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Can Mindfulness Training Reduce Stress Reactivity in First-Year College Students?

Liat Zitron
The Graduate Center, CUNY

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CAN MINDFULNESS TRAINING REDUCE STRESS REACTIVITY IN FIRST-YEAR COLLEGE STUDENTS?

by

LIAT ZITRON

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy,

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This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

Yu Gao, PhD

Date Chair of Examining Committee

Richard Bodnar, PhD

Date Executive Officer, Psychology

Supervisory Committee:

Laura A. Rabin, PhD
Margaret-Ellen Pipe, PhD
Benzion Chanowitz, PhD
Elisabeth Brauner, PhD

The City University of New York
ABSTRACT

Can Mindfulness Training Reduce Stress-Reactivity in First-Year College Students?

By

Liat Zitron

Advisor: Yu Gao, PhD

The positive effects of mindfulness-based practices on stress reactivity have been gaining steady attention in recent years. Yet, the effects of mindfulness training on stress responses via the autonomic nervous system (ANS) functioning, and in particular, changes in cardiovascular activity, have rarely been researched. The polyvagal theory (Porges, 1995) offers a theoretical framework in which the roles of the subdivisions of the ANS in regulating emotion and behaviors are delineated, and closely connected to the concept of heart rate variability (HRV) and its association with stress responses. A select literature review highlighting prior mindfulness studies utilizing physiological markers to index the ANS response to stress in different populations across the lifespan follows. Special attention is given to first-year college students and their unique challenges as they navigate this critical juncture in their lives. In this study, 25 first-year college students were randomly assigned to attending six weekly sessions of either mindfulness training (intervention group) or a ‘sham’ mindfulness stress-reduction training (control group). Subjective reports of anxiety and stress, as well as psychophysiological responses during a lab social stressor were assessed pre and post training for both groups. Additionally, trait mindfulness was assessed prior to the training. Results showed that participants in the mindfulness group had statistically significant increases in their HRV measures from pre to post training, indicative of an attenuated stress response and a more
balanced ANS. Specifically, participants who were dispositionally lower in trait mindfulness were the ones to gain these stress reduction training-related benefits, whereas those high in dispositional mindfulness did not show similar gains. These results provide initial evidence that mindfulness training may be an effective means to reduce stress reactivity in college students, especially at the pivotal transition into college life.

Keywords: mindfulness, meditation, stress response, emotion regulation, heart rate variability, Polyvagal theory, first-year college students, Trier Social Stress Test
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List of Abbreviations

AMAS-C ............................. The Adult Manifest Anxiety Scale – College Version
ANS ................................. Autonomic Nervous System
ECG ................................. Electrocardiography
GAD-7 ............................... Generalized Anxiety Disorder 7-Item
HPA ................................. Hypothalamic-Pituitary-Adrenal
HRV ................................. Heart Rate Variability
L2B ................................. Learning to BREATHE
MAAS ............................... Mindfulness Attention Awareness Scale
MBSR ............................... Mindfulness Based Stress Reduction
PNS ................................. Parasympathetic Nervous System
PSS ................................. Perceived Stress Scale
RCT ................................. Randomized Controlled Trial
RMSSD ............................. Root Mean Square Successive Differences
RSA ................................. Respiratory Sinus Arrhythmia
SNS ................................. Sympathetic Nervous System
STAI-T ............................. State Trait Anxiety Index – Trait subscale
TAU ................................. Treatment as Usual
TSST ............................... Trier Social Stress Test
UMass ............................. University of Massachusetts Medical School
CHAPTER 1 – MINDFULNESS

Introduction

In recent years, research on the effects of mindfulness training on physical and psychological health has proliferated. Many claims have been made about the benefits of mindfulness-based practices for ameliorating various physical and mental health conditions, as and reduced symptoms have been reported for chronic pain, fibromyalgia, psoriasis, irritable bowel syndrome, HIV/AIDS, and cancer among other medical conditions, alongside reduced symptomology in depressive, anxiety, and addiction disorders (Baer, 2003; Creswel, 2017; Hölzel et al., 2011).

Despite the growing popularity of mindfulness-based approaches, and emerging empirical support for their proposed health benefits, additional evidence is still needed to establish whether these programs can modulate the stress response in a way that may be quantified and objectively measured. The majority of mindfulness studies to date utilized self-report scales to measure participants’ recorded changes in stress levels over time from pre to post training. While a person’s subjective experience is a key component in stress perception, the use of self-report scales as a sole means of ascertaining health claims, without objective physiological measures to complement such investigations, has been subject to frequent criticisms as one of the shortcomings in current mindfulness research (Garland & Gaylord, 2009). Self-report scales are prone to response biases such as demand characteristics and social desirability, among others. There can also be concerns regarding comprehension of the scale questions that may not be interpreted uniformly by all study participants. Furthermore, answering questions regarding one’s perceived stress level and anxiety as well as about mindfulness
characteristics requires a level of introspection that a participant may or may not have. This may be especially problematic when attempting to measure mindfulness – a construct intimately related to the concepts of awareness and introspection, and may call into question the validity of using self-report measures to accurately capture the essence of mindfulness (Bergomi, Tschacher, & Kupper, 2013; Grossman, 2011).

Mindfulness studies utilizing brain imaging have provided some evidence for brain functional and structural changes following mindfulness training (Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007; Cahn & Polich, 2006; Chiesa, Serretti, & Jakobsen, 2013). These studies are an important addition to the field, with results showing mindfulness effects on brain plasticity, such as grey matter concentration changes in brain areas responsible for memory and learning, emotion regulation, and perspective taking (Hölzel et al., 2011). Yet, these studies primarily shed light on the effect of mindfulness on the central nervous system’s contribution to the stress response, whereas the effect of mindfulness on the Autonomic Nervous System (ANS) and its cascade of events during a stress response remains neglected and uncharted territory.

Relatively few mindfulness studies to date had used physiological markers to index ANS activation, including changes in vagal tone as reflected by heart rate variability (HRV) or respiratory sinus arrhythmia (RSA), systolic blood pressure, skin conductance, and cortisol levels. Such studies have provided initial evidence in support of mindfulness-based practices as a means of reducing stress and promoting physical and psychological health through increasing vagal tone and corresponding emotional regulation (Carlson, Speca, Faris, & Patel, 2007; Matchim, Armer, & Stewart, 2011; Regehr, Glancy, & Pitts, 2013).
However, even those few studies utilizing objective physiological measures were often characterized by deficient methodology and poor design, lacking properly constructed randomized controlled trials (RCT). Many of these studies consisted of pre and post training comparisons only, with no control group. Other studies employed a wait-list or ‘treatment as usual’ (TAU) control group, rather than using an active control condition. An active control condition can be defined as matching the intervention group in aspects such as time and attention, so that expectations regarding participation benefits are kept equivalent. Some examples include a support group or psychoeducation sessions. A more specific type of an active control group may be comparing the intervention group with a different established treatment or protocol, such as cognitive behavioral therapy or progressive muscle relaxation (Goyal, 2014).

The absence of an active control group creates a ‘pseudo’ mixed factorial design, when in reality, such repeated measures studies are more akin to a pre-post within subject design only, since there is no real between-subject variable, because the control group is not receiving any intervention (until the study’s completion, when the wait-listed participants will usually be offered intervention). Using such a design makes it easier to artificially achieve statistical significance in favor of the mindfulness training, in the absence of a true comparison to another concurrent intervention. Deriving from the absence of an active control group is the issue of proper randomization. In many mindfulness studies, participants knew they were participating in a true mindfulness condition, possibly confounding study findings.

In the current study, I aimed to address some of these gaps in research and methodological limitations, by utilizing HRV as a physiological marker to index ANS stress reactivity, in addition to self-report of stress and anxiety. Additionally, I created an active control
group, in the form of a ‘sham mindfulness’ stress-reduction condition, in order to delineate intervention effects, so that both within as well as between group comparisons can be made.

**What is Mindfulness?**

Although multiple definitions for mindfulness exist, and there is no consensus regarding how to operationalize the construct (Chiesa & Malinowski, 2011); the most commonly accepted definition is: “Mindfulness is the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experiences moment by moment” (Kabat-Zinn, 2003, p. 145). This definition includes two components: The first component is attention regulation that allows individuals to focus on their immediate experience and become aware of thoughts, emotions, and sensations – in the present moment. The second component includes an attitude of openness, curiosity, and acceptance that individuals espouse toward these moment by moment experiences (Bishop, 2002; Hölzel et al., 2011). These experiences consist of both external and internal events, such as sounds, sights, smells as well as thoughts, feelings, and bodily sensations (Hooker & Fodor, 2008).

There is a common confusion about the distinction between mindfulness and meditation (Hooker & FoDoR, 2008), and these two terms are often used interchangeably despite their differences. There are also many types of meditation practices, but the current discussion is limited to meditation in the context of mindfulness meditation, unlike purely concentration-based meditation practices, such as transcendental meditation where there is a narrow focus on a single stimulus, such as a mantra, with little regard to or exploration of arising distractions and their nature (Baer, 2003). By contrast, mindfulness meditation is a way to cultivate and develop a practice of sustainable and deepened awareness of all that is going on at the present moment. It is derived from ancient Eastern practices but has been developed into a multitude of secular,
scientifically-based approaches and programs, adapted to fit modern life Western society, although some concerns regarding its religious and spiritual origins remain (Greenberg & Harris, 2011).

Often, in the beginning stages of a mindfulness practice, during a sitting meditation, the attention is directed to the breath, in order to train the mind to focus without distraction. But with continued practice, as the mind does not wander as much, object-focused meditation becomes less necessary (Hölzel et al., 2011) and mindfulness of the present moment and its ongoing stream of thoughts, sensations, and emotions is more easily accessed at will. This growing awareness and wakefulness then expands to additional areas of life, including everyday actions, such as mindfulness in eating, driving, walking, or any other daily experience.

This difference between formal mindfulness meditation and cultivating mindfulness through everyday living also pertains to the distinction between state and trait mindfulness. The conscious act of paying attention, which is the foundation of mindfulness, is a mental skill being cultivated and formally practiced through meditation, and it refers to the moment to moment transient state aspect. Conversely, maintaining an open, non-evaluative approach of focused interest and curiosity in broader, everyday living pertains to a trait aspect, which can either be dispositional in nature, or developed through mindfulness-based training including a dedicated meditation practice that then generalizes to other areas of life (Bishop, 2002; Kiken, Garland, Bluth, Palsson, & Gaylord, 2015). It has been argued that over time, the repetitive activation of neural networks that represent state mindfulness in meditation results in neuroplastic changes in both brain function and structure – supporting increases in trait mindfulness (Garland et al., 2010). Yet, more research is needed regarding within-person (state), and between-person (trait)
variations of mindfulness to investigate both their distinct characteristics, as well as their inter-relatedness.

Another distinction needs to be made between Jon Kabat Jinn’s approach to mindfulness, which is the most prevalent in Western culture today since the initiation of the Mindfulness-Based Stress Reduction (MBSR) program in 1979, and Ellen Langer’s (1989, 1997) cognitive model of mindfulness. Some similarities exist between the two mindfulness approaches: Chiefly, self-regulation of attention, and the importance of awareness in counteracting the ill effects of automaticity – acting while in an ‘autopilot’ mode rather than a wakeful, conscious state. However, there are also distinct differences between the two approaches, reflecting different aspects and qualities of mindfulness. Langer’s emphasis is on learning goals and teaching skills to discern differences in one’s external environment, while considering information from multiple perspectives. These skills are thought to be a prerequisite to developing creativity and problem-solving. Conversely, mindfulness meditation, as per Jon Kabat Zinn’s approach is less goal-directed and consists of a multifaceted construct: In addition to paying attention to sounds and scenes externally, attention is directed inwardly. The development of meta-cognitive abilities results from increased awareness through paying attention to one’s thoughts in a detached third-person observer manner (Baer, 2003; Hart, Ivtzan, & Hart, 2013). Another key component is becoming more aware of one’s emotions and sensory experiences, as they happen in the moment. Gentle yoga exercises, walking meditation, and the body scan exercise are all incorporated into the practice to encourage embodiment and to increase interoception capabilities. Because my training is based on Jon Kabat Zinn’s approach, and the current study used an intervention that is directly derived from his MBSR protocol, the remainder of this document will refer to mindfulness from this perspective.
Mindfulness-Based Interventions

Mindfulness-based techniques have been gaining special interest as a non-invasive, cost effective means of self-regulation and symptom reduction. A broad range of mindfulness-based training programs exist. Many of these programs are derivatives of the original Mindfulness Based Stress Reduction (MBSR), an eight-week program developed by Jon Kabat-Zinn in 1979 at the University of Massachusetts Medical School (UMASS) center for mindfulness in medicine stress reduction clinic. The program was developed as an adjunct treatment protocol designed to alleviate the suffering of chronic pain patients who had failed to respond to more traditional medical approaches (Kabat-Zinn, 2013).

Mindfulness Based Stress Reduction

Participants meet once a week for two hours each, for a duration of eight weeks, and learn various skills to help them increase their awareness of moment to moment experiences. The main skill-based components of the program include: Sitting meditation involves sitting in an upright, yet non-stiffed position (typically on a meditation cushion, but a chair is acceptable) with eyes closed while observing thoughts, emotions, and body sensations as they fluctuate from moment to moment, and using the breath as a focal point of return to the present. Body scan involves moving the attention systematically through the body, while lying down with closed eyes, and focusing on one body organ at a time; noticing any sensations or feelings that may arise. Mindful movement consists of Hata yoga gentle movements, stretches and postures that are designed to increase body awareness and strengthen the musculoskeletal system. Participants are encouraged to observe their limits carefully, breathing into challenging positions, yet without forcing or over-exerting. Walking meditation is also incorporated into the program and consists of developing an awareness of the experience of walking itself, without regard to speed, a certain
destination, or multitasking while walking. The act of paying attention to the walking is the destination. Walking is done in slow movements to allow attention to gait, one’s breathing, sensations, and awareness of the whole body, as it is involved in the act of walking. Class sessions also include reading of inspirational poems, many group discussions, and experiential exercises; participants are encouraged to also complete homework assignments consisting of daily formal and informal mindfulness practice. Around week six, there is a day of a silent ‘retreat’ to reinforce meditation skills (Kabat-Zinn, 2013).

Additionally, several types of mindfulness-based clinical ‘third wave’ interventions, such as Mindfulness-Based Cognitive Therapy, Dialectical Behavioral Therapy, and Acceptance and Commitment Therapy incorporate components of mindfulness practices into their treatment protocols.

**Mindfulness-Based Cognitive Therapy**

The Mindfulness-Based Cognitive Therapy (MBCT; Segal, Williams, & Teasdale, 2002) was developed as a clinical program for relapse prevention in individuals with a history of depressive episodes. This eight-week group structured program combines many MBSR components of mindfulness meditation, and mindfulness in everyday activities, with more traditional cognitive behavioral techniques, teaching clients self-detection of early dysphoric thoughts that, unnoticed, may escalate into full depressive episodes. When compared to maintenance antidepressant medication, MBCT was shown to be similar in its protective effects on depression relapse recurrence. MBCT was shown to be especially beneficial for individuals with prior severe depressive episodes and a history of childhood abuse. (Kuyken et al., 2015).
Dialectical Behavioral Therapy

The Dialectical Behavioral Therapy (DBT; Linehan, 1993) was originally founded as a multi-faceted intensive therapy program for people with borderline personality disorder and suicidal tendencies. It is rooted in both Eastern approaches and more modern CBT techniques. The main dialectic that is dealt with in this program is the one between acceptance and change. Clients are encouraged to accept themselves and their condition while working hard to change maladaptive thoughts and habits, in order to create a life that is worth living. Mindfulness skills are incorporated with techniques for changing maladaptive thoughts, emotions, and behaviors, with an emphasis on distress tolerance, emotional regulation, and interpersonal effectiveness. Clients are given homework assignments and opportunities to practice their newly-learned skills both in individual therapy and in a group modality setting (Baer, 2003; Chiesa, & Malinowski, 2011). DBT was found efficacious in stabilizing high-risk borderline patients by decreasing suicidal and parasuicidal behaviors, and associated psychiatric hospitalizations (Panos, Jackson, Hasan, & Panos, 2014; Scheel, 2000).

Acceptance and Commitment Therapy

The Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 1999) is a therapeutic program for clients suffering with anxiety, depressive, psychotic disorders, or chronic pain. The emphasis is on meta awareness of all thoughts, emotions, and sensations that arise, with a non-judgmental attitude and a decentering approach, creating a space, by separating between the observing self and the actual thoughts or emotions that he or she is having. This reduces experiential avoidance and the tendency to try and control or suppress one’s thoughts or emotions. Consequently, cognitive flexibility and behavior regulation increase, allowing clients to live a life that is more congruent with their chosen values (Baer, 2003; Forman, Herbert,
Moitra, Yeomans, & Geller, 2007). The evidence for ACT is not as compelling as it is for other mindfulness-based interventions. More RCTs are needed to establish ACT’s efficacy for psychiatric disorders. Some limited evidence exists for ACT’s beneficial effects on reducing patients’ suffering from chronic pain (Öst, L. G., 2014).

How is Mindfulness Measured

There are multiple surveys and scales that have been developed to assess the construct of mindfulness; all consist of self-report measures. The three most prevalent ones are the Mindfulness Attention Awareness Scale (MAAS; Brown & Ryan, 2003), the Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietmeyer, & Toney, 2006), and the Toronto Mindfulness Scale (TMS; Lau et al., 2006). Garland and Gaylord (2009) assert that as we envision the future of mindfulness research, existing psychological measures may not be sufficient, and additional performance-based cognitive and behavioral measures, as well as psychophysiological and neuroimaging methodologies should be incorporated to bolster mindfulness research and its empirical findings.

Theoretical Foundations

Despite the growing empirical evidence to support the favorable outcomes of mindfulness-based interventions, there is no single agreed-upon theory that encompasses all facets of mindfulness or how mindfulness techniques exert positive effects on stress-reduction and health outcomes. Two main theories that are consistent with the focus of the current study will be discussed.
The Mindfulness Stress Buffering Hypothesis

The mindfulness stress buffering hypothesis (Creswell & Lindsay, 2014) suggests that mindfulness (either dispositional or via training effects) contributes to health effects indirectly, by mitigating the stress response through a reduction in threat appraisals, thereby offering protection against psychological and physiological illness. The theory posits that mindfulness will exert the greatest effect on vulnerable individuals and populations who are already exhibiting high levels of psychological distress and/or are more susceptible to developing pathological health conditions that are triggered by stress. As such, according to this hypothesis, mindfulness may not in and of itself offer health benefits. Instead, mindfulness may mitigate the ill effects of stress, thereby removing barriers to health.

Some support for this hypothesis has been shown in a study by Brown, Weinstein, and Creswell (2012) where dispositional mindfulness trait mediated the relationship between a social evaluative threat lab task, the Trier Social Stress Test (TSST), and stress responses as measured by participants’ cortisol levels. Participants who were dispositionally higher in mindfulness trait showed reduced stress reactivity during the TSST challenge, while during a low-stress control condition no difference in cortisol response was found between high and low trait individuals. Whether similar stress buffering effects would be found in individuals who had completed a mindfulness intervention rather than have dispositional differences was tested in a study by Kemeny et al. (2012). Only tentative evidence for the buffering stress theory was found in this study: While no group differences in blood pressure or RSA between a meditation training group and control group were noted during the TSST task right after the training, differences were observed at a later follow-up, but only for participants with a greater number of hours of meditation practice. Mixed physiological results were reported by Nykliček, Mommersteeg, Van
Beugen, Ramakers, and Van Boxtel (2013): In response to a similar TSST repeated challenge, MBSR participants showed no improvements in heart rate variability (HRV) or cortisol levels as compared with a waitlist control group. However, a reduction in overall blood pressure was noted from pre to post training for the MBSR group.

Creswell and Lindsay (2014) offered biological pathways to account for their mindfulness stress buffering hypothesis. Their model involves both the central nervous system and indirectly the peripheral nervous system: Mindfulness increases activity in prefrontal regulatory areas that are responsible for inhibiting parts of the brain involved in stress processing. More directly, mindfulness also reduces amygdala reactivity, which is responsible for triggering the ANS sympathetic fight or flight response via hormonal release cascades in both the sympathetic-adrenal-medullary (SAM) and the hypothalamic-pituitary-adrenal (HPA) systems.

Similarly, the neurovisceral integration theory discusses the dynamic interplay between the prefrontal cortex and the limbic system in regulating the stress response (Thayer & Lane, 2000). However, a more detailed account of the direct role that the ANS plays in the stress response is necessary in order to better understand the impact of mindfulness practices on the ANS.

**The Polyvagal Theory**

The polyvagal theory (Porges, 1995) offers a sophisticated and comprehensive understanding of the role of the ANS and its function in stress adaptation and emotion regulation, by delineating the relationship and biological underpinnings of social and emotional behaviors with HRV fluctuations. This theory compiles an additional layer, namely the social engagement response, to the already widely known stress-response mechanisms of fight/flight, directed by the
The polyvagal theory distinguishes between the two branches of the vagus, the tenth cranial nerve: the more ancient, unmyelinated dorsal branch, and the more recently acquired ventral, myelinated branch. The unmyelinated branch oversees the function of the organs below the diaphragm, executing the “freeze” response in reptiles in times of extreme stress. In contrast, the myelinated branch oversees the organs above the diaphragm, and controls facial, head, voice box, and heart muscles that are involved in interactions with others, reflecting the social engagement responses in mammals. Specifically, the ability to modulate facial expressions is unique to mammals, and is not seen in reptiles that are primarily motivated by survival behaviors (Porges, 1995).

According to the polyvagal theory, individuals’ senses are constantly scanning the environment for cues of risk or safety. This information then gets evaluated by the human brain to determine how a person should act, and whether a person’s nervous system can afford to relax in ways that promote prosocial behaviors, or mobilize into a defensive survival mode instead. Porges (2004) termed this ongoing process of perception and evaluation that takes place below conscious awareness ‘neuroception’. This quest for safety starts at birth through the infant-mother relationship, and continues throughout the lifetime through ongoing co-regulation via meaningful relationships with friends and loved ones (Porges, 2015).

A key feature of the polyvagal theory is its hierarchical organizational structure: When a situation or a person is perceived as sufficiently safe, the parasympathetic nervous system (PNS) branch of the ANS down-regulates defense, acting as a brake on the sympathetic response via the inhibitory effect of the more newly evolved myelinated vagus nerve on the heart.
thus allowing for self-soothing and social engagement. However, when a situation escalates from safe to risky, or friendly maneuvers and interactions with others are not well-received, a fight/flight response, triggered by the sympathetic nervous system (SNS) branch of the ANS occurs. Yet, if the fight/flight response is unsuccessful and all else fails, humans may resort to the oldest and most primitive response of all: the body begins immobilizing and disengaging. At its most extreme form, this would lead to a complete shutdown, resulting in the organism’s demise.

When the social engagement system is working properly, the PNS is activated, and individuals do not have to be on alert constantly. This frees the SNS from the primary task of defense, and allows the body instead to move towards growth and wellness. When a threat is detected, a vagal withdrawal leading to a fight/flight response takes place, the SNS utilizes adrenaline, resulting in an aroused response as reflected by increased respiratory rate, heart rate, skin conductance, blood pressure, and dilated pupils. The body mobilizes for action, while the SNS activates body organs necessary for survival. When we receive a cue indicating that the environment is now safe, the ‘vagal brake’ is applied again, and the body down-regulates defense and moves away from the SNS-dominated fight/flight reaction towards a PNS-dominated state – embracing its calming effects (Quintana, Guastella, Outhred, Hickie, & Kemp, 2012). The PNS secretes acetylcholine to aid in basic bodily functions such as digestion and healing, while deactivating body functions that are not necessary for the task at hand, to conserve energy and return the body to equilibrium. In the PNS-dominated state that corresponds to a relaxation response, breathing and heartbeats slow down, blood pressure drops, and heart rate variability increases (Dusek & Benson, 2009). The flight/fight system can sometimes be lifesaving when used sparingly at times of true emergency, as long as the nervous system has sufficient time to
recover and recuperate between emergencies, that is, going back to baseline. However, when stress responses become chronic due to an ongoing stressful situation, or due to repeated false alarms, being in an elevated sympathetic state for prolonged periods can exhaust and deplete resources, disrupt autonomic balance, and create an allostatic load leading to illness, premature aging and even death (Esch & Stefano, 2010; Thayer, & Sternberg, 2006).

When neither social engagement nor fight/flight responses are sufficient to enable an individual to cope with impeding danger, as a last resort, the PNS turns to immobilization, an involuntary reaction involving extreme slowing down of all body systems in preparation for an impending doom. This process be adaptive and life preserving, for instance, when staying frozen while being robbed (rather than objecting the attacker and risking more aggression), or when all is lost and the end is near, by minimizing the pain experienced during those last moments of life. During immobilization, the body reduces oxygen intake, leading to bradycardia and apnea, which in extreme cases can result in death (Porges, 1995). In humans, a state of immobilization can translate to a psychological pathology, in the form of dissociative symptoms, or to physically passing out.

It is important to note that both mobilization and immobilization can be placed on a continuum. Mobilizing does not necessarily equate to a fight/flight reaction. A certain level of alertness is a prerequisite to healthy functioning and is an integral part of optimal daily activity. Likewise, while at its extreme end, immobilization translates to a complete shutdown of all body systems, when feeling calm and safe, it allows individuals to go to sleep without fear, or to stay still in the arms of a loved one. In a healthy individual, the PNS and SNS work in harmony to keep people healthy and balanced and to regulate homeostasis (Van Der Kolk, 2014).
According to the polyvagal theory, people with low vagal tone may exhibit a distorted stress response: They may either under-react when a threat is real, and the situation calls for a sympathetic activation, or they may over-react when a situation is innocuous, and a fight or flight reaction is not warranted, reflecting poor physiological and emotional regulation. When individuals have a properly working ANS, and its subdivisions (e.g., SNS and PNS) are in harmony, vagal tone is moderately high, indicating a good blood flow to needed organs, and the ability to balance the SNS and PNS according to the demands of the situation. The individual thus has the flexibility to transition from one response to another as needed. Vagal tone can be measured indirectly via the biological marker known as heart rate variability (HRV) or respiratory sinus arrhythmia (RSA) that factors in the impact of breathing on heart rate by computing the differences between the heart rate when breathing in, and the heart rate when breathing out. Inhaling triggers the SNS and increases heart rate, while exhaling activates the PNS with a consequent decrease in heart rate. A higher level of HRV or RSA indicates a higher vagal tone, driven by parasympathetic capacity for proper inhibition of autonomic arousal, and a better capability to regulate emotions (Van Der Kolk, 2014).

Appropriately high HRV indicates well-synchronized cyclic variations, exhibiting a good flexibility between the sympathetic and parasympathetic branches of the ANS, according to situational demands, and the ability to maintain homeostatic balance (Gao, Borlam, & Zhang, 2015). Dynamic variability and energy regulation of all system elements are crucial for the successful adaptation of the organism to constantly changing environmental conditions. By contrast, rigidity and static levels are linked to poor health, and are often a precursor to morbidity and mortality (Thayer & Sternberg, 2006).
Low HRV had been implicated in cardiac diseases, both as a predictor of poor outcomes and prognostic mortality following a myocardial infarction, as well as a risk factor for cardiac events in the non-clinical, general population (Tsuji et al., 1996). Given that the vagus nerve is the longest nerve in the body, and is involved in the functioning of many body organs, it is not surprising that the vagus nerve can create substantial havoc when it goes out of tune. A dysfunctional vagal muscle and corresponding long-term low HRV has been linked to a multitude of medical conditions including: epilepsy (Schachter & Saper, 1998), diabetes and other autoimmune conditions, osteoporosis, arthritis, Alzheimer’s disease, dental disease and cancer -- with the likely underlying mechanism involving immune dysfunction and elevated levels of proinflammatory cytokines cascades (Porges, 2003; Thayer & Sternberg, 2006).

The role of vagal dysfunction has also been implicated in multiple mental illnesses, including mood and anxiety disorders, trauma and stress-related disorders, autism spectrum disorders (Porges, 2003), conduct and antisocial behavior as well as psychopathic traits in children (Gao, Huang, & Li, 2017), and borderline personality disorder (Koenig, Kemp, Feeling, Thayer, & Kaess, 2016). Predictably, all of these disorders involve difficulties with self-management of either social, emotional and/or behavioral regulation. It is likely that reduced HRV and corresponding autonomic imbalance play a pivotal role in the observed difficulties associated with these psychiatric disorders (Quintana et al., 2012).

Given the far-reaching ramifications of a vagal nerve dysfunction, improving vagal tone, and more “in sync” ANS has been a topic of interest for some time. Yet, it is only in recent years that empirical studies began emerging to scientifically explore the various methods to achieve this goal, and the beneficial outcomes that they claim to have, in the form of improved physical and mental health. Although invasive interventions, such as vagal nerve stimulation via implant,
have shown promise as a treatment modality for improving vagal tone among those with dangerously low levels of vagal tone, including human patients with epilepsy (Schachter & Saper, 1998), and animals with cardiac conditions (Li et al., 2004), attempts are being made to find less invasive ways to stimulate the vagal nerve and increase heart coherence. Mindfulness-based techniques have been gaining special interest as a means of regulating ANS function.

**Mechanisms of Action**

Learning how to bring ANS activity under control can be a useful, noninvasive way to promote a calmer and less reactive nervous system, improve physical and psychological well-being, and in some cases even reduce the need for medications (Dusek & Benson, 2009). However, the mechanisms by which mindfulness practices exert their effects on the ANS are not yet clear. A few possibilities have been proposed.

**Relaxation**

Although a relaxation response often follows from mindfulness practice, studies have suggested that the benefits of mindfulness are not simply due to being in a relaxed state (Tang et al., 2009). Specifically, it has been argued that if meditation were identical to relaxation, one would expect comparable physiological changes following meditation of novice and experienced meditators (Rubia, 2009). Instead, some evidence suggests that the effect of mindfulness practices on physiological measures varies as a function of meditation experience. For example, although some studies have suggested that even short-term meditation may yield positive results (Hölzel et al., 2011; Tang et al., 2009), more experience with mindfulness practices may be required to achieve optimized outcomes (Rubia, 2009).
Breathing

Many mindfulness practices incorporate breathing exercises that can serve as a trigger point for PNS activation, putting the “brake” on the SNS through slowing respiration and corresponding heart rate, thereby improving vagal tone, and restoring a feeling of safety and well-being. This appears to be a direct path through which mindfulness practice alters the ANS and the stress responses. Streeter, Gerbarg, Saper, Ciraulo, and Brown (2012) pointed out the bidirectional relationship between emotional states and breathing, and suggested that by voluntarily changing breathing patterns, it would be possible to impact the ANS. The authors also alluded to Brown and Gelbarg’s neurophysiologic model, pointing out that breathing might the sole component of the ANS that can be put under control. More importantly, since breathing is imperative for survival, vagal messages concerning changes in breathing rate or patterns are regarded as top priority by the brain, and help shape its interpretation and response to perceived threat (Brown & Gelbarg, 2005). Yet, in some of the most studied mindfulness practices, such as MBSR, no attempt is made to control breathing, which is primarily used as an anchor during meditation practice, as well as incorporated into the body scan and yoga components of the program.

Embodiment / Somatic Awareness and Emotional Regulation

Components of meditation practices, such as the body scan, increase the experience of embodiment – the perception of bodily sensations and the state one’s body is in. Humans need an awareness of their own body and its responses to internal and external stimuli in order to make sense of emotions and regulate them, as well as to cultivate a sense of empathy toward others (Hölzel et al., 2011). The attentional processes cultivated in mindfulness practices may be a
prerequisite to developing such body awareness, which, in turn, is the foundation for the surfacing of emotions and their regulation (Hölzel et al., 2011).

Not only is embodiment integral for emotional processing, the relationship between bodily sensations and felt emotions may be more specific than previously thought. In a series of experiments (Nummenmaa, Glerean, Hari, & Hietanen, 2014), participants were asked to identify distinct body areas where they felt activation or deactivation when presented with a range of emotionally eliciting stimuli. This has led to the tentative mapping of different emotions associated with distinct (yet sometimes overlapping) sensations in various parts of the body. The study was replicated in several cultures with similar results, pointing to the universal basis of bodily sensation maps of emotions. Interestingly, increased activity in the upper chest area was experienced in association with the majority of basic emotions, likely reflecting autonomous fluctuations in breathing and heart rate.

**Exposure and Extinction**

Bringing attention to distressing internal stimuli including sensations and emotions that may come into awareness during mindfulness practices can be conceptualized as exposure (in a similar manner to exposure interventions used in behavioral therapy). Such exposure eventually leads to habituation and extinction of conditioned fear responses. When individuals no longer avoid fear, under the relaxed conditions that the mindfulness practice often fosters, the nervous system no longer reacts in an exaggerated way. The individual learns a more adaptive way of responding to stimuli. New learning and connections overwrite old ones, and a feeling of safety is restored and takes the place of fear (Hölzel et al., 2011).

The important role that exposure to emotions plays in a well-functioning ANS can be seen in a study conducted by Gross and Levenson (1997). The authors demonstrated that merely
giving students the instructions that they had to suppress their feelings, either positive or negative, while watching a video, led to more SNS activation of the cardiovascular system. Although a certain level of emotional inhibition is necessary to function appropriately in society, undue suppression leads to a stress response. Therefore, it is plausible that turning towards whatever manifests during meditation is an indirect mechanism through which a brake is placed on the SNS, allowing for more PNS activity and greater relaxation, and better emotion regulation.

In addition to the content of thoughts, emotions, and memories of stressful events that may surface during the practice of mindfulness meditation, prolonged sitting during meditation sessions while maintaining an upright posture, also presents a challenge that may cause physical discomfort. Meditators are encouraged to try to stay with the discomfort and any related cognitions (“I cannot take it any longer”), rather than shift positions, and to adapt an open and unjudgmental attitude towards their experience, as an exercise in increasing tolerance and equanimity. Over time and continued practice, this exposure without avoidance may result in desensitization and diminished distress levels. As the meditator watches the ebb and flow of his or her own undercurrent, with curiosity and absence of reactivity, intense feelings dissipate (Baer, 2003).

Liang et al. (2018) suggest another possible pathway for the reduction of suppression via meditation: Mindfulness awareness reduces feelings of hostility, thereby reducing the need to engage in surface acting and disguise of one’s negative emotions. This reduced need to engage in surface acting makes emotional regulation resources more readily available at the individual’s disposal, increasing autonomic and behavior regulation.
Rumination Reduction

Liang et al. (2018) also posit that mindfulness awareness reduces ruminative thinking via the focus on the present, and training the mind to pay attention to moment to moment experiences. Because a person can only have one thought at a time, thinking about the present reduces the obsessive need of replaying unpleasant past events. In addition, because rumination is taxing on mental resources, reducing ruminative tendencies frees up regulatory resources that may then be used for functional emotion regulation.

Cognitive Reappraisal

As thoughts, emotions, and memories of stressful events surface during the practice of mindfulness meditation, individuals come to view these aspects of themselves in a new light and gain a new perspective. This cognitive process is called positive reappraisal (Garland, Gaylord, & Fredrickson, 2011). However, Farb et al. (2010) point out that the process of reappraisal paradoxically entails elaboration on its negative emotional content at first, and may ironically lead to more rumination, increasing dysphoric mood in already susceptible individuals. Ochsner, Silvers, and Buhle (2012) separate the emotional regulation strategy of reappraisal into two types of tactics: The first, reinterpretation, involves changing one’s evaluation of an event from negative to more positive. The second is termed distancing in which a person adapts a more detached, third person perspective to a given situation, thereby reducing its emotional valence. The authors posit that reinterpretation calls on more mental resources, and involves higher cognitive processes such as semantic memory and language, in the quest to make a new meaning. It also involves inhibitory processes of the initial interpretation given, making this tactic more taxing on neural resources than the other (i.e., distancing).
**Distancing**, or stepping back and observing one’s thoughts and emotions in a more objective manner, has received much attention in mindfulness literature, under different terminology. It has been called **reperceiving** by Shapiro, Carlson, Astin, and Freedman (2006), and **decentering** by Baer (2003). Yet, these different terms carry similar meaning: Non-judgmental observation of one’s thoughts and feelings that leads to disengagement and a reduction in negative emotional valence. Unlike the use of reappraisal in cognitive therapy where the goal is to stop ruminative and maladaptive thoughts by replacing them with more adaptive ones via cognitive restructuring, in mindfulness practices the emphasis is on non-evaluative observation of all that comes into our ‘radar’ during meditation, without an attempt to either change the thoughts and feelings, suppress them, or hold onto them longer than necessary. Rather, the aim is to observe them with openness, curiosity, and kindness, recognize their transient nature, and gently bring the focus back to the breath or other ‘anchor’ used (at least in the initial stages of training). Hence, rather than changing one’s internal landscape of thoughts, feelings and sensations, one instead changes his or her relationship to them. This exposure without avoidance reduces reactivity, and through repeated practice, builds distress tolerance skills, which are key to emotion regulation (Metz et al., 2013).

Similarly, the state of ‘being’ rather than ‘doing’ promoted in mindfulness practices allows for greater flexibility in emotional responses. The more objective observation of thoughts and emotions fostered in the meditative state enables a level of detachment, acceptance, and the choice of a broader range of responses (Mankus, Aldao, Kerns, Mayville, & Mennin, 2013).

I would like to suggest another possible mechanism: Mindfulness practice assists regular meditators in being better equipped to deal with everyday tribulations or frustrations, via fostering emotion regulation skills for managing stress more effectively. The ability to respond to
triggering events from an equanimity stance may also reduce situational escalation, and secondary positive feedback loops that lead to more ANS arousal, and consequent emotional and behavioral reactions.

**Social Connectivity**

In addition to embodiment increasing the ability to be in touch with one’s emotions and feel more connected to oneself, the effects of greater connectivity expand beyond the individual self. Mindfulness meditation retreats often foster a sense of a community that may last long after the retreat is over. Group discussions and exercises built into the MBSR program, often include personal as well as universal themes. Even during silent periods, and during sitting and walking meditations, in the absence of any verbal or non-verbal communication (‘custody of the eyes’), there is an emphasis on the cohesive effort in maintaining meditative conditions together, and on the unity of the group as a whole. As Jon Kabat Zin said at the end of a week-long retreat to program’s participants: “When you go home, keep on practicing. We are still all going to be here meditating together. It is just that the room got a whole lot bigger” (Personal communication, Omega Institute, May 2018).

Connection to others and reducing isolation and loneliness are crucial to psychological and physical well-being. Creswell et al. (2012) found that MBSR training managed to reduce perceptions of loneliness and corresponding pro-inflammatory gene expression in a group of older adults. These are promising results, and more research is needed on the role that mindfulness may play in alleviating loneliness and subjective perceptions of isolation and evaluative social threats in the elderly and other at-risk populations.
The Downside of Mindfulness

Systemic research on the adverse effects of mindfulness has been meager, and often lumped together with studies on various meditation approaches and their effects, which may not generalize to mindfulness-based programs. However, because formal meditation is a fundamental part of MBSR, reports regarding various meditation-related ill effects may apply to mindfulness approaches as well. Due to publication bias, mindfulness literature contains reports primarily of its salutary effects. Accounts of neutral or negative effects are less likely to receive adequate attention (Fjorback, Arendt, Ørnbøl, Fink, & Walach, 2011; Shonin, Van Gordon, & Griffiths, 2014). Additionally, conclusions regarding favorable outcomes are often based on mixed results, and positive findings are sometimes bolstered disproportionally when, in fact, most of the study’s predictions were not substantiated. A careful look at studies with mixed results is necessary for gaining a more balanced and realistic view of the current state of research.

Furthermore, attrition rates in mindfulness programs are not always well-documented. When people experience negative effects due to participation in a mindfulness program, they are likely to drop out from the training earlier in the process, and their experiences are often not accounted for in the study’s outcome report.

Starting with the goal of ‘do no harm’, the main question is whether mindfulness practices can be detrimental to practitioners, and in what ways. Direct adverse effects can be considered as any maladaptive symptoms triggered by mindfulness practices or exacerbation of pre-existing conditions, such as depression, anxiety and psychosis (Lomas, Cartwright, Edginton, & Ridge, 2015). Indirect adverse effects may be related to turning to mindfulness as a cure-all ‘magic bullet’, due to the current mindfulness ‘hype’, in lieu of more conventional treatments.
that have a stronger evidence-based track record as being efficacious for a specific condition. The slogan ‘meditate, don’t medicate’, may steer people clear of allopathic medicine, or lead them to invest time and money in a mindfulness program, instead of a therapeutic approach that has been empirically validated (Van Dam et al., 2018).

Although overall, mindfulness has been established as a safe and cost-effective intervention (Shonin et al, 2014), there are accounts detailing deleterious effects of meditation, and mixed reports of both negative and positive effects: Alongside reporting increased positive affect such as joy and happiness, practitioners also often report developing greater anxiety, mood fluctuations and alterations between ‘blissful’ states to dysphoric ones, having difficulty integrating difficult material that surfaced during practice (including re-experiencing memories of trauma), and difficulty transitioning from retreats to ‘back home’ everyday life, including social and occupational functioning. Even more alarming are frequent reports of feeling disorientated or ‘spaced out’ after practicing, and in more severe cases, feeling dissociated or experiencing psychotic episodes, which can lead to hospitalizations (Lindahl, Fisher, Cooper, Rosen, & Britton, 2017; Shapiro, 1992). These ill effects were noted for both new meditators as well as more experienced ones, and while frequently they were transient in nature, in other cases their impact was long-term. Although the majority of the individuals reporting adverse effects had a history of prior mental illness, in some cases, no prior history was known (Shonin et al., 2014). The rate of these reported adverse effects is disconcerting: In a study of 60 Buddhist meditators, as much as 73% of the sample reported moderate to severe levels of impairment attributed to their meditation experience (Lindahl, et al., 2017). In another study of 27 individuals practicing intensive Vipassana meditation, more than half of all participants reported at least one meditation-related adverse effect (Shapiro, 1992).
According to MBSR guidelines, as a rule (with some exceptions), people who are suicidal or present with diagnosed mental disorders should not attend MBSR trainings (Van Dam et al., 2018). Yet, participant screening for mindfulness retreats is often poor or altogether absent. Instructor quality is another concern: under the guidance of a competent teacher, a challenging meditation experience may be transformed into an opportunity for growth and learning. Yet, mindfulness teachers’ qualifications have not been adequately regulated, and instructors often do not have the necessary background in health-care or mental health to deal with participants’ psychological emergencies (Dobkin, Irving, & Amar, 2012). Studies outcomes may be impacted as well by the instructor’s competency and level of experience, and because instructor quality is not uniform across studies, outcome comparisons may vary, and subsequent conclusions may be inaccurate.

Class size is another issue: Many mindfulness retreats run in large groups of approximately 200 people. Under such conditions, close monitoring is not possible, and even a qualified clinician would be unable to address a crisis should it arise. Additionally, due to the inherently covert nature of meditation, a participant’s distress may not be obvious. Mindfulness participants are often encouraged to curiously observe and tolerate any difficult material that may arise during meditation, realizing its transitory nature. Jon Kabat Zinn is known to refer to it as ‘surfing the wave’. Yet, not everyone is a competent surfer. Some people may feel overwhelmed and go under instead. Especially in high season, when the ‘beach’ is crowded and there are not enough ‘life guards’ to monitor the crowds, ‘drowning’ is a more likely event. In a class of 200 people and few teachers, noting a participant who is struggling, and responding to his or her distress in real time, may not always be possible.
Exposure has been widely considered as one of the primary mechanisms of mindfulness (refer to the mechanisms section of this document for more detail). However, there is a distinction to be made (not previously made in the literature), between the 8-week long MBSR program format that may fit the description of gradual exposure, to intensive mindfulness retreats (typically ranging from five to ten days) that may be more akin to an extreme form of exposure therapy technique known in clinical terms as ‘flooding’. In ‘flooding’, the therapist targets the most feared object or situation for the client at once, with corresponding high subjective units of discomfort. Such an approach may not be appropriate in many situations, and is therefore used sparingly, at the discretion of the clinician. Yet, while almost anyone can sign up for a week-long mindfulness retreat, not all are prepared for the intensity of the experience, or have the necessary ego strength to deal with the difficult emotions that may arise. (Even the name ‘retreat’ may be misleading. Post training, people often refer to their experience as enriching, yet more akin to a ‘boot camp’ rather than a luxurious vacation).

Under optimal conditions of proper screening, quality instruction and small class size, it is often possible to adapt the practice to include even people with pre-existing conditions. Examples of adaptations include shortening mediation length, or changing its focus from internal to external, when focusing inward may be too overwhelming or counterproductive (e.g. increasing rumination in depressive individuals). Movement-based meditation may be used when concentration is a challenge, such as in attention deficit hyperactive disorder, or when staying still and lying down with closed eyes may trigger traumatic memories (Russell, & Siegmund, 2016). Matching the intensity level of the practice with participants’ meditation experience level is also crucial. For many people it may be advised to start with one day, or even just one hour of
silence, as opposed to attempting a 10-day silent retreat without any prior background or preparation.

A separate concern regarding mindfulness training programs is their spiritual Buddhist roots that may run counter to some participants’ belief systems. MBSR programs have been ‘westernized’ to increase their appeal, and marketability, to people from all walks of life. They are often touted as purely scientific and unaffiliated with any specific faith or belief system. Yet Buddhist ideas and terminology are routinely incorporated into such programs, and related study materials. This lack of transparency may be misleading and presents ethical concerns. In particular, when applied to clinical settings, this may translate to imposing religious values on unsuspecting clients. It may be argued that since there is a growing body of empirical findings pointing to the usefulness of mindfulness, in the form of symptom reduction and decrease in levels of distress and suffering, this intervention may be helpful, regardless of its theological underpinning. However, it is the absence of informed consent that is troubling, as some individuals may have chosen to opt out if the religious foundation of the practice been made transparent from the beginning (Compson, 2017).

CHAPTER 2 – LITERATURE REVIEW

Empirical Findings

As the number of mindfulness studies is constantly increasing, evidence begins to accumulate regarding the physiological, emotional, and cognitive benefits of mindfulness practices. However, comparing findings from myriad studies is nearly impossible due to lack of uniformity in study outcome measures, as well as the mindfulness-based interventions used. Furthermore, some mindfulness approaches, such as the MBSR, contain multiple components, as
detailed earlier -- making it difficult to pinpoint which element(s) of the program contribute to the positive benefits.

Additionally, participants in numerous studies have been drawn from different populations. Some studies have focused on people with medical conditions, such as cancer, hypertension, or diabetes, while others have utilized patients with various psychological diagnoses including anxiety or mood disorders, or comorbid conditions. Yet other studies were conducted with healthy individuals with no clinical diagnosis, receiving training in widespread settings including educational institutions, the workplace, and the military. In addition, studies may involve participants belonging to different age groups, with varying levels of prior mindfulness practice experience. Together, these factors make direct comparisons among studies unattainable.

Despite these challenges to the scientific inquiry of mindfulness practice’s impact on physiological markers, a sample review of current literature is the first step in attempting to capture the essence of this topic, and in proposing future directions to address some of its shortcomings. In the following section, studies utilizing physiological measures of the stress response, with MBSR or a similar program as the study’s intervention, will be reviewed. Taking a developmental approach across the lifespan, the review will begin with examples of adult studies, including the elderly, followed by studies with children, and finally, special attention will be given to studies of emerging adults, reflecting the focus of this current study – first year college students and their unique challenges.

**Studies in Adults**

When individuals struggle with a chronic, serious illness, psychological factors may either support the healing process, or conversely, exacerbate the person’s condition. A fair
number of studies have tested whether mindfulness practices can alleviate some of the mood and anxiety symptoms associated with cancer. For example, in a study examining the impact of the MBSR on 49 individuals diagnosed with early stage breast cancer and 10 with prostate cancer, level of stress was assessed via blood pressure, resting heart rate, and saliva cortisol levels, at the baseline prior to introducing an eight-week MBSR program, the program’s completion, six months post program, and 12-month follow-up (Carlson et al., 2007). Both systolic blood pressure and heart rate were lowered – especially immediately following the program’s intervention. Cortisol levels decreased as well when comparing pre- and post-intervention, and this downward trend had continued in a linear fashion through the follow-up year. However, changes in physiological markers were primarily noticed in those with a shorter duration and earlier stage of illness. Continued mindfulness home practice, or its absence, following the completion of the program did not appear to interact with these improvements in ANS functioning. However, lack of control group and multiple statistical comparisons utilized are notable limitations of this study.

Another study compared the physiological changes between an intervention group who received an eight-week MBSR training (n = 15) and a control group who did not (n = 17) among early stage breast cancer survivors. The intervention group showed reduced blood pressure, heart rate, respiratory rate, and morning cortisol levels, although the effect on cortisol did not sustain at the 1-month follow-up (Matchim et al., 2011). Such effects were not found in the control group. However, findings were difficult to interpret given that participants were not randomly assigned to groups, and the two groups were not matched on multiple factors, including age, duration of the illness, and comorbidities.
Chronic illness can take a toll on an individual, even when not life-threatening, like cancer. Fluctuating states of remission and acute relapse can be overwhelming, and an unpredictable course of illness, and its associated ambiguity and impairment, can be hard to tolerate. Mindfulness meditation teaches people that all things in life are transient. As one takes a step back, and observes the flow of the internal and external landscape with openness and curiosity, attitudes start shifting. Learning to adopt a "this too shall pass" approach to relapse, and enjoy remissions fully while they last, can make a difference in reducing a sense of suffering, and can improve the quality of life for those struggling with chronic conditions.

Maintaining a high quality of life, despite an ongoing illness, is a prime goal worth pursuing: In a study of 55 ulcerative colitis patients in remission, no noticeable difference was found between MBSR and those attending a psychoeducation control condition at a year follow-up (Jedel et al., 2015). Relapse rate was similar in both groups, both in terms of flare-up frequency and intensity. However, although the two groups were comparable in disease course, MBSR participants who flared up reported higher quality of life than those who flared up in the control condition. Additionally, a post hoc analysis revealed that a subset of MBSR participants who had the highest stress level at baseline as measured by perceived stress reports and urinary cortisol, benefited more from the MBSR training, and had fewer flare-ups than those less susceptible to stress. Based on these results, the authors suggested that mindfulness interventions may be more effective in preventing relapse in individuals who are more vulnerable to stress as a disease trigger than those whose illness etiology was unrelated to stress.

Another example for the positive effect of MBSR on stress-associated symptoms of chronic illness is shown in a study of 110 individuals diagnosed with type 2 diabetes (Hartmann et al., 2012). Participants attending MBSR showed reductions in reported depressive symptoms
and reduced diastolic blood pressure at a one-year follow-up, as compared with TAU control, but no changes in neuropathy progression were noted.

The effect of MBSR on blood pressure as a main study outcome has also been explored: In a RCT study conducted in India, 30 coronary heart patients were assigned to either an eight-week MBSR group or a TAU control group (Parswani, Sharma, & Iyengar, 2013). The MBSR group showed a significant reduction in perceived stress levels, depression and anxiety, and importantly, had lower systolic blood pressure, both as compared with the TAU group, as well as compared to their baseline levels. Some evidence for MBSR as an effective complementary treatment for blood pressure exists even when compared to an active control group: When 56 adults in the prehypertensive range were randomized to either MBSR intervention or a progressive muscle relaxation control, MBSR was found more effective in reducing both systolic and diastolic blood pressure, as measured in the clinic post training (Hughes et al., 2013). These findings hold promise for the possibility of using MBSR as a stress-management means for modifying elevated blood pressure at an early disease stage, possibly eliminating or postponing the need for hypertensive medication. However, in another study of 101 unmedicated adults with stage 1 hypertension, no between groups differences in blood pressure were noted when the MBSR group was compared with the wait-list control group (Blom et al., 2013).

Mindfulness practices may also be beneficial for ameliorating psychiatric conditions, but few studies have utilized physiological markers as outcome measures. In a pilot study, an eight-week MBSR training was administered to eight veterans to assess whether mindfulness practices would diminish their Post-Traumatic Stress Disorder (PTSD) symptoms and improve their HRV (Bhatnagar et al., 2013). Only five of the eight veterans completed HRV assessment. At the one-month follow-up, a reduction in PTSD score and an increase in HRV were noted for all five
participants. While these results are encouraging, RCT with larger sample sizes are needed to draw conclusions regarding the utility of mindfulness interventions on PTSD and related PNS function.

Trait mindfulness has been shown to impact alcohol cravings: Fifty-eight adults with alcohol dependency were tested for their dispositional mindfulness. Those who scored higher on trait of mindfulness found it easier to resist alcohol cues during a computerized alcohol attention bias test. Their HRV also recovered more rapidly back to baseline levels after being exposed to the alcohol- related cues, as compared with individuals with lower mindfulness trait exposed to the same computerized challenge (Garland, 2011). Emerging evidence for utilizing mindfulness training as a potential treatment for addictions was shown in a study by Brewer et al. (2011). Study participants (n = 41) who attended mindfulness training showed a greater reduction in nicotine dependence and associated cigarette use post training, as compared to an active control condition-- Freedom from Smoking (n = 47). Smoking abstinence was verified by expired-air carbon monoxide breathe test, and findings sustained at a 17- month follow-up.

HRV has been shown to be significantly lower in individuals with major depressive disorders (Wheeler et al., 2014), as well as individuals with bipolar disorder (Faurholt-Jepsen, Kessing, & Munkholm, 2017). Low HRV is a known health risk, predictive of heart disease and a multitude of other medical conditions. There is some evidence that standard interventions for major depressive disorder, such as psychotherapy and antidepressants, are not effective in returning HRV to normal levels, even after successful decrease in depressive symptoms has been achieved through treatment (Caldwell, & Steffen, 2018). Whether a treatment program that combines CBT techniques with mindfulness meditation can impact both depressive symptoms as well as HRV was subject to investigation in a study of 27 people who participated in an eight-
week MBCT program (Wheeler et al., 2014). Results showed that while a decrease in reported depression symptoms, and increases in quality of life were found, no HRV improvement was noted in study participants, with or without a lab stressor administration. However, another pilot study utilizing a modified MBCT program for bipolar patients (n = 12), showed increases in emotional processing following the 8-week program, and improved HRV and corresponding attenuated physiological reactivity during an affect matching task (Howells, Rauch, Ives-Deliperi, Horn, & Stein, 2014).

Healthy adults may also benefit from mindfulness practice. Krygier et al. (2013) found that a 10-day intensive Vipassana meditation training focusing on objective observation of physical sensations in the body improved well-being and resting HRV in 36 participants. In another study, Ditto, Eclache, and Goldman (2006) randomly assigned 32 healthy adults to one of the three groups: body scan meditation, progressive muscular relaxation, and a wait-list control group. Each group participated in two laboratory sessions 4 weeks apart. Although no blood pressure reductions were noted in any of the groups, the meditation group displayed significantly greater increase in RSA while meditating than the other two groups, and these RSA increases were larger in the second session, suggesting the effects of practice. The fact that higher RSA values were noted even after correcting for respiration rate supports the notion that increased vagal activity, but not slow breathing, may be a primary contributor to the noted cardiac improvements.

In another study, 49 healthy volunteers were randomized to either MBSR training or a health enhancement program control group (Rosenkranz et al., 2013). While cortisol response to TSST challenge was similar between the two groups, the MBSR participants showed a smaller flare response when a skin lesion was induced by an irritant capsaicin cream. This reduction in
Inflammation was correlated to the amount of time spent practicing meditation skills during the 8-week program.

In an effort to reduce stress, and increase retention and productivity at the workplace, some studies have examined the effects of mindfulness practices on employees. Klatt et al. (2009) adapted MBSR to the workplace, in order to overcome time and space constraints, with the goal of sustaining favorable program outcomes for stress reduction. Forty-eight healthy working adults who were not practicing meditation at the time were assigned to either the light dose 6-week MBSR or a wait-list control group. Although both groups reported lower stress and better quality of sleep six weeks later, no changes in cortisol levels were found. Matousek, Dobkin, and Pruessner (2010), in a review of mindfulness studies that used cortisol levels as outcome measures, suggested that failure to find significant changes in Klatt et al.’s study may be due to lack of control over potential confounding variables such as diet and exercise, to which cortisol levels are sensitive. In another study, 186 university employees at risk for heart disease were randomized to either workplace modified MBSR or a life-style education control group. MBSR was not found effective in lowering cortisol and serum inflammatory markers (Malarkey, Jarjoura, & Klatt, 2013).

Finally, in a recent systematic review and meta-analysis (De Vibe et al., 2017), out of 6877 mindfulness articles identified from around the globe, including studies in well adults, and those diagnosed with medical or psychological conditions, only 101 studies met inclusion criteria of RCTs, adhering to MBSR protocol. Out of the included 101 studies, only 37 had an active control condition, 11 used physiological outcome measures, and only four had both an active control group as well as physiological outcome measures. Taken together, when compared with an inactive control group (Wait list or TAU), MBSR had a moderately large effect on both
mental health and somatic health outcome measures. But when compared to an active control
group, the effect sizes became small, yet still significant for mental health, and comparable to
other active treatments for physical health.

**Studies in the Elderly**

Old age is a period of life that may afford more leisure time for personal development
and shared moments with loved ones. Yet, frequently, old age also entails losses of various kinds
and magnitude, loneliness, and undesired internal and external changes. A fundamental tenet of
mindfulness is an attitude of cultivating acceptance to all that is experienced in a given moment;
embracing an open and non-judgmental stance towards the change of seasons within and
without. Such an approach may be especially conducive for older individuals wishing to age with
grace and dignity. As life expectancy increases, improvements in physical and mental health, and
quality of life become paramount. To date, the main focus of mindfulness studies in the elderly
has been on cognitive functioning, and the potential of mindfulness to ameliorate cognitive
decline (Gard, Holzel, & Lazar, 2014). Relatively less attention has been given in these studies to
changes in overall physical and emotional functioning.

In a recent review by Geiger et al. (2016), out of 285 studies of mindfulness interventions
in old age, only 15 met the inclusion criteria for peer-reviewed published papers in English,
describing quantitative MBSR or MBCT studies with sample mean age of 65 or higher. Papers
were not excluded if they were not RCT. A further narrowing down of the inclusion criteria to
RCT studies only, brings the count down to merely nine published papers. Five of these studies
used a biological or physiological outcomes measure, to assess blood pressure, respiration or
immune function in addition to self-report scales. Four of those studies utilized an active control
group.
Overall, the 15 reviewed studies together show that mindfulness-based interventions have some positive effects on the psychological well-being of elderly participants, as measured by reductions in stress, anxiety, depression, rumination, loneliness, and pain acceptance scores. However, when reviewing studies with active control groups (psychoeducation, nutritional education or social support) separately from those with a wait-listed control, no main effects for group were noted. This calls into question the ‘main ingredient’ responsible for the observed improvements, and whether mindfulness approaches have a unique contribution to these favorable outcomes beyond that of social support.

Another plausible reason for the absence of significant findings was suggested by Moss et al. (2015). In a sample of 39 healthy seniors in a retirement community (mean age = 82), no significant differences between the MBSR group and a wait-list control group were found in the majority of study outcomes, except for greater acceptance and psychological flexibility noted for MBSR participants. The authors attributed the absence of findings to the sample’s low baseline distress and depression levels, and suggested that effects of MBSR may be better demonstrated with clinical populations of severe symptomology (Moss et al., 2015; de Vibe et al., 2017).

Results of mindfulness-based interventions on physical health outcomes of older adults are mixed as well: Some studies offer support for positive effects, while others do not substantiate such claims. Blood pressure was lowered in 20 low-income African American seniors (mean age = 73) following an 8-week MBSR program, as compared with a social support control condition (Palta et al., 2012). In a RCT of older adults (n = 40, mean age = 78) suffering from back pain, both the MBSR group and the education control group showed reductions in pain and associated disability following their respective trainings, but no advantage was shown for the MBSR group (Morone, Rollman, Moore, Li, & Weiner, 2009).
Also, while reductions in pro-inflammatory gene expressions were shown in a study by Creswell et al. (2012; n = 40, mean age = 65), no evidence for reductions in inflammatory markers was shown by Gallegos et al. (2013; n = 100, mean age = 72), and an unexpected worsening of immune response at a 24-week follow-up was found by Moynihan et al. (2013; n = 105, mean age = 73).

When attempting to draw conclusions based on the above studies, caution must be taken to recognize the homogeneity factor: Some of the samples were clinical while others were healthy community seniors. Additional distinctions, such as race (not always reported), male to female ratios, and age differences, must be made as well. For example, older adults in their sixties may have quite a different profile than study participants in their eighties. Yet, they are grouped together and categorized as ‘elderly’ in mindfulness research, without attention to their differences, and unique characteristics and challenges. However, taken together, it appears that mindfulness approaches may provide older adults with some health benefits, although additional RCT studies with active control groups are needed to delineate specific program components and their respective contribution to observed outcomes.

Studies in Children and Adolescents

While there is a growing interest regarding the possible benefits of mindfulness interventions for children and adolescents, few studies have investigated mindfulness effects on this age group. Juveniles are especially susceptible to many sources of stress at home and at school, including maladaptive family dynamics, academic demands, and peer pressure (Meiklejohn et al., 2012). There is some evidence that these risks may begin as early as in utero, and that the mother’s level of mindfulness may serve as a protective factor for the newborn child,
predicating social adjustment and positive affect in infancy (Braeken, Jones, Otte, Nyklíček, & Van den Bergh, 2017).

Adolescence is another time period of heightened sensitivity and vulnerability to stress and emotional reactivity, due to swift hormonal and neurobiological changes (Broderick & Jennings, 2012). Mindfulness practices can act as a buffer against excessive stress that may harm the developing brain at this critical period (Meiklejohn et al., 2012). Additional potential benefits of mindfulness practices for youth include improvements in memory, attention, self-control, understanding themselves and the world around them (Hooker & Fodor, 2008), and social, emotional, and behavioral development (Mendelson et al., 2010), as well as building resilience (Greenberg & Harris, 2011).

Regarding the optimal age for children to start benefiting from mindfulness practices, Thompson and Gauntlett-Gilbert (2008) pointed out that from a Piagetian perspective, children may have to reach the “formal operational” stage in order to benefit. However, the authors contend that younger children who are still at the “concrete operational” stage, may be able to benefit too, if the practice is adjusted and modified based on their developmental stage. Shorter duration of practice at each session, adjusted instructions that are more detailed, and using relevant metaphors from youth’s life, may be helpful in bringing mindfulness closer to children.

The need to intervene from an early age is especially critical for children at risk, such as those who exhibit aggressive behaviors. Beauchaine, Gatzke-Kopp, and Mead (2007) noted that vagal tone deficiencies in these children begin to emerge between preschool and middle school years, and may reflect “a failure in development for affected individuals, who do not acquire the self-regulatory, executive functioning, and attentional capabilities that are developing normally in their peers” (Beauchaine et al., p. 180). This often translates to difficulties with emotional
regulation and subsequent disruptive behaviors. Scarpa (2015) emphasizes the interrelated roles of genetic and epigenetic factors in predisposing children to difficulties with arousal regulation, which in turn lead to maladjustment and psychopathology, with stress and social adversity heightening children’s inherited susceptibility to unfavorable outcomes. However, systematic study of the effects of mindfulness, either as a dispositional trait or cultivated through practice, on physiological regulation in youth is extremely rare.

In a study of 156 expecting women (Braeken et al., 2017), those who scored higher on dispositional mindfulness trait were found to have more stable time-domain HRV and less parasympathetic withdrawal from trimester to trimester. They reported less distress both during the pregnancy and at postpartum. Importantly, a higher level of mindfulness in the mother during pregnancy was associated with the child’s healthier social and emotional development in the first year of life, and better adaptive functioning compared with infants who were born to less mindful mothers.

In a RCT of 97 fourth and fifth graders from Baltimore City public schools, children were randomized to a 12-week mindfulness intervention or a wait-list control condition (Mendelson et al., 2010). The intervention was successful in improving children’s self-ratings on their self-regulatory reactivity to social stresses. Improvements were noted on several subcomponents, including Rumination, Intrusive Thoughts, and Emotional Arousal, with a trending effect on Impulsive Action and Physiologic Arousal. However, no direct assessment of physiological arousal was obtained, although these self-report measures were associated with lab-assessed heart rate reactivity in another study (Connor-Smith, Compas, Wadsworth, Thomsen, & Saltzman, 2000).
In one study of African American adolescents at risk for hypertension, significant cardiovascular improvements were found in the 3-month Breathing Awareness Meditation (BAM) intervention group (n = 53), as compared with the individuals in the Botvin Life Skills training program (a substance abuse prevention program; n = 69) or those in the health education program (n = 44) (Gregoski, Barnes, Tingen, Harshfield, & Treiber, 2011).

In a study of youth in foster care (n = 42) psychological self-reports and resting HRV were measured pre and post mindfulness training, as compared with a control group that only had pre and post measures (Jee et al., 2015). The participants reported improvement in breath awareness post training, and shared that they enjoyed program components such as yoga and other exercises aimed at teaching self-regulation. However, no significant quantitative pre to post changes were found in any of the study outcomes, and surprisingly, some slight elevations in heart rate were noted, possibly indicative of attenuation in vagally-mediated parasympathetic influence on heart functioning, although the authors did not regard these minor changes as alarming or clinically meaningful. The authors also suggested that due to the traumatized nature of the sample, it is likely that longer than ten weeks would have been needed for changes to manifest, and that starting mindfulness training earlier, at a younger age, may prove beneficial for children at risk.

In a recent study, 33 depressed adolescent girls at risk for diabetes were randomized to either Learning to Breath program (L2B; n = 17) or a cognitive-behavioral intervention (n = 16). The girls in the mindfulness group (n = 17) showed greater decreases in depressive symptoms, and improved insulin resistance compared to the girls attending the cognitive-behavioral treatment (Shomaker et al., 2017).
A systematic review of 12 recent mindfulness programs for K-12 students (Meiklejohn et al., 2012), had some preliminary encouraging results which pointed to social, emotional and educational gains, but physiological measures were not incorporated in any of the studies to evaluate outcomes. Adding physiological markers, such as HRV or blood pressure, to carefully designed RCTs of mindfulness studies in children and adolescents would be a step forward in establishing the efficacy of mindfulness programs in improving children and youth well-being.

**Studies in ‘Emerging Adults’: The College Years – Unique Challenges**

The target population for the current study is first-year college students. Whereas stress is a universal phenomenon experienced by everyone at some point during life, stress can be particularly salient during transitional periods such as entering college. It has been theorized that populations undergoing developmental transitions are more susceptible to stress (Cohen, Burt, & Bjorck, 1987). The age range of 18-25 years, frequently corresponding to the college years, was coined by Arnett (2000, 2006) as *emerging adulthood*, the developmental period that takes place between adolescence to young adulthood. Emerging adulthood is a highly unstable phase in the life of young people who are in the process of exploring their identity and all facets of their lives, including work, education and intimate relationships (Ramler, Tennison, Lynch, & Murphy, 2016). No longer a child, but not quite an adult, the first-year college student may feel out of place. This may exacerbate the stress level that the transition to college environment, with its multitude of challenges, precipitates.

From a developmental psychopathology perspective, the stress inherent in these transitional college years may act as a trigger to a host of psychological disorders. Although the etiology of mental illness exhibited in the college years can often be traced to adolescence or even childhood when the onset of the emotional or behavioral disruption began, it is often during
the college years that maladaptive behaviors manifest or get consolidated (Schulenberg, Sameroff, & Cicchetti, 2004). While the need for promoting mental health during the childhood years is well known and studied, comparable work concerning prevention of psychological disorders in the college population is lacking.

Despite prevailing data indicating that approximately half of all college students report struggling with anxiety, depression, and other stress-derived mental health issues with concurrent reports of decreased levels of academic engagement, diminished relationships with peers and faculty, lower GPA, and lower graduation rates, only an estimated 10% of students receive on campus mental health services (Regehr et al., 2013). In addition to student reluctance to utilize services, colleges often lack adequate resources to address the mental health needs of all the students that require it. Group settings structured into the college curriculum, offering preventive interventions, may be more cost-effective, less stigmatizing, and have the potential to reach a larger number of students who can benefit from such services (Conley, Travers, & Bryant, 2013).

However, it is still a matter of debate whether preventive programs, designed to mitigate students’ stress and consequent maladjustment, can achieve their goals. Additionally, more information is needed on what kinds of programs are most effective, and who may benefit most.

A literature review and systematic meta-analysis of 24 studies consisting of 1,431 higher education students was conducted to compare the benefits of various stress-reduction interventions utilized in university settings to help address students’ anxiety and depression (Regehr et al., 2013). Identified studies were categorized into three groups by the researchers based on their intervention types: psycho-educational, art-based, and cognitive behavioral or mindfulness-based interventions. However, the psycho-educational and art-based interventions did not meet inclusion criteria and were not incorporated into the final meta-analysis.
Participants were students attending a wide range of educational programs from different disciplines and levels of higher education around the globe. Out of 24 studies that met criteria, only three used a physiological measure, namely – cortisol. All other studies utilized self-report scales only for study measures. Results indicated that all of the cognitive, behavioral and mindfulness-based interventions targeting stress-reduction, regardless of their respective duration, and program specification, were successful in reducing students’ reported anxiety levels. Other effects included improvement in depression levels and cortisol measures (Regehr et al., 2013).

The similarity of successful outcomes, despite the heterogeneity of intervention approaches, calls into question the specific component that acted as a change agent and was responsible for improvement in students’ scores. More specified meta-analyses are needed to clarify what interventions are most advantageous and who may benefit from them the most.

In addition to the fact that only a minority of studies included in this meta-analysis had incorporated a biological marker of stress, results from studies utilizing cortisol as a sole biological measure are often inconclusive. Cortisol is a sensitive measure that is susceptible to multiple confounding variables (Klatt, Buckworth, & Malarkey, 2009), and in the absence of other psychophysiological measures it may not fully capture fluctuations in ANS arousal corresponding to a stress response.

Another evaluative review examined 72 different types and formats of universal stress management programs in higher education, and compared those that were primarily psycho-educational with others that were skill-building programs (Conley et al., 2013). Within the skill-building programs, a further comparison was made between those programs that had embedded supervision to ensure that skill was being rehearsed and developing properly, as opposed to
programs that did not include such a component. Psycho-education (didactic) programs were not effective in creating change in adjustment outcomes, while programs that fostered skill-building were. Further, programs that afforded participants the possibility of practicing skills were approximately 5 times more effective compared with skill-building programs that did not include supervision, and 7 times more effective than the psycho-education programs. Out of the different strategies employed, mindfulness programs were the most effective, followed by CBT. Although all seven mindfulness programs were adaptations of the MBSR program, and were therefore similar to each other, the CBT programs each utilized different techniques with varied skill emphasis. This makes the comparison between the mindfulness programs and the CBT programs less meaningful.

Although a range of outcomes was measured in these studies, including: self-perception, social-emotional skills, and level of anxiety, depression and stress – which are the most prevalent maladjustment issues that higher education students face in college, biological markers demonstrating the stress response were not included as outcome measures.

Mindfulness studies that specifically target the first-year college population while employing psychophysiological measures are scarce. In a recent study that incorporated a mindfulness intervention and utilized a biological marker to measure stress reactivity, 30 first-year college students at College of Saint Benedict/Saint John’s University attended an 8-week adapted MBSR program as part of their first-year curriculum (Ramler et al., 2016). The control group (n = 32) only completed the assessment portion of the study, and did not receive any equivalent intervention. The two main hypotheses were that: (1) participants in the intervention program would exhibit improved scores on the Student Adaption to College Questionnaire (SACQ; Baker & Siryk, 1986), as well as on physiological measures of salivary cortisol, as
compared with participants who did not attend the mindfulness intervention; and (2) participants in the intervention would show pre- to post-intervention increases in their mindfulness scores as measured by the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). Results had supported the above hypotheses, with two exceptions: (1) the improvement in morning cortisol levels was only noted for male but not female participants; and (2) the improvement in student adjustments was mainly in the Personal-Emotional SACQ subset. In the Academic Adjustment subscale, scores were not statistically significantly different between the intervention and control groups.

The absence of an active control group is a notable limitation in this study. Additionally, only the intervention participants completed the mindfulness questionnaire, and it was the only measure that was completed at both pre- and post- intervention. All other measures, including the psychological assessment of student adjustment, and the physiological measure of salivary cortisol, were only administered at the completion of the intervention period, without a within baseline for comparison.

Another recent study incorporated both the use of an active control group, as well as HRV measures: Seventy-four undergraduate students at the University of Pennsylvania were randomized into either a four-week mindfulness meditation training, stress reduction control interacting with a therapy dog, or a third no-treatment group (Shearer, Hunt, Chowdhury, & Nicol, 2016). A mindfulness scale, and mood and anxiety scales were administered at baseline and post trainings. Additionally, after each weekly session, participants again completed the mood inventory. At the completion of the four-week trainings, all three groups were given the Wechsler Adult Intelligence scale (WAIS-IV), used as a performance stressor, while their ECG data were collected throughout the task. Students in the mindfulness group showed somewhat
greater reductions in anxiety measures, from pre to post training, as compared with the dog-interacting group who, in turn, showed some advantage compared with the ‘no treatment’ group. Both the mindfulness group and the dog-interacting condition were as effective in reducing dysphoric affect, as compared with the ‘no treatment’ control group. However, post trainings, the mindfulness group was superior to the other two groups in demonstrating higher HRV during the cognitive challenge test, indicative of an adaptive stress response. While this study is an improvement over previous studies by including HRV as a physiological measure, and incorporating both an active control group as well as a third ‘no treatment’ control group to the study’s design, one notable limitation is the absence of establishing a baseline HRV prior to the training sessions, for comparing pre and post levels.

Psychophysiological measures for assessing students’ stress reactivity level are more objective and less prone to bias than using self-report scales only. They also have the advantage of providing an immediate means of evaluating a student’s stress level in the here and now, thereby, identifying at-risk students whose stress reactivity level is highest. Yet, as can be seen from this brief review, to date, few studies have utilized psychophysiological measures to assess students’ stress level or their response to a mindfulness intervention program.

CHAPTER 3 –CURRENT STUDY

Despite emerging mindfulness studies utilizing physiological markers to index ANS functioning, much remains unknown. RCTs, utilizing active control conditions, objective outcome measures, and systematic pre to post comparisons are needed. Furthermore, to date, studies have either investigated the effect of mindfulness as a dispositional trait, or the effect of mindfulness training, but the relationship between trait and state mindfulness has rarely been explored. To address these gaps in the literature, this study aimed to improve upon extant
mindfulness research by utilizing heart rate variability (HRV) as a stress reactivity measure both pre and post training, in addition to using self-report scales. Additionally, the inclusion of an ‘active’ control group, matching in time and attention to the intervention group, makes it possible to delineate intervention effects more clearly. To date, only one other study utilizing the Learning to Breath program, the intervention used in this study, has incorporated an active control group and biological measures (Shomaker et al., 2017). Additionally, investigating the moderating role of mindfulness as a dispositional trait on training effects is another step forward toward gaining a better understanding of the relationship between trait and state mindfulness and determining who may benefit most from mindfulness programs. Low scores on the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) indicate a tendency for operating in automatic ‘auto pilot’ mode with little awareness of body states, thoughts, or emotions. Lacking such awareness makes self-management difficult, especially under stress conditions that require adaptive coping. It follows that mindfulness training would, therefore, be especially beneficial for individuals who lack such innate awareness and the corresponding emotion-regulation skills by providing these individuals with new tools to increase recognition and tolerance of stressful situations and respond with less reactivity.

**Aims and Hypotheses**

The first study aim was to determine if mindfulness training would change psychological stress responses. The corresponding hypothesis was that compared to the control group, the mindfulness intervention group would show greater reductions in stress and anxiety scores from pre to post training.
The second study aim was to determine if mindfulness training would change autonomic stress responses. The corresponding hypothesis was that compared to the control group, the intervention group would show greater increases in HRV from pre to post training.

Finally, the third aim, linked to the previous two -- was to explore the moderating effect of trait mindfulness on the effectiveness of mindfulness training. The corresponding hypothesis was that participants in the intervention group with initial lower scores on trait mindfulness would show more improvement in psychological and autonomic stress responses following training, as compared with individuals with initial higher mindfulness scores.

**Method**

**Participants**

Thirty-three first year college students were recruited from Brooklyn College, City University of New York, through flyers, information sessions during orientation events, and the Psychology Department subject pool. Students were eligible to participate in the study if they were male or female first-year students at Brooklyn College, in the 18 – 25 age range, and not currently enrolled in another study involving mindfulness or stress reduction skills. Out of the 33 students who were scheduled for the first lab visit for pre-training measurements, 25 students completed all parts of the study. The average student in this study was 18 years old ($M = 18.4$, $SD = 1.15$, range = 18-22). There were sixteen females and nine males, of diverse ethnic and racial backgrounds: 28% Asian, 20% Caucasian, 20% Hispanic, 16% Black, and 16% ‘other’ (‘Middle Eastern’, ‘Brown’). A majority of the students did not have any prior mindfulness experience ($N = 22$), and the three students who reported some prior experience with meditation indicated that they had not practiced any mindfulness techniques in the month before the current study. Only two students reported attending therapy or counseling services in the past six
months. Fifty-eight percent of students reported having experienced at least one form of social adversity at some point in their lives. An index of Social adversity was created based on participants’ responses on the demographic survey given during the first lab visit. One point was given for any positive response to one of the following 10 items: foster home, public housing, crowded home (five or more family members per room), welfare/food stamps, large family (> five siblings), teenage mother (participant was born to a mother who was younger than 19 years old), divorced parents, physical illness of a parent, mental illness of a parent, and arrest of a parent (Choy et al., 2015). Fifty percent of the students had a declared major at the beginning of the semester while the other 50 % were undecided. For details of participants’ characteristics by group, see Table 1. In addition to receiving a free stress-reduction training as part of this study, participants who signed up through the SONA system were eligible to receive three course credits, and all students completing the training, as well as the pre and post assessments, received a $10 gift card at the study’s completion.

Measures

Psychological Measures

**Perceived Stress Scale.** (PSS; Cohen, Kamarck, & Mermelstein, 1983). Participants completed the 10-item version of this questionnaire, using a 5-point Likert scale (0= ‘never’, 4= ‘very often’) aimed to measure their subjective appraisals of life situations in the past month, and the extent to which they found them stressful. Item responses are added to form a total score, ranging from 0 to 40, with higher scores indicating higher levels of experienced stress. An example item includes: “In the last month, how often have you felt that difficulties were piling up so high that you could not overcome them?” The PSS has been widely used in college student populations. The 10-item version was used in this study, as its psychometric properties were
determined superior to those of the longer 14-item version and the brief 4-item version (Lee, 2012).

**Generalized Anxiety Disorder 7-item Scale.** (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006). Participants completed this brief seven-item, 4-point scale (0=not at all, 1=several days, 2=more than half the days, and 3=nearly every day) to assess their anxiety symptoms over the past two weeks. Scores of all items are added for a total score ranging from 0 to 21, with 5, 10, and 15 as designated cut-off points indicating mild, moderate and severe levels of anxiety, respectively (Spitzer et al., 2006). An example item is: “worrying too much about different things”. The GAD-7 has a demonstrated strong reliability and validity (Löwe et al., 2008).

**The Adult Manifest Anxiety Scale – College Version.** (AMAS-C; Reynolds, Richmond, & Lowe, 2003). This 49-item anxiety scale was designed to assess anxiety in college students. This scale includes four sub-scales: worry/oversensitivity (12 items), social concern/stress (7 items), physiological anxiety (8 items), test anxiety (15 items), and a validity/lie scale (7 items). Together, these subscales (excluding the lie scale items) make up the total anxiety score, ranging from 0 to 42, that is the sum of all ‘yes’ responses. Higher scores indicate a higher anxiety level. An example item for the physiological anxiety subscale is: “My muscles feel tense”. An example for the lie subscale is: “I like everyone I know”. Both convergent and discriminant validity of this scale have been established (Lowe, 2013).

**State and Trait Anxiety Index - Trait Subscale.** (STAI-T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Participants completed this 20-item trait subscale to measure their dispositional anxiety. Items are scored on a 4-point Likert scale (ranging from 1 = “not at all” to 4 = “very much”). Scores range from 20 to 80, with higher scores indicative of a higher
disposition towards anxiety. Example items include: “Some unimportant thought runs through my mind and bothers me”. The STAI shows good psychometric properties (Fonseca-Pedrero, Paino, Sierra-Baigrie, Lemos-Giraldez, & Muniz, 2012).

**Mindful Attention Awareness Scale.** (MAAS; Brown & Ryan, 2003). Participants took this 15-item, 6-point Likert scale (1 = almost always, 6 = almost never) to assess their dispositional mindfulness as defined by their ability to stay in the present moment, and the frequency of their attentive awareness in everyday situations and activities. The 15 items are negatively worded and convey the absence of mindfulness (or mindlessness) in everyday activities. Scoring consists of computing a mean of all 15 items, with higher scores indicating a greater disposition towards mindfulness. Possible scores range from 1 to 6. An example item is: “I find myself listening to someone with one ear, doing something else at the same time”. This scale has robust psychometric properties and been validated for use in a variety of samples, including college and community populations (MacKillop & Anderson, 2007), making it suitable for first-year college students. For analysis purposes, participants were categorized into high or low trait mindfulness using a median split (range: 2.13 - 4.73), with those scoring below 3.53 being categorized as low trait and those scoring 3.6 or higher as high trait.

**Physiological Measures**

All physiological data were acquired using the Biopac MP150 system (Biopac Systems, Inc, Goleta, CA). Electrocardiography (ECG) signals were recorded using an ECG100C amplifier with two electrodes placed at a modified Lead II configuration (on both sides of the chest). Respiration was recorded using RSP100C amplifier with a belt around the chest. Heart rate and heart rate variability (HRV) were derived from the ECG100C data and measured offline using Kubios HRV software (Version 2.2; Tarvainen, Niskanen, Lipponen, Ranta-Aho,
A time-domain parameter of HRV, root mean square successive differences (RMSSD), was calculated to measure fluctuations in participants’ HRV. It has been widely used to gauge the heart’s vagal control and reflect HR changes as they correspond to respiration (Berntson, Lozano, & Chen, 2005). HRV was recorded at baseline -- during the initial two-minute rest period, and throughout the TSST task.

Utilizing AcqKnowledge software (Biopac Systems), raw ECG recordings for each participant were divided into two-minute-long segments. Segments included "Base rate", "Speech Preparation", "Speech Task", "Rest 1", "Math Task" and "Rest 2". Each file was then examined in Kubios HRV software to detect for any abnormalities. Files were then quality checked to ensure that QRS complexes were correctly classified. Displaced, incorrect or missing R peaks in the ECG segments were manually corrected by adding or removing R wave markers. When the correct time instances for R waves could not be visually observed, low level artifact correction was utilized. After quality checking review of ECG data, time-domain measurements of root mean square successive differences (RMSSD) from Kubios HRV software were compiled and analyzed in SPSS.

Baseline HRV was derived at the start of the TSST task by measuring participants’ HRV during an initial two-minute rest period, in which the research assistant (RA) instructed participants to stay seated while looking at an x at the center of a computer screen. The HRV measures collected during the two-minute speech preparation, speech and math segments of the TSST challenge consisted of the participants’ task HRV measures. For analysis purposes, because these three HRV task scores were highly correlated for both pre and post measures, two new composite variables were created for pre and post combined measures, consisting of the
average scores of the three separate segments, and reflecting the combined task HRV during the lab-elicited stress response.

**Procedures**

After initial sign-up and eligibility screening, participants were invited, in mid-September to mid-October, for their first visit at the psychophysiological lab located in the Psychology Department at Brooklyn College. This first lab visit lasted between 60 and 90 minutes. When participants arrived at the lab, they received in-depth information about the study, were consented as per the study’s IRB approved protocol, and completed a demographic survey, a mindfulness predisposition scale, and self-rating psychological questionnaires to assess their current level of stress and anxiety.

Next, after completing the self-report scales, the participants engaged in a social stressor task, the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993). In this task they had to give a two-minute impromptu speech and answer some computational questions in front of a research assistant and a video camera, while their physiological responses, including heart rate, heart rate variability, and respiration were recorded continuously.

A modified form of the TSST was used in the current study in order to elicit and measure physiological stress responses (Choy et al., 2015; Gao, Raine, & Schug, 2012). The TSST is the most commonly used social evaluative stress protocol under lab conditions, mimicking as closely as possible a real-life stressful experience (Kirschbaum et al., 1993; Kudielka, Hellhammer, Kirschbaum, Harmon-Jones, & Winkielman, 2007). In addition to the elicited stress response derived from the social evaluative nature of the task and the fear of being judged negatively, cardiac activity is associated with mental effort and is increased with high-demand cognitive tasks (Lumma, Kok, & Singer, 2015) leading to ANS arousal. Therefore, giving participants a
challenging computational task as part of the TSST is another contributor to the noted cardiovascular reactivity. Following prior literature (Zygmunt & Stanczyk, 2010), a mental arithmetic challenge, in which the participant is asked to perform serial abstraction, was included in our study as part of the TSST.

In this current study, the TSST task started with a two-minute rest period, in which the research assistant (RA) instructed participants to stay seated while looking at an x at the center of a computer screen. After this, the RA re-entered the room and instructed the participant to prepare a speech for the next two minutes about a personal fault or weakness. The participant was told that the RA was going to stay in the room during the speech and take notes, and that the speech would be recorded on video. When the two-minute prep time was over, the RA entered the room, turned on the camera, and asked the participant to start talking. If the participant paused for longer than 10 seconds during the two-minute speech, the RA let him or her know that there was still time left and instructed the participant to keep on speaking. To further augment the stress level, the RA wore a white lab coat and kept a neutral facial expression throughout the TSST task. After the speech task, there was another two-minute rest period in which participants sat still while looking at the center of the computer screen, followed by a two-minute mental math task. In the math task, the RA instructed the participant to subtract the number 13 from 1,022 as quickly and accurately as possible. If a mistake was made, the participant was notified and asked to start all over again from 1,022. A countdown clock on the screen indicated to the participant how much time was left. This arithmetic task was followed by a final two-minute rest period.

After this first lab visit, participants were randomly assigned to attend either the intervention group (N = 15), consisting of mindfulness training (Learning to Breathe; Metz et al.,
2013) or a ‘sham’ mindfulness condition (N = 15), incorporating educational information on the stress response, and artistic and group dynamics activities designed to reduce stress and strengthen interpersonal efficacy. Both groups were trained for 45 minutes once a week, for six consecutive weeks, on Brooklyn College campus during Tuesday common hours, by a trained facilitator and a research assistant. At the end of the 6-week training program, all participants who completed the program (intervention group N = 12; control group N = 13) were invited to a second lab visit to repeat the procedure in the first lab visit (except for the consenting).

**Intervention**

The mindfulness intervention used in this study, Learning to BREATHE (L2B; Broderick & Metz, 2009), is an evidence-based universal prevention, skill-based program based on the MBSR program. It aims to promote students' stress-management capabilities, emotion regulation, and well-being (Broderick & Jennings, 2012). This mindfulness-based program was initially developed to promote adolescent well-being, yet in the current study, the version adapted for use with undergraduate students (Dvorakova et al., 2017) was adopted.

Each of the six weekly sessions lasted 45 minutes, and targeted a specific module in the program, corresponding to a letter in the acronym BREATHE -- utilizing mindfulness tools, such as breathing, Body scan (awareness of body sensations in the moment), Reflections on thoughts and healthy Emotions, Attention, Tenderness (compassion towards self and others), developing healthy Habits leading to self-Empowerment. Each session started with a brief sitting meditation, and a review of skills taught in the previous session. Participants were taught various resiliency, emotion regulation and stress reduction skills through lecture, meditations, and activities, in a supportive group environment. Yoga mats were provided, and students were encouraged to practice their new meditations and mindfulness skills both in and out of the classroom.
The 'sham' mindfulness intervention control condition also consisted of a total of six 45-minute stress-reduction training sessions. In the first 15-minute segment of each session, participants received psychoeducational information about the stress response and stress triggers relevant to common students’ concerns, such as procrastination, test anxiety, and interpersonal conflict. In the second 15-minute segment, participants engaged in theme-related group exercise or discussion. Finally, in the last 15-minute segment, participants engaged in a relaxing activity, such as drawing or coloring mandala pages, followed by a brief ‘nap’ on the yoga mats in the room, while listening to soothing music. Both training sessions took place in the same location and approximately at the same time of the day. All sessions were administered by the same facilitator and research assistant who assisted in taking attendance, and giving out materials.

**Trainer Qualifications**

The PI on this study (LZ) administered both the mindfulness group and the control group. She attended several MBSR week-long retreats and was trained by Jon Kabat Zinn and other UMass seasoned mindfulness teachers. She was also trained by Patricia Broderick, a Pennsylvania State University researcher and founder of the L2B mindfulness training program. Written permission had been obtained from her and her student Kami Dvořáková, to use the college-adapted version of the program. Additional mindfulness-related clinical training includes several courses in Dialectical Behavior Therapy. Additionally, the trainer keeps to a personal daily meditation practice—a fundamental requirement for teaching others mindfulness (Burke, 2010).

**Design and Data Analysis**

A mixed factorial design was used in this study, and participants’ scores on psychological and physiological measures were compared both within (pre and post training) and between
(mindfulness vs. control) groups. To test the first hypothesis predicting that the mindfulness intervention group would show greater reductions in stress and anxiety scores from pre to post training as compared with the control group, a 2 (pre vs. post training) x 2 (mindfulness vs. control group) MANOVA was conducted for PSS, GAD, AMAS, and STAI-T scores. Univariate ANOVA was then followed. To test the second hypothesis predicting that the mindfulness intervention group would show greater increases in HRV from pre to post training as compared with the control group, a 2 (pre vs. post training) x 2 (mindfulness vs. control group) MANOVA was conducted for baseline HRV and task HRV, followed by univariate ANOVA. Additional MANOVAs were conducted to test for the third hypothesis, predicting that participants in the intervention group with initial lower scores on trait mindfulness would show more improvement in psychological and autonomic stress responses following training, as compared with individuals with initial higher mindfulness scores. A 2 (pre vs. post training) x 2 (mindfulness vs. control group) x 2 (high vs. low trait mindfulness) MANOVA was conducted for PSS, GAD, AMAS, STAI-T, followed by univariate Anova. Finally, a similar analysis was conducted for baseline HRV and task HRV scores, followed by univariate Anova.

Statistical analyses were conducted using SPSS software (version 20, IBM Corp.). All tests were two-tailed with an α level of .05. Prior to statistical analyses, one outlier (3 standard deviations beyond the mean) was identified and removed from the physiological data, as constant coughing during this participant’s first visit rendered her data unusable.

Results

Descriptive Statistics

Out of the 33 participants who came for their first lab visit, three did not show up for any training sessions and were therefore excluded from any analyses. Eighty percent of the remaining
30 participants had attended at least four out of six training sessions (73% in the intervention group, and 86% in the control group). Five participants dropped out of the study after one or two sessions (17%): three in the intervention group, and two in the control group. The intervention and control groups were initially balanced for their male to female ratio, but were unmatched for gender at the study’s completion due to drop-out. All of the remaining twenty-five students (Intervention group N = 12, control group N = 13) had completed both the pre and post lab visits, including all psychological and physiological assessments, and attended the majority of training sessions. On average, participants in the intervention group attended 4.91 sessions ($SD = 0.99$), and participants in the control group attended 5.15 sessions ($SD = 0.55$). The main reasons reported for missing a session were schedule conflict and personal illness. See Figure 1 for a flowchart of participants retained at each phase of the study.
Figure 1. Flow diagram of study participants’ enrollment, randomization, and analysis.

The training program had a high acceptability rate for participants as indicated by the low attrition and high attendance rate, and as per participants’ responses to a follow-up feedback form. The vast majority of participants stated that since they started their respective training they
had noticed that their stress level reduced either ‘somewhat’ or ‘significantly’ (91.7% of Mindfulness group, 84.6% of Control group, 88% combined). Only one participant in the mindfulness group and two in the control group did not report experiencing any improvement in their stress level. Most participants felt that the duration of the intervention, both in terms of number of sessions, and length of each session was ‘just right’ (length of each session: 66.7% of mindfulness, 76.9% of control, 72% combined; length of overall training: 66.7% of mindfulness, 84.6% of control, 76% combined). While different participants liked various aspects of their respective trainings, only one person, in the control group was somewhat unlikely to recommend their training to a friend. The vast majority of participants in both groups were either ‘highly likely’ or ‘somewhat likely’ (100% of mindfulness, 92.3% of control, 96% combined) to recommend their respective training to a friend. Demographic information for the sample is displayed in Table 1. Groups (Mindfulness vs. Control) were not different in terms of their demographic characteristics, except for the proportion of declared/undeclared majors. Descriptive statistics of the intervention and control group pre and post training can be found in Table 2.
Table 1.

Demographic Information and Group Comparisons

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mindfulness Group</th>
<th>Control Group</th>
<th>Comparison</th>
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<tr>
<td></td>
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<td>n = 13</td>
<td>$x^2$</td>
</tr>
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<td>Sex (%)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
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<td>30.8</td>
<td>.019</td>
</tr>
<tr>
<td>Female</td>
<td>66.7</td>
<td>69.2</td>
<td>.019</td>
</tr>
<tr>
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<td>18.31 (1.11)</td>
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</tr>
<tr>
<td>Ethnicity (%)</td>
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<td></td>
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<tr>
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<td>30.8</td>
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<td>.019</td>
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<td>.019</td>
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<tr>
<td>Asian</td>
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<td>.019</td>
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<tr>
<td>Other</td>
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<td>23.1</td>
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<td>Majors (%)</td>
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<td>4.891</td>
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<tr>
<td>Undeclared</td>
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<td>.019</td>
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<tr>
<td>Declared</td>
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<td>69.2</td>
<td>.019</td>
</tr>
<tr>
<td>Social Adversity [M (SD)]</td>
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<td>1.3 (1.12)</td>
<td>.435</td>
</tr>
</tbody>
</table>

Note. Fisher’s exact test was run for ethnicity.
Table 2.

Pre and Post-Training Mean Comparison for all Outcome Variables by Group

| Measure   | Mindfulness Group | | | Control Group | | |
|-----------|-------------------|---------|---------|----------------|---------|
|           | Pre               | SD      | Post    | SD      | t      | p     | Pre   | SD      | Post    | SD      | t      | p     |
| **Self-GAD** | **11.91 5.72 7.33 5.58 2.66 .022** | | | **10.46 5.62 8.61 5.28 1.45 .172** | | |
| **PSS**    | **22.08 6.52 15.41 5.55 3.18 .009** | | | **20.59 7.08 17.00 6.00 1.82 .094** | | |
| **AMAS**   | **28.00 8.79 20.16 11.37 2.89 .015** | | | **27.07 7.95 22.23 7.94 3.82 .002** | | |
| **STAI**   | **51.08 11.73 44.58 12.29 1.71 .115** | | | **50.92 11.38 47.61 12.14 1.21 .249** | | |
| **MAAS**   | **3.35 0.65 3.46 0.75 -0.71 .489** | | | **3.60 0.86 4.00 0.77 -2.14 .054** | | |
| **HRV Baseli** | **32.34 10.77 43.94 14.61 -1.86 .175** | | | **31.44 9.56 38.54 16.92 -2.05 .063** | | |
| **Speech** | **35.48 13.87 39.11 12.50 -1.96 .863** | | | **33.63 12.56 37.00 11.90 -0.83 .421** | | |
| **Speech** | **31.25 7.58 35.24 9.67 -1.38 .106** | | | **26.81 8.06 26.38 7.82 0.22 .826** | | |
| **Rest 1** | **40.28 15.50 47.10 16.87 -1.12 .935** | | | **38.14 16.05 37.77 12.00 0.10 .920** | | |
| **Math**   | **30.94 9.56 35.81 11.58 -1.38 .395** | | | **29.79 11.09 29.91 10.80 -0.05 .956** | | |
| **Rest 2** | **40.42 13.84 45.87 15.81 -0.83 .847** | | | **39.50 15.41 38.97 14.98 0.26 .796** | | |

*Note. N = 24; intervention = 12, control = 13. *p < .05, **p < .01. GAD = Generalized Anxiety Disorder 7-item Scale; PSS = Perceived Stress Scale; AMAS = The Adult Manifest Anxiety Scale; STAI = State and Trait Anxiety Index; MAAS = Mindfulness Awareness Attention Scale.*
Correlations among all physiological and psychological variables were examined for both pre and post training conditions (see Tables 3 and 4). In both conditions, anxiety measures were significantly correlated with one another. For example, there was a strong correlation between GAD and AMAS scores, (pre: $r = .789$, $p < .01$; post: $r = .858$, $p < .01$). Mindfulness score (MAAS) was negatively correlated with both GAD (pre: $r = - .551$, $p < .01$; post: $r = -.444$, $p < .05$) and AMAS anxiety scores (pre: $r = - .424$, $p < .05$; post: $r = -.457$, $p < .05$). Similarly, HRV measures (baseline, speech prep, speech task, and math task) were correlated with one another (see Tables 3 and 4). However, there appeared to be no significant correlations between physiological and psychological measures, with the exception that pre-training baseline HRV was negatively associated with PSS score ($r = - .541$, $p < .01$).
<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>8</th>
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<th>10</th>
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<td>3. AMAS</td>
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<td>.675**</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>.701**</td>
<td>.763**</td>
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<tr>
<td>7. HRV Speech Prep</td>
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<td>-.041</td>
<td>-.048</td>
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<td>.114</td>
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<td>.475*</td>
<td>.789**</td>
<td>.479*</td>
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<td>.821**</td>
<td>.490*</td>
<td>.929*</td>
<td>.777**</td>
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</table>

*Note.* N = 24; *p < .05, **p < .01. GAD = Generalized Anxiety Disorder 7-item Scale; PSS = Perceived Stress Scale; AMAS = The Adult Manifest Anxiety Scale; STAI = State and Trait Anxiety Index; MAAS = Mindfulness Awareness Attention Scale.
Table 4.

### Correlations Among Post-Training Study Variables

<table>
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<tr>
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<th>4</th>
<th>5</th>
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**Note.** N = 24; *p < .05, **p < .01. GAD = Generalized Anxiety Disorder 7-item Scale; PSS = Perceived Stress Scale; AMAS = The Adult Manifest Anxiety Scale; STAI = State and Trait Anxiety Index; MAAS = Mindfulness Awareness Attention Scale.
A preliminary check showed that scores on all measures were comparable between the control and intervention groups at the outset, pre-training condition: GAD ($t(22) = -0.815, p = .424$); PSS ($t(22) = -0.727, p = .475$); AMAS ($t(22) = -0.369, p = .715$); STAI-T ($t(22) = -0.091, p = .928$); MAAS ($t(22) = 0.843, p = .408$); HRV baseline ($t(22) = -0.217, p = .830$); and task HRV ($t(22) = -0.670, p = .510$).

Although no pre-training group differences were noted, as above, for any of the study measures, it is worthy to note that when comparing participants who were dispositionally low on mindfulness trait with those that scored high, regardless of group assignment, low trait individuals reported higher anxiety pre-training as measured by GAD ($M = 15, SD = 4.06$) as compared with high trait individuals ($M = 7.666, SD = 4.57; t(22) = 4.1, p < .01$). Low trait individuals also reported higher anxiety scores pre training on the AMAS ($M = 32.25, SD = 6.85$) as compared with high trait individuals ($M = 23.08, SD = 7.26; t(22) = 3.28, p < .05$), and showed a trend towards significance for higher anxiety scores pre training scores on the STAI ($M = 55.66, SD = 10.02$) as compared with high trait individuals ($M = 46.58, SD = 11.52; t(22) = 2.06, p = .051$). Finally, low and high mindfulness trait groups did not differ pre-training on HRV measures (HRV baseline, $t(22) = -0.220, p = .828$; task HRV, $t(22) = -0.207, p = .838$).

**Hypothesis 1: Psychological Measures**

In the first study hypothesis, it was predicted that compared to the control group, the mindfulness intervention group would show greater reductions in stress and anxiety scores from pre to post training. A 2 (pre vs. post) by 2 (control vs. mindfulness) MANOVA was conducted with four anxiety/stress measures as the dependent variables: PSS, GAD, AMAS, and STAI. Since all assumptions for the MANOVA test were met, no corrections or data transformations
were required. A significant multivariate main effect of time was observed ($F (4, 19) = 5.384, p < .01$). No multivariate main effects of group ($F (4, 19) = 0.141, p = .965$) or interaction between group and time ($F (4, 19) = 0.798, p = .541$) were observed. Univariate ANOVAs were then followed to assess the effects on individual anxiety measures: significant univariate main effects of time were observed for three of the four measures: PSS, $F (1, 22) = 10.89, p < .05, \eta^2_p = .331$; AMAS, $F (1, 22) = 16.71, p < .001, \eta^2_p = .432$; and GAD, $F (1, 22) = 7.92, p < .05, \eta^2_p = .265$. In all cases, scores on these measures decreased from pre- to post training (see Figure 2; Table 2). No significant main effect of group or time by group interaction was obtained for any of the psychological measures.

![Figure 2](image-url)

**Figure 2.** Pre and post-training self-report stress and anxiety measures comparison between control and mindfulness group. Error bars represent +/- 1 standard error.
Hypothesis 2: Physiological Measures

In the second study hypothesis, it was predicted that compared to the control group, the intervention group would show greater increases in HRV measurements from pre to post testing. A 2 (pre vs. post) by 2 (control vs. mindfulness) MANOVA was conducted on baseline HRV and task HRV. A significant multivariate main effect of time ($F(2, 21) = 3.809, p < .05$) was observed. No multivariate main effect of group ($F(2, 21) = 0.815, p = .456$) or interaction between group and time ($F(2, 21) = 0.354, p = .706$) were observed.

Given the overall significance found, univariate ANOVAs were followed to assess the effects of baseline HRV and task HRV respectively.

Baseline HRV:

A significant univariate main effect of time on baseline HRV was observed with an increase in baseline HRV from pre to post training ($F(1, 22) = 7.429, p < .05, \eta^2_P = .331$; see Figure 3) for both groups. Although the intervention group showed somewhat greater increases in baseline HRV compared to the control group, these group differences did not reach statistical significance ($F(1, 22) = 0.547, p = .467$). Additionally, no interaction between group and time was noted ($F(1, 22) = 0.429, p = .519$).
Figure 3. Comparison of mean baseline HRV between intervention and control group from pre to post training.

Task HRV:

No univariate main effect of time ($F(1, 22) = 1.99, p = .172$), group ($F(1, 22) = 1.67, p = .210$), or an interaction between time and group were found ($F(1, 22) = 0.737, p = .172$).

Hypothesis 3: Trait Mindfulness as a Moderator

In the third hypothesis, it was predicted that participants in the intervention group with initial lower trait mindfulness would show more improvement in psychological and physiological responses following training, as compared with individuals with initial higher mindfulness scores.

Moderating Effect of Trait Mindfulness on Psychological Measures

To examine the moderating effect of trait mindfulness on the effectiveness of mindfulness training, as measured by self-report stress and anxiety scales, a 2 (pre vs. post) by 2
(control vs. mindfulness) x 2 (high vs. low trait mindfulness) MANOVA was conducted for PSS, GAD, AMAS, and STAI.

Significant multivariate main effects of time ($F(4, 17) = 3.947, p < .05$), and trait ($F(4, 17) = 3.254, p < .05$) were observed. No multivariate main effect of group, or any two-way or three-way interactions were observed. Univariate ANOVAs were then followed to assess effects on individual anxiety measures: A significant univariate main effect of time was observed for three of the four measures: PSS, $F(1, 20) = 7.39, p < .05, \eta_p^2 = .270$; AMAS, $F(1, 20) = 10.427, p < .001, \eta_p^2 = .343$; and GAD, $F(1, 20) = 5.350, p < .05, \eta_p^2 = .211$. Main effects of trait were noted for GAD ($F(1, 20) = 8.98, p < .01, \eta_p^2 = .310$, and for AMAS ($F(1, 20) = 6.46, p < .05, \eta_p^2 = .244$), such that participants with low trait mindfulness scored higher on these two anxiety scales as compared with those with high trait mindfulness. An interaction effect of time and trait was noted for PSS ($F(1, 20) = 6.64, p < .05, \eta_p^2 = .249$), indicating that the reduction in PSS scores from pre to post trainings was moderated by trait. Post-hoc pairwise comparisons were conducted to explore this interaction effect. It was shown that low trait mindfulness participants (in either mindfulness or control group) had significantly reduced their perceived stress scores from pre to post trainings (Mean difference = 7.81, $p < .01$), while high trait mindfulness participants did not (Mean difference = 0.281, $p = .924$). No univariate main effect of group or other interaction effects were observed.

Moderating Effect of Trait Mindfulness on Physiological Measures

To examine the moderating effect of trait mindfulness on the effectiveness of mindfulness training, as assessed by HRV measures, a 2 (pre vs. post) by 2 (control vs. mindfulness) x 2 (high vs. low trait mindfulness) MANOVA was conducted for baseline HRV and task HRV.
A trend towards significance in multivariate main effect of time \((F (2, 19) = 3.28, p = .059)\) was observed. Additionally, a significant multivariate three-way interaction effect of time by group by trait mindfulness was found \((F (2, 19) = 4.80, p < .05, \eta^2_p = .336)\) was noted. No multivariate main effect of group or other interactions were observed.

Univariate ANOVAs were then followed to assess the moderating effects of trait on baseline RHV and task HRV separately. A trend towards significance in univariate main effect of time was observed for baseline HRV \((F (1, 20) = 4.02, p = .059)\).

More importantly, a significant univariate three-way interaction effect of time, group, and trait mindfulness was found for task HRV \((F (1, 20) = 7.89, p < .05, \eta^2_p = .283)\). To further investigate this interaction, and to delineate the simple effects driving the interaction, post-hoc pairwise comparisons were conducted. They revealed that the task HRV increased significantly from pre to post training for the intervention group only (Mean Difference = 8.02, \(p < .01\)) but that this finding was moderated by trait, such that only low-trait individuals in the mindfulness group showed HRV increases from pre to post training, while low-trait individuals in the control group or high-trait individuals in either the intervention or the control group did not show significant changes (See Figure 4). Finally, no univariate main effects of group, trait or interaction effects between time and group, time and trait, or group and trait were observed.
Figure 4. Pre and post training comparison of mean task HRV moderated by trait mindfulness. Mean HRV combines RMSSD measures during speech prep, speech task and math task. Task HRV increased significantly from pre to post training only for low trait mindfulness participants in the mindfulness intervention (A) but not for those in the control group (B).
Figure 5 presents a sample comparison of HRV recordings during the speech task pre- and post- mindfulness training for one study participant. Graph A shows low HRV: There is little variation in beat-to-beat intervals, especially as evident in the middle region of the recording, indicating a stress response. In Graph B, higher peaks and deeper dips indicate greater variation, signifying attenuated parasympathetic withdrawal, and more ANS flexibility and adaptability in responding to task demands.

Discussion

This study aimed to examine whether mindfulness training can be an effective means of alleviating stress levels in first-year college students, and thereby ease their transition into college. The results of this study partly support its hypotheses: While participants’ self-report scores did not significantly vary by group from pre to post training, HRV measures during a social stressor did. Specifically, participants in the mindfulness group who were low in
dispositional mindfulness trait showed significant increases in their HRV during the lab social stressor task from pre to post training, while participants in the control group did not show similar gains. The fact that these HRV task increases were found for low-trait mindfulness training participants only, lends support to the third hypothesis predicting greater improvement in autonomic functioning from pre to post mindfulness training for individuals lower on mindfulness scores. However, this hypothesis was not fully supported for the self-report measures. Although a time by trait interaction was shown for the self-report stress measure (PSS), indicating that reductions in reported stress level from pre to post trainings were moderated by trait, this finding was not specific to group assignment. Participants low in trait mindfulness in either the mindfulness or control group showed significant reductions in their reported stress levels from pre to post trainings. Furthermore, this time by trait effect was only shown in regard to stress scores (PSS) while observed reductions in the self-reported anxiety scores (GAD, AMAS, and STAI-T) from pre to post training were not specific to trait or group.

An important test of a person’s health and resiliency is how he or she responds during a challenging yet innocuous situation. An exaggerated reaction that does not fit the situation may trigger an unwarranted flight or fight response in the absence of actual danger, with costly consequences to all body systems. This study found that students low in dispositional mindfulness who participated in the mindfulness training experienced a decrease in cardiovascular reactivity to a social stressor. This was measured by a substantial increase in their task HRV from pre to post training, relative to low-trait participants who attended a control stress-reduction training or high-trait participants who participated in either the mindfulness intervention training or its control condition. Namely, students who had initial low scores on
mindfulness trait (MAAS) and then attended the mindfulness training group had reduced autonomic stress arousal in response to a repeated evaluative social threat lab task.

This finding supports the hypothesized claim to the advantage of the mindfulness intervention beyond that of the control group, and suggests that individuals with lower scores on a mindfulness trait may benefit more from such training. This finding is especially remarkable given the brief length of the intervention, six weekly forty-five minutes sessions only, as compared with standard MBSR program training that usually involves eight weekly two-hour sessions. Additionally, the large magnitude of the effect size (\(\eta^2_p = .283\)) found in such a small sample likely reflects a real difference between the two group conditions. Furthermore, previous mindfulness studies often achieved only small effects when outcome benefits were relative to an active control. Larger effects that were found in studies with wait-list or TAU control conditions were often attenuated when an active control group was added, likely due to general beneficial factors such as time and attention that were common to both groups. This pilot study points to the potential of mindfulness meditation as a means of modulating the ANS responses and mitigating the adverse effects of stress on the ANS, in accordance with both the mindfulness stress-buffering model and the Polyvagal theory.

In this study, the TSST lab stressor was conducted twice: pre and post training. A common concern regarding a repetition of the TSST challenge as a reliable measure of stress reactivity is that repeated exposure to the same social evaluative stressor may result in habituation effects (Creswell, Pacilio, Lindsay, & Brown, 2014). It is therefore important to ascertain that any attenuated reactivity measured during a TSST challenge post training is indeed due to the mindfulness intervention effects, rather than the habituation effects that led to a blunted response, due to the repetition of the TSST challenge.
Petrowski, Wintermann, and Siepmann (2012) found that a TSST challenge repeated after 10 weeks could elicit detectable levels of physiological arousal in the form of HPA reactivity, demonstrating that no habituation effects were present. The authors concluded that ten weeks interval between repeated administrations of TSST were a sufficient time for any habituation effect to dissipate. In our sample, the mean number of days between TSST exposures during the first and second lab visits was 54.9 days ($SD = 8.4$). This is equivalent to 7.85 weeks – shorter than the ten-week interval used in the study above (Petrowski et al.). Yet, the authors concede that the choice of a 10-week separation was somewhat arbitrary, and it can be argued that a shorter interval is sufficient to reverse habituation effect and elicit physiological arousal in a renewed TSST challenge. Additionally, other studies showed that a repeated TSST challenge may only be susceptible to habituation of the HPA system specifically, while the sympathetic nervous system is more sensitive to reactivity and does not habituate to repeated challenges of TSST (Schommer, Hellhammer, & Kirschbaum, 2003). It is therefore plausible that potential concerns about the repetition effects do not apply to HRV, the cardiovascular biomarker of parasympathetic activity that was used in this study.

While some sympathetic activity during a stressful situation is adaptive because it prepares the individual for defensive coping with the threat at hand, an excessive stress response exceeding the level of actual danger, or a failure to recover and habituate back to baseline once the threat is over is maladaptive and has been linked to poor prognosis in psychiatric disorders (Goleman & Schwartz, 1976). In this current study, because we only used abbreviated recovery periods of two minutes each between TSST cognitive tasks, there might not have been sufficient time for habituation to take place, and for HRV scores to go back to baseline. Hence, rest periods in this study may not reflect a reliable index of recovery and were therefore not used to assess
improvement in stress reactivity from pre to post training. Additionally, improvements in recovery time following a stressor may only be noticed for experienced meditators, as a function of ongoing meditation practice, while recovery effects experienced by novices may only be minimal (Goleman & Schwartz). Since our participants only had a short 6-week training, it is unlikely that substantial recovery effects during rest periods would have been found. Therefore, in this study we used tracked changes in elicited cardiovascular arousal during TSST task periods from pre to post training, as well as differences in baseline HRV from visit 1 to visit 2 as stress reactivity measures.

Considering the important goal of stress reduction for first year college students, overall this study appears to have succeeded, in reducing students’ stress levels, as they were making their first steps towards adjustment to college life. While both groups exhibited a significant increase in baseline HRV from pre to post measures, an important indicator of a balanced ANS, these changes did not differ significantly between groups. A similar pattern was shown for improvement in psychological measures as manifested by reduced stress and anxiety scores from pre to post training, yet without reaching statistical significance for a main group effect. It is likely that attainment of a more fundamental change in baseline HRV that would substantiate group differences may require a longer period of mindfulness practice than was warranted in this brief six-week mindfulness training. Similarly, consistent mindfulness practice over an extended period of time may also be needed to change people’s self-report scores more substantially, corresponding to a decrease in negative self-evaluations, an increase in emotion regulation, and an evolving subjective experience of stress reduction and overall well-being.

While HRV measured during the task segments of the TSST reflects ‘in the moment’ situational mindfulness, baseline HRV and self-report psychological measures of stress and
anxiety reflect more pervasive everyday functioning and can therefore be categorized as dispositional (Brown, Weinstein, & Creswell, 2012). Going from state to trait and increasing one’s capacity for mindful awareness in daily life takes practice – through formal meditation, as well as more broadly by applying a mindful approach to everyday activities (e.g., eating, conversing, driving, etc.). Mindfulness training benefits may generalize over time to improved overall emotional regulation skills, and increases in mindfulness as a trait, but it entails cultivating a systemic regular practice (Rubia, 2009). It stands to reason, therefore, that mindfulness training effects would first be noted as state changes, as demonstrated in this study, and only later with continued practice may become ingrained in one’s personality and manifest as trait effects. Yet more research is needed to further investigate the effects of mindfulness training on baseline HRV as compared with task HRV.

Although pre to post score changes in psychological scales did not reach significance for group-differences in this study, the fact that both groups had shown a clear downward pattern in reported stress and anxiety is noteworthy and merits additional discussion. The statistical analyses revealed a significant within-subject factor effect for time, associated with participants’ reduced stress and anxiety. The very large effect size ($\eta_p^2 = .531$) for this main effect of time cannot be overlooked. However, it highlights the fact that while mindfulness intervention was effective, it was not differentially effective. One plausible explanation for the absence of group effect in self-reports is the small sample size in this pilot study, potentially leading to a type II error. It is possible that with a larger sample size and consequent increased statistical power, group effect would have become more apparent, reaching statistical significance. Future studies with larger samples are needed to test this hypothesis.
Additionally, while mindfulness training likely reduced stress levels, it may have also led to participants’ increased sensitivity to their sensations and emotions, contributing to a growing awareness, with corresponding greater report of distress symptoms that previously went unnoticed. Such effect may skew results of self-reported perceived stress and anxiety.

It is also possible that while mindfulness is a valuable tool that can enhance students’ coping capacity under stress conditions, some kind of stress-reduction training, regardless of its specific nature, may be preferable to none. In addition to the relaxation component of the control group, in the form of music, drawing, and taking brief naps, the training sessions targeted themes that commonly concern college students, including procrastination, test anxiety, and interpersonal conflict, and provided students with new coping skills to address these concerns and improve their time management, test-taking skills and interpersonal effectiveness. Additionally, having a safe space, guided by an experienced teacher and clinician, and in the company of other freshmen, may have provided a level of support and comfort that may have eased the transition into college for many students, regardless of their group assignment.

Adding an ‘active’ control to the experimental design of this study addressed a substantial gap in current mindfulness research. However, creating a control group that operates as a proper active condition, yet without becoming a competing treatment is a balancing act. An important consideration in the study design was the overarching goal of helping college freshmen reduce their stress level. While we aimed to establish the superiority of mindfulness as an effective stress-reduction intervention, the decision making regarding the structure and nature of the control condition was driven by ethical considerations. We wished to offer all participating students something of value, yet without losing sight or compromising the main study hypotheses. The aim was to balance as best as possible statistical with clinical significance in
evaluating study design and treatment effects. Hence, the similarity in self-report outcomes may be an artifact of the strong, active control condition utilized in this study.

An alternate explanation to the finding of main effect of time in the absence of group effect for the self-report measures is that the decrease in anxiety scores over time may simply reflect adjustment to college life, regardless of attendance of one type of training or another. Time itself may have been the ‘remedy’. As the semester progressed, the students’ stress may have diminished, as reflected by lower anxiety self-reports during the second lab visit, in contrast to the first assessment that took place in the beginning of the semester, when students were likely overwhelmed by the transition to college and the multiple demands placed on them. A follow-up study with a third ‘no treatment’ group who would just have pre and post measures is needed to test the latter, and determine whether the observed reductions in anxiety scores were due to passage of time and students’ adjustment or due to the effects of the stress-reduction training they had received. However, it is important to remember that even if the mere passage of time may have contributed to students’ adjustment, the end of the semester –when the post training assessment took place, is typically a time of escalating stress levels associated with final exams. This stress may be especially acute for freshmen who are encountering end of the semester, college-level final exams for the first time – another ‘first’ in their journey towards higher education. Thus, increased anxiety post scores would have been expected, or if some adjustment due to passage of time had taken place, and was then counterbalanced by the end of the semester stress effect – the expectation may be that the anxiety scores remain approximately the same from lab visit 1 to lab visit 2. Instead, we clearly note a decline in stress and anxiety scores. The latter seems to suggest that it was not just the mere passage of time, but rather the actual trainings, that had led to the declining scores, and that with a bigger sample size, the mindfulness
training’s greater impact, as compared with the control group training, would become apparent. Future studies would hopefully shed light on this possibility.

While no group differences were shown for the self-report measures, task HRV findings in this study pointed to training group differences, specifically as they applied to low-trait mindfulness participants who benefited most from the mindfulness training. Additionally, low-trait study participants, pre-group assignment, had shown higher anxiety scores at the outset, as measured by GAD and AMAS self-reports. Combined, these findings seem to suggest that students who are predispositionally lower in trait mindfulness may be more susceptible to stress, especially as they transition into college, and that mindfulness intervention may be beneficial for them in buffering the harmful effects of stress. When resources are limited, and colleges are forced to make difficult decisions, and reluctantly cut back on expenses, these are important considerations to keep in mind. Targeting students who may be most at risk and offering them health promoting evidence-based group interventions may be key in increasing students’ wellness and academic retention.

In order to achieve favorable results, care must be taken when choosing and implementing a stress-reduction program for college students. With the current proliferation of mindfulness-based programs, and their heterogeneous training components, it remains unknown what program component, chiefly, is responsible for the observed salutary outcomes. In this study, the addition of an active control that was matched in time and attention clarifies that observed benefits were not solely due to common factors such as group support. Yet, it remains undetermined what mindfulness program component, specifically, contributed the most to the noted improvements. Additional randomized studies, with several control groups
corresponding to each of the primary MBSR components (e.g., meditation, body scan, yoga) would help delineate relative program’s effects.

**Limitations and Future Directions**

Several study limitations warrant mention. First, the sample of 25 participants was admittedly small, and larger-scale replications are needed to verify the positive findings of this study. Statistically under-powered studies make it challenging to detect effects and replicate findings. This is a common issue in studies utilizing mindfulness-based interventions such as L2B because the small group format of such classroom-based training does not lend itself to large numbers of participants. Additionally, the inclusion of a third ‘no treatment’ control, with only pre and post measures, would be helpful in accounting for natural fluctuations of anxiety levels during a course of a semester. An addition of a follow-up assessment, several months after the study’s completion, would have contributed valuable information regarding the sustaining of training effects. Additionally, due to randomization, the two groups were not matched for their ratio of low to high mindfulness trait participants, per group, at the outset. As such, there were more high trait participants in the control group, while most students in the mindfulness group were low-trait, making findings regarding high vs low mindfulness trait individuals harder to interpret. Yet, the two groups did not differ significantly on trait mindfulness before training. Finally, although the L2B program is based on MBSR, and is also a universal preventive program, not meant to diagnose or treat any condition, some of the modules include components that are similar to CBT, with psychoeducational and experiential exercises delineating the difference between thoughts and emotions and teaching specific emotion-regulation skills. These added features, not included in the original MBSR protocol, make it even more challenging to
assess the particular components responsible for the observed outcomes, and their relative contribution to the noted effects.

Despite the above limitations, this study is a step forward in mindfulness research, bridging some of the gaps in current literature through the inclusion of HRV measure -- an important ANS biological marker that is not susceptible to demand characteristics, and having a proper RCT study design, allowing for both within and between group comparisons. This study’s finding that students who were new to mindfulness meditation showed a distinct pattern of attenuated autonomic arousal during an evaluative social threat condition following a mere six weeks of mindfulness training is encouraging and justifies follow-up investigation of this important topic. Larger-scale trials, with bigger samples size, a more extended mindfulness training, and additional post training follow-up assessment points are needed to continue investigating the potential positive effects of mindfulness for reducing stress, and promoting health outcomes.
APPENDIX A: Perceived Stress Scale

Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983)

Instructions: The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling how often you felt or thought a certain way.

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

1. In the last month, how often have you been upset because of something that happened unexpectedly? ........................................
   0 1 2 3 4

2. In the last month, how often have you felt that you were unable to control the important things in your life? ........................................
   0 1 2 3 4

3. In the last month, how often have you felt nervous and “stressed”? ..........
   0 1 2 3 4

4. In the last month, how often have you felt confident about your ability to handle your personal problems? ........................................
   0 1 2 3 4

5. In the last month, how often have you felt that things were going your way? ........................................
   0 1 2 3 4

6. In the last month, how often have you found that you could not cope with all the things that you had to do? ........................................
   0 1 2 3 4

7. In the last month, how often have you been able to control irritations in your life? ........................................
   0 1 2 3 4

8. In the last month, how often have you felt that you were on top of things? ....
   0 1 2 3 4

9. In the last month, how often have you been angered because of things that were outside of your control? ........................................
   0 1 2 3 4

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? ........................................
    0 1 2 3 4
APPENDIX B: Generalized Anxiety Disorder 7-Item Scale

Generalized Anxiety Disorder 7-Item Scale (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006)

<table>
<thead>
<tr>
<th>Over the last 2 weeks, how often have you been bothered by the following problems?</th>
<th>Not at all</th>
<th>Several days</th>
<th>Over half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Feeling nervous, anxious, or on edge</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Not being able to stop or control worrying</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Worrying too much about different things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Trouble relaxing</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Being so restless that it's hard to sit still</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Becoming easily annoyed or irritable</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Feeling afraid as if something awful might happen</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
APPENDIX C: The Adult Manifest Anxiety Scale

The Adult Manifest Anxiety Scale – College Version (AMAS -C; Reynolds, Richmond, & Lowe, 2003).  

Please circle one answer to each sentence.

| Yes | No | 1. Others seem to do things more easily than I can. |
| Yes | No | 2. I worry too much about tests and exams. |
| Yes | No | 3. I feel that others do not like the way I do things. |
| Yes | No | 4. I have trouble making up my mind. |
| Yes | No | 5. I have trouble sleeping the night before a big test. |
| Yes | No | 6. I worry a lot of the time. |
| Yes | No | 7. I worry about even small, unimportant exams. |
| Yes | No | 8. I am always kind. |
| Yes | No | 9. I feel someone will tell me I do things the wrong way. |
| Yes | No | 10. I always have good manners. |
| Yes | No | 11. No matter how much I study for an exam, it is not enough. |
| Yes | No | 12. Other people are happier than I. |
| Yes | No | 13. I worry about what other people think about me. |
| Yes | No | 14. Taking a test is harder on me than on most people. |
| Yes | No | 15. I worry about doing the right thing. |
| Yes | No | 16. I am always good. |
| Yes | No | 17. On most exams, I expect my score to be worse than it turns out to be. |
| Yes | No | 18. I worry about what is going to happen. |
| Yes | No | 19. I am often described as restless. |
| Yes | No | 20. It is hard for me to keep my mind on my schoolwork. |
| Yes | No | 21. I am always nice to everyone. |
| Yes | No | 22. My feelings get hurt easily when I am scolded. |
| Yes | No | 23. No matter how much I study for an exam, I am still nervous. |
| Yes | No | 24. I tell the truth every single time. |
| Yes | No | 25. I get nervous when things do not go the right way for me. |
| Yes | No | 26. I often get lonesome when I am with people. |
| Yes | No | 27. I hate taking tests. |
| Yes | No | 28. I never get angry. |
| Yes | No | 29. I worry about how well I am doing in school. |
| Yes | No | 30. I worry when I go to bed at night. |
| Yes | No | 31. I often feel sick before tests. |
| Yes | No | 32. I am nervous. |
| Yes | No | 33. Tests make me nervous. |
| Yes | No | 34. I often feel restless. |
| Yes | No | 35. I worry about the future. |
| Yes | No | 36. My muscles feel tense. |
| Yes | No | 37. After an exam, I worry until I learn my grade. |
| Yes | No | 38. I worry a lot about the past. |
| Yes | No | 39. I get nervous taking an exam, even if I am well prepared. |
| Yes | No | 40. I feel keyed up or on edge a lot. |
| Yes | No | 41. I always worry about a test or exam. |
| Yes | No | 42. I feel alone even when there are people with me. |
| Yes | No | 43. My feelings get hurt easily. |
| Yes | No | 44. Sometimes I worry about a test so much that I get a headache. |
| Yes | No | 45. My body often feels tense. |
| Yes | No | 46. I am tired a lot. |
| Yes | No | 47. I notice my heart beats very fast sometimes. |
| Yes | No | 48. I like everyone I know. |
| Yes | No | 49. Sometimes I worry about things that do not really matter. |
APPENDIX D: State and Trait Anxiety Index - Trait Subscale

State and Trait Anxiety Index - Trait Subscale (STAI-T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983)

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the most appropriate number to the right of the statement to indicate how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I feel pleasant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>I feel nervous and restless</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>I feel satisfied with myself</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>I wish I could be as happy as others seem to be</td>
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<td>5.</td>
<td>I feel like a failure</td>
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<td>6.</td>
<td>I feel rested</td>
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<td>7.</td>
<td>I am “calm cool and collected”</td>
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<td>8.</td>
<td>I feel that difficulties are piling up so that I can’t overcome them</td>
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<td>9.</td>
<td>I worry too much over something over something that really doesn’t matter</td>
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<td>10.</td>
<td>I am happy</td>
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<tr>
<td>11. I have disturbing thoughts</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
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<tr>
<td>12. I lack self-confidence</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>13. I feel secure</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<td>14. I make decisions easily</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<td>15. I feel inadequate</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>16. I am content</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>17. Some unimportant thought runs through my mind and bothers me</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>18. I take disappointments so keenly that I can’t put them out of my mind</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>19. I am a steady person</td>
<td>1</td>
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<tr>
<td>20. I get in a state of tension or turmoil as I think over my recent concerns and interests</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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</tbody>
</table>
APPENDIX E: Mindful Attention Awareness Scale

Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003).

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.

<table>
<thead>
<tr>
<th></th>
<th>almost always</th>
<th>very frequently</th>
<th>somewhat frequently</th>
<th>somewhat infrequently</th>
<th>very infrequently</th>
<th>almost never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I could be experiencing some emotion and not be conscious of it until some time later</td>
<td></td>
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<td>2</td>
<td>I break or spill things because of carelessness, not paying attention, or thinking of something else</td>
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<td>3</td>
<td>I find it difficult to stay focused on what’s happening in the present</td>
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<td>4</td>
<td>I tend to walk quickly to get where I’m going without paying attention to what I experience along the way</td>
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<td>5</td>
<td>I tend not to notice feelings of physical tension or discomfort until they really grab my attention</td>
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<td>6</td>
<td>I forget a person’s name almost as soon as I’ve been told it for the first time</td>
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<td>7</td>
<td>It seems I am “running on automatic” without much awareness of what I’m doing</td>
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<td>8</td>
<td>I rush through activities without being really attentive to them</td>
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<td>9</td>
<td>I get so focused on the goal I want to achieve that I lose touch with what I am doing right now to get there</td>
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<td>10</td>
<td>I do jobs or tasks automatically, without being aware of what I’m doing</td>
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<td>11</td>
<td>I find myself listening to someone with one ear, while doing something else at the same time</td>
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<td>12</td>
<td>I drive places on “automatic pilot” and then wonder why I went there</td>
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<td>13</td>
<td>I find myself preoccupied with the future or the past</td>
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<td>14</td>
<td>I find myself doing things without paying attention</td>
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<td>15</td>
<td>I snack without being aware that I’m eating</td>
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Theme B: Mindfulness in My Life

You can practice mindful attention in all of the moments of your day. As an experiment, select an activity as “your practice”: a simple daily activity that you choose to do mindfully on a regular basis. Pick one of these examples or come up with your own. Do this activity with awareness and interest; really “be there” for this simple activity. Try adding one new practice each week.

- Washing your face
- Going up and down stairs
- Washing dishes
- Getting dressed
- Getting or preparing a snack
- Eating breakfast
- Answering a phone call
- E-mailing
- Driving to a certain place
- Waiting at a red light
- Walking down a hallway
- Eating lunch
- Opening and closing your locker
- Walking a pet
- Washing your hands
- Texting
- Standing in line
- Waiting for a bus
- Listening to someone
- Brushing your teeth
- Other ___________________
Theme B: Tips to Take Away: Three-Minute Body Scan

You can do a short “Body Scan” at any time, especially if you notice that you’re feeling tense or anxious.

Try it:

• while seated in class
• before tests
• before athletic events
• before speaking in public
• before getting out of bed in the morning
• before falling asleep
• while standing in line
• during social events
• before an interview

How to do it:

1. Use your attention to find your breath in your body.

2. Starting from either your feet or your head, move your attention through your body and notice your experience. Scan for tension in your feet; lower back; stomach; shoulders; face, jaw, or forehead; or wherever you hold tension in your body.

3. As you scan each area, breathe into the area, releasing tension and bringing in new energy as you did in the “Body Scan.”

4. Expand your awareness to your entire body and feel the breath move from your head to your feet.
Theme R: Tips to Take Away: Dealing with Troubling Thoughts

Notice the thoughts that are arising in your mind.

Try the mindful approach:

1. Become aware of what your mind is doing: thinking. It’s generating thoughts. The thought is like a bubble that arises in the space of the mind. It’s just what the mind does.

2. Step back and examine the thought with curiosity. How loud or soft is it in your mind? How strong is it? How long does it last? Can you notice sensations in your body when the thought arises? Don’t try to push it out of your mind. Just observe.

3. Get in touch with your breath as you observe the thought. Remember, it’s just a thought. Don’t struggle with it, because that can make it stronger.

4. Watch the thought change in intensity. Return your full attention to your breath.
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