breathing but once I did it was nice	It was really hard to utilize the technique during the test. I was trying to talk and control my breathing and that's very hard	--
	the technique itself was overall fine	relaxing, needed more practice	--
	The technique did really well when I was alone.	I think it did help during the psychological test, but it did not help as much as I wanted it to. I certainly experienced a more calm feeling, but I think it can be easily disturbed and almost removed by highly stressful situations. I was not consciously breathing deeply, but I was doing so subconsciously. I was in more control over my overall breathing when compared to other experiences of feeling stressed out.	Again, I did not actively count my breathing during the recovery period, but I did remind myself at times to control my breathing better. I think that the practice was not highly effective because it was greatly disturbed during the psychological task.
	The stress management and techniques I experienced today was relaxing. I enjoyed the breathing techniques. I found the experience enlightening and provided me with insight on my mind and body connection.	I made sure to focus on breathing and how much I was tensing up.	I used the breathing technique to lower my heart rate and to level my mind. When I found myself winding down I still made sure to focus on my breathing.
	The practice/technique was very calming.	I feel like when I tried to use it during and before the tasks I either didn't have enough time to use it or enough concentration but was able to use it after. It was difficult to use it during the task but when I started to feel overwhelmed I took a couple deep breaths.	In between saliva samples, I used it a couple times to center myself.
	The experience was good. The practice seemed pretty simple	Every once in a while during the "interview" I would take those breaths.	--
	The breathing technique was calming and i think it is quite useful	Utilized it once and it gave me some time to think about the topic	Once the task was done took my time to settle down and breath slowly inhale and exhale
	It was interesting- I felt sort of pensive. But I didn't feel as rushed.	The technique didn't really help as far as the math or psychological tasks. Almost wanted to stop the study lol. But i didn't because i wanted to continue- but those people really were trifling. A little intimidating too I tried breathing but I kept being told to look at the camera so they didn't really get to be put to use much	--
	I found the stress management method to helped me calm down and center myself.	During the assessments I found myself stressed and feeling emotionally insecure since I wanted to do well. After the assessment I found	I used to hep focus and adress my concerns of emotional insecurity. I also

		myself using the technique to calm down from the stress and to help mange the anxiety and to help myself think through why I felt emotionally insecure during the assessment. I used deep breathing to help give myself some time to think of what to speak about next. Additionally, I used it in between assessments to try and center myself and to reduce my anxiety going into the next task.	used to help destress myself after the difficult tasks.
MO	This stress management technique was very relaxing for me and actually almost made me fall asleep multiple times since it's similar to my ritual of falling asleep each night.	I used it to make sure that the circumstances I was given were not too stressful; I would stop myself from overthinking and breathe to focus.	After the task I just made sure to take deep breathes and ground myself while coloring to calm myself down from the stressors.
	The technique really helped minimize my stress as I was thinking about the stressors I currently have. The practice really did make me feel more relaxed and made me think less which I think was a success. Breathing is not really a technique I would use but after today, I think that this will help me with stress related problems.	To be honest I forgot how the psychological task was because I think I blanked out and got really anxious during it but I did continue to breathe and think my way through the task.	Mainly the whole time because that task really made me uncomfortable and anxious so I did use it during the recovery period and I continue to just breathe and think positive instead of negative.
	The practice was interesting and I think the new technique gave me new ideas as to how I can manage my stress more effectively. I think I need more time to be able to put the technique into practice as 20 minutes is not really enough (personally) for me to be able to learn, and utilize effectively for stress management. What I did learn today I might be putting into use later along with other stress techniques I know. Thank you!	I tried using the technique during the first part (the business meeting) and I tried focusing on my breathing and sort of I guess grounding myself to stay calm. For the second one I completely forgot and I panicked (internally) and was unable to really utilize it.	While I was coloring, I focused on my breathing and the sound of the pencil on paper. I let my thoughts come and go and once they did I would bring my attention back to the sound of the pencil or my breathing.
	The guided breathing was relaxing.	It felt kind of silly having the two judges there telling me what I could and couldn't do but it did give me a lot of anxiety. It was especially anxiety inducing because they were called judges and they were judging what I was doing or wasn't doing. I can't do math in my head so I didn't know what to say. I took deep breaths during times I didn't know what to say or needed to recollect my thoughts. I used the technique sometimes during the activity.	I started to focus on other activities and it helped me calm my breathing down.
	Practice was fairly calming as I mostly focused on the voice and breathing however it made me tired.	When I became noticeably stressed I started breathing however I was prompted to keep speaking which minimized the effectiveness of the technique for me.	I sometimes used this practice during recovery however I focused more on the enrichment bag.
	Ngl I did not like it at all. However, it definitely was effective in making me stressed. [talking about TSST]	If I lost my train of thought I used the slow breathing exercises If I lost my train of thought during my speech I remembered to do the slow breathing from the audio guide. I would have been too anxious to	Just got into a zone where all I did was breathe and color

		make a real career sales pitch, so I just made up a fun one instead. That was also a useful way to not get too stressed	
	It was very Helpful [on TSST]	It was helpful during the tasks, without that technique performance on the task wouldn't be better. focus on the breathing assisted to focus the problem during stress and relax resulted a better outcome.	By focusing on the task rather worrying about the output to some extent its helpful
	It was an nice experience as I got to experience a variety of ways to deal with the stressors that were placed in front of me. Knowing there are different ways for me to tackle my stress, I can go about resolving my issues much better, by knowing what helps me and what does not.	I took my time and did not let my stressors get to me.	I practiced breathing slowly and at a steady pace. I used this but I did not focus on implementing it.
	I think the breathing practice was very calming and helpful	the interviews and math with the judges just made me more nervous and scared even after calming down with the activity before that. I took a second to breathe and rethink what I had to say but I was pushed to keep talking which distracted me and made me more anxious.	just for a little in the beginning to calm down my anxiety.
	I like the first part when I practice and control my breeding basically.	Inhaling and exhaling was the only technique I can think right now	Trying to realize it was not a serious situation and of course figure out that anyone can make mistakes even if I did put a lot of effort on it
MA	While the practice/technique is very calming, I don't think these kind of grounding techniques are quite as effective or come as easily to me because I'm more used to being scatter-brained and spontaneous. I think with practice, the technique will come easier but as for today, it was somewhat difficult for me to tune completely into the activity.	I reminded myself that it was a research study, and not an actual interview and attempted to remind myself the quality of what I say wasn't as important	For most of the recovery period, I had more time to attempt to tune into my surroundings, I tried to focus on breathing and it helped me recover a bit. My mind was fairly empty and free but towards the end I began functioning more alertly and began having swarms of thought.
	The stress management practice which I was directed to utilize was somewhat useful. When outside of the high-intensity tests near the start, I was able to use it -- especially the part of acknowledging negative thoughts and refocusing upon breathing -- to be able to control them somewhat. It was somewhat hard to focus on the video initially.	During the job interview portion, I wasn't really able to use the task very much due to the limited time provided and the required focus upon the screen and continuous talking making it impossible to take time and focus as required. I was not able to utilize it either during the counting part. **Afterward, I was able to utilize it to somewhat effect to control negative thoughts and feelings.**	As previously mentioned, I was able to use it to control negative thoughts and emotions during the recovery period that had resulted from the psychological tasks. I used them probably once every ten or twenty minutes, whenever a negative thought appeared, to be able to move past them.
	The practice was somewhat boring, It made me want to go to sleep	I took a deep breath in the middle of the interview	--
	The practice was good it made me think about each muscle and body part individually and seeing how they felt. I normally just think about how I feel on a wholistic scale.	I tried to refocus myself and keep steady breathing in order to continue with the task	I used the technique for about 5-10 minutes after practice and after that I felt fine.

	The breathing technique was helpful and I can see myself using it in the future.	The interview portion was very stressful and the breathing helped some but not too much. I took deeper breaths and tried to ground myself.	taking slower and deeper breaths.
	It was weird at first, but I quickly got the hang of it and learned how to concentrate and quickly calm myself when in tense situations.	I closed my eyes and took a second to feel the air through my body so I could refocus myself	Anytime I felt like it I just closed my eyes and took deep breathes and that helped to clear my mind of all the clutter
	It was very stressful but also made me learn a lot. [talking about TSST]	I think this really helped me to do breathing exercises when I am feeling stressed. The judges were scary and I was nervous to talk around them but I just remembered to breathe to help me although I was still stressed. The rest of the study I felt comfortable with. When I started to feel stressed I would accept the hard things around me then focus on my breathing and try again.	I used it when recovery started mostly and just tried to breathe and bring myself back to a calm state. Once I was calm I didn't think of it too much.
	It was very relaxing and calming. I felt at peace during and after I completed it.	I utilized it before I did the "mock interview." It completely left my head when I did the math test.	I utilized the acceptance piece for my thoughts and embarrassment.
	It was very engaging and easy to follow along to. The instructor was clear and concise. I was able to enjoy the experience.	I followed my breathing and stayed present in the moment instead of ruminating over the pressure of the task.	I tried very hard to not get lost in my head and instead focus on the things I was doing to pass time.
	It was interesting. I was able to feel calm during the guided breathing and enjoyed when there were things to focus on. I noticed myself trying to practice accepting whatever sensations/feelings came up during the practice today.	I took measured breaths a few times and told myself that 'this is what it is' a few times to accept the task ahead of me.	--
	I truly enjoyed the thought process behind the study. I feel as though it was very elaborate and thought out very well. Even though I enjoyed both the breathing technique and the 20 minute stress management video, I feel as though if the techniques were perhaps reminded/ if the video were to be rewatched in between the two stressful situations, then the participant could implement them better into the situations.	As someone who has an anxiety disorder and is avidly attempting to learn new techniques and implement them into stressful day to day tasks, I found it very difficult to utilize the tasks or even think about them. I reminded myself to breathe.	--
	Calmed my mind, very relaxing	Tried to relax my breathing and take my time. It stopped my hands from shaking from the stress	Took my time and relaxed my mind

Note: BO = breathing only control, MO = monitor only condition, MA = monitor + accept condition. Each row is same participant's written responses to each open-ended post-recovery question prompt. – indicates that participant did not respond to question prompt.