THE RELATIONSHIP BETWEEN TRAIT MINDFULNESS AND HEART RATE DURING STRESS

Honours Thesis

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Abstract

Chronic stress can lead to adverse physical and psychological outcomes. Empirical research demonstrates that mindfulness-interventions can serve as an effective stress-management strategy. Furthermore, individuals who are naturally more mindful (i.e., displaying higher trait mindfulness) can attenuate their psychological appraisal of stress, which may influence their physiological response (e.g., heart rate [HR]) to a stressor. The aim of the present study was to examine whether trait mindfulness predicted HR reactivity and recovery to a lab stressor. To achieve this, University of Regina students \( n = 110 \), 78% female, \( M = 21.5 \) were recruited via the Psychology Department’s Participant Pool. Participants partook in a modified version of the Trier Social Stress Task (TSST; Kirschbaum, Pirke, & Hellhammer, 1993). HR was measured before, during and after the laboratory stressor to assess physiological reactivity and recovery from stress. Participants subsequently completed several questionnaires examining demographic information, depression, and trait mindfulness. A paired samples t-test revealed that HR significantly increased during the TSST, implying the success of the manipulation to induce stress \( (p < .001) \). Trait mindfulness was positively correlated with HR reactivity. However, a hierarchical regression test revealed that trait mindfulness did not significantly predict HR recovery to the TSST, over and above demographic and depressive symptomatology scores \( (p = .135) \). Nonetheless, studying the moderating effects of trait mindfulness and how it influences cardiovascular functioning remains an important research endeavor. Trait mindfulness can provide insights into the efficacy of mindfulness-interventions ability to reduce stress in at-risk and general populations.
The Relationship Between Trait Mindfulness and Heart Rate During Stress

Everyone experiences stress to a varying degree throughout their life. Exposure to low to moderate acute stress is considered adaptive and normal; but, the accumulation of chronic stress can lead to the development of psychological, physical, cognitive, and behavioural deficits (Cruess et al., 2015). Cardiovascular disease, in particular, is responsible for one out of every six deaths, and costs the American economy upwards of $100 billion annually (Holt, 2012). Intervening the potential risks between stress and cardiovascular functioning has become a medical imperative. Mindfulness is defined as the maintenance of awareness, intention, and acceptance of the present moment (Nezlek, Holas, Rusanowska, & Krejtz, 2016), and has roots in Buddhism and other contemplative and Eastern traditions (Chiesa, 2013). Mindfulness is both a natural skill and a set of formal practices (Creswell, Pacilio, Lindsay, & Brown, 2014). The notion that mindful people react more flexibly to stress (Nezlek et al., 2016) has spurred research to further assess the relationship between mindfulness, stress and physiological functioning.

Poor cardiovascular functioning is problematic, and poorly managed stress is known to be a contributing factor. Research suggests that mindfulness-based training teaches individuals adaptive psychological responses to stress, which may influence adaptive physiological stress reactions (Nezlek et al., 2016). Mindfulness promotes positive coping strategies, which have been found to increase overall well-being and enhance behavioural and emotional regulation (Beshai, Mcalpine, Weare, & Kuyken, 2016; Nezlek et al., 2016; Rau & Williams, 2016). Individuals who are naturally mindful and who practice mindfulness report lower ruminative thoughts and behaviours, less depression and anxiety symptoms, increases in positive relationships, self-confidence, self-compassion, and productivity (Beshai et al., 2016; Holt, 2012; Nezlek et al., 2016; Shearer, Hunt, Chowdhury & Nicol, 2016). The favorable long term and
short term benefits suggest mindfulness may effectively moderate stress, which warrants further empirical investigation.

**Stress**

Stress can be conceptualized as “a pervasive experience that occurs when one’s perceived demands outweigh one’s perceived resources” (Cruess et al., 2015, p. 271). As such, perception and cognition play a role in the experience of stress (Holt, 2012). Any stressful situation (i.e., a stressor), whether it be major life events or minor daily annoyances, can cause tension and discomfort that strains one’s ability to effectively cope (Shearer et al., 2016). Psychological appraisals of stress can greatly impact a person’s sense of well-being (Cruess et al., 2015). Not only are there individual differences in how stress is subjectively perceived, but there are also individual differences in physiological reactions to stress (Bibbey, Carroll, Roseboo, Phillips, & Rooij, 2013). Given the multimodal nature of stress, many factors can influence physiological stress reactions, including age, experience, family history, depression, and anxiety (Creswell et al., 2014). Research on mindfulness-based training and trait mindfulness found a significant diminution in both perceived stress and autonomic stress responses in an acute stressful situation (Beshai et al., 2016; Creswell et al., 2014).

The body’s main neuroendocrine axes responsible for responding to stress are the hypothalamus-pituitary axis and the sympathetic adrenomedullary system (Cruess et al., 2015). These two axes interact with each other and either stimulate or inhibit the autonomic division of the nervous system (Curess et al., 2015; Lilienfeld et al., 2011). The release of stress hormones (i.e., cortisol) also plays a role in the body’s stress response. Elevated cortisol levels have been linked to numerous negative outcomes that are maintained and aggravated by stress, including: exhaustion, avoidant behaviour, depressive and anxiety symptomatology, low self-esteem, peptic
ulcers and immune system deficiency (Cruess et al., 2015; Lilienfeld et al., 2011; Rasmussen & Pidgeon, 2011; Shearer et al., 2016). The many potential risks associated with prolonged exposure to stress underscore the importance of effective stress management techniques (Pinsloo, Derman, Lambert, & Rauch, 2013). Mindfulness may therefore be a target for intervention, as it appears to protect against or effectively treat stress-related disease (e.g., chronic inflammation; Creswell et al., 2014).

**HR reactivity and recovery.** HR is one cardiovascular indicator of stress that can be easily monitored (Shearer et al., 2016). HR reactivity and recovery are pertinent topics in assessing the behavioural and cardiovascular mechanisms underlying stress-related disease (Kudielka, Buske-Kirschbaum, Hellhammer, & Kirschbaum, 2004). Since cardiovascular disease is the number one cause of death in America (Holt, 2012), research has delved into how poor HR reactivity and recovery functions as an additive factor. Excessive rumination and worry sustains physiological responses (e.g., chronic HR elevations) to a stressor, which is associated with hypertension, atherosclerosis and eventual cardiovascular disease (Brosschot, Gerin, & Thayer, 2006). Therefore, prominent HR recoveries following stress can be essential for cardiovascular health. Blunted HR and cortisol reactivity also have adverse consequences on health (e.g., addiction, depression, inflammation, and obesity; Phillips, Ginty, & Hughes, 2013). Phillips et al. (2013) stated that blunted effects may be due to a physiological incapability to respond to stress because of an overexcited sympathetic division. A flexible and moderate HR reaction to stress is most preferable.

It is proposed that cardiovascular functioning is influenced by emotionally relevant stressors (Bibbey et al., 2013). Individuals who regulate their emotions to stress may enhance their physiological reactions (Shearer et al., 2016). Emotion regulation is conceptualized as
“processes by which individuals modulate the experience, expression, and response to emotions” (Mankus, Aldao, Kerns, Mayville, & Mennin, 2013, p. 386). HR reactivity and recovery can be two indicators of flexible emotion regulation, which is a key underpinning for mental health (Goodman, Quaglia, & Brown, 2015; Mankus et al., 2013). Mindfulness is positively correlated with HR reactivity and recovery and emotional flexibility, as suggested by improved cardiovascular responses (Shearer et al., 2016). This study examined HR reactivity and recovery to an emotionally provoking lab stressor to infer the outcomes mindfulness has on autonomic functioning.

**Trier Social Stress Task (TSST).** People typically respond negatively to being evaluated by others in social situations (Rasmussen & Pidgeon, 2011). The TSST (Kirschbaum, Pirke, & Hellhammer, 1993) is a reliable social evaluative stressor that allows researchers to observe physiological stress reactions in a controlled laboratory setting (Birkett, 2011; Goodman et al., 2015). In the TSST, participants are asked to prepare and deliver a speech for judges to evaluate, which is designed to mimic a socially evaluative ‘threat’ that individuals frequently encounter in school or at work (Birkett, 2011; Holt, 2012; Shearer et al., 2016). Adequate pre-stress and post-stress measurements (e.g., HR) can be obtained and compared to the TSST preparation and delivery phase (Birkett, 2011). Recent studies have demonstrated that interventional and trait mindfulness reduces psychological reactions to the TSST (Creswell et al., 2014; Cruess et al., 2015). Additionally, mindfulness appears to attenuate emotional reactivity to negative stimuli that is self-generated or imposed by others (e.g., social evaluation; Rasmussen & Pidgeon, 2011).

**Mindfulness**

Publications focused on mindfulness have grown exponentially in the past two decades. Mindfulness and other Eastern traditions have been increasingly incorporated into Western
psychotherapies (Follette, Palm, & Pearson, 2006). This integration of Buddhist approaches with Western psychology began in 1970, and Jon Kabat-Zinn was the first to develop a mindfulness-based protocol to reduce stress (Rau & Williams, 2016). Mindfulness has been studied in two main ways: mindfulness-intervention or training and trait mindfulness. These two conceptions of mindfulness are not exclusive to each other, because their interaction greatly enhances emotional functioning (Holt, 2012) which decreases adverse stress symptoms (Schwager, Hulsheger, & Lang, 2016).

**Mindfulness as an intervention.** Mindfulness has been incorporated into many treatments for a variety of psychiatric conditions, including: mood, substance use, personality, and anxiety disorders (Mankus et al., 2013). Examples of these treatments include Mindfulness-Based Cognitive Therapy, Dialectical Behaviour Therapy, Acceptance and Commitment Therapy, and Emotion Regulation Therapy (Follette et al., 2006; Mankus et al., 2013). These therapies help individuals attend to the full gamut of their experience, including negative thoughts and emotions, in a non-reactive and accepting manner (Cruess et al., 2015). Unlike other cognitive approaches that help patients identify and restructure negative cognitions, mindfulness encourages the acceptance of negative thought patterns without evaluation (Follette et al., 2006). Whether brief or extensive, researchers have found that mindfulness may build a resilience to stress that is adaptive and non-suppressive (Beshai et al., 2016; Cresswell et al., 2014; Cruess et al., 2015; Mankus et al., 2013; Shearer et al., 2016).

**Mindfulness as a trait.** Trait mindfulness is the natural capacity to be nonjudgmentally aware of the present moment (Schwager et al., 2016). Mindful dispositions can map onto personality theories as a framework for individual differences in mindfulness (Rau & Williams, 2016). Personality characteristics may be associated with both mindfulness skills and emotional
regulation skills (Nyklíček & Irrmischer, 2017). Two traits that are mainly of interest are neuroticism and openness (Rau & Williams, 2016). Individuals exhibiting neuroticism tend to experience negative moods and may engage in avoidant behaviours when they encounter stress (Bibbey et al., 2013; Rau & Williams, 2016). Individuals high in openness are likely to recognize, accept, and experience a range of emotions (Rau & Williams, 2016). There is not a clear link between trait mindfulness and openness, but they are theoretically congruent with each other (Rau & Williams, 2016). Bibbey et al. (2013) found that high neuroticism and low openness are associated with a blunted cardiovascular effect to an acute lab stressor. Positive personality characteristics, such as trait mindfulness and openness, are positively related to HR reactivity to stress. In other words, individuals higher on trait mindfulness likely engage with negative stimuli such as stress, resulting in high HR reactivity and quicker recovery times, displaying balanced cardiovascular functioning (Holt, 2012; Shearer et al., 2016).

In conjunction with physiological functioning, various scales that measure trait mindfulness are related to positive psychological outcomes. Goodman et al. (2015) reported that high trait mindfulness scores (as measured by the Mindfulness Attention Awareness Scale [Brown & Ryan, 2003] and the Five Facet Mindfulness Questionnaire [FFMQ; Baer, Smith., Hopkins, Krietemeyer, & Toney, 2006]) are negatively correlated with anxiety and depression symptomatology, mood disturbance, and perceived stress. Further assessing the relationship between trait mindfulness and cardiovascular functioning can demonstrate how mindfulness-training can be utilized to reduce stress (Nyklíček & Irrmischer, 2017).

**Present Study**

Despite the expanding research-driven interest in mindfulness, more studies are needed to examine the interaction of trait mindfulness and physiological stress responses (Bibbey et al.,
2013). To our knowledge, there have been no studies that have empirically assessed the degree to which trait mindfulness is associated with HR reactivity and recovery to stress. The current study tested whether levels of trait mindfulness correlated with a flexible HR reactivity and recovery to a lab stressor (TSST). This research was necessary to (a) assess the effect mindfulness has on the body during stress, and (b) provide a more comprehensive picture that includes an objective physiological measure of stress and a subjective self-reported measure of trait mindfulness.

Based on other study outcomes (Beshai et al., 2016; Creswell et al., 2014; Cruess et al., 2015; Markus et al., 2013; Nezlek et al., 2016; Rausmussen & Pidgeon, 2011; Shearer et al., 2016), it was expected that higher levels of trait mindfulness would be positively correlated with HR reactions, and negatively correlated with time needed for HR to recover from the TSST.

Method

Participants

Prior to data collection, the study was approved by the University of Regina’s Research Ethics Board. Students aged 18 years and over were recruited through the University of Regina’s Department of Psychology Participant Pool and received one course credit for their participation. Determined by G*Power analysis, the hypothesized relationships were expected to be demonstrated based on a medium effect ($\alpha = .05$, power $= .80$, $n = 80$). However, we were able to recruit 110 participants. Other study outcomes demonstrated significant results based on a medium effect (Beshai et al., 2016; Creswell et al., 2014; Cruess et al., 2015; Mankus et al., 2013; Nezlek et al., 2016; Rausmussen & Pidgeon, 2011; Shearer et al., 2016). Due to the diverse community of the University of Regina, people with a variety of ages, ethnicities, and socioeconomic backgrounds participated in this study.

Procedure
The study will be conducted in a designated room in the Depression, Cognition, and Culture Lab in the Classroom Building at the University of Regina. Eligible participants will first provide consent before partaking in a modified version of the TSST where their HR will be measured at three phases using wearable technology (i.e., a chest band and a mobile app). First, participants will be instructed on how to put on the HR monitor. HR measurements will be taken before the TSST to establish a baseline HR average that will be compared to the activation phase of the TSST as participants prepare a brief presentation. After the TSST, the researcher will record how long it takes (in seconds) for participant’s HR to return to baseline levels. Following, participants will be asked to remove the HR monitor and fill out demographic information and several questionnaires that assess trait mindfulness and depressive symptoms via Qualtrics. Lastly, participants will be thoroughly debriefed and any feedback will be gathered.

**Measures**

**Patient Health Questionnaire (PHQ-8; Kroenke, Strine, Spitzer, Williams, Berry, & Mokdad, 2009).** The PHQ-8 is a measure that assesses the severity of depressive symptoms in the general and psychiatric populations. The 8 items are based off the 9-item criteria for depressive symptoms (e.g., little interest or pleasure in doing things) in the DSM-IV (American Psychological Association, 2000; Kroenke et al., 2009). Suicide ideation in clinical populations, the ninth item in the original scale (PHQ-9; Kroenke, Spitzer, & Williams, 2001), was not a quality of interest in this study (Sullivan et al., 2017). Frequencies of symptoms during the past two weeks are rated on a 4-point Likert scale, ranging from 0 (*not at all*) to 3 (*nearly everyday*). One study found that the PHQ-8 can be a valid indicator of mental distress (Bossarte, He, Claassen, Knox, & Tu, 2011). This measure provided useful information on the prevalence of poor mental health among participants.
Five Facet Mindfulness Questionnaire Short-Form (FFMQ-SF; Baer, Smith, Lykins, Button, Krietemeyer, & Sauer, 2008). The FFMQ-SF analyzes levels of trait mindfulness. FFMQ-SF was developed to assess the five current facets of mindfulness: observing (e.g., “I pay attention to physical experiences, such as the wind in my hair or sun on my face”), describing (e.g., “I’m good at finding the words to describe my feelings”), acting-with-awareness (e.g., “I rush through activities without really being attentive to them”), non-judging of inner experience (e.g., “I tell myself I shouldn’t be thinking the way that I’m thinking”) and non-reactivity to inner experience (e.g., “I watch my feelings without getting carried away by them”). The 24 items are rated on a 5-point Likert scale, ranging from 1 (never or very rarely true) to 5 (very often or always true), with higher scores being indicative of higher mindfulness skills. This questionnaire encompasses the multidimensional nature of the mindfulness construct (Rau & Williams, 2016). One study examining the measure’s factor structure, internal consistency, and construct validity concluded that the short form has similar psychometric properties as the original 39-item FFMQ (Bohlmeijer, Klooster, Fledderus, Veehof, & Baer, 2011).

Modified TSST (Kirschbaum et al., 1993). Generally, the TSST operates on the stress reactions from social evaluation and uncontrollability (Birkett, 2011). In the current study, participants were asked to prepare a three minute presentation about “why they are a good friend.” Participants had several minutes to prepare while the researchers had set up a Skype conversation in a different room for their presentation to be streamed live to a panel of judges. Once the participants were told that they do not have to give a presentation after all, their HR was monitored to see how long it took to return to resting levels as an indication of recovery from stress. A recent study that tested the ecological validity of the TSST found that TSST
responses were significantly associated with acute stress responses in real life (Henzea et al., 2017).

**Data Analyses**

Data were analyzed using the IBM Statistical Package 23.0 version (IBM corp., 2015). Approximately 10% of the data were checked for entry errors, and we concluded that there were no misinterpretations in the data entered based on the values that were checked. A reliability analysis (Cronbach’s α) was calculated for total FFMQ-SF scores to determine the internal consistency of the mindfulness facets (non-reactivity, acting-with-awareness, non-judgement, etc.). We calculated means for the first two phases (adaptation and reactivity) of the TSST, and calculated reactivity scores by subtracting average baseline HR from average reactivity HR. We conducted a paired samples t-test to compare baseline HR levels and HR reactivity, and whether the TSST significantly induced stress in participants. We ran a Pearson’s correlation to examine the relationships between HR reactivity scores and recovery (in seconds) and all predictors involved (i.e., demographics, PHQ-8, and FFMQ-SF). To directly examine the prediction relating to trait mindfulness and HR recovery from the TSST, a hierarchical linear regression analysis was conducted.

**Results**

**Sample Characteristics**

The total sample consisted of 110 participants (78.2% female; \(\bar{X} = 21.5\) years), all of whom were attending the University of Regina as students. About 51% of participants \((n = 56)\) were psychology students. 60% of participants \((n = 66)\) were White. Out of a possible 120 score on the FFMQ-SF, the average score was approximately 75.3 \((SD = 11.8)\), and the reliability test
supported the measures’ internal consistency (Cronbach’s $\alpha = .815$). Demographic variables are summarized in Table 1.

**Manipulation Check**

As planned, we conducted a paired samples t-test to determine if the TSST significantly induced stress by increasing HR from baseline levels. The mean for resting HR during the adaptation phase of the TSST was $M = 84.60$ ($SD = 14.02$). The mean for HR during the reactivity phase of the TSST was $M = 94.62$ ($SD = 15.76$). The difference between the means was statistically significant, $t (108) = 10.31, p < .001, d = -1.005$. On average, participants HR increased by 10 BPM.

**Zero Order Correlations**

A Pearson’s correlation was conducted to assess the relationships between HR reactivity and recovery and other variables (i.e., PHQ-8 and FFMQ-SF). There was a positive relationship between FFMQ-SF and HR reactivity, $r = .20, p < .05$. There was a positive relationship between HR reactivity and recovery times, $r = .24, p < .05$. There was a negative correlation between FFMQ-SF and PHQ-8 scores, $r = -.48, p < .001$. There were no statistically significant correlations between other variables; refer to Table 2 for more information.

**Unique Variance Contributed by Trait Mindfulness in HR Recovery**

A hierarchical linear regression analysis was conducted with Demographic information in the first block, PHQ-8 total scores in the second block, and FFMQ-SF total scores in the third block predicting HR recovery. Blocks one (demographics), $F (2, 103) = 2.20, p = .12, \hat{R}^2 = .04$, two (depressive symptoms), $F (3, 102) = 1.84, p = .15, \hat{R}^2 = .05$, and three (trait mindfulness), $F (4, 101) = 1.80, p = .14, \hat{R}^2 = .07$ were not significant predictors of HR recovery. Change from
the first and second blocks to the third was also not statistically significant, \( \Delta \bar{M} (1, 101) = 1.66, p = .20, \Delta \bar{M}^2 = .02 \). See table 3 for a summary of the regression analysis statistics.

**Discussion**

The purpose of this study was to examine if trait mindfulness predicted HR reactivity and recovery during a standardized stress-induction procedure (TSST). Existing research suggested trait mindfulness has a role in adaptive psychological appraisals of stress, which may influence cardiovascular reactions to stress (Bibbey et al., 2013; Creswell et al., 2014). To test this, a sample of University of Regina students participated in a modified version of the TSST, and HR was monitored before, during and after the lab stressor. These HR reactions and recoveries were compared to questionnaire scores that assessed depressive symptoms and trait mindfulness. We predicted that individuals higher in trait mindfulness would have the quickest HR recovery times from the TSST. Other studies have evaluated psychologically perceived stress to the TSST in individuals who have practiced mindfulness. However, ours was a novel study that examined the directional relationship between naturally occurring mindfulness and HR to the TSST while also including other psychological predictors of cardiovascular functioning (e.g., depression). The present study was necessary to reveal the mediating effects of psychological and dispositional wellbeing on bodily functions during stress, which may underscore the credibility of mindfulness’ ability to buffer stress-related disease.

As expected, the TSST significantly elicited stress responses from participants as indicated by a marked increase in their autonomic functioning (i.e., HR). These results show that the modified version of the TSST was successful at inducing stress. This finding is in line with other research outcomes that support the reliability of the TSST (Birkett, 2011; Creswell et al., 2014; Cruess et al., 2015; Holt, 2012). The success of the TSST allowed for the direct
examination of physiological changes during stress, and how quickly these physiological proxies returned to equilibrium once the stressor was removed. Many participants had commented that they felt stressed during the reactivity phase of the TSST, and their increased HR reflected this increased arousal.

Additionally, the negative correlation between FFMQ-SF and PHQ-8 scores was expected. Participants who exhibited more trait mindfulness tended to score lower on depressive symptomology. This finding is consistent with other evidence. Nyklíček and Irrmischer (2017) stated neuroticism (which is also commonly associated with depressive symptoms) has strong negative correlations with various mindfulness facets (e.g., non-judgmental acceptance, awareness, and non-reactivity). Bibbey et al. (2013) reported that unhealthy cardiovascular reactions to stress are more prevalent among individuals scoring high on neuroticism, and so the insignificant relationship between PHQ-8 scores and HR in our study was an inconsistent finding. In accordance with trait mindfulness and adaptive stress responses, the findings of this study suggest that an increase in mindful capacities can benefit clinically depressed or distressed populations. The positive correlation between HR reactivity and recovery was logical: generally, higher HRs were indicative of slower recovery times. The finding that HR reactivity was positively correlated with FFMQ-SF scores is consistent with research (Creswell et al, 2014; Beshai, Prentice & Huang, 2017; Bibbey et al., 2013). This demonstrated that individuals high in trait mindfulness also had high HR reactions perhaps due to their increased awareness with present-moment stimuli and stressors. However, the insignificant correlation between HR recovery times and FFMQ-SF scores does not follow the above logic, and this is largely inconsistent with other research outcomes.
Our prediction that trait mindfulness would predict HR recovery during the TSST over and above demographics and depressive symptoms was not supported. This finding is inconsistent with other studies that found mindfulness-like traits procure healthy HR recoveries from stress (Bibbey et al., 2013; Creswell et al. 2014; Mankus et al. 2013; Rasmussen & Pidgeon, 2011). Individuals higher in trait mindfulness have exhibited high HR reactions and quicker HR recoveries from stress, indicating balanced autonomic functioning between sympathetic and parasympathetic divisions (Bibbey et al., 2013). Also, in one study, trait mindfulness was positively associated with cardiovascular health and negatively correlated with cardiovascular disease risk factors (Loucks, Britton, Howe, Eaton, & Buka, 2015).

There are a few plausible explanations behind our conflicting finding. First, recovery times may be more associated with physiological health, and trait mindfulness may be more related to psychologically perceived stress than physiology. Second, inadequate recovery times may have been due to technical errors. Third, many participants reported that they seldom or never have practiced mindfulness ($n = 89$), and it is contentious that trait mindfulness even exists among untrained respondents (Goodman et al., 2015). In this view, it is uncertain whether trait mindfulness is a naturally occurring disposition that individuals have, unless they “have engaged in specific, formal mental [mindfulness] training” (p. 12). Lastly, there may have been other moderating physiological, psychological and socio-environmental factors that affected trait mindfulness and stress recovery (Goodman et al., 2015), as this study only took into account depressive symptoms, age and gender.

**Strengths, Limitations, and Future Directions**

This study possessed several strengths. First, as mentioned before, no previous studies examined the relationship between trait mindfulness and HR during the TSST, and so this study
included both physiological measures of stress and subjective self-report measures. Second, the modified version of the TSST allowed us to record stress reactions in a time-efficient manner. The mere anticipation of delivering a speech elicited a significant increase in participant HRs without requiring them to speak in front of judges. Third, the University of Regina’s Participant Pool provided an operative means for recruiting a sizable and diverse sample in accordance with a medium effect.

Despite such strengths, this study suffered from several limitations. The sample consisted of students, which undermines the generalizability of these results to general and clinical populations. Furthermore, a large percentage of students were studying Psychology (or have taken a Psychology course), and it is conceivable that many of them would have learned about the TSST in their classes which might have altered their HR reactions in some way. We included a number of self-report measures, which posed the risk of impression management. For example, participants may have consciously or unconsciously altered their answers to coincide with researcher or societal expectations. We included reliable and internally consistent measures for the constructs under study, and so self-report questionnaires are an appropriate method of measurement. A modified version of the TSST may have insufficiently induced stress in all participants. Perhaps having participants deliver an actual speech instead of just preparing one may have produced stronger correlational results. However, there is evidence that the TSST functioned to significantly increase stress reactivity. Certain points in the semester in which students participated may have influenced levels of trait mindfulness. Similar to Nykliček and Irrmischer’s (2017) study sample, student participants may have been more stressed and less likely to exhibit mindful dispositions due to exam periods and impending project deadlines.
Lastly, the design of the present study was correlational; therefore causal inferences about trait mindfulness and stress-related cardiovascular functioning cannot be made.

Future research should extend this study in the context of clinical populations. Improving trait mindfulness and reducing negative affect may explain the success of mindfulness-based interventions (Nykliček, & Irrmischer, 2017). Subjective measures of perceived stress and another physiological indicator of cardiovascular functioning (e.g., blood pressure) could be useful in future studies. Student bodies remain an important cohort for research as they experience extensive academic pressures and responsibilities. Enhancing mindfulness skills may be a cost and time-effective means for students and young adults to manage their stress, mental health, and productivity (Shearer et al., 2016). Also, the addition of comparison groups between individuals who do and do not practice mindfulness can further strengthen the relationship between mindful dispositions and stress responses. If possible, the addition of follow-up tests can lend some information on long-term welfare and healthy cardiovascular functioning that trait mindfulness exacerbates.

Conclusions

In conclusion, the present analyses indicated that the modified TSST successfully induced stress in participants by significantly increasing HR. Trait mindfulness and depression scores were negatively correlated. Trait mindfulness was positively correlated with HR reactivity but did not share a significant relationship with HR recovery. Also, a hierarchical regression test revealed that trait mindfulness did not predict HR recovery over and above demographics and depressive symptoms. These outcomes support earlier evidence that trait mindfulness plays a role in cardiovascular functioning during stress; although, further research should be undertaken to examine the moderating effects trait mindfulness has on adaptive physiological functioning.
following stress. As such, perhaps these findings are preliminary evidence of the complex mind-body interactions of mindfulness during stressful circumstances.
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Table 1. Demographic characteristics and measures of interest

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<th>Age: M (SD)</th>
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<td>Sex</td>
<td>n= 110 (%)</td>
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<td>Female</td>
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**Marital status**

| Single | 101 (91.8) |
| Married | 5 (4.5) |
| Divorce | 1 (0.9) |
| Other | 3 (2.7) |

**Ethnicity**

| White/Caucasian | 66 (60) |
| Black | 8 (7.3) |
| Indigenous | 4 (3.6) |
| Middle Eastern | 6 (5.5) |
| Asian | 24 (21.8) |
| Other | 7 (6.4) |

**Year of study**

| 1 | 24 (21.8) |
| 2 | 36 (32.7) |
| 3 | 27 (24.5) |
| 4 | 15 (13.6) |
| 5+ | 8 (7.3) |

**Major of study**

<p>| Psychology | 56 (50.9) |
| Human Justice | 5 (4.5) |
| Health Studies/ | 7 (6.4) |
| Nursing |  |  |
| Biology/ | 14 (12.7) |
| Biochemistry |  |  |
| Buisness/Finance | 6 (5.5) |</p>
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<tr>
<th>Trait</th>
<th>Mindfulness and Heart Rate During Stress</th>
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<table>
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<th>Category</th>
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**Employment status**

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<tr>
<th>Employment Status</th>
<th>Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployed</td>
<td>42 (38.2)</td>
</tr>
<tr>
<td>Part-time</td>
<td>65 (59.1)</td>
</tr>
<tr>
<td>Other</td>
<td>3 (2.7)</td>
</tr>
</tbody>
</table>

**History of Psychiatric Condition(s)**

<table>
<thead>
<tr>
<th>History</th>
<th>Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>19 (17.3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean (SD), Cronbach's α</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHQ-8: M (SD),</td>
<td>8.2 (6.2), 0.904</td>
</tr>
<tr>
<td>Cronbach's α</td>
<td></td>
</tr>
<tr>
<td>FFMQ-SF</td>
<td>75.3 (11.8), 0.815</td>
</tr>
</tbody>
</table>

Note: PHQ-8= Patient Health Questionnaire; FFMQ-SF= Face Facet Mindfulness Questionnaire Short-Form
Table 2. Correlations between HR reactivity and recovery and all measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 HR Reactivity</td>
<td>-</td>
<td>-0.08</td>
<td>.24*</td>
<td>.20*</td>
</tr>
<tr>
<td>2 PHQ</td>
<td>-</td>
<td>0.15</td>
<td>-.48**</td>
<td></td>
</tr>
<tr>
<td>3 HR Recovery</td>
<td>-</td>
<td>-0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 FFMQ</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: PHQ-8= Patient Health Questionnaire; FFMQ-SF= Five Facet Mindfulness Questionnaire Short-Form

(*) p < .05*, p < .01**, p < .001***
Table 3. Hierarchical regression analysis for HR recovery

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.99</td>
<td>0.87</td>
<td>-0.12</td>
<td>1.15</td>
</tr>
<tr>
<td>Gender</td>
<td>-20.55</td>
<td>10.12</td>
<td>-0.21</td>
<td>2.03</td>
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<tr>
<td>Block 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-1.08</td>
<td>0.87</td>
<td>-0.13</td>
<td>1.24</td>
</tr>
<tr>
<td>Gender</td>
<td>-18.65</td>
<td>10.28</td>
<td>-0.19</td>
<td>1.81</td>
</tr>
<tr>
<td>PHQ-8</td>
<td>-0.68</td>
<td>0.65</td>
<td>-0.1</td>
<td>1.05</td>
</tr>
<tr>
<td>Block 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.86</td>
<td>0.88</td>
<td>-0.1</td>
<td>0.98</td>
</tr>
<tr>
<td>Gender</td>
<td>-19.25</td>
<td>10.26</td>
<td>-0.19</td>
<td>1.88</td>
</tr>
<tr>
<td>PHQ-8</td>
<td>-1.1</td>
<td>0.73</td>
<td>-0.17</td>
<td>1.52</td>
</tr>
<tr>
<td>FFMQ-SF</td>
<td>-0.5</td>
<td>0.39</td>
<td>-0.14</td>
<td>1.29</td>
</tr>
</tbody>
</table>

Note: PHQ-8= Patient Health Questionnaire; FFMQ-SF= Five Facet Mindfulness Questionnaire Short-Form

(*) p < .05, p < .01**, p < .001***