The Psychophysiology of Maladaptive Perfectionism and Mindfulness Meditation: An Investigation Using Heart Rate Variability

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ABSTRACT

Heart rate variability (HRV) is a vagal nerve-mediated biomarker of cardiac function used to investigate chronic illness, psychopathology, stress and, more recently, attention-regulation processes such as meditation. This study investigated HRV in relation to maladaptive perfectionism (MP), a stress-related personality factor, and mindfulness meditation (MM), a stress reduction practice expected to elevate HRV, and promote relaxation. Maladaptive perfectionists (MPs; *n* = 21) and controls (*n* = 39) were exposed to a lab-based assessment in which HRV was measured during (1) a 5-minute baseline resting phase (2) a 5-minute cognitive stress-induction phase, and (3) a post-stress phase. In the post-stress phase, participants were randomly assigned to a 10-minute audio-instructed MM condition or a 10-minute rest condition with an audio-description of MM. Analyses revealed a significant elevation in HRV during MM for controls but not for MPs. These results suggest that MM promotes cardiac relaxation following cognitive stress and that the perfectionist personality hinders relaxation likely because of influences that decrease cardiac vagal tone. The results are discussed in the context of developing psychophysiological models to advance therapeutic interventions for distressed populations.

Keywords: heart rate variability, mindfulness meditation, stress, maladaptive perfectionism, psychophysiology

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1.0 INTRODUCTION

Heart rate variability (HRV) describes the variation in beat-to-beat heart rate (HR) or the inter-beat intervals (i.e. heart period), and is a widely used biomarker for the coordinated activity of the sympathetic nervous system (SNS) and parasympathetic nervous system (PNS; Allen, Chambers, & Towers, 2007; Cacioppo, Tassinary, & Bernston, 2007; Karim, Hasan, & Ali, 2011). Two international committee reports have established the quantification and physiological processes implicated in HRV (Berntson et al., 1997; Force, 1996), and it has since been used in studies of cardiovascular disease (Chida & Steptoe, 2010; Kemp, Quintana, Felmingham, Matthews, & Jelinek, 2012; Stein & Kleiger, 1999), diabetes (Maser, Mitchell, Vinik, & Freeman, 2003), psychopathology (Lyonfields, Borkovec, & Thayer, 1995; Marano et al., 2009; Miu, Heilman, & Miclea, 2009; Thayer, Friedman, & Borkovec, 1996), emotion regulation (Quintana, Guastella, Outhred, Hickie, & Kemp, 2012), and acute stress (Fabes & Eisenberg, 1997; Pattyn, Migeotte, Neyt, den Nest, & Cluydts, 2010; Radespiel-Tröger, Rauh, Mahlke, Gottschalk, & Mück-Weymann, 2003). As cardiac and cardiovascular activation (e.g. elevated heart rate, increased blood pressure) commonly occur in response to psychological stress (i.e. threat appraisal, problem solving, decision-making, worrying), this involuntary process is primarily attributed to the autonomic nervous system (ANS; Fabes & Eisenberg, 1997; Taelman, Vandeput, Spaepen, & Huffel, 2009). Dysfunction of the cardiac response to psychological stress, such as exaggerated cardiac reactivity (to mild-moderate stressors) and prolonged cardiac activation (instead of return to resting state), are considered risk factors for cardiovascular disorder and psychiatric illness (Brosschot, Gerin, & Thayer, 2006; Verkuil, Brosschot, de Beurs, & Thayer, 2009). For the purposes of studying psychological stress factors that can contribute to cardiac dysfunction and psychopathology, as well as behavioural interventions to promote cardiac relaxation and mental health, HRV provides a useful index of stress reactivity and adaptation (Porges, 2011; Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012).

Many physical and mental illnesses can develop if there are maladaptive responses to stressors from one's environment (e.g. interpersonal conflicts, traumatic events, poverty, famine, etc.) and/or of the psychological kind (e.g. worry and anxiety, negative affectivity, medical and psychiatric emergencies, pain, etc.), particularly if these stressors occur chronically (Karademas, Karamvakalis, & Zarogiannos, 2009; McEwen, 2004). Accordingly, it is essential to study the physiological markers of psychological events that help identify the mechanisms underlying various stress-related pathologies (e.g. depression, anxiety, diabetes, hypertension, etc.). Due to extensive empirical evidence, parasympathetic activity—inferred by measures of HRV—has been proposed as a physiological concomitant of top down attention regulation (Applehans & Luecken, 2006). In this context, 'top down' attention regulation refers to an executive control function which involves recognition of relevant information (i.e. attentional engagement) combined with attentional disengagement from irrelevant information in the external and/or internal environments (Sarter, Givens, & Bruno, 2001; Thayer & Lane, 2000). Attention regulation deficiencies have been proposed as contributing factors to psychological stress responses, and can become so severe that they manifest in anxiety disorders (Sheppes, Luria, Fukuda, & Gross, 2013). As a result, practices that improve attention regulation are suggested to modulate the cardiac autonomic response and promote successful adaptation to stressful conditions. These assertions served as the basis for this thesis' focus on examining the relationship between a psychological stress factor (maladaptive perfectionistic responses to stress), a physiological response (sympathetic-parasympathetic activity), and an increasingly influential stress-reduction practice (mindfulness meditation). The following literature review begins with an account of the physiological mechanisms underlying HRV, then covers its use as a marker of psychophysiological responses, psychopathological risks, and stress-related illnesses. Next, there is exploration of the personality factor of maladaptive perfectionism, followed by a discussion of the evidential basis of mindfulness meditation. The review supports the present study's rationale and hypotheses. Section 3 describes the methods used in this project, including participant recruitment, data acquisition equipment, self-report measures, procedures, and statistical analysis. Results of this study are detailed in section 4, and section 5 discusses the study's clinical implications and limitations.

2.0 LITERATURE REVIEW

2.1 Heart Rate Variability Mechanisms & Measurement

The parasympathetic influence on the heart rate is mediated by the vagus nerve—a cranial nerve emerging from the medulla oblongata that extends through several branched connections to multiple internal organs and tissues enabling bidirectional communication with brain structures (Berntson et al., 1997; Cacioppo et al., 2007; Porges, 2011; Thayer, Hansen, Saus-Rose, & Johnsen, 2009). In the context of cardiac arousal, the vagal connection to the heart's sinoatrial (SA) node plays a key role (Figure 1). The cardiac stress response involves SNS activation wherein sympathetic nerve fibers release the excitatory neurotransmitters epinephrine and norepinephrine onto the heart's sinoatrial SA node that accelerate HR (Cacioppo, Tassinary, & Bernston, 2007; Karim, Hasan, & Ali, 2011; Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012). In the aftermath, a return to cardiac resting state requires the reinstatement of parasympathetic influence through vagal nerve activation and its associated release of acetylcholine—a neurotransmitter that inhibits the SA node and decelerates HR.

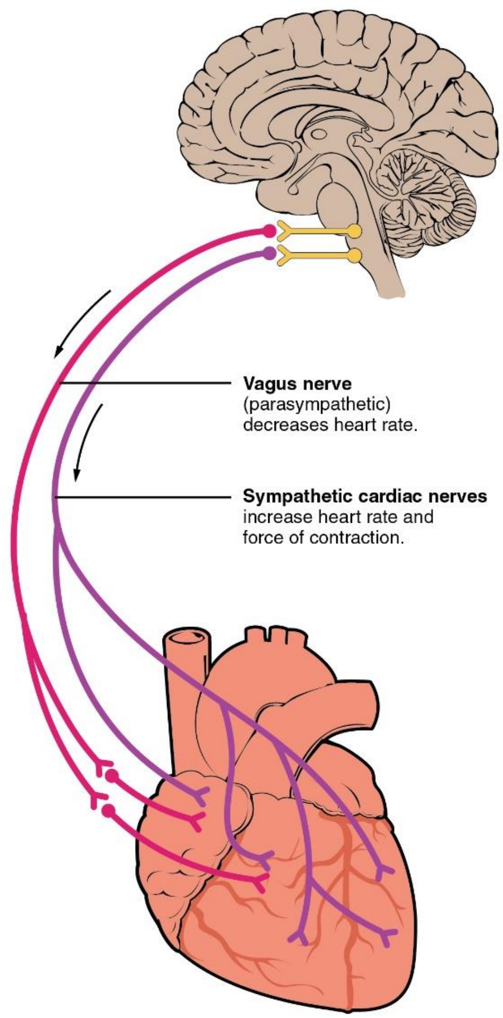

Figure 1. Autonomic nerve pathways to the heart. Image retrieved from the web (Academy, 2015)

The opposing influences of SNS and PNS on the heart manifest in beat-to-beat interval variations synchronized with the cycles of respiration (Allen et al., 2007; Clancy et al., 2014; Force, 1996). This pattern is referred to as respiratory sinus arrhythmia (RSA) and is characterized by a decrease in the beat-to-beat intervals during inhalation, and an increase in the beat-to-beat intervals during exhalation (Allen et al., 2007; Force, 1996). This is equated to increased HR (sympathetic activation) during inhalation, and decreased HR (parasympathetic activation) during exhalation (Grossman, Stemmler, & Meinhardt, 1990; Grossman & Taylor, 2007; Katona & Jih, 1975; Magagnin, Mauri, Cipresso, Mainardi, & Brown, 2013; Yasuma &

Hayano, 2004). This pattern is observable on an electrocardiograph (ECG) reading, as seen in Figure 2. Studies using pharmacological blockade techniques have consistently supported the notion of vagal-mediated HR changes on the basis of respiration. It has been shown that when cholinergic nerve pathways are blocked, there is a suppression of the RSA (Grossman, Stemmler, & Meinhardt, 1990; Katona & Jih, 1975; Yasuma & Hayano, 2004) while the same result does not occur with the same magnitude when adrenergic pathways are blocked (Clancy et al., 2014; Coker, Koziell, Oliver, & Smith, 1984; Houtveen, Rietveld, & de Geus, 2002). This difference suggests that high fluctuations of HR changes (at the frequency range of RSA) are primarily modulated by cholinergic (i.e. vagal) pathways. Thus, variations in HR during a specific time period (e.g. at rest, or during specific behavioural tasks and conditions) can be used to infer the activity of the vagus nerve, with greater HRV suggesting more parasympathetic (vagal) tone (Allen et al., 2007; Force, 1996; Grossman et al., 1990; Pattyn et al., 2010).

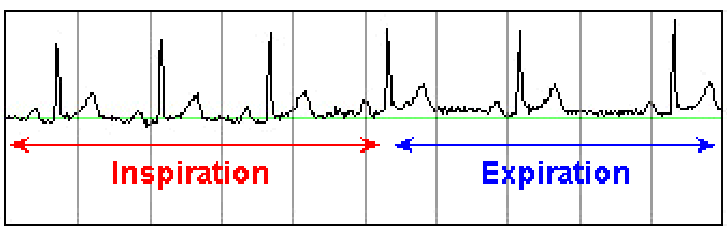

Figure 2. Respiratory Sinus Arrhythmia Observed on an Electrocardiograph. Image retrieved from the web (Skills, 2015)

There are several metrics that quantify HRV, the majority of which are either time-based or frequency-based. In terms of time-based metrics, there are indicators of the overall level of variability in an ECG recording series (which collect the time length of each beat-to-beat interval). With the beat-to-beat interval series (also referred to as the R-R series), one can estimate the variance of the interbeat intervals (IBI) and their standard deviation (SDNN) (Allen et al., 2007; G. G. Berntson et al., 1997). It is important to note that both the IBI and SDNN are subject to increases with longer ECG recordings (influenced by slower, long range fluctuations in HR independent of the beat-to-beat changes) (Ewing et al., 1981). Thus, the Task Force (1996) has recommended 5 minutes as a standardized length of HRV assessment in clinical and psychophysiological research. In terms of delineating respiratory-linked changes in HR, one can compute the percentage of the absolute differences between consecutive IBIs that are greater than 50 ms (pnn50; Mietus, Peng, Henry, Goldsmith, & Goldberger, 2002). Additional respiratory-linked time domain measures include the mean of the absolute value of the difference between successive interbeat intervals (MSD), and the square root of the mean of squared successive differences between interbeat intervals (RMSSD; Berntson, Lozano, & Chen, 2005; Kleiger et al., 1991). These measures have been found to be better correlated with respiration based HR changes (Berntson et al., 1997), and thus more indicative of the vagal influence on HR fluctuations.

Using the frequency domain measure, one can examine the extent to which the HR varies within specific frequency ranges. The Fourier transform method deconstructs the time domain representation of the R-R series and computes a measure of 'power' in several frequency bands in units of milliseconds squared (ms^2). These bands include ultra-low frequency (< 0.04 Hz), low frequency (LF; 0.04–0.15 Hz), and high frequency (HF; 0.15–0.4 Hz). Typically, the frequency band of interest for the purposes of HRV interpretation is the HF band, as this is where the respiratory-linked beat-to-beat changes are reflected (Allen et al., 2007; Berntson et al., 1997; Cacioppo et al., 2007; Force, 1996). While this is not intended to be an exhaustive account of HRV metrics, the aforementioned measures are the most commonly used in studies of vagal influence on cardiac chronotropy. Based on the recommendations by the two international committees (Berntson et al, 1997; Force, 1996), the present study focused on the frequency measure to interpret changes in vagal-mediated HRV across different conditions.

2.2 Psychophysiological Models of Heart Rate Variability

Two major theories on ANS function have been developed to account for the empirical evidence of the relationship between HRV and various states and illnesses. Porges has proposed a ‘polyvagal theory’ to describe how adaptive social functions (e.g., threat recognition, vocalization, and nonverbal communication) are modulated by vagal tone (Porges, Doussard-Roosevelt, & Maiti, 1994; Porges, 1998; Porges, 2011). The theory states that a healthy vagal connection is one that can appropriately exert or withdraw its neuroinhibitive transmission, thereby enabling individuals to flexibly engage and disengage with environmental or psychological stimuli. The key feature of this connection is its speed. This reflects the ability of the myelinated vagus, which emerges from the brainstem, to rapidly impart its influence on areas that regulate the head and facial muscles (and are involved in speech generation and recognition) and the SA node that triggers heartbeat (Porges, 1995; Porges, 2011). From an evolutionary standpoint, the polyvagal theory offers an understanding of the most recently developed human ‘social engagement’ system. Accordingly, stress is defined as a disruption of homeostasis which results in a reduction of vagal tone, which explains why SNS activation occurs in the midst of challenging social and psychological experiences (Porges, 1992; Porges, 1995). Cross-sectional research has found associations between vagal tone and self-regulatory behaviours such as impulse control, positive self-talk, and social support seeking (Geisler, Kubiak, Siewert, & Weber, 2013). In the second part of this study, it was found that vagal tone predicted less use of maladaptive coping strategies and more use of socially-adaptive coping strategies. This corresponds to a similar finding by Segerstrom and Nes (2007) on the impact of vagal tone on the capacity for emotional self-regulation in a decision-making context. In their study, self-regulation was experimentally manipulated as conditions in which participants had to either refrain from eating cookies and only eat carrots (high self-regulation), or eat cookies and resist carrots (low self-regulation). Greater HRV was found in the high self-regulation condition. However, in the subsequent task performance of solving an 'unsolvable' anagram, the group previously exposed to the high self-regulation condition showed less persistence (operationalized as time before voluntarily giving up on the task) than those subjects previously exposed to the low self-regulation condition (Segerstrom & Nes, 2007). This finding was interpreted as demonstrating the role of vagal tone in adapting to a stressful condition, particularly since it showed a likely fatigue factor related to self-regulatory effort, i.e. the group who had to *first* engage in high self-regulation were then unable to continue to operate in a high self-regulation manner when exposed to a second context that required it. In this respect, resting state HRV (oftentimes referred to as tonic vagal tone) has the potential to reflect the range of influence that can be exerted by the vagus nerve in modulating parasympathetic activation to the heart. On the other hand, phasic vagal tone (i.e. under conditions requiring some capacity of self-regulation) demonstrates the ability to engage or disengage with stimuli. While some research based on the polyvagal theory shows evidence of the relationship between HRV and sustained attention (Hickey, Suess, Newlin, Spurgeon, & Porges, 1995; Suess, Porges, & Plude, 1994), more experimental evidence has emerged for the neurophysiological concomitants of attention regulation.

According to the 'neurovisceral integration' theory developed by Thayer and colleagues (Friedman, 2007; Thayer et al., 2012; Thayer, Hansen, Saus-Rose, & Johnsen, 2009; Thayer & Lane, 2000), processes of emotion, cognition, and related physiological responses emerge from a subsystem of brain networks that can be indexed by HRV. This system is called the 'central autonomic network' (CAN), which functions as a neurophysiological response center that exerts inhibitory control through inputs from prefrontal brain regions to the brainstem (where the myelinated vagus nerve is located). For instance, it has been observed via neuroimaging analysis that the prefrontal cortex activity associated with HRV changes are interacting with regions involved in emotional response (amygdala) and reflect emotional regulation (specifically in the ventromedial prefrontal cortex) (Thayer et al., 2012). Under these circumstances, the CAN regulates emotional responding, as reflected in the duration and magnitude of cardiac activation when threat appraisals are made. Individual differences in attentional engagement to threatening stimuli have been explored in behavioural experiments that divide participants according to high or low resting (tonic) vagal tone. One study used a selective attention task where participants had to identify a specific letter superimposed on either fearful or neutral facial expressions. Results showed higher tonic HRV was associated with significant HRV increases during the fearful face conditions, while lower tonic HRV correlated with phasic HRV decreases (non-significant) irrespective of facial expression (Park, Vasey, Van Bavel, & Thayer, 2014). This suggests that higher resting HRV predicts the capacity for HRV enhancement when more processing is required (selective attention task with a fearful face instead of neutral face). In a similar study, participants (N = 32, all female) were instructed to perform an emotional spatial cueing task where they had to indicate the area in which a target symbol appeared after fearful and neutral faces of low and high spatial frequency were shown at opposite sides of a screen. Results showed that participants with low tonic HRV were quicker in attending to low spatial frequency fearful faces compared to participants with high tonic HRV (Park, Van Bavel, Vasey, & Thayer, 2013). This was taken to indicate that low vagal tone may be related to a negative information bias. In a second experiment, the authors found that participants with low HRV, as expected, were slower to disengage from high spatial frequency fearful faces (Park et al., 2013). While both the neurovisceral integration model and polyvagal theory offer accounts of how attention and emotion regulation processes are reflected in HRV, the former focuses on the neuroanatomical links between the ANS and brain regions, while the latter describes the neural connections between the vagus nerve and peripheral structures involved in social engagement (e.g., the muscles of the face and head). Ultimately, both theories converge in the notion that neuroinhibitive influences on autonomic arousal are healthier when flexibly modulated by the parasympathetic vagus nerve to generate attentional, emotional, and physiological functions in a stressful context. By applying the theoretical principles in these models, researchers have investigated vagal functioning in individuals in a mental health context and contributed substantial supporting evidence to these models.

2.3 Heart Rate Variability as a Marker of Psychopathological Risk

The HRV literature has consistently found evidence for the relationship between parasympathetic tone and psychopathologies such as depression and anxiety. Depressed mood has been explored through its association with cardiac risk given that major depressive disorder (MDD) substantially increases the risk of cardiac mortality (Barth, Schumacher, & Herrmann-Lingen, 2004; Nicholson, Kuper, & Hemingway, 2006; Penninx, Beekman, Honig, Deeg, & Schoevers, 2001; Whang, Kubzansky, Kawachi, Resrode, & Kroenke, 2009). A study grouped participants (N = 53) on the basis of high or low depressed mood and executed a protocol involving a stressful speech delivery task and a forehead cold pressor task. It was found that highly depressed mood was related to a greater degree of HRV reduction during the stress task and smaller degrees of HRV increase during the pressor task (Hughes & Stoney, 2000). Further, resting state HRV assessment has revealed individuals with MDD to exhibit lowered HRV in comparison to controls, while individuals with comorbid MDD and generalized anxiety disorder

(GAD) showed even lower baseline HRV levels (Kemp et al., 2012). The literature on anxiety disorders is even more extensive and consistent. Pittig et al. (2013) observed individuals with panic disorder, social anxiety, obsessive-compulsive disorder, and GAD during a resting state and a relaxation period. All conditions were associated with reduced high frequency HRV relative to controls, and these reductions were maintained during the relaxation period, supporting the notion of chronically reduced vagal tone in stress-related conditions (Pittig, Arch, Lam, & Craske, 2013). Thayer and colleagues have also found individuals with GAD to exhibit deficits in vagal tone during conditions of relaxation (Thayer et al., 1996) and while exposed to worry-inducing stimuli (Lyonfields et al., 1995). The consistent pattern that participants with anxiety conditions showed minimal phasic differences in HRV across experimental tasks, i.e. relaxation or stress, is noteworthy as it supports the relationship between persistently reduced vagal tone and psychopathology.

2.4 Heart Rate Variability as a Marker of Stress-Related Illnesses

Individual differences in stress reactivity (varying by intensity and duration) are considered to contribute to a range of somatic illnesses. Stressors that activate the SNS to a greater degree and for longer durations can amplify the detrimental effects of the physiological stress response. For instance, heightened cardiovascular responses can lead to hypertension (Turner, Sherwood, & Light, 1991), while prolonged cardiac arousal can lead to dysregulation of the ANS (Berntson et al., 1994). Among the earliest psychophysiological theories in this area, the ‘cardiovascular reactivity hypothesis’, states that greater physiological response to behavioural stressors is a risk factor for developing hypertension (Blascovich & Edward, 1993). Moreover, more evidence has emerged for the tendency for individuals to remain ‘stuck’ in a stress response (i.e. the sympathetic dominant “fight or flight” mode) while not actually exposed to a current stressor. Thayer and colleagues (2006 & 2010) have proposed the 'perseverative cognition' model to explain the contribution of psychological stress to the development of chronic disease. In the term 'perseverative cognitions' (PC), 'perseverative' refers to repetition, and the concept encapsulates anticipatory worry (future-oriented) about a stressful event, and/or rumination (past-oriented) after undergoing a stressful experience. Thus, a PC is defined as a thought process unit containing stress-related information about a stressor that either has occurred in the past or is expected in the future. An individual prone to PCs experiences chronic activation of stress-related physiological responses that would normally be activated in the presence of a current stressor (Brosschot et al., 2006; Verkuil et al., 2009; Verkuil, Brosschot, Gebhardt, & Thayer, 2010).

This pattern has been supported by both short and long-term ambulatory monitoring studies investigating the cardiac stress response to worry and rumination (Brosschot, Dijk, & Thayer, 2007; Brosschot & Thayer, 2003; Glynn, 2002; Pieper, Brosschot, van der Leeden, & Thayer, 2007, 2010; Verkuil et al., 2009). In a study on HR and emotions, healthy subjects (N = 33) were assessed by ambulatory monitoring and self-reports (stating the degree of their positive or negative emotional state) every hour for an 8-hour period. It was found that self-reports of negative emotions were associated with prolonged periods of HR increase, while the same effect was not found for positive emotions (Brosschot & Thayer, 2003). This suggests that negative emotions have a more persistent, longer term cardiac activation effect. A similarly designed study used HRV as an outcome variable and asked participants (N =52) to use an hourly diary to report their stressors as well as the frequency and duration of worry episodes for a full day. Analyses of ambulatory data revealed reduced HRV (and increased HR's) during periods where participants reported stressors and worry episodes, and this cardiac pattern extended into the sleeping period (Brosschot et al., 2007). Naturally, parasympathetic activity is subdued in times of psychological stress in favor of sympathetic activity to generate physical and mental energy expenditure. However, there appears to be a cost associated with this if individuals who experience PCs needlessly remain in a stress arousal state, and deplete their physiological resources to the extent of becoming vulnerable to a somatic disease. Taken together with section 2.2, reduced HRV is not only found in in psychiatric illnesses but also somatic illness such as cardiovascular disease (Chida & Steptoe, 2010; Kemp et al., 2012; Stein & Kleiger, 1999), diabetes (Maser et al., 2003), and chronic pain conditions (Heiden, Barnekow-Bergkvist, Nakata, & Lyskov, 2005; Koenig, Jarczok, Ellis, Hillecke, & Thayer, 2013),. Thus, there is increasing interest concerning the study of stress-related psychological factors and determining what risks they might pose to this pathogenic process.

2.5 Maladaptive Perfectionism

In recent years, there has been increased attention on the perfectionist personality and its impact on mental health and stress coping. Maladaptive perfectionism (MP) is characterized by the setting of excessively high standards and evaluating oneself in a harsh, self-critical manner when facing the perception of failure (Burns, 1980; Frost, Marten, Lahart, & Rosenblate, 1990). Perfectionists tend to overgeneralize cases of failure, and base their self-identity on accomplishing extreme goals (Blatt, 1995; Burns, 1980). These tendencies have been found to increase psychopathological risks, as MP has been associated with vulnerability to anxiety (Antony, Purdon, Huta, & Swinson, 1998; Saboonchi & Lundh, 1997), eating disorders (Fairburn, Shafran, & Cooper, 1999; Shafran, Cooper, & Fairburn, 2002), and depressive disorders (Blatt, 1995; Flett, Hewitt, Blankenstein, & Mosher, 1995; Hewitt & Flett, 1993).

Perfectionist motivations stem from a strong desire to avoid negative outcomes, which is linked to the excessive anticipation of future stressors and potential failures.

Estimates of the prevalence of mental health problems suggest nearly 30% of university students experience significant levels of depressive distress and anxiety symptoms (Adlaf, Gliksman, Demers, & Newton-Taylor, 2001; Eisenberg, Gollust, Golberstein, & Hefner, 2007). As university attendance represents a period of adjustment and coping with new academic, interpersonal, and financial demands, much of this distress can be considered normative (Abouserie, 1994; Archer & Lamnin, 1985). In a better effort to understand the source of this distress, there have been several attempts to determine and further assess personality factors (e.g. perfectionism) that increase vulnerability to chronic stress. Evidence of high prevalence of perfectionist behaviour in post-secondary settings can be explained given frequent exposure to performance-based stressors such as exams and assignments that inadvertently promote and, at times, reward such behaviours (Hayward & Arthur, 1998; Kearns, Forbes, Gardiner, & Marshall, 2008).

Over the years, perfectionism has been closely investigated for its multidimensional features to determine a range of perfectionistic cognitions and behaviours. These features include heightened concerns over mistakes, doubt in the quality of one's actions, perceptions of high parental expectation and criticism paired with high personal standards, and desire for organization (Frost et al., 1990). A different multidimensional framework of perfectionism describes self-oriented, other-oriented, and socially-prescribed categories that perfectionists may fall into depending on the nature of one's perceptions (Hewitt & Flett, 1991). Self-oriented perfectionism is primarily concerned with performance-oriented cognitions directed towards the self (e.g. having unrealistic standards and self-criticism), socially prescribed perfectionism accounts for perceived perfectionistic expectations from others, while other-oriented perfectionism prevails when one expects perfection from others. Despite the research emphasis on Maladaptive Perfectionism, some facets of perfectionistic behaviour are seen as representing conscientious, goal-driven functioning (Bieling, Israeli, & Anthony, 2004; Enns, Cox, & Clara, 2002) that contribute to a relatively healthy achievement-orientation. Specifically, while perfectionists are negatively motivated to avoid failure and exhibit self-punitive tendencies, adaptive perfectionists are motivated by accomplishments in their pursuit of excellence (Burns, 1980). This distinction between adaptive and maladaptive perfectionism is interesting in light of what is known about cognitive stressors and subsequent coping behaviours.

Although perfectionism can be considered adaptive as a healthy and goal-driven pursuit of excellence, failure in reaching one's expectations can provoke self-criticism, disappointment in cases of perceived failure, and can also impede successful adjustment to one's environment whether a workplace or academic setting. The key difference between the adaptive and maladaptive perfectionist is that the former individuals retain their motivations while accepting imperfections and performance setbacks, while the latter individuals are quicker to make harsh self-judgments, fixate on negative aspects of their performance, and generalize experiences of failure. Individuals affected by MP are also prone to procrastination (Kearns et al., 2008) due to persistent fears of failure and consequent attempts to avoid negative social evaluation (Fee & Tangney, 2001).

2.6 Deconstructing & Treating Maladaptive Perfectionism

Building on previous perfectionism investigations (Arpin-Cribbie et al., 2012), a recent study described a theoretical framework of relationships between perfectionism, distress, and anxious-depressive symptoms; negative automatic thoughts (NATs) and anxiety sensitivity (AS)

(Pirbaglou et al., 2013). NATs are self-critical cognitions pertaining to a loss of mastery and personal failings, while anxiety sensitivity emerges from sensitivity to somatic feelings of anxiety, which elicits a desire to avoid anxiety by perfecting one's performance (Ellis, 2002). In terms of the relationship between perfectionism and depressive symptoms, NATs are characterized as spontaneous, transient cognitions emerging from individual core beliefs and reflecting biased and distorted interpretations of one's reality (Beck, 2011). These negative cognitions occur in both asymptomatic and depressed individuals, varying in frequency and intensity (Kumari & Blackburn, 1992). From a cognitive-behavioural therapy (CBT) perspective, NATs should be the primary targets of modification as they reflect distorted appraisals that constitute maladaptive cognitive-behavioural responses (Beck, 2011).

Research has found that perfectionism is associated with depressive symptoms in cases where (a) the individual reacts self-critically to subpar performance (Powers, Zuroff, & Topciu, 2003), (b) the individual bases their self-worth on successfully satisfying one's standards (Sturman, Flett, Hewitt, & Rudolph, 2009), and/or when (c) harsh parental criticisms have been internalized (Burns, 1980). Based on these criteria, NATs appear to represent a source of perfectionistic distress and are distinct from purely aspirational and adaptive perfectionistic cognitions. Most importantly, NATs appear to mediate the relationship between perfectionism and depressive symptoms (Pirbaglou et al, 2013). The other mediating pathway between perfectionism and distress involves anxiety sensitivity; the fear of anxiety stemming from beliefs about harmful physical consequences and potential anxiety-based negative social evaluations (McNally, 1999; Reiss, Peterson, Gursky, & McNally, 1986). Anxiety-sensitive individuals exhibit a pronounced, fear-driven reaction to what are normal physical and mental anxiety sensations, and thereby have elevated risks of panic attacks (Maller & Reiss, 1992) and anxiety disorder (McNally, 1999; Schmidt, Lerew, & Joiner, 1998). Fears of failure, shame, and embarrassment have also been consistently found to be important characteristics of perfectionism (Sagar & Stoeber, 2009), adding to the sources of stress in social situations. Given the links between perfectionists and anxiety sensitivity, perfectionists tend to cope with the stress of experiencing anxiety sensations by attempting to perform perfectly. According to the cognitive panic perspective (Clark, 1986), panic arises when a perceived threat is met with apprehension and misinterpretation of normal anxiety sensations resulting in an exacerbation of the stress response. Therefore, it appears likely that this pattern could be observed when perfectionistic cognitions (emphasizing excellent performance) are combined with anxiety sensitivity, resulting in debilitating anxiety outcomes.

To further investigate how anxiety sensitivity increases the risk factor for panic attacks and anxiety disorders, Taylor et al. conducted a principal component analysis of the Anxiety Sensitivity Scale (ASI) and found a 3 factor model that included: (a) fear of publicly observable symptoms (b) fear of loss of cognitive control, and (c) fear of bodily sensations. An interesting distinction was found between anxious patients and those with symptomatic depression. Fears of publicly exposed symptoms and bodily sensations were elevated across anxious patients, whereas patients with symptomatic depression were primarily characterized by the fear of losing cognitive control (Taylor et al., 1996). Examples of fear of losing cognitive control may relate to one's attention (lack of focus on a task), emotions (when emotional expression becomes frequent), mental stability (when experiencing perpetual nervousness). Converging research by Flett et al. (2007) has also shown that perfectionistic cognitions are more strongly associated with the fear of losing cognitive control. Therefore, anxiety sensitivity, or more specifically, the fear of losing cognitive control, may act as a non-specific risk factor for both anxiety and depressive symptoms (Schmidt et al., 1998). Therefore, current research suggests that fear of losing cognitive control can theoretically mediate the relationship between perfectionism and depressive symptoms, particularly in light of the identified hypersensitivity of perfectionists to evaluative contexts and negative interpersonal feedback (Conroy, Kaye, & Fifer, 2007; Frost et al., 1990).

In considering the background of HRV described in sections 2.2—2.4, it appears that the theoretical account of maladaptive perfectionism overlaps with some aspects of the perseverative cognitions hypothesis. Specific PCs, i.e. worry and rumination, have been suggested to produce health detriments including frequently prolonged elevations in HR and decreases in HRV (Brosschot et al. 2006) due to perpetual cognitive representations of stressors that evoke anxious bodily reactions. Perfectionist cognitions can be considered a type of PC as they are often related to concerns about the future or rumination about the past without current exposures to the stressors themselves. Taken together, these findings support the hypothesis that MPs, who are known to engage in a higher frequency of perseverative cognitions, have a decrease in HRV during and after stressors that elicit perceptions of failure and unrealistic performance standards. If this is the case, there must be additional consideration paid to the type of psychological intervention that produces the most benefit for MPs so as to alleviate their stress-related vulnerabilities.

To this end**,** there is a paucity of research on stress-regulation practices that target maladaptive perfectionism and also promote cardiac relaxation (evident through HRV increases). Recent theoretical and empirical developments suggest perfectionism and perseverative cognitions can be reduced by cognitive-behavioural therapy (CBT) and mindfulness meditation (Delgado et al., 2010; Masuda & Tully, 2012; Nyklíček, Mommersteeg, Van Beugen, Ramakers,

& Van Boxtel, 2013). Two recent randomized controlled-trial (RCT) of a CBT-mindfulness intervention for MPs revealed significant reductions in anxiety sensitivity and negative automatic thoughts (Radhu, Daskalakis, Arpin-Cribbie, Irvine, & Ritvo, 2012; Arpin-Cribbie, Irvine, & Ritvo, 2012). These trials follow the longstanding tradition of utilizing cognitive therapy techniques to reduce psychological distress and anxiety-depression symptoms. It is particularly noteworthy that the former RCT (Radhu, Daskalakis, Guglietti, et al., 2012) resulted in post-intervention improvements in cortical inhibition—a neurophysiological mechanism associated therapy-related improvements and mindfulness meditation (Guglietti, Daskalakis, Radhu, Fitzgerald, & Ritvo, 2013; Radhu, Daskalakis, Arpin-Cribbie, Irvine, & Ritvo, 2012; Radhu, Daskalakis, Guglietti, et al., 2012). This lends credence to the approach of studying this personality factor through physiological variables known to differentiate between pathological states (and vulnerabilities) and well-being. The aforementioned RCT intervention also involved a mindfulness meditation training component, suggesting this stress reduction practice can be of help to MP populations. Cross-sectional research (N = 141 inpatients of clinical depression) has found mindful awareness to be a mediator of the positive relationship between maladaptive perfectionism and depression severity (Argus & Thompson, 2007). Other correlational research has found that while worry and rumination mediate the relationship between perfectionism and negative affect, the mediating effect of rumination is reduced in a subset high in mindfulness (Short & Mazmanian, 2013). Given the importance of mindfulness to current psychotherapeutic approaches, more understanding and evidence is needed for how mindfulness training can assist individuals modulate their psychophysiological stress response.

2.7 Mindfulness Meditation

Mindfulness meditation (MM) is an element of the Buddhist traditions first introduced as a clinical intervention in the West by Jon Kabat-Zinn (1982). The practice has received significant interest in clinical and health psychology, neurophysiology, and, more recently, psychophysiology in the past few decades. Mindfulness is conceptualized as a family of techniques that emphasize purposeful and nonjudgmental awareness of present moment experiences i.e. cognitions, emotions, physical sensations, and external stimuli (Didonna, 2009; Levinson, Stoll, Kindy, Merry, & Davidson, 2014; Lutz, Slagter, Dunne, & Davidson, 2008). Seated MM is a common form of practice that putatively generates a relaxation effect through a combination of focal attention on one's breathing sensations and the simple acceptance of immediate experiences (Brown & Ryan, 2003; Carmody, Reed, Kristeller, & Merriam, 2008; Didonna, 2009; Teper & Inzlicht, 2013). As a clinical treatment, MM studies have reported positive changes in cognitive function (Chiesa, Calati, & Serretti, 2011; Ramel, Goldin, Carmona, & Mcquaid, 2004; Sedlmeier et al., 2012), attention (Anderson, Lau, Segal, & Bishop, 2007; Frewen, Lundberg, MacKinley, & Wrath, 2011; Levinson et al., 2014; Lutz et al., 2008; Tang et al., 2007) and emotion regulation (Lutz et al., 2008; Shapiro, Brown, & Biegel, 2007; Young & Baime, 2010), as well as reductions in chronic stress (Mankus, Aldao, Kerns, Mayville, & Mennin, 2013; Ritvo et al., 2013). Regular meditation practice is considered to alleviate psychological distress, e.g. worry and rumination, by encouraging sustained awareness of the present time-frame in contrast to past or future events, as well as non-reactivity to 'inner' experiences (Brown & Ryan, 2003; Grossman, Heidenreich, & Michalak, 2004; Masuda & Tully, 2012). As an intervention for cardiovascular diseases, there is promising evidence for the effectiveness of mindfulness-based programs that typically take the form of 8-week structured sessions involving a combination of mindfulness education and formal MM training. A meta-analysis by Abbott et al. (2014) reviewed 9 studies (n = 578) providing mindfulness-based stress reduction or mindfulness-based cognitive therapy to individuals diagnosed with (pre) hypertension, type I or II diabetes, heart disease, and stroke. Analyses revealed significant decreases in stress ($p = .01$), depression ($p = .003$), and anxiety ($p < .001$) but inconsistent results for physiological variables such as blood pressure and stress hormones (Abbott et al., 2014). While the relationship between MM practice and cardiovascular disease management has not been established through observable physical changes, there appears to be important linkages to psychological variables of stress, depression, and anxiety. Interestingly, since MM's original conception as a psychological intervention, substantial literature has emerged on the relationship between mindfulness and various physiological processes. A diverse array of studies have reported that MM's benefits can be evidenced through changes in neural oscillations (Ahani et al., 2014; Chiesa & Serretti, 2010), cortical activity (Berkovich-Ohana, Glicksohn, & Goldstein, 2012; Brewer et al., 2011), cortical plasticity (Hölzel et al., 2011; Lazar et al., 2006), cell aging (Epel et al., 2012; Jacobs et al., 2011; Schutte & Malouff, 2014), and cardiovascular activity (Ditto, Eclache, & Goldman, 2006; Nyklíček et al., 2013). The next section provides an overview of the emerging research on MM and the modulation of the stress response by way of cardiac relaxation.

2.8 Mindfulness Meditation for Cardiac Relaxation

According to the aforementioned 'perseverative cognition' hypothesis (Brosschot et al., 2006; Brosschot, 2010; Verkuil et al., 2009, 2010), persistent cardiac activity can occur despite the absence of stress cues in one's environment, which reflects deficits in parasympathetic (vagal) tone that, under normal circumstances, enables cardiac relaxation. Without sufficient vagal tone, exhaustion of ANS function can be a pathway to cardiovascular disease (Haensel, Mills, Nelesen, Ziegler, & Dimsdale, 2008; Kemp et al., 2012) and to chronic anxious-depressive conditions (Brosschot et al., 2006). Conversely, a growing literature associates increased HRV with enhanced attention-regulation and stress adaptation (Chida & Steptoe, 2010; Segerstrom & Nes, 2007; Thayer, Hansen, Saus-Rose, & Johnsen, 2009). There is convergent evidence that practice of various meditation forms results in HRV enhancement (Burg & Wolf, 2012; Krygier et al., 2013; Lisa, 2002; Phongsuphap, Pongsupap, Chandanamattha, & Lursinsap, 2008). As described in section 2.7, MM can be conceptualized as an attention regulation technique that promotes an awareness of present moment experiences in order to improve adaptation to stress. Indeed, researchers have begun to investigate cardiac activity during MM and have found HRV beyond what is observed in a resting state (Burg & Wolf, 2012; Krygier et al., 2013; Libby, Worhunsky, Pilver, & Brewer, 2012). In other words, MM practice might allow individuals to enter a state of relaxation that can be evidenced through greater vagal activation. In a recent investigation measuring HRV during meditation after participants had attended a 10-day Vipassana meditation retreat, Krygier and colleagues (2013) found a significant increase in high frequency HRV during mindfulness meditation compared to resting baseline with a large effect size. Prior to this, Burg and colleagues (2012) found that the ability to maintain attention on one's breathing, as assessed by a mindful breathing exercise, was related to elevated HRV. To date, there has not been an investigation of HRV during MM immediately after a stressful period. It is arguable that it is in the post-stress period where the perseverative stress response is most influential (Brosschot et al., 2006; Verkuil et al., 2009, 2010), as this is where worry, ruminative thoughts, and/or excessive cardiac activity can occur in relation to a stressor previously experienced. Thus, it is important to determine whether MM practice results in enhanced HRV following a stressful condition, supporting its effectiveness as a coping method to promote cardiac relaxation. Collectively, evidence suggests that varied cardiac relaxation capabilities after stressful conditions are mediated by the effective practice of attention regulation activities by healthy populations. In considering this, there is also the likelihood that mindfulness and maladaptive perfectionism are conflicting psychological factors that might manifest in initial difficulties for MP's being able to practice MM after becoming distressed, especially if inexperienced with the practice. The purpose of the present study was to investigate whether MM practice results in enhanced HRV following a stressful period, and whether these effects are observable in maladaptive perfectionists.

2.9 Hypotheses

The present study assessed a sample of maladaptive perfectionists (MPs) and a control group on their vagal tone during stress and relaxation conditions. A three-phase protocol involved HRV measurement (primary outcome) during a baseline rest phase, a stress-induction phase, and a post-stress phase in which participants were randomized to a brief audio-guided MM condition or a resting condition consisting of an audio description of MM. The following hypotheses were tested:

1. Phase 2 (stress phase) HRV would be significantly lower than Phase 1 (baseline) HRV for all participants.
2. MPs would exhibit lower HRV than Controls in Phase 2 (stress phase) as well as a significant reduction from Phase 1 (baseline).
3. Control participants assigned to the MM condition would exhibit increases in HRV from Phase 2 (stress phase) to Phase 3 (MM).
4. Controls, but not MPs, would exhibit greater HRV in post-stress phases during the MM condition compared to rest.

3.0 METHODS

3.1 Participants

This study was conducted at a large public university and recruited undergraduate students of all years of study and majors through an online system of research participation which grants course credit.

Exclusion criteria included a history or current diagnosis of any anxiety disorder and/or major depressive disorder and cardiovascular disease (hypertension, coronary artery disease, and arrhythmias) as these conditions are known to involve ANS dysfunction (Chalmers, Quintana, Abbott, & Kemp, 2014; Haensel et al., 2008; Kemp et al., 2012; Marano et al., 2009; Miu et al., 2009). Participants were excluded if they had a history of practicing MM or even minimal exposure to MM (> 60 minutes). There were no risks associated with participation in this study.

3.2 Sample Size Estimation

Based on a review of the literature, changes in HRV during MM have been reported to range between medium (Burg & Wolf, 2012; Takahashi et al., 2005) and large effect sizes (Krygier et al., 2013). Given $\alpha = .05$ and the employment of multivariate statistical tests to study within-subject HRV changes during MM, it was estimated that a total sample size of 40 participants would provide acceptable power (0.80) to assess a medium effect size (partial eta squared > 0.06), and excellent power (0.95) for detecting a large effect size (partial eta squared > 0.14).

3.3 Screening Method

The Perfectionism Cognitions Inventory (PCI) assesses the frequency of automatic thoughts with perfectionist themes that highlight the discrepancy between one’s current and ideal self (Flett, Hewitt, Whelan, & Martin, 2007; Flett et al., 1998; Flett et al., 2011). Participants are asked to indicate how often they experienced perfectionistic thoughts (e.g. “I should never make the same mistake twice” and “I must be efficient at all times”) in the previous week on a 5-point Likert scale. The PCI has demonstrated adequate validity and reliability and correlational analyses have revealed strong associations with trait perfectionism, psychological distress, and depressive-anxious symptoms (Flett et al., 2007; Flett et al., 2011; Pirbaglou et al., 2013). Furthermore, there has been no gender difference in mean PCI scores found (Flett et al., 1998).

The current study utilized the procedure used in two previous RCT’s (Arpin-Cribbie et al., 2012; Radhu, Daskalakis, Guglietti, et al., 2012) to screen for maladaptive perfectionism. The MP group consisted of participants with PCI scores falling at or above 66, which represents the value lying one standard deviation above the established mean of the PCI, and thus, reflects an extreme degree of perfectionist thinking (Arpin-Cribbie et al., 2008). The Control group consisted of all eligible participants whose scores fell below the cut-off of 66. The alpha coefficient value for the PCI in this study indicated excellent internal consistency ($\alpha = .96$). An additional perfectionism measures was obtained using the Multidimensional Perfectionism Scale (MPS), containing the factor of self-oriented perfectionism (Hewitt, Flett, Turnbull-Donovan, & Mikail, 1991).

3.2 Materials

3.2.1 Heart Rate Variability Data Collection & Analyses

Electrocardiogram (ECG) recordings were collected using ADInstruments’ (ADI) PowerLab 4-channel data acquisition system (Colorado Springs, United States), which utilizes 2 adhesive electrodes applied to the chest and a ground electrode on the ankle. Midway through the study’s data collection period, an ADI respiratory belt-transducer was acquired to obtain respiratory measures. The belt was securely placed across a participant's midsection and acquired respiration rate data (Allen, Chambers, & Towers, 2007).

3.3 Measures

3.3.1 Heart Rate Variability & Respiration

LabChart Pro software by ADI is integrated with the PowerLab unit and was used to calculate frequency-based HRV metrics (Allen et al., 2007). Frequency-based metrics are of greater interest due to their associations with the modulation of the ANS; changes in the power of frequency bands is considered to better represent the sympatho-vagal response compared to time-domain metrics (Force, 1996). Three primary spectral components are determined in a spectrum calculated from ECG recordings of 2-5 minutes; very low frequency (VLF; 0.003 – 0.04 Hz), low frequency (LF; 0.04 – 0.15 Hz), and high frequency (HF; 0.15 – 0.4 Hz). The power of the HF band is extensively used as an index of RSA (Force, 1996). This band captures HR fluctuations attributed to parasympathetic (vagal) function (with power computed as units of milliseconds^2). Given that parasympathetic HR control is primarily established by respiratory-linked variations modulated by the vagus nerve (Allen et al., 2007; Force, 1996), and respiration (i.e. awareness of breathing) is central to MM, this posits HRV as a physiological correlate of mindful states, and respiration, as an important confounding variable to control (Allen, Chambers, & Towers, 2007; Grossman & Taylor, 2007; Porges & Byrne, 1992). This study reports on both HF-HRV and respiration rate measures.

3.3.2. Self-Report Measures

Perfectionism Cognitions Inventory (PCI; Flett, Hewitt, Whelan, & Martin, 2007). The PCI measures how often an individual engages in cognitions focused on the discrepancies between one's current self and ideal self. Correlational analyses have found the PCI to be associated with psychological distress characterized by lack of self-reinforcement and positive perception of self (Flett et al., 2007). Participants are asked to indicate how often they experienced perfectionistic thoughts (e.g. “I should never make the same mistake twice” and “I must be efficient at all times”) in the previous week on a 5-point Likert scale. The PCI has demonstrated adequate validity and reliability in addition to association with measures of psychological distress. Furthermore, there has been no gender difference in mean PCI scores found between males and females (Flett et al., 1998). As mentioned in section 3.3, a cut-off score of 66 was used to screen for maladaptive perfectionism.

Multidimensional Perfectionism Scale (MPS; Paul L. Hewitt, Flett, Turnbull-Donovan, & Mikail, 1991). The MPS is a 45-item questionnaire designed to assess perfectionism across 3 factors: 1) self-oriented perfectionism (SOP) reflects a tendency to be overly perfectionistic with oneself; 2) other-oriented perfectionism (OOP) reflects a tendency to expect perfection from other people; and 3) socially prescribed perfectionism (SPP) is a measure of a person's beliefs regarding other people's expectations of him or her (Hewitt et al., 1991). Several studies have established the MPS as a multidimensional measure of perfectionism with excellent reliability and validity (Flett, Hewitt, Blankstein, & Spomenka, 1991; Frost, Heimberg, Holt, Mattia, & Neubauer, 1993).

Kentucky Inventory of Mindfulness Skills (KIMS; Baer, Smith, & Allen, 2004). The KIMS comprises 39 items that largely target the conceptualization of mindfulness skills as described in Dialectical Behavioral Therapy (DBT; Bergomi, Tschacher, & Kupper, 2013). The KIMS was designed to measure four aspects of mindfulness in daily life (Observing, Describing, Acting with Awareness and Accepting without Judgment). One aspect of mindfulness unique to the KIMS and largely based on elements of DBT is describing, the ability to verbally describe (or label) experiences (e.g. “I’m good at thinking of words to express my perceptions, such as how things taste, smell, or sound.”). Its emphasis is on the capacity to label one’s experiences, as this is considered a core component of mindfulness. Internal consistency is considered to be adequate to good as alpha coefficients for Observe, Describe, Act with Awareness, and Accept Without Judgment have been found to be .91, .84, .83, and .87, respectively (Baer et al., 2004).

Depressive Experiences Questionnaire (DEQ; Blatt, Quinlan, Chevron, McDonald, & Zuroff, 1982). This 66-item questionnaire is used to assess levels of Self-Criticism and Dependency through a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Dependency is characterized by submissiveness in interpersonal relationships and an intense desire for closeness coupled with fear of rejection while Self-criticism is defined by feelings of inferiority, guilt, and worthlessness, related to a sense of failure in meeting standards and expectations (Blatt et al., 1982). Test-retest reliabilities for the DEQ factors are high, with test-retest correlations of .86 over a 3-4 week interval (Fuhr & Shean, 1992), .72 - .81 after a 13-week interval (Blatt et al., 1982) and of .79 for Dependency and Self-Criticism after a 1-year interval (Zuroff, Igreja, & Mongrain, 1990). Alpha coefficients have been previously calculated as .80 for Self-Criticism (Blatt et al., 1982), and construct validity has been evidenced in a variety of contexts (Zuroff, Mongrain, & Santor, 2004).

Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986). The ASI is a 16-item inventory in which a 5-point Likert-based scale is used to rate the degree of concern about negative consequences of anxiety-related sensations. Anxiety sensitivity (AS) refers to a set of beliefs that physical anxiety symptoms have negative effects such as causing more severe distress, development of major illness, or socially detrimental consequences (Reiss et al., 1986). As the most well-established index of AS (Hazen, 1994), the ASI has been found to have valid and reliable factorial structure (Rodriguez, Bruce, Pagano, Spencer, & Keller, 2004) and measures 3 factors; physical concerns (e.g. “It scares me when my heart beats rapidly”), mental incapacitation concerns (e.g. “When I can’t keep my mind on a task, I worry that I might be going crazy”), and fears of publicly observable anxiety reactions (e.g. “Other people notice when I feel shaky”).

Automatic Thoughts Questionnaire (ATQ) (Hollon & Kendall, 1980). The ATQ evaluates 4 dimensions of automatic or frequently occurring negative self-statements; a) personal maladjustment and desire for change; b) negative self-concepts and negative expectations; c) low self-esteem; d) helplessness. It has been found to reliably distinguish depressed from non-depressed groups, with a Cronbach’s alpha of 0.96 (Hollon & Kendall, 1980).

3.4 Procedure

All participants provided written informed consent upon arriving at the laboratory session. All study procedures were approved by the Human Participants Review Subcommittee at the university where the study was conducted. Upon arrival at the lab, and after obtaining informed written consent to participate, all participants completed computer-based self-report questionnaires. Following this, all participants were first measured during a baseline rest phase, followed by a stress-induction phase, and post-stress conditions. Post-stress condition allocation was determined by the experimenter immediately following the stress-induction using a previously prepared randomization schedule (www.randomization.com) to a MM or resting (control) condition. No indication was provided to the participants as to whether they qualified as MPs or Controls, or to the purpose of the stress-induction and post-stress conditions.

In the baseline rest phase, participants were asked to remain seated in a relaxed and upright manner for 5 minutes while thinking freely with their eyes open. They were instructed not to make any sudden movements, keep their gaze in the same direction, and remain silent.

For the stress-induction phase, a stress-induction task was needed to elicit cardiovascular stress and perfectionist cognitions. Although, Stroop, mental arithmetic, and Trier social stress tasks were considered, they lacked the perfectionistic context that relates to a preoccupation with performance or were not compatible with the measurement modalities being used. The task also had to mitigate individual differences in performance capabilities, yet maintain a performance-based theme. Error detection tasks have been shown to elicit SNS activations (Fechir et al., 2008; Hajcak, McDonald, & Simons, 2004), which supported the design of a task that provides real-time performance feedback. Further, Papousek et al (2011) studied HR responses to a task that provided performance feedback manipulated to be inconsistent with participants' self-concept. They found evidence of delayed psychophysiological recovery which supported the 'perseverative cognition' model in terms of the detriments of negative cognitive representations of stressful conditions (Papousek, Paechter, & Lackner, 2011).

In a computer-based pattern recognition task (PRT), participants were asked to study 4 alphanumeric characters presented at the top of the screen for 9 seconds and determine the pattern that they follow (Figure 1). After 9 seconds, a 5th character was shown and the text "True or False?" appeared in the middle of the screen. Participants were instructed to respond with the following key as quickly as possible "True" (← key) if they believed the 5th character followed the pattern or "False" (→ key) if it did not. Immediately after the response, the text "Right Answer" or "Wrong Answer" was presented at the bottom left or bottom right of the screen, respectively for 3 seconds. Numbers indicating total “Correct [x]” (bottom right) and “Incorrect [y]” (bottom left) answers totaled to the current trial remained on the screen.

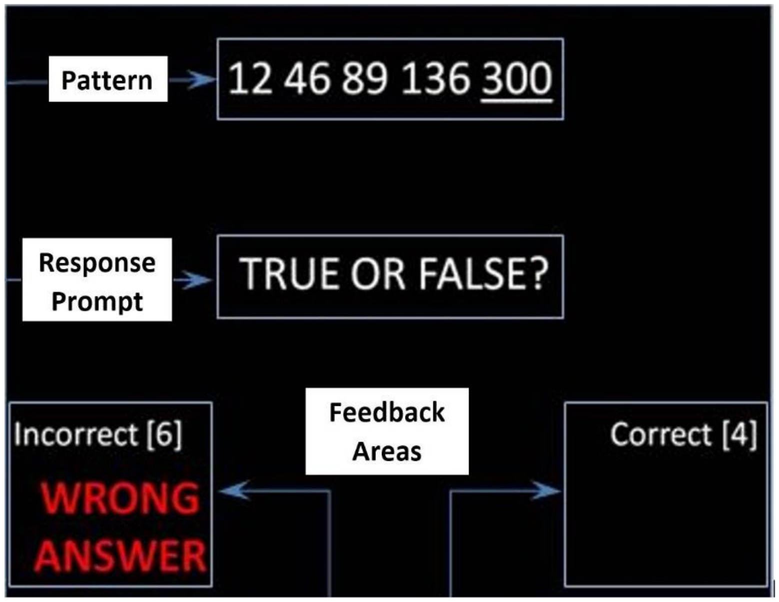

Figure 1. Pattern Recognition Task

The alphanumeric characters were designed to appear as if they followed simple or complex patterns, however, none of the problem sets followed a specific pattern (see Appendix A for characters used). The “Right Answer” and “Wrong Answer” presentation was configured using a pre-determined random order so that each would be presented 11 times throughout the 22 trials. Participants were informed that the PRT “assesses one’s capacity for abstract problem solving” and that for each trial they had to “respond as quickly as possible”. The average time to task completion was 5 minutes and 15 seconds. After task completion, a manipulation check was performed in which participants were asked to rate their performance of the PRT by selecting one of five possible options, “poor”, “below average”, “average”, “above average”, or “excellent”.

For the post-stress phase, MM condition participants were asked to remain seated in a relaxed and upright manner with eyes closed. A 10 minute audio recording was played featuring mindfulness instructions emphasizing attention to breathing sensations and a reorientation to breathing sensations once there was awareness of thoughts, emotions, bodily sensations, and/or external stimuli (Ritvo et al., 2013). The instructions were recorded by a clinical psychologist and experienced MM instructor.

In the post-stress rest condition, participants were seated identically as in the MM condition (including eyes closed), and were played an audio description of historical and scientific information on MM by the same instructor for 10 minutes. This recording did not deliver any instruction on how to practice MM, participants were asked to simply rest while the recording played.

At the end of the final phase, participants were debriefed and informed that the PRT involved unsolvable problem sets and feedback was administered for stress-induction purposes.

3.5 Statistical Analyses

All data was examined for normality prior to statistical testing. Comparisons of demographic and psychometric data between MP and Control groups were conducted using independent t-tests and chi-square tests of independence (Tables 1, 2, & 3). Respiration rate, as suggested by Houtveen et al. (2002), was analyzed by 3-way analysis of variance (ANOVA) with Group (MP vs. Control), Condition (MM vs. rest) x and Phase (baseline, stress, post-stress 1-5 minutes, post-stress 6-10 minutes) as factors.

Analysis was conducted using 2 x 2 x 4 between-subjects ANOVA with Group (MPs vs. control) and Condition (MM vs. rest) as the between-subjects factors, and Phase (baseline, stress, post-stress 1-5 minute period, and post-stress 6-10 minute period) as the within-subjects factor. The violation of the sphericity assumption was handled by conducting a multivariate ANOVA (MANOVA). Significant interaction effects were followed up with simple effects analysis and pairwise comparisons using a Bonferroni Type I error rate correction.

Results of the MANOVA were interpreted using Wilk's Lambda ($\wedge$) values, significance values (p), and effect size multivariate eta squared (η_p^2). In interpreting effect size for MANOVA, guidelines of Cohen (1988) were followed for small (η_p^2 = 0.01), medium (0.06), and large (0.14). Comparisons of means results are provided with means (M) and standard errors (SEM).

4.0 RESULTS

4.1 Data Preparation

The HRV data was log transformed to neutralize positive skews. The 10-minute post-stress recordings were divided into two 5-minute segments in order to; a) keep the time-length of the ECG recordings used to calculate HRV consistent (i.e. 5 minutes for baseline, stress-induction, and two post-stress phases) and b) to allow for an additional time-point to assess cardiac changes within the MM session.

4.1 Participant Recruitment

A total of 68 participants was recruited (males = 36; females = 32). One participant (female, control) completed consent and questionnaires but withdrew from the study prior to phase 1. Seven participants were excluded from the final analyses; 5 due to unanalyzable ECG data (signal noise), and 2 due to their disclosure (in the debriefing interview) that they suspected deception in the PRT during the stress phase (Figure 2). Table 1 displays characteristics of the 60 participants included in the final analyses based on stratification into MPs or Control groups.

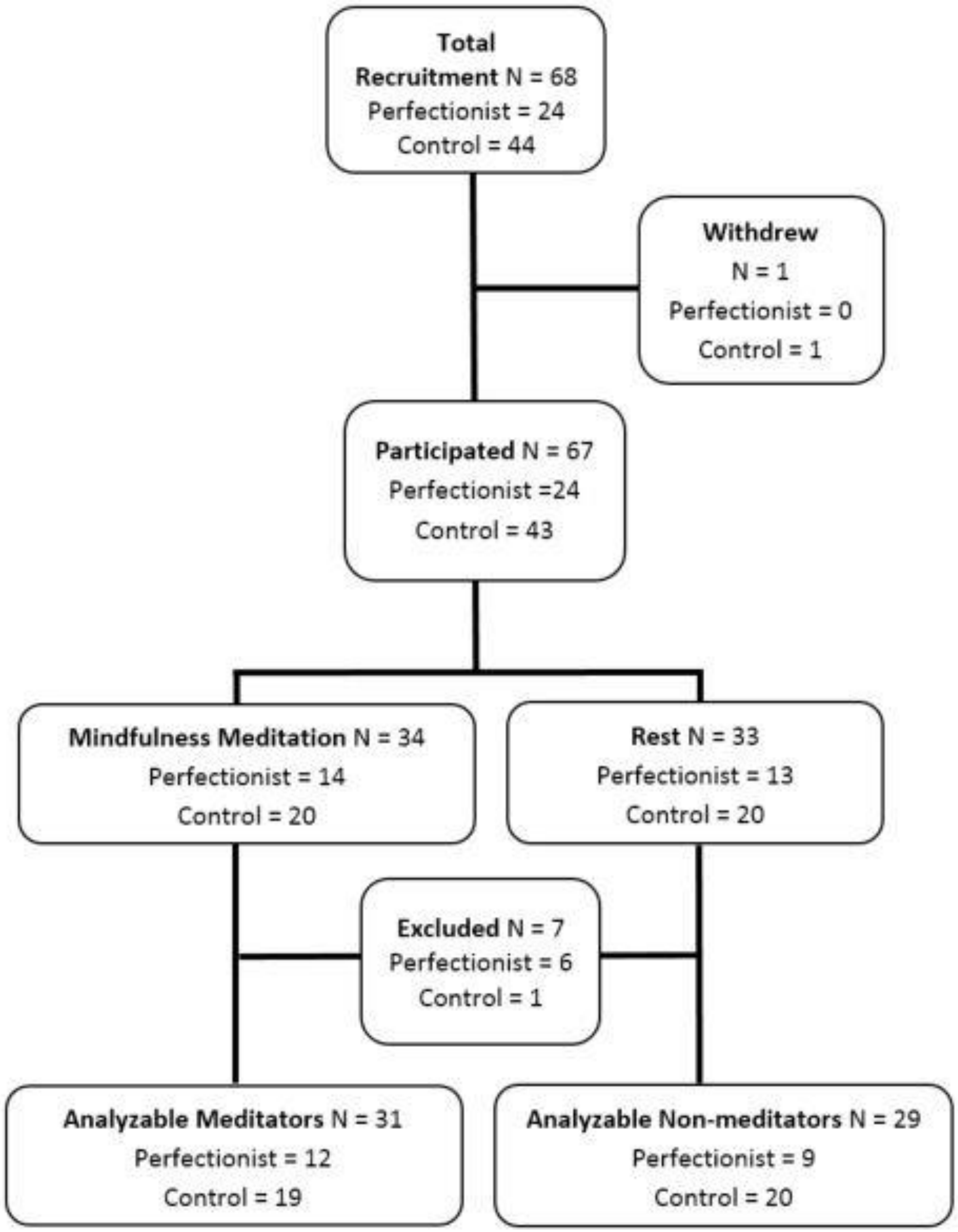

Figure 2. Flow of Participants through the Study

4.2.1 Group Characteristics

Twenty-one participants were classified as MPs, and 39 as Controls. MPs were 52% female, with a mean age of 22 (SD = 1.57), and Controls were 53% male, with a mean age of 21 (SD = .82) (Table 1).

Table 1. *Demographic Data*

Measure	Perfectionists (n = 21)	Controls (n = 39)	Tests of Significance
Age (years) (*SD*)	22.05 (1.57)	20.62 (.82)	$t_{(58)} = .89$, $p = .38$
Gender n (%)			$\chi^2(1) = .21$, $p = .64$
Male	10 (47.62)	21 (53.85)	
Female	11 (52.38)	18 (46.15)	
Education n (%)			$\chi^2(3) = 7.63$, $p = .05$
Bachelor’s Degree	1 (4.76)	1 (4.76)	
College	4 (19.04)	2 (9.52)	
High School	14 (66.67)	36 (92.3)	
Master’s Degree	2 (9.52)	0 (0)	
Weekly Exercise n (%)			$\chi^2(2) = .45$, $p = .80$
Often	11 (52.38)	17 (43.59)	
Sometimes	8 (38.10)	17 (43.59)	
Rarely/Never	2 (9.52)	5 (12.82)	

Note. SD = standard deviation.

In addition to significant group differences found with the PCI, there were significant group differences with respect to self-criticism, anxiety sensitivity, and accept (KIMS) (Bonferroni adjusted α = .008). No significant differences were found with respect to verbal performance ratings between groups (Table 2). Approximately 59% of Control participants self-rated as performing “Average” or above on the PRT after stress-induction, while 52% of MPs self-rated as performing “Below Average” or lower.

Table 2. *Psychometric Data*

Measure *M (SD)*	Perfectionists (n = 21)	Controls (n = 39)	Tests of Significance
Perfectionism			
PCI[a]	73.8 (6.79)	39.13 (15.72)	$t_{(58)} = 11.87$, $p < .000$
SOP	75.43 (13.43)	61.67 (15.06)	$t_{(58)} = 3.50$, $p = .001$
Self-Criticism (DEQ)	.32 (.87)	-.50 (1.19)	$t_{(58)} = 2.79$, $p = .007$
Anxiety Sensitivity[a]	33.57 (9.31)	26.21 (5.08)	$t_{(58)} = 3.37$, $p = .002$
Automatic Thoughts[a]	69.85 (31.82)	50.33 (15.29)	$t_{(58)} = 2.59$, $p = .016$
Accept (KIMS)	25.14 (7.71)	30.71 (7.43)	$t_{(58)} = -2.74$, $p = .008$
Performance Rating n (%)[b]			$\chi^2(3) = 1.62$, $p = .65$
Excellent	0 (0)	0 (0)	

Above Average	0 (0)	2 (5.1)	
Average	10 (47.62)	21 (53.85)	
Below Average	8 (38.10)	11 (28.21)	
Poor	3 (14.29)	5 (12.82)	

Note. Bonferroni adjusted alpha = .008. Unadjusted p values are reported. PCI = Perfectionism Cognitions Inventory; SOP = Self-Oriented Perfectionism; (factor score from Multidimensional Perfectionism Scale). DEQ = Depressive Experiences Questionnaire. KIMS = Kentucky Inventory of Mindfulness Skills (Accept factor). [a.] t-test based on Levene's correction for unequal variances. [b.] Ratings obtained after stress-induction task. *M* = Mean; PCI = Perfectionism Cognitions Inventory; SOP = Self-Oriented Perfectionism; SPP = Socially Prescribed Perfectionism (factor scores from Multidimensional Perfectionism Scale).

According to a 3-way ANOVA, there was no significant group or condition effect for respiration rate (Table 3). Independent t-test did not find a significant group difference in stress HR.

Table 3. *Respiration Rate and Heart Rate Data*

Measure	Perfectionists (n = 21)	Controls (n = 39)	Tests of Significance
Respiration BCM (*SD*)[a]			$F_{(3, 20)} = .04$, $p = .94$
Rest	15.73 (2.87)	15.75 (2.42)	
Stress	19.92 (2.25)	20.08 (5.33)	
Post-Stress Meditation	13.99 (2.41)	12.99 (2.40)	
Post-Stress Rest	10.86 (2.55)	16.73 (4.46)	
Stress Heart Rate (BPM)	76.32 (8.11)	79.61 (8.06)	$t_{(58)} = -1.51$, $p = .87$

Note BCM = Breath cycles/minute. BPM = Beats per Minute.. [a.] *n* = 23 (perfectionists = 8; controls = 15).

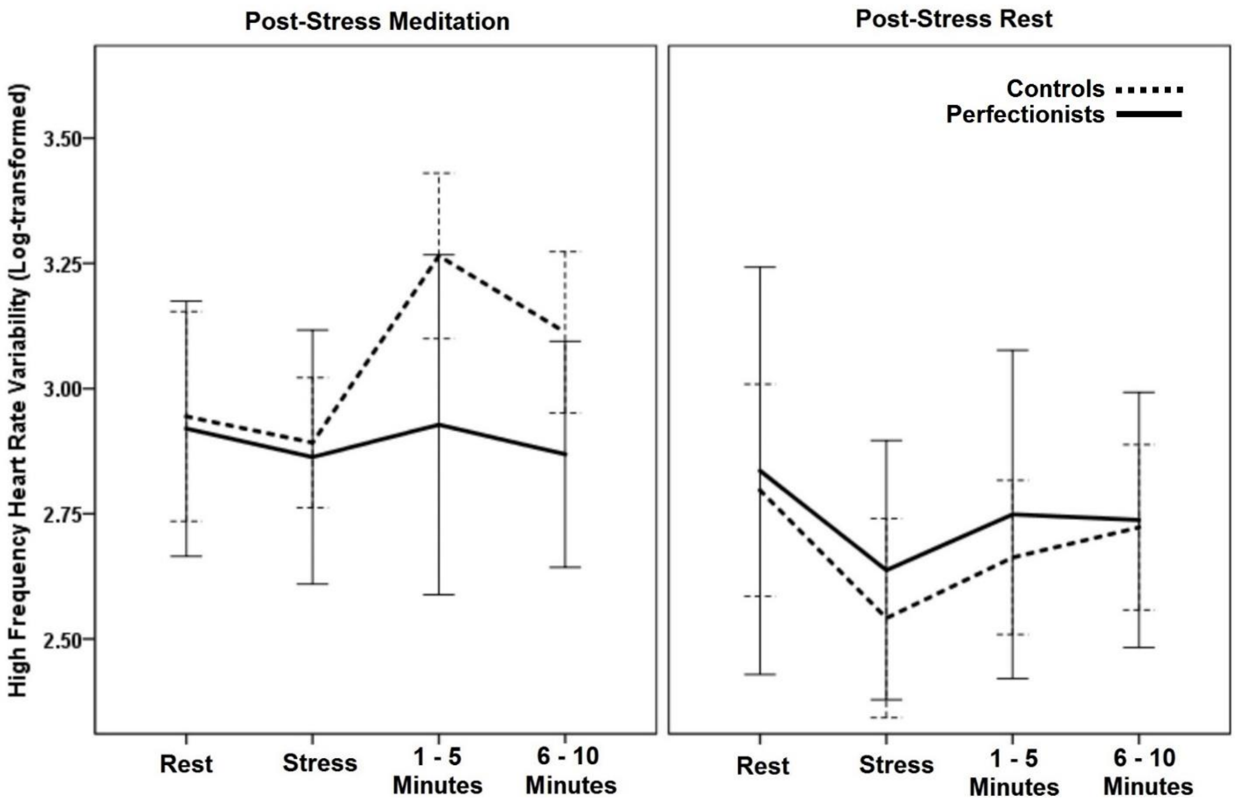

Figure 3. Log-transformed high frequency heart rate variability (ms^2) in Perfectionists and Controls during phases of rest, stress, and post-stress conditions MM and rest. Left plot displays means for participants randomized to the MM condition, N = 31 (Perfectionists = 12; Controls = 19); Right plot displays means for participants randomized to rest condition N = 29 (Perfectionists = 9; Controls = 20). Bars represent standard errors.

4.3 Hypothesis Testing

4.3.1 Overall Results

For the initial ANOVA, Mauchly's test of sphericity was significant ($\chi^2(5) = .73$, p = .005), and a MANOVA approach to results was taken. The MANOVA revealed a significant main effect of Phase ($\wedge$ =.25, $F_{(3, 54)} = 6.09$, p = .001, $\eta_p^2 = .25$), a significant Group x Phase interaction ($\wedge$ =.86, $F_{(3, 54)} = 2.82$, p = .047, $\eta_p^2 = .14$), and a significant Group x Condition x Phase interaction ($\wedge$ = .14, $F_{(3, 54)} = 2.98$, p = .039 $\eta_p^2 = .14$). All other main effects and interaction effects were not significant (all p > 0.05) (Figure 3).

4.3.2 Hypothesis 1: Decreased HRV during Stress

The significant main effect of Phase was followed up with pairwise comparisons showing, as hypothesized, that mean HRV was lower during Phase 2 (stress) (M = 2.73, SEM = .05) compared to Phase 1 (baseline) (M = 2.87, SEM= .06) (p = .005).

4.3.3 Hypothesis 2: Lower HRV in Maladaptive Perfectionists during Stress

Hypothesis 2 was evaluated by analyzing the Group x Phase interaction. The simple effect of Group at the stress phase was not significant ($F_{(1, 56)}$ = .12, p = .73, η_p^2 = .002). The simple effect of Phase within groups was significant for Controls ($\wedge$ = .37, $F_{(3, 54)}$ = 10.63, p < .000, η_p^2 = .37) but not MPs ($\wedge$ = .94, $F_{(3, 54)}$ = 1.20, p = .32, η_p^2 = .06). Bonferroni-adjusted pairwise comparisons in Controls revealed a trend for HRV during the baseline rest phase (M_{rest} = 2.87, SEM = .07) to be greater than that during the stress phase (M_{stress} = 2.72, SEM = .06) (p = .009).

4.3.4 Hypothesis 3: Increased HRV in Controls during Mindfulness

Hypothesis 3 was evaluated by analyzing the Group x Condition x Phase interaction. The simple effect of Phase for Controls in the MM condition was significant ($\wedge$ = .50, $F_{(3, 54)}$ = 17.96, p < .000, η_p^2 = .50). Follow-up pairwise comparisons showed that HRV in Controls was significantly greater during the first 5 minutes of MM than during stress and it remained elevated at 6-10 minutes (Table 4). In contrast, the simple effect of Phase for MPs in the MM condition was not significant ($\wedge$ = .98, $F_{(3, 54)}$ = .42, p < .74, η_p^2 = .02).

Table 4. *Means and SEM of HF-HRV during Post-stress Phases according to Conditions within Groups*

	Maladaptive Perfectionists (n = 21)

	MM Condition (n = 12)		Rest Condition (n = 9)	
Phase	Mean	SEM	Mean	SEM
Stress	2.86	.11	2.64	.12
Post-stress (1-5 min)	2.93	.11	2.75	.13
Post-stress (6-10 min)	2.87	.10	2.74	.12

	Controls (n = 39)			
	MM Condition (n = 19)		Rest Condition (n = 20)	
Phase	Mean	SEM	Mean	SEM
Stress	2.89	.08	2.54	.08
Post-stress (1-5 min)	3.27**	.09	2.66	.09
Post-stress (6-10 min)	3.11*	.08	2.72	.08

Note. Bonferroni-adjusted ($p < .008$) pairwise comparisons were conducted with stress phase. Estimated marginal means based on log-transformed HF-HRV.
** p < 001
* p < .01

4.3.5 Hypothesis 4: Greater HRV in Controls during Mindfulness

Hypothesis 4 was also evaluated by analyzing the Group x Phase x Condition interaction. The simple effects of Condition for Controls at the first ($F_{(1, 56)} = 22.57$, $p < .000$, $\eta_p^2 = .29$) and second post-stress ($F_{(1, 56)} = 12.45$, $p = .001$, $\eta_p^2 = .18$) phases were significant, indicating Controls showed greater HRV during MM when compared to rest (Table 5). The simple effect of Condition for MPs was not significant at either the first post-stress ($F_{(1, 56)} = 1.05$, $p = .31$, $\eta_p^2 = .02$) or second post-stress ($F_{(1, 56)} = .75$, $p = .39$, $\eta_p^2 = .01$) phase.

Table 5. *Means (SEM) of HF-HRV in Conditions according to post-stress phases within Groups*

	Maladaptive Perfectionists (n = 21)		Controls (n = 39)		
Phase	Meditation (n = 12)	Rest (n = 9)	Meditation (n = 19)	Rest (n = 20)	*p* value[a]
Post-stress 1 – 5 Min.	2.92 (.11)	2.75 (.13)	3.27 (.09)	2.66 (.09)	< .000
Post-Stress 6 – 10 Min.	2.87 (.10)	2.76 (.11)	3.11 (.08)	2.72 (.08)	.001

Note. [a.] Based on univariate F tests for simple effects of Condition. Estimated marginal means based on log-transformed HF-HRV and adjusted with covariate resting HF-HRV. Standard errors of the mean in brackets

5.0 DISCUSSION

5.1 Summary of Findings

This study examined HRV during conditions of baseline, stress, and post-stress MM versus rest in maladaptive perfectionists and Controls. According to psychometric analyses, the MP group reported significantly greater levels of perfectionist cognitions, self-oriented perfectionism, depressive self-criticism, and anxiety sensitivity (Table 2) compared to Controls. Further of note is that the MP group reported significantly lower levels of Accept, a mindfulness skill assessed with the KIMS (Baer et al., 2004). As predicted, the Control participants responded to the audio-instructed MM condition with higher levels of HRV compared to the (MM) audio-description rest condition. This difference had a large effect size and appears to demonstrate the effectiveness of MM in promoting relaxation after a cognitive stress-induction. Importantly, the lack of a significant response by MPs to the MM condition raises questions about the psychophysiological dynamics of perfectionism in relation to mindfulness effects.

5.2 Clinical Implications

In a recent controlled experiment on MM that used cardiac measures, Zeidan and colleagues (2010) studied 82 undergraduates with no meditation experience in a design comparing traditional MM training with a sham condition. The sham condition lacked the essential instructions of MM (i.e. awareness of breathing sensations) yet included verbal cues that suggested the group was undergoing a meditation session. The study reported greater decreases in distressed mood and HR following the MM condition compared to the sham condition (Zeidan, Johnson, Gordon, & Goolkasian, 2010) indicative of a cardiac relaxation effect. The present study extends this research by inducing a stress-phase prior to randomizing naive meditators to a MM instruction or an MM description condition. The inclusion of a stress condition eliciting a sympathetic reaction permitted the study of cardiac relaxation using HRV to assess the activity of the parasympathetic vagal nerve. The present finding of enhanced HRV during MM in Controls is consistent with recent research (Burg & Wolf, 2012; Krygier et al., 2013), and suggests that some predisposition to stressful cognitions (i.e. perfectionism) may hinder the effectiveness of brief MM treatments.

The 'perseverative cognition' model, which describes the role of worry and rumination activating, and elongating, the stress response (Brosschot et al., 2006, 2010), may explain why MM effects were not present in MP's. The stress-induction task included a self-evaluative component by providing immediate feedback of each trial response ("Right Answer" or "Wrong Answer") and total correct and incorrect responses up to the current trial. Given the MP's higher tendency for perfectionist (i.e. self-evaluative) cognitions, they might have been more susceptible to the 'perseverative' stress response during meditation practice due to ruminations about the prior task performance or worry about implementing meditation instructions. Furthermore, in specifically studying cardiovascular stress responses to tasks with self-evaluative components, Gendolla and colleagues (2008) found greater systolic blood pressure reactivity during high self-focus conditions with participants exposed to their own facial expressions in a monitor amidst performance. This finding was consistent across tasks with varying difficulty (unfixed, difficult, extreme) (Gendolla, Richter, & Silvia, 2008) and suggests that an achievement context with an element of self-focused feedback can be a hindrance to cardiovascular regulation. The current study's MM instructions did not explicitly reference the task performance, however, the instructions to relax and become aware of one's thoughts necessitate a self-focus that may have resulted in the hindrance to cardiac function observed in

MP's. With regards to the content of attention during mindfulness meditation, this raises question about how self-focused attention may relate to the expected relaxation effects.

In indexing attention regulation, the polyvagal theory asserts that parasympathetic (vagal) tone can reflect, and predict, an individual's capability to adapt to a stressful situation (Porges, 2011). According to this theory, stress disrupts homeostatic processes as is evident in the withdrawal of vagal tone resulting in decreased HRV. The present finding of enhanced HRV during MM after a cognitively stressful condition supports the polyvagal framework that an adjustment to stress using an attention-regulation (MM) practice is marked by HRV elevations. Other similar findings of HRV increases have been reported by studies on self-regulatory effort (Segerstrom & Nes, 2007), impulse control (Fabes & Eisenberg, 1997), and working memory retrieval (Hansen, Johnsen, & Thayer, 2003). Conversely, decreased HRV has been observed in individuals at risk for psychopathology during (Di Simplicio et al., 2012), before (Pieper et al., 2010), and after (Verkuil et al., 2009) cognitively stressful periods. Therefore, the hindered parasympathetic response in MPs during MM points to a detrimental effect of psychological distress on their vagal tone.

Regulating attention amidst distressing cognitions and emotions is a coping strategy taught to distressed individuals in current therapeutic paradigms such as mindfulness-based stress reduction (Nyklíček et al., 2013) and acceptance and commitment therapy (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). However, there is little psychophysiological evidence for the effectiveness of attention regulation in modulating the stress response. Only one published study (Healy, 2010) has investigated the relationship between attention regulation and HRV in the context of stress. This study found that students reporting low levels of attentional control displayed lower resting HRV and self-reported higher levels of anxiety (Healy, 2010).

Attentional difficulties after a period of cognitive stress may explain why, in the present study, MPs did not demonstrate a substantial HRV increase when exposed to brief MM training. When contrasted with the Control response to MM, the lack of HRV increase in MPs during MM is suggestive of a maladaptive response to what is typically a relaxation-inducing practice (Grossman et al., 2004).

One explanation for this response may be that in attending to perfectionist cognitions, MPs are avoiding somatic, stress-related sensations. According to Santanello and Gardner (2006), the relationship between maladaptive perfectionism and worry is partially mediated by experiential avoidance—the tendency to avoid attention towards undesirable sensations, emotions, and thoughts. The requirement of implementing the MM instructions may have been interpreted as a cognitive challenge and provoked perfectionistic cognitions, which in turn, led to avoiding rather than attending to the experiential qualities of distress (Bardeen, Fergus, & Orcutt, 2013; Santanello & Gardner, 2006). The question of whether the lack of HRV increase in MPs is due to inherent physiological incapability or to the attention regulation difficulties still remains. Nonetheless, it appears MPs did not demonstrate the enhanced vagal tone achieved by Controls attributed to attention on the MM instructions of breathing awareness and nonjudgmental observation of thoughts, emotions, and sensations. Given this result, future research should focus explicitly on the instructional features of MM (including the nature, amount, and duration of instructions) and the factors that affect their successful implementation by both distressed personality types and novice meditators.

The results of the present study do not support the hypothesis of a group effect on HRV, as MPs did not exhibit a significantly lower HRV than controls during rest or stress. Of further note is that the Control group showed a trend toward decreased HRV from baseline to stress, whereas MPs did not (Figure 2). Recent research on the Big Five personality variables has found individuals high on neuroticism and low on agreeableness exhibit blunted stress reactivity based on measures of salivary cortisol, HR, and blood pressure (Bibbey, Carroll, Roseboom, Phillips, & de Rooij, 2013). The current HRV-based stress assessment raises questions about the possibility of MPs exhibiting a similarly blunted stress reactivity as seen with other distressed personality factors. The lack of a substantial stress response in MPs compared to Controls might indicate a perpetual withdrawal of vagal tone resulting from continuous encounters with perfectionistic stress. Compounding this notion is the fact that the Controls HR was greater (non-significantly) than the MPs during the stress-phase (Table 1). Afterwards, in post-stress rest conditions, MPs and Controls exhibited similar HRV (Figure 2), which does not reflect the tendency for delayed cardiac relaxation in MPs as previously speculated (2.3 & 2.4). For the purposes of studying cardiac recovery with only rest (and not coping practices), it would be advisable to use longer durations of post-stress assessment.

Previous attempts to examine HRV during MM have observed increases in the high-frequency band (0.15 – 0.4 Hz), the most approximate estimate of parasympathetic function and, thereby, respiration-based vagal activity (Allen et al., 2007; Force, 1996). In a recent investigation measuring HRV during meditation after participants had attended a 10-day Vipassana meditation retreat, Krygier and colleagues (2013) found a significant increase in HF-HRV during MM compared to resting baseline with a large effect size. In the present study, a significant HRV increase in Controls during post-stress MM with a large effect size is consistent with the previous finding. Importantly, the simple effect of Condition for Controls was highly significant (Table 3) with a similarly large effect size. This pattern may suggest that a different physiological response was evident at the levels of group and post-stress conditions, and supports the potential for HRV to be an important physiological correlate of cognitively stressed and mindful states.

5.3 Limitations

The present study has several limitations. The practical significance of a short term stress response is questionable, particularly as the stress-induction (pattern recognition task) in this study was newly designed. While the task achieved the goal of evoking a stress response as supported by significant HRV decreases, the verbal performance ratings did not indicate significant differences between MPs and Controls (Table 1). In other words, MPs did not report perceiving greater failure after the stress-induction compared to Controls. This combined with comparable HRV measures during the stress phase for MPs and Controls (Figure 2) make it difficult to determine whether there are substantial differences in (subjectively perceived) stress levels. This indicates a need to operationalize perfectionism for use in future studies to determine whether normative stress and perfectionist-themed stress could have differing effects on HRV.

These findings must be conservatively interpreted as they are only generalizable to undergraduate populations. Recruitment through a credit system predicated on research participation indicates reliance on a convenience sample. On this note, future studies focusing on perfectionism should consider using multiple perfectionistic dimensions to classify MPs, particularly as the personality construct is further conceptualized in the clinical context (Shafran, Cooper, & Fairburn, 2003). For this purpose, the present study measured related psychological constructs (e.g. self-criticism, anxiety sensitivity, automatic thoughts, and acceptance) and indeed found substantial differences between the MP and Control groups (Table 2) that warrant follow-up investigations.

Lastly, the current study utilized a screening procedure which resulted in uneven sample sizes of Perfectionists (N = 21) and Controls (N = 39), and also necessitated the analysis to be conducted on a non-clinical, categorical group variable. In defense of this approach, it is important to note that the PCI has reliably differentiated populations requiring clinical intervention such as individuals with lowered self-esteem, anxiety, and depressive disorder (Arpin-Cribbie et al., 2008; Arpin-Cribbie, Irvine, & Ritvo, 2012; Flett et al., 2007; Flett, Hewitt, Blankenstein, & Mosher, 1995). Furthermore, the PCI has been employed in multiple randomized-controlled trials which have demonstrated that Perfectionists can achieve benefits in depressed and anxious moods (Radhu, Daskalakis, Arpin-Cribbie, et al., 2012) as well as cortical inhibition (Radhu, Daskalakis, Guglietti, et al., 2012), by way of cognitive-behavioural therapy and mindfulness practice. In the first RCT, independent samples t-tests revealed that these perfectionists had significantly greater ($p < .001$) means on all scales of depression, anxiety, negative automatic thoughts, and perceived stress (Arpin-Cribbie et al., 2012). Further, the PCI was used as the main baseline-outcome measure, and a large effect size improvement in this measure was achieved (Arpin-Cribbie et al., 2012). This indicates the manifestation of maladaptive perfectionism was severe enough for the interventions provided to be effective, as reflected in the large effect size. In the second RCT, of the N = 992 participants who volunteered for baseline testing in a study assessing the effects of web-based cognitive behavioural therapy (CBT), a total of N = 248 scored equal or greater than 1 standard deviation (66) above the mean (Radhu, Daskalakis, Arpin-Cribbie, et al., 2012). Significant differences were found in the comparison of neurophysiological measures used (MP's receiving intervention compared to controls) (Radhu, Daskalakis, Guglietti, et al., 2012) as well as in standard psychometric measures of distress (Radhu, Daskalakis, Arpin-Cribbie, et al., 2012). Furthermore, the uneven proportion in this study is representative of the typical prevalence found at this university, in which a previous recruit of N = 992 participants yielded N = 248 (~ 25%) maladaptive perfectionists with the same screening procedure (Pirbaglou et al., 2013).

5.4 Future Research Directions

In spite of the above limitations, the present study improved on various aspects of previous attempts of assessing HRV during MM. Firstly, as suggested by Zeidan and colleagues (2010), the inclusion of stress-induction prior to randomization to MM or a rest condition helped show the benefits of brief mindfulness training after the experience of stress. Secondly, the lack of adequate control conditions in meditation research has been a source of criticism (Toneatto & Nguyen, 2007). The use of an identically structured rest condition featuring an audio-stimuli description of MM demonstrates a novel and effective approach to controlling for brief MM practice in novice meditators. This corresponds to the approach taken in studies of Mindfulness-Based Stress Reduction (MBSR), wherein an active control condition, Health Enhancement Program, involved health education (e.g. nutrition, chronic disease) but did not feature any specific mindfulness training (MacCoon et al., 2012; Rosenkranz et al., 2013). Furthermore, that protocol did not involve a true mindfulness intervention, although there is now support for using such an approach to evaluate MM program effectiveness. Our study evaluated a brief session of mindfulness that gave participants, who had little or no previous meditative experience, a 10 minute dose of MM instruction. Initial exposure to the MM instruction might theoretically result in a larger physiological response in naïve individuals which might then decrease with repeated exposures (i.e., in those experienced with meditation). Thus, the answer to the question of adequate dosage in MM is still uncertain although HRV offers a compelling avenue for exploring this relationship. Finally, the focus on maladaptive perfectionists demonstrated the viability of including personality factors to assess psychopathological risks with consideration for attention regulation capabilities. Future psychophysiological research may consider stratifying samples with greater clinical implications such as depressive or anxious personality styles.

6.0 CONCLUSION

The effects of maladaptive perfectionism and mindfulness meditation on HRV were found to be consistent with expectations in this study. After a stress procedure, only Controls randomized to the MM condition exhibited a significant HRV increase, while neither MP meditators nor non-meditators exhibited substantial HRV elevations. Further testing revealed HRV was significantly elevated during MM compared to post-stress rest in the Controls but not MPs. These findings suggest that brief MM is conducive to post-stress cardiac relaxation, whereas relaxation is hindered in the context of perfectionistic stress. This finding can prove useful in designing mindfulness-based therapeutic interventions for individuals prone to maladaptive perfectionism and other, non-clinically defined but, nonetheless, high stress conditions. If additional research demonstrates a strong relationship between HRV and mindfulness, then HRV may be used to index improvement in attention regulation and, thereby, progress made through a therapeutic intervention. It is hoped that the potential of studying psychological processes such as perfectionism and mindfulness through autonomic physiological variables will stimulate increased interdisciplinary research in this area.

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APPENDICES

Appendix A – Problems Sets for Pattern Recognition Task

14 48 88 140 400
AB AZ AC AX AY
F1 D3 C5 E7 B9
90 09 19 96 69
AG NA CL OH CO
18 56 72 27 63
A1 91 B1 81 C1
26 66 36 96 16
SH CH ST TH SC
US CA RU UK VU
12 21 32 45 59
44 2 56 8 22 4
AT AN AM AD AH
54 78 96 12 62
UI UO UA UI UE
3e 4A 1b 6U 7i
PI IP OP PE AP
13 26 49 82 116
T2 F5 N9 S7 E8
OR OP OS OW OX
31 24 53 46 75
4T T6 7T T8 9T
MU NU PI XI OM
10 25 50 75 0
CT CH CK CL CR
11 3 13 6 15 9

Appendix B – **Psychological Health Questionnaire**

Background

1. Date (MM/DD/YYYY): ____

2. Full Name: ____

3. Telephone number: (Cell) ____________________ E-mail: ______________________

4. Age _____

5. Please provide your URPP ID# _______

6. Gender:
   - ☐ Male
   - ☐ Female
   - ☐ Other: ____

7. How would you identify your ethnicity?
   - ☐ White
   - ☐ Black
   - ☐ Hispanic
   - ☐ East Asian
   - ☐ South Asian
   - ☐ Middle Eastern
   - ☐ Aboriginal
   - ☐ Other: ____

8. What is the highest level of education you have completed?
   - ☐ Elementary School
   - ☐ High School (or equivalent)
   - ☐ Vocational/Technical School
   - ☐ College
   - ☐ Professional Degree (MD, JD, etc.)
   - ☐ Bachelor's Degree
   - ☐ Master's Degree
   - ☐ Doctoral Degree
   - ☐ Other: ____

9. Year of Study (whole number, e.g. 1, 2, 3, 4, 5): _____

10. Program of study __________________________________

10. Have you ever partaken in counseling or psychotherapy? (Circle one)

Yes, current   Yes, in the past   Never   Prefer not to answer

13. History of illness (select an answer for each condition):

Depressive Disorder	Yes, current	Yes, in the past	Never	Prefer not to answer
Anxiety Disorder	Yes, current	Yes, in the past	Never	Prefer not to answer
Cardiovascular Disease (e.g. coronary artery disease, hypertension)	Yes, current	Yes, in the past	Never	Prefer not to answer
Abnormal heart rhythm or arrhythmias	Yes, current	Yes, in the past	Never	Prefer not to answer

14. During a typical 7-day period (a week), in your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

Often   Sometimes   Rarely/Never

15. Do you have an impairment in your vision for which you require eyewear (e.g. prescription glasses, contact lenses etc.)?

Yes, Current   Yes, in the past   Never

16. If you've practiced a meditation technique before, how much experience do you feel you've gained with meditation (provide approximates for any or all ranges)?

a. Minutes/Hours: _____

b. Days/weeks: _____

c. Years: _____

Perfectionism Cognitions Inventory (Flett, et al., 1998)

Instructions: Listed below are a variety of thoughts about perfectionism that sometimes pop into people's heads. Please read each thought and indicate how frequently, if at all, the thought occurred to you over the last week. Please read each item carefully and circle the appropriate number, using the scale below.

0 = Not At All 1 = Sometimes 2 = Moderately Often 3 = Often 4 = All of the Time 0 = Prefer Not to Answer

1. Why can't I be perfect?

0 1 2 3 4

2. I need to do better

0 1 2 3 4

3. I should be perfect

0 1 2 3 4

4. I should never make the same mistake twice

0 1 2 3 4

5. I've got to keep working on my goals

0 1 2 3 4

6. I have to be the best

0 1 2 3 4

7. I should be doing more

0 1 2 3 4

8. I can't stand to make mistakes

0 1 2 3 4

9. I have to work hard all the time

0 1 2 3 4

10. No matter how much I do, it's never enough

0 1 2 3 4

11. People expect me to be perfect

0 1 2 3 4

12. I must be efficient at all times

0 1 2 3 4

13. My goals are very high

0 1 2 3 4

14. I can always do better, even if things are almost perfect

0 1 2 3 4

15. I expect to be perfect

0 1 2 3 4

16. Why can't things be perfect?

0 1 2 3 4

17. My work has to be superior

0 1 2 3 4

18. It would be great if everything in my life was perfect

0 1 2 3 4

19. My work should be flawless

0 1 2 3 4

20. Things are seldom ideal

0 1 2 3 4

21. How well am I doing?

0 1 2 3 4

22. I can't do this perfectly

0 1 2 3 4

23. I certainly have high standards

0	1	2	3	4

24. Maybe I should lower my goals

0	1	2	3	4

25. I am too much of a perfectionist

0	1	2	3	4

Multidimensional Perfectionism Scale (Hewitt & Flett, 1991)

Instructions: Listed below are a number of statements concerning personal characteristics and traits. Read each item and decide whether you agree or disagree and to what extent. If you strongly agree circle 7. If you strongly disagree, circle 1. If you feel somewhere in between, circle one of the numbers between 1 and 7. If you feel neutral or undecided, the mid-point is 4. 1 is Strongly Disagree; 4 is Neutral or Undecided; 7 is Strongly Agree. 0 = Prefer Not to Answer

1. When I am working on something, I cannot relax until it is perfect

0 1 2 3 4 5 6 7

2. I am not likely to criticize someone for giving up too easily

0 1 2 3 4 5 6 7

3. It is not important that the people I am close to are successful

0 1 2 3 4 5 6 7

4. I seldom criticize my friends for accepting second best

0 1 2 3 4 5 6 7

5. I find it difficult to meet others' expectations of me

0 1 2 3 4 5 6 7

6. One of my goals is to be perfect in everything I do

0 1 2 3 4 5 6 7

7. Everything that others do must be of top-notch quality

0 1 2 3 4 5 6 7

8. I never aim for perfection in my work

0 1 2 3 4 5 6 7

9. Those around me readily accept that I can make mistakes too

0 1 2 3 4 5 6 7

10. It doesn't matter when someone close to me does not do their absolute best

0 1 2 3 4 5 6 7

11. The better I do, the better I am expected to do

0 1 2 3 4 5 6 7

12. I seldom feel the need to be perfect

0 1 2 3 4 5 6 7

13. Anything I do that is less than excellent will be seen as poor work by those around me

0 1 2 3 4 5 6 7

14. I strive to be as perfect as I can be

0 1 2 3 4 5 6 7

15. It is very important that I am perfect in everything I attempt

0 1 2 3 4 5 6 7

16. I have high expectations for the people who are important to me

0 1 2 3 4 5 6 7

17. I strive to be the best at everything I do

0 1 2 3 4 5 6 7

18. The people around me expect me to succeed at everything I do

0 1 2 3 4 5 6 7

19. I do not have very high standards for those around me

0 1 2 3 4 5 6 7

20. I demand nothing less than perfection of myself

0 1 2 3 4 5 6 7

21. Others will like me even if I don't excel at everything

0 1 2 3 4 5 6 7

22. I can't be bothered with people who won't strive to better themselves

0 1 2 3 4 5 6 7

23. It makes me uneasy to see an error in my work

0 1 2 3 4 5 6 7

24. I do not expect a lot from my friends

0 1 2 3 4 5 6 7

25. Success means that I must work even harder to please others

0 1 2 3 4 5 6 7

26. If I ask someone to do something, I expect it to be done flawlessly

0 1 2 3 4 5 6 7

27. I cannot stand to see people close to me make mistakes

0 1 2 3 4 5 6 7

28. I am perfectionistic in setting my goals

0 1 2 3 4 5 6 7

29. The people who matter to me should never let me down

0 1 2 3 4 5 6 7

30. Others think that I am okay, even when I do not succeed

0 1 2 3 4 5 6 7

31. I feel that people are too demanding of me

0 1 2 3 4 5 6 7

32. I must work to my full potential at all times

0 1 2 3 4 5 6 7

33. Although they may not show, other people get very upset with me when I slip up

0 1 2 3 4 5 6 7

34. I do not have to be the best at whatever I am doing

0 1 2 3 4 5 6 7

35. My family expects me to be perfect

0 1 2 3 4 5 6 7

36. I do not have very high goals for myself

0 1 2 3 4 5 6 7

7. My parents rarely expected me to excel in all aspects of my life

0 1 2 3 4 5 6 7

38. I respect people who are average

0 1 2 3 4 5 6 7

39. People expect nothing less than perfection from me

0 1 2 3 4 5 6 7

40. I set very high standards for myself

0 1 2 3 4 5 6 7

41. People expect more from me than I am capable of giving

0 1 2 3 4 5 6 7

42. I must always be successful at school or work

0 1 2 3 4 5 6 7

43. It does not matter to me when a close friend does not try their hardest

0 1 2 3 4 5 6 7

44. People around me think I am still competent even if I make a mistake

0 1 2 3 4 5 6 7

45. I seldom expect others to excel at whatever they do

0 1 2 3 4 5 6 7

Automatic Thoughts Questionnaire (Hollon & Kendall, 1987)

Instructions: Listed below are a variety of thoughts that pop into people's heads. Please read each thought and indicate how frequently, if at all, the thought occurred to you over the last week. Please read each item carefully and fill in the appropriate answer in the following fashion:

1 = Not at all 2 = Sometimes 3 = Moderately often 4 = Often 5 = All the time 0 = Prefer Not to Answer

1. I feel like I'm up against the world

0 1 2 3 4 5

2. I'm no good

0 1 2 3 4 5

3. Why can't I ever succeed?

0 1 2 3 4 5

4. No one understands me

0 1 2 3 4 5

5. I've let people down

0 1 2 3 4 5

6. I don't think I can go on

0 1 2 3 4 5

7. I wish I were a better person

0 1 2 3 4 5

8. I'm so weak

0 1 2 3 4 5

9. My life's not going the way I want it to go

0 1 2 3 4 5

10. I'm so disappointed in myself

0 1 2 3 4 5

11. Nothing feels good anymore

0 1 2 3 4 5

12. I can't stand this anymore

0 1 2 3 4 5

13. I can't get started

0 1 2 3 4 5

14. What's wrong with me?

0 1 2 3 4 5

15. I wish I were somewhere else

0 1 2 3 4 5

16. I can't get things together

0 1 2 3 4 5

17. I hate myself

0 1 2 3 4 5

18. I'm worthless

0 1 2 3 4 5

19. I wish I could just disappear

0 1 2 3 4 5

20. What's the matter with me?

0 1 2 3 4 5

21. I'm a loser

0 1 2 3 4 5

22. My life is a mess

0 1 2 3 4 5

23. I'm a failure

0 1 2 3 4 5

24. I'll never make it

0 1 2 3 4 5

25. I feel so helpless

0 1 2 3 4 5

26. Something has to change

0 1 2 3 4 5

27. There must be something wrong with me.

0 1 2 3 4 5

28. My future is bleak.

0 1 2 3 4 5

29. It's just not worth it

0 1 2 3 4 5

30. I can't finish anything

0 1 2 3 4 5

Anxiety Sensitivity Index (Taylor et al., 2007)

Instructions: Please select the number that best corresponds to how much you agree with each item. If any items concern something that you have never experienced (e.g., fainting in public), then answer on the basis of how you think you might feel if you had such an experience. Otherwise, answer all items on the basis of your own experience.

0 = Very Little 1 = A Little 2 = Some 3 = Much 4 = Very Much 5 = Prefer Not to Answer

It is important for me not to appear nervous.

0 1 2 3 4 5

When I cannot keep my mind on a task, I worry that I might be going crazy.

0 1 2 3 4 5

It scares me when my heart beats rapidly.

0 1 2 3 4 5

When my stomach is upset, I worry that I might be seriously ill.

0 1 2 3 4 5

It scares me when I am unable to keep my mind on a task.

0 1 2 3 4 5

When I tremble in the presence of others, I fear what people might think of me.

0 1 2 3 4 5

When my chest feels tight, I get scared that I won’t be able to breathe properly.

0 1 2 3 4 5

When I feel pain in my chest, I worry that I’m going to have a heart attack.

0 1 2 3 4 5

I worry that other people will notice my anxiety.

0 1 2 3 4 5

When I feel “spacey” or spaced out I worry that I may be mentally ill.

0 1 2 3 4 5

It scares me when I blush in front of people.

0 1 2 3 4 5

When I notice my heart skipping a beat, I worry that there is something seriously wrong with me.

0 1 2 3 4 5

When I begin to sweat in a social situation, I fear people will think negatively of me.

0 1 2 3 4 5

When my thoughts seem to speed up, I worry that I might be going crazy.

0 1 2 3 4 5

When my throat feels tight, I worry that I could choke to death.

0 1 2 3 4 5

When I have trouble thinking clearly, I worry that there is something wrong with me.

0 1 2 3 4 5

I think it would be horrible for me to faint in public.

0 1 2 3 4 5

When my mind goes blank, I worry there is something terribly wrong with me.

0 1 2 3 4 5

The Depressive Experiences Questionnaire (DEQ; Blatt et al)

Instructions: Listed below are a number of statements concerning personal characteristics and traits. Read each item and decide whether you agree or disagree and to what extent. If you strongly agree select 7, if you strongly disagree select 1. The midpoint, if you are neutral or undecided, is 4. 0 = Prefer Not to Answer

1. I set my personal goals and standards as high as possible.

0 1 2 3 4 5 6 7

2. Without support from others who are close to me, I would be helpless.

0 1 2 3 4 5 6 7

3. I tend to be satisfied with my current plans and goals, rather than striving for higher goals.

0 1 2 3 4 5 6 7

4. Sometimes I feel very big, and other times I feel very small.

0 1 2 3 4 5 6 7

5. When I am closely involved with someone, I never feel jealous.

0 1 2 3 4 5 6 7

6. I urgently need things that only other people can provide.

0 1 2 3 4 5 6 7

7. I often find that I don't live up to my own standards or ideals.

0 1 2 3 4 5 6 7

8. I feel I am always making full use of my potential abilities.

0 1 2 3 4 5 6 7

9. The lack of permanence in human relationships doesn't bother me.

0 1 2 3 4 5 6 7

10. If I fail to live up to expectations, I feel unworthy.

0 1 2 3 4 5 6 7

11. Many times I feel helpless.

0 1 2 3 4 5 6 7

12. I seldom worry about being criticized for things I have said or done.

0 1 2 3 4 5 6 7

13. There is a considerable difference between how I am now and how I would like to be.

0 1 2 3 4 5 6 7

14. I enjoy sharp competition with others.

0 1 2 3 4 5 6 7

15. I feel I have many responsibilities that I must meet.

0 1 2 3 4 5 6 7

16. There are times when I feel "empty" inside.

0 1 2 3 4 5 6 7

17. I tend not to be satisfied with what I have.

0 1 2 3 4 5 6 7

18. I don't care whether or not I live up to what other people expect of me.

0 1 2 3 4 5 6 7

19. I become frightened when I feel alone.

0 1 2 3 4 5 6 7

20. I would feel like I'd be losing an important part of myself if I lost a very close friend.

0 1 2 3 4 5 6 7

21. People will accept me no matter how many mistakes I have made.

0 1 2 3 4 5 6 7

22. I have difficulty breaking off a relationship that is making me unhappy.

0 1 2 3 4 5 6 7

23. I often think about the danger of losing someone who is close to me.

0 1 2 3 4 5 6 7

24. Other people have high expectations of me.

0 1 2 3 4 5 6 7

25. When I am with others, I tend to devalue or "undersell" myself.

0 1 2 3 4 5 6 7

26. I am not very concerned with how other people respond to me.

0 1 2 3 4 5 6 7

27. No matter how close a relationship between two people is, there is always a large amount of uncertainty and conflict.

0 1 2 3 4 5 6 7

28. I am very sensitive to others for signs of rejection.

0 1 2 3 4 5 6 7

29. It's important for my family that I succeed.

0 1 2 3 4 5 6 7

30. Often, I feel I have disappointed others.

0 1 2 3 4 5 6 7

31. If someone makes me angry, I let him (her) know how I feel.

0 1 2 3 4 5 6 7

32. I constantly try, and very often go out of my way, to please or help people I am close to.

0 1 2 3 4 5 6 7

33. I have many inner resources (abilities, strengths).

0 1 2 3 4 5 6 7

34. I find it very difficult to say "No" to the requests of friends.

0 1 2 3 4 5 6 7

35. I never really feel secure in a close relationship.

0 1 2 3 4 5 6 7

36. The way I feel about myself frequently varies: there are times when I feel extremely good about myself and other times when I see only the bad in me and feel like a total failure

0 1 2 3 4 5 6 7

37. Often, I feel threatened by change.

0 1 2 3 4 5 6 7

38. Even if the person who is closest to me were to leave, I could still "go it alone."

0 1 2 3 4 5 6 7

39. One must continually work to gain love from another person: that is, love has to be earned.

0 1 2 3 4 5 6 7

40. I am very sensitive to the effects my words or actions have on the feelings of other people.

0 1 2 3 4 5 6 7

41. I often blame myself for things I have done or said to someone.

0 1 2 3 4 5 6 7

42. I am a very independent person.

0 1 2 3 4 5 6 7

43. I often feel guilty.

0 1 2 3 4 5 6 7

44. I think of myself as a very complex person, one who has "many sides."

0 1 2 3 4 5 6 7

45. I worry a lot about offending or hurting someone who is close to me.

0 1 2 3 4 5 6 7

46. Anger frightens me.

0 1 2 3 4 5 6 7

47. It is not "who you are," but "what you have accomplished" that counts.

0 1 2 3 4 5 6 7

48. I feel good about myself whether I succeed or fail.

0 1 2 3 4 5 6 7

49. I can easily put my own feelings and problems aside, and devote my complete attention to the feelings and problems of someone else.

0 1 2 3 4 5 6 7

50. If someone I cared about became angry with me, I would feel threatened that he (she) might leave me.

0 1 2 3 4 5 6 7

51. I feel comfortable when I am given important responsibilities.

0 1 2 3 4 5 6 7

52. After a fight with a friend, I must make amends as soon as possible.

0 1 2 3 4 5 6 7

53. I have a difficult time accepting weaknesses in myself.

0 1 2 3 4 5 6 7

54. It is more important that I enjoy my work than it is for me to have my work approved.

0 1 2 3 4 5 6 7

55. After an argument, I feel very lonely.

0 1 2 3 4 5 6 7

56. In my relationships with others, I am very concerned about what they can give to me.

0 1 2 3 4 5 6 7

57. I rarely think about my family

0 1 2 3 4 5 6 7

58. Very frequently, my feelings toward someone close to me vary: there are times when I feel completely angry and other times when I feel all loving towards that person.

0 1 2 3 4 5 6 7

59. What I do and say has a very strong impact on those around me.

0 1 2 3 4 5 6 7

60. I sometimes feel that I am "special."

0 1 2 3 4 5 6 7

61. I grew up in an extremely close family.

0 1 2 3 4 5 6 7

62. I am very satisfied with myself and my accomplishments.

0 1 2 3 4 5 6 7

63. I want many things from someone I am close to.

0 1 2 3 4 5 6 7

64. I tend to be very critical of myself.

0 1 2 3 4 5 6 7

65. Being alone doesn't bother me at all.

0 1 2 3 4 5 6 7

66. I very frequently compare myself to standards or goals.

0 1 2 3 4 5 6 7

Kentucky Inventory of Mindfulness Skills (Baer, 2006)

Instructions: Please rate each of the following statements using the scale provided. Select the number that best describes your own opinion of what is generally true for you.

1 = Never or very rarely true	2 = Rarely true	3 = Sometimes true	4 = Often true	5 = Very often or always true
0 = Prefer Not to Answer				

I notice changes in my body, such as whether my breathing slows down or speeds up

0 1 2 3 4 5

I'm good at finding the words to describe my feelings

0 1 2 3 4 5

When I do things, my mind wanders off and I'm easily distracted

0 1 2 3 4 5

I criticize myself for having irrational or inappropriate emotions

0 1 2 3 4 5

I pay attention to whether my muscles are tense or relaxed

0 1 2 3 4 5

I can easily put my beliefs, opinions, and expectations into words

0 1 2 3 4 5

When I'm doing something, I'm only focused on what I'm doing, nothing else

0 1 2 3 4 5

I tend to evaluate whether my perceptions are right or wrong

0 1 2 3 4 5

When I'm walking, I deliberately notice the sensations of my body moving

0 1 2 3 4 5

I'm good at thinking of words to express my perceptions, such as how things taste, smell or sound

0 1 2 3 4 5

I drive on "automatic pilot" without paying attention to what I'm doing

0 1 2 3 4 5

I tell myself that I shouldn't be feeling the way I'm feeling

0 1 2 3 4 5

When I take a shower or bath, I stay alert to the sensations of water on my body

0 1 2 3 4 5

It's hard for me to find the words to describe what I'm thinking

0 1 2 3 4 5

When I'm reading, I focus all my attention on what I'm reading

0 1 2 3 4 5

I believe some of my thoughts are abnormal or bad and I shouldn't think that way

0 1 2 3 4 5

I notice how foods and drinks affect my thoughts, bodily sensations and emotions

0 1 2 3 4 5

I have trouble thinking of the right words to express how I feel about things

0 1 2 3 4 5

When I do things, I get totally wrapped up in them and don't think about anything else

0 1 2 3 4 5

I make judgments about whether my thoughts are good or bad

0 1 2 3 4 5

I pay attention to sensations, such as the wind in my hair or sun on my face

0 1 2 3 4 5

When I have a sensation in my body, it's difficult for my to describe it because I can't find the right words

0 1 2 3 4 5

I don't pay attention to what I'm doing because I'm daydreaming, worrying or otherwise distracted

0 1 2 3 4 5

I tend to make judgments about how worthwhile or worthless my experiences are

0 1 2 3 4 5

I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing

0 1 2 3 4 5

Even when I'm feeling terribly upset, I can find a way to put it into words

0 1 2 3 4 5

When I'm doing chores, such as cleaning or laundry, I tend to daydream or think of other things

0 1 2 3 4 5

I tell myself that I shouldn't be thinking the way I'm thinking

0 1 2 3 4 5

I notice the smells and aromas of things

0 1 2 3 4 5

I intentionally stay aware of my feelings

0 1 2 3 4 5

I tend to do several things at once rather than focusing on one thing at a time

0 1 2 3 4 5

I think some of my emotions are bad or inappropriate and I shouldn't feel them

0 1 2 3 4 5

I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow

0 1 2 3 4 5

My natural tendency is to put my experiences into words

1 2 3 4 5

When I'm working on something, part of my mind is occupied with other topics, such as what I'll be doing later, or things I'd rather be doing

0 1 2 3 4 5

I disapprove of myself when I have irrational ideas

0 1 2 3 4 5

I pay attention to how my emotions affect my thoughts and behavior

0 1 2 3 4 5

I get completely absorbed in what I'm doing, so that all my attention is focused on it

0 1 2 3 4 5

I notice when my moods begin to change

0 1 2 3 4 5

Appendix C - Debriefing Statement

You were a participant in a study to determine whether perfectionist personality styles are associated with autonomic nervous system dysfunction by i) studying associations between heart rate variability (HRV) and perfectionism psychometrics ii) measuring HRV under different laboratory conditions. The purpose of the rest task was to assess the relationship between your baseline HRV and your frequency of perfectionist thoughts that you reported in the questionnaire. The purpose of the Pattern Solving Task (PST) was to assess your stress reactivity relative to your level of perfectionist thinking. The PST was pre-configured to provide random feedback of "right" and "wrong" answers. The alphanumeric characters were tailored to appear as if they follow simple or complex patterns, but all patterns have been created so that they do not have a correct solution. This was intended to elicit stress reactivity and attentional biases as a response to feedback or "right" and "wrong" during the task, which we'll assess based on your HRV and your eye movement recordings respectively. The purpose of the post-stress phase was to assess your recovery from a stressful performance under one of two conditions: Mindfulness Meditation (MM), or eyes closed resting which is intended to mirror MM in all but the specific audio instructions provided.

Despite the withholding of this information, we hope that this was a positive experience for you and that your understanding of your stress reactivity and post-stress experience may have improved. Please let us know if you have further questions at this time.