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A thesis submitted to the Faculty of Emory College of Arts and Sciences

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Abstract

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The purpose of this study is to evaluate the effects of a breath-focused mindfulness intervention on dissociation and heart rate variability (HRV) in patients with posttraumatic stress disorder (PTSD) and dissociative symptoms. HRV is a psychophysiological indicator of autonomic nervous system (ANS) function. Dissociative PTSD patients have been found to have dysregulated HRV in response to stressful stimuli. Mindfulness-based interventions have been shown to improve ANS functioning in various populations, and thus may be useful in addressing these problems in dissociative traumatized patients. Thus, I hypothesize that an improvement in ANS functioning, manifested physiologically as improved HRV, will be associated with improved dissociative symptoms in traumatized dissociative patients following a mindfulness intervention. A total of 30 female African American participants aged 18-65 ($\underline{x} = 42.8$, $SD = 13.0$) were recruited from Grady Memorial Hospital in Atlanta, GA and underwent clinical assessments for PTSD and dissociative symptoms. Following consent, participants completed 6 brief (15 minute) breath-focused mindfulness meditation (BFMM) sessions. HRV data was collected during each session and subsequently analyzed using frequency domain analysis. Results showed a significant correlation between an increase in HRV and decrease in dissociative disengagement. Dissociation and PTSD symptoms significantly decreased from pre- to post-treatment. The findings of this study provide compelling evidence that breath-focused mindfulness may improve ANS functioning and dissociative symptoms in traumatized people.

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I. Introduction

A. Posttraumatic Stress Disorder and Dissociation

1. PTSD and dissociation

Dissociation is a response to stress that emerges in a subset of traumatized individuals. This response can manifest as an altered state of consciousness accompanied by a feeling of detachment from the self or surroundings, as well as a reduced ability to integrate and access memories, thoughts, perceptions, and feelings (Briere et al. 2005). Dissociation can often develop as a way to cope with inescapable stressors, such as severe childhood abuse or extended exposure to combat (Ginzburg et al., 2006; Stein et al., 2013; Wolf et al., 2012). Extensive research has shown that trauma can be etiologically linked to dissociative responses to stress (Dutra et al., 2009; Lanius et al., 2010; van der Kolk et al., 1996). Trauma severity is positively correlated with dissociation severity, indicating that highly traumatized individuals exhibit elevated levels of dissociation (Cardeña & Carlson, 2011; Lanius et al., 2012).

Numerous studies were conducted on dissociation and its relation to posttraumatic stress disorder (PTSD), which led to the only current subtype of PTSD, the dissociative subtype, defined in the 5th version of the Diagnostic and Statistical Manual for Psychiatric Disorders (DSM-V) (American Psychiatric Association, 2013). The DSM-V defines the criteria for meeting this subtype as exhibiting two specific categories of symptoms in addition to PTSD diagnosis: 1) Depersonalization (disconnect between the mind and body) and 2) Derealization (disconnect between the self and the environment). In a 2013 study investigating cross-national epidemiological surveys, only about 14.4% of patients with PTSD in the United States qualified for this dissociative subtype (Stein et al., 2013). However, many traumatized individuals who do not meet criteria for the dissociative subtype of PTSD likely still experience detrimental symptoms of dissociation which can cause impairments in daily functioning (Dorahy & Hart, 2015; Fani et al., 2019; Lanius et al., 2012). As much as 15-30% of people diagnosed with PTSD experience symptoms of dissociation (Boyd et al., 2018; Wolf et al., 2012).

A number of studies suggest that traumatized people can exhibit a wide range of dissociative symptoms including emotional numbing, identity confusion, or gaps in awareness/consciousness on a somatic, behavioral, cognitive, or affective level (Briere et al., 2005; Cardeña & Carlson, 2011; Dorahy & Hart, 2015). This evidence supports the idea of dissociation as multidimensional instead of narrowly restriction to depersonalization or derealization symptoms. This prompted the creation of several measures that assess the different manifestations of dissociation symptoms including the Multiscale Dissociation Inventory (MDI) measure which examines 6 different dimensions of dissociation (disengagement, identity dissociation, memory disturbance, emotional constriction, depersonalization and derealization), as compared to just the two that characterize in the DSM-V subtype of dissociative PTSD (Briere et al., 2005). The MDI measure allows clinicians to have a more comprehensive understanding of the variety of dissociative symptoms that their patients might be experiencing which can help in deciding the course of treatment.

2. *Connecting clinical significance with biological evidence: Neurobiological basis of PTSD*

The pathophysiology of PTSD involves abnormal response in brain circuits involved with emotion regulation and fear expression. Among the neurological structures heavily implicated in PTSD are the ventromedial prefrontal cortex (vmPFC), amygdala, and insula. The vmPFC has been associated with emotion regulation and top-down inhibition of emotional input from the amygdala (Koenigs & Grafman, 2009). The amygdala is involved in fear response and fear signaling which is normally dysregulated in PTSD patients. Connectivity between the vmPFC and the amygdala has been associated directly with emotion regulation (Koenigs & Grafman, 2009). The insula is associated with salience detection and interoceptive awareness, which is the perception of internal physical sensations such as heartbeat, respiration, and other autonomic nervous system (ANS) activity related to emotion (Price & Hooven, 2018).

Emotion dysregulation presents in different ways in patients with PTSD. Among those who exhibit more hyperarousal and re-experiencing symptoms, exaggerated amygdala response and reduced vmPFC response is observed (Yehuda, 2001). This has been referred to as emotion undermodulation model, since fear responses are thought to be insufficiently inhibited by the vmPFC (Lanius et al., 2012). In addition, these patients often display an overactive insula response, which may result in exaggerated attention to internal stimuli (Sripada et al., 2012).

3. Unique neurophysiological characteristics of dissociative PTSD patients

Patients with PTSD and dissociative symptoms have been associated with different patterns of response with respect to these emotion regulation networks. In contrast to patients with more fear-related symptoms, those with dissociative symptoms have been shown to exhibit higher levels of activity in the vmPFC as well as decreased activity in limbic areas - namely the amygdala (Lanius et al., 2012). Since the amygdala is involved in fear signaling, dampening its effect impairs an individual’s ability to generate an appropriate fear response to stimuli. Increased activity in the prefrontal cortex and reduced amygdala response characterize people with PTSD who overmodulate their emotional reactions, including dissociative people (Lanius et al., 2012).

Persistent over-activity of the frontal cortex acts antagonistically with activity in the amygdala resulting in a blunted fear response and constricted emotional affect. Unlike PTSD patients with greater re-experiencing and hyperarousal symptoms, patients with PTSD and dissociation symptoms exhibit hypoarousal and excessive activation of fear inhibition brain areas (Yehuda, 2001). One study investigated which brain regions were active when dissociative PTSD patients consciously and unconsciously processed fear. Results of the study showed that the vmPFC was very active in the dissociative patients during conscious processing of fear, which aligned with emotional overmodulation and hypoarousal dominance neurophysiology (Felmingham et al., 2008). A prominent study by Lanius et. al investigated pain response in healthy individuals when they were put into hypnosis-induced states of depersonalization. Neurobiological evidence from the study demonstrated that the amygdala response was attenuated when the participants were in an induced dissociative state (Lanius et al., 2010). Another neurophysiological characteristic discovered in patients with dissociative PTSD was the underactivation of the right anterior insula. Patients with dissociation have difficulties in attending to their internal physical sensations and demonstrate impaired interoceptive ability (Lanius, 2015). Since the insula is implicated in interoceptive awareness, patients with dissociation, especially symptoms of depersonalization, were expected to have reduced activation in the insula (Hopper et al., 2007; Yehuda, 2001).

Along with examining neurological correlates of dissociative PTSD, psychophysiological measures must be discussed to provide a thorough understanding of the biological effects of PTSD with dissociative symptoms.

4. Psychophysiological differences between non-dissociative and dissociative PTSD

In addition to having distinct neurophysiology, patients with PTSD and dissociative symptoms seem to display distinct psychophysiological characteristics from non-dissociative PTSD patients. Few studies have thoroughly investigated psychophysiological differences between non-dissociative and dissociative PTSD patients, so results are heterogeneous. Although these studies are limited in number, emerging data indicates that dissociative PTSD patients tend to display a blunted stress response as a result of rigidity in the parasympathetic nervous system (PNS).

Dysregulation of the ANS is caused by an imbalance between its two branches (the parasympathetic and sympathetic nervous systems) resulting in psychophysiological changes. In non-dissociative PTSD patients, chronic overactivation of the sympathetic nervous system (SNS) results in an exaggerated fear response and high cortisol levels, increased skin conductance, increased startle response, and increased heart rate (Vieweg et al., 2006). Patients with overactivation of the SNS normally display hyperarousal/hyperreactivity symptoms and an impaired ability to discern between safe and threatening environments. These physiological findings are consistent with the emotional under modulation model in which emotional responses and increased arousal levels are ineffectively regulated by frontal cortex brain structures (Lanius et. al, 2012).

In contrast to non-dissociative PTSD patients, PTSD patients with dissociative symptoms exhibit overactivation of the PNS and underactivation of the SNS manifesting as a blunted stress response (Zaba et al., 2015). The overactivation of the PNS is associated with a decreased heart rate, lower cortisol levels, and decreased skin conductance (Griffin et al., 1997). A study conducted in 2012 demonstrated that in response to trauma-related stimuli, individuals with high dissociative symptoms exhibited lower heart rate and skin conductance in comparison to individuals with low dissociative symptoms (Sack et al., 2012). Another study examining psychophysiological responses during a trauma interview discovered that highly dissociative and highly traumatized women demonstrated suppressed autonomic functioning with regards to skin conductance and heart rate (Griffin et al., 1997).The emotional overmodulation mechanism discussed by Lanius (2012) can help explain these psychophysiological differences seen in dissociative versus non-dissociative PTSD patients. As mentioned earlier, the neurophysiological characteristics of emotional overmodulation involve underactivation of the amygdala and excessive modulation of the amygdala by the vmPFC. In the context of stress, this emotional overmodulation impairs the ability of an individual to generate an appropriate fear response to threat stimuli. Corticolimbic structures, namely the amygdala, which are involved in the stress response and subsequent activation of the SNS are suppressed in dissociative patients. These findings demonstrate associations between dissociation and abnormalities in the physiological response, with some evidence to indicate that dissociation is linked to sympathetic suppression.

Sympathetic and parasympathetic functioning can be assessed using certain psychophysiological measures which can help characterize psychiatric disorders.

B. Heart Rate Variability

1. Heart rate variability as a measure of ANS functioning

An important non-invasive psychophysiological measure that is used to measure ANS functioning is heart rate variability (HRV). HRV is defined as the variability in time between R-R intervals of heart beats. Mali et. al provides a clear depiction of what an R-R interval is in a figure included in their paper which has been provided below (Mali et al., 2008)

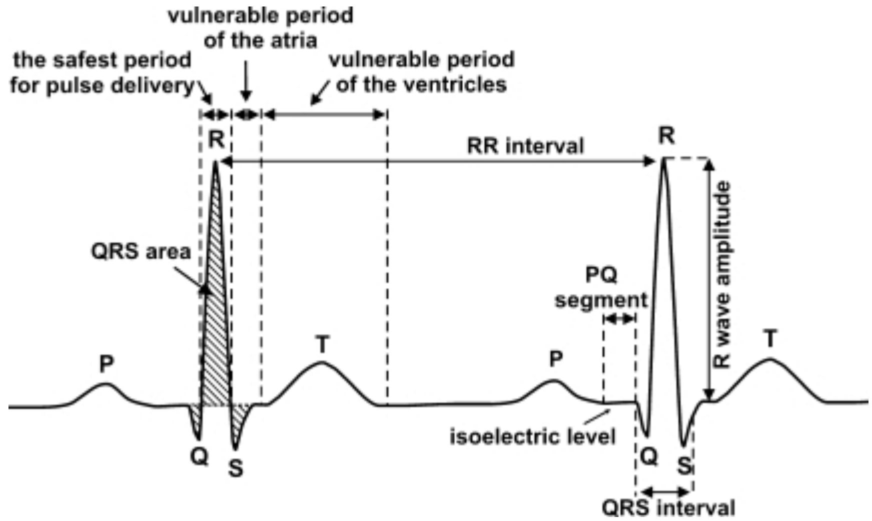

Figure 1. Diagram of R-R intervals between successive heartbeats which is used to determine HRV (Mali et al., 2008)

High variability indicates a healthy functioning ANS whereas low variability correlates with a poorly functioning ANS (de Souza Filho et al., 2019). A healthy functioning ANS allows for easy flexibility between the parasympathetic and sympathetic branches to allow for appropriate responses to different stimuli. A poorly functioning ANS indicates a rigidity of either system or inability to toggle between the two systems efficiently. Individuals with chronic activation of the SNS or chronic activation of the PNS will likely both display low HRV. An individual with a healthy functioning ANS will have a balance between the two systems and display high HRV. Figure 2 helps explain how low HRV is associated with rigidity and high HRV with flexibility between the ANS branches.

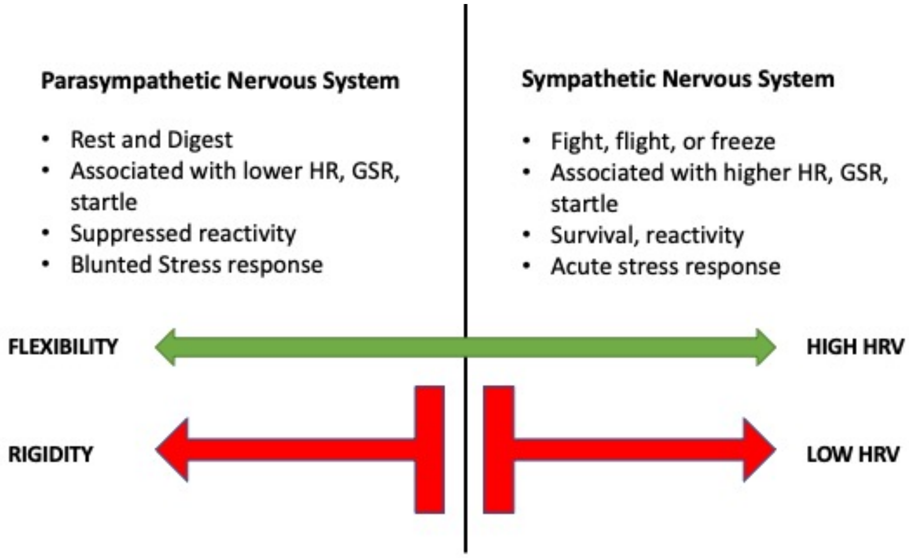

Figure 2. HRV is determined by how flexibly one is able to move between the two ANS branches

The sinoatrial node (SA) is directly involved in regulating heart rate and is heavily innervated by parasympathetic and sympathetic nerves. Thus, heart rate reflects the modulating effects of each ANS branch on the SA node (Berntson et al., 1997). Activation of the parasympathetic nerves slows heart rate whereas activation of the sympathetic system nerves increases heart rate and cardiac output during stressful situations. The interplay of these two systems allows the heart to respond quickly to what the situation demands. Thus, HRV is a useful metric for examining how efficiently the ANS is functioning by determining if there is an imbalance between the two ANS branches.

HRV can be measured using time or frequency domain analysis. Time domain analysis quantifies the amount of HRV during certain monitoring periods that can last anywhere from <1 min to >24 hours (Shaffer & Ginsberg, 2017). Frequency domain analysis involves distinguishing heart rate based on its intensity and frequency. This provides information on all changes in the heart rate by looking at the periodic heart rate oscillations in different frequencies.

(Yilmaz et al., 2018). Frequency domain analysis is similar to a prism refracting light into its component wavelengths (Shaffer & Ginsberg, 2017). There are generally two frequencies at which heart rate variability is normally measured: high frequency and low frequency. High frequency HRV is hypothesized to be mediated by the parasympathetic system whereas the low frequency HRV does not have a clear correlation with the SNS (Pumprla et al., 2002). Evidence shows that while the SNS does have a mediating effect on low frequency HRV, the parasympathetic system may also have an effect on regulating low frequency HRV as well. Thus, it can only be concluded that high frequency HRV is a reliable measurement of parasympathetic functioning (Pumprla et al., 2002).

The usefulness of HRV as a biomarker for ANS functioning cannot be underscored in relation to characterizing different illnesses. In fact, HRV has been increasingly used as a psychophysiological biomarker for many mental health illnesses that involve ANS dysregulation.

2. *Low HRV characterizes psychiatric disorders*

Several psychiatric disorders such as schizophrenia, depression, panic disorders, and PTSD are correlated with relatively low HRV compared to healthy controls without a psychiatric disorder as found through multiple studies (Alvares et al., 2016; Birkhofer et al., 2005; Hauschildt et al., 2011).

Emotion regulation is highly correlated with an ability to move flexibly between the two branches of the ANS in response to various stimuli. A rigid autonomic nervous system can result in constriction of emotional response or uncontrolled emotions (Appelhans & Luecken, 2006). The model of neurovisceral integration proposed by Thayer relates HRV and emotion regulation by incorporating a dynamic systems perspective. In this model, large scale observable patterns are products of smaller interacting forces. Thus, observable emotion states emerge as a result of interactions among sympathetic and parasympathetic systems (Appelhans & Luecken, 2006). Therefore, dysregulated HRV can help clinicians interpret emotion dysregulation that may accompany certain disorders.

Studies have shown that there is a link between trauma exposure and decreased HRV levels which prompts further investigation into how HRV can act as a biomarker for patients with PTSD.

3. HRV as a biomarker in the context of PTSD

HRV may be a useful index of emotional arousal and ANS functioning in PTSD patients. Many PTSD patients demonstrate an exaggerated SNS response and suppressed parasympathetic response in general and in response to different stimuli (Kibler et al., 2014; Morris & Rao, 2013; Williamson et al., 2015). This indicates a rigidity in the ANS which refers to an impaired ability to move flexibly between the parasympathetic and sympathetic system.

A pilot study investigating psychophysiology of combat veterans demonstrated that those with combat-related PTSD had significantly lower HRV in comparison to participants without PTSD (Tan et al., 2011). In another veteran population, a study found that military sexual trauma concomitant with PTSD predicted greater autonomic dysregulation as measured by HRV compared to female veterans without PTSD, trauma exposed female veterans and patients with non-combat related PTSD (Lee & Theus, 2012). These studies clearly show the relationship between PTSD and ANS dysregulation as measured by HRV.

Other studies looking into civilian populations have found that amongst highly-traumatized community samples, patients with PTSD demonstrate lower HRV than those without a PTSD diagnosis and in comparison to healthy controls (Hauschildt et al., 2011; Jovanovic et al., 2009; Liddell et al., 2016). During a trauma recall task and mental arithmetic task, patients with PTSD were found to have lower HF-HRV than healthy controls (Keary et al., 2009). The findings of this study show that PTSD patients have decreased HRV in all situations whether or not traumatic stimuli were present, which indicates a persistent dysregulation in autonomic functioning. In a population of 32 drug-naive PTSD patients, researchers found that resting cardiac vagal control (measured by HRV) was significantly decreased which underscored the importance of autonomic dysregulation in PTSD patients (Chang et al., 2013). A longitudinal study showed that heart rate indices (including HRV) predicted greater posttraumatic stress symptomatology in children after exposure to a traumatic event (Haag et al., 2019). This could indicate that autonomic dysregulation could contribute to the maintenance and severity of PTSD symptomology. In PTSD patients with dissociative symptoms, less is known about how dissociation impacts autonomic functioning.

4. <u>HRV in dissociation</u>

Few studies have been conducted on the relationship between HRV and dissociation. However, collective data seem to suggest that patients with dissociative PTSD or high levels of trauma exposure and dissociative symptoms show low HRV. Apart from PTSD and dissociation, patients with dissociative disorders tend to display dysregulated cardiac vagal tone, measured by HRV, in comparison to healthy controls (Schäflein et al., 2018). One study conducted in 2017 showed that highly dissociative patients with trauma, especially those exhibiting high depersonalization and disengagement symptoms, had reduced HRV compared to non-dissociative trauma patients (Gosain & Kongsvik, 2017). In 2019, another study showed greater parasympathetic tone and decreased heart rate in PTSD patients were significantly associated with high dissociation symptoms (Seligowski et al., 2019). In this case, autonomic dysregulation appears to be a biomarker for emotion dysregulation in people with PTSD and dissociative symptoms. A review of dissociation studies in children found that with prolonged exposure to trauma, children will display dysregulated SNS responses due to vagus nerve activation and circulation of noradrenaline which results in decreased heart rate and likely lower HRV in comparison to healthy controls (Diseth, 2005). A study of PTSD in adults highly exposed to the 9/11 attacks on the World Trade Center found that patients with dissociation exhibited blunted HRV reactivity in comparison to non-dissociative PTSD participants (Simeon et al., 2008). Further research is required to determine how to improve these physiological aberrations in patients with dissociation and PTSD.

C. Treatments to address autonomic abnormalities associated with dissociation: Mindfulness interventions

1. *Origins and anthropological perspective of mindfulness*

Mindfulness meditation is a technique that is increasingly being used in the context of psychiatric disorders, including PTSD. Despite its secular application today, mindfulness originally was a somatic practice that was part of traditional Buddhist religious rituals and appeared in the Upanishads ancient texts of Hinduism.

The concept of mindfulness meditation has roots in Zen Buddhism (Desbordes et al., 2015). Originating in India, mindfulness focuses on interoception and somatic awareness. Interoception refers to focused attention on internal body signals such as heartbeat, respiration, and muscle tension amongst other body processes. Interoception is thought to enhance mind-body connection and is a critical component of mindfulness (Gibson, 2019). There are different types of meditation within Buddhism. One branch that specifically focuses on interoception is called "*vipassana*" or "*insight*" meditation (Edi: Srimat Kuvalayananda, 1930). Vipassana meditation emphasizes focusing on one's breathing and being aware of different physical sensations (i.e. chest rising, heart beating slower, proprioception) in the body without judgement or any distracting thoughts (Behanan, 1937). In some pieces of literature, this type of meditation is also known as *'anapasanti'* which literally translates to 'mindfulness of breathing' (Birch, 2011). Meditation has been implemented in a variety of cultures now as the biological evidence of its usefulness continues to be investigated.

This cross-cultural borrowing of practices can have exciting implications in clinical application as treatment supplements and integration into Western medicine. Increasing interest in meditation and mindfulness, in particular, prompts further investigation into the beneficial effects of these practices.

2. Biological effects of mindfulness

From a biological standpoint, many studies have been conducted to examine the physiological effects of mindfulness. Several studies have shown that mindfulness meditation affects physiology in the form of decreased heart rate, decreased breathing rate, decreased cortisol levels, increased HRV, decreased oxygen consumption, and decreased muscle tension in clinical populations (Austin, 2006; Benson & Klipper, 2000; Cardeña & Carlson, 2011; de la Fuente del Moral et al., 2010; Zeidan et al., 2010). A meta-analysis conducted in 2017 showed that various forms of meditation interventions significantly reduced cortisol levels, resting blood pressure, systolic blood pressure, and heart rate amongst both healthy and clinical populations (Pascoe et al., 2017).

Additionally, participation in mindfulness based stress reduction programs has been shown to significantly improve ANS functioning by enhancing HRV in healthy populations (Nijjar et al., 2014; Peressutti et al., 2012) Furthermore, the practice of yoga in conjunction with mindfulness has been associated with decreased activity of the HPA-axis which is involved in the stress response by release of cortisol and increase in parasympathetic response in a public school population (Brown, 2019). Breath-focused mindfulness has the unique component of combining both involuntary and voluntary practices. Breathing is under control of both autonomic and somatic processes that are intertwined in complex feedback loops (Zaccaro et al., 2018). Voluntarily controlling the breath can influence HRV and cardiac vagal tone (Daigneault et al., 2016). A study asked healthy individuals to engage in breath-focused mindfulness meditations and EEG as well as respiration data was collected. Results from the study showed that there was an increase in alpha and theta waves during the intervention which are related to relaxation and deep meditation (Ahani et al., 2013). Additionally, respiration rate decreased during the breath-focused meditation which was associated with greater activation of the PNS (Ahani et al., 2013). One study found that various mindfulness based practices including breath focused mindfulness resulted in decreased activation of the SNS as well as decreased heart rate, blood pressure, oxygen consumption, and muscle tension in a healthy, nonclinical population (Brisbon & Lowery, 2011).

In terms of neurophysiology, mindfulness has been associated with increased activation of the insular cortex and somatic cortices which are involved with body awareness and interoceptive ability (Tang et al., 2015).

In the context of psychiatric disorders, mindfulness is a useful non-pharmaceutical treatment to address affective, cognitive, and physiological dysregulation. Since mindfulness promotes a more adaptive response to stressful stimuli, it has been evaluated with patients who suffer from anxiety and depressive disorders including PTSD.

3. Mindfulness and PTSD

In the context of PTSD, mindfulness is increasingly under investigation as a primary treatment method. Mindfulness is a useful PTSD treatment since it targets many aspects of PTSD symptomatology such as avoidance, hyperarousal, and dissociation. Lang et. al posited that 3 components of mindfulness (attention, mindful cognition, and non-judgment) can help address PTSD symptoms (Lang et al., 2012). Lang suggested that mindful shifting of attention can improve attentional control in PTSD patients, mindful cognition can decrease ruminative tendencies that often lead to anxious behavior, and nonjudgmental acceptance of experience and emotions can mitigate emotional numbing behavior often associated with dissociation (Lang et al., 2012). Concurrent with Lang's hypothesis, a systematic review of mindfulness-based treatments for PTSD found that, among studies that reported changes in PTSD symptom domains, there was a consistent significant decrease in re-experiencing, avoidance, numbing, and hyperarousal symptoms (Boyd et al., 2018). A systematic review of randomized clinical trials of mind-body interventions found that the majority of participants randomized to mindfulness treatments experienced a significant within-group decrease in overall PTSD symptoms and many showed significant decreases in PTSD symptoms when compared with a control group (Niles et al., 2018). Another review of mind-body interventions to treat PTSD suggested that mindfulness can be clinically useful as an adjunct treatment for PTSD. The review found that mindfulness could allow participants to reduce their stress and arousal symptoms, improve their mood, and approach treatment with less fear (S. H. Kim et al., 2013).

A prospective study looking at how mindfulness based practices affected PTSD symptom severity in trauma exposed adults found that the group receiving mindfulness treatment exhibited lower PTSD symptom severity and lower cortisol levels than the control group not receiving mindfulness (S. Kim, 2012). Results from this study may support the idea of mindfulness as a possible prophylactic for progression of PTSD symptoms. Further prospective studies should be conducted to determine applicability of mindfulness as a preventative measure for PTSD symptoms.

A 2016 study conducted by Wabeh et. al (2016) investigated how mindfulness based meditation (anapasanti), slow breath practices (breath regulation practices), or wearing a biofeedback machine while breathing, affected PTSD symptoms in combat veterans with PTSD (Wahbeh et al., 2016). The study found that participants in the mindfulness experimental group had greater within-group reduction of PTSD symptoms. Additionally, there was a greater reduction in PTSD symptoms Those who practiced deep breathing and mindfulness meditation for the intervention had decreased respiration in comparison to the control group. The mindfulness group also had lower awakening cortisol within-group but not between groups (Wahbeh et al. 2016). These findings also prompt further investigations into how yogic practices including breath-focused mindfulness meditation can affect physiological systems like the stress response and parasympathetic function. The Gallegos meta-literature study done in 2017 evaluated several studies done investigating the effects of yoga and meditation on PTSD symptoms (Gallegos et al., 2017). The studies categorized yogic practices into 1) mindfulness meditation 2) other meditation and 3) asanas. The study found that there were no significant differences in symptom reduction between the groups; however there was a greater effect size in the yogic practice groups versus controls (Gallegos et al. 2017). Once again the evidence encouraging further research into mindfulness as a PTSD treatment is substantial and promising.

4. Mindfulness and dissociation

In terms of dissociative PTSD, mindfulness has not been studied thoroughly as a treatment and should be considered an area for future studies. However, mindfulness has been explored in patients with dissociation in the context of other disorders such as dissociative identity disorder.

A review of psychological interventions used to treat dissociative disorders suggested that mindfulness can help improve certain common symptoms of dissociation including emotion dysregulation and distress tolerance (Subramanyam et al., 2020). These experiences highlight the need for further investigation into mindfulness and its relation to dissociation. A cross sectional study investigating mindfulness traits and dissociative symptoms in a clinical population experiencing auditory hallucinations found that there was a significant negative correlation between mindfulness ability and dissociative symptoms (Escudero-Pérez et al., 2016). Another cross sectional study looked at the relationship between trauma, mindfulness, and dissociation in a clinical population consisting of patients with either high or low levels of visual hallucinations. The study found that there was a significant negative correlation between high levels of dissociation symptoms (specifically depersonalization and absorption) and low levels of mindfulness (Perona-Garcelán et al., 2014). The results provide interesting data for further investigation into how mindfulness training could possibly serve as a treatment for dissociative symptoms. Dialectical behavioral therapy (DBT) has been an intriguing area of mindfulness treatment that has been used with patients experiencing dissociative symptoms. DBT is defined as a form of psychotherapy that combines aspects of cognitive behavioral therapy with an additional focus on mindfulness and emotion regulation (Robins, 2002). A 2016 case study investigated DBT as a possible treatment for dissociative identity disorder (Foote & Van Orden, 2016). During a breath-focused component of the DBT intervention, the patient was able to attend to affective and physical sensations that preceded “switching” to a different personality state and was more prepared for the dissociative symptoms she experienced (Foote & Van Orden, 2016). Treatments to address dissociative symptoms have emphasized the need to engage in practices that encourage paying attention to the present moment and surroundings. Using techniques such as grounding can facilitate that attention to the present moment which can be directly related to mindfulness (Kennedy et al., 2013) These experiences highlight the need for further investigation into mindfulness and its relation to dissociation.

Mindfulness stresses connection between the body and the mind, which is an area of weakness in people with high levels of dissociation (Zerubavel & Messman-Moore, 2015). Many people with high levels of dissociation experience a severed connection between their body and mind known as depersonalization. This disconnect may arise as a coping mechanism to handle overwhelming stress by avoiding paying attention to physical sensations related to trauma or other stressful stimuli (Steinberg & Schnall, 2010). When depersonalization symptoms become persistent, they can manifest as debilitating feelings of being in a constant dream state, having frequent out-of-body experiences, or lacking ownership over one’s body (Michal et al., 2007). A few cross sectional studies have been conducted investigating the relationship between mindfulness and dissociation with relation to trauma. A study done in 2018 found that mindfulness deficits and dissociation were, in fact, mediators of PTSD symptomology (Kratzer et al., 2018). An investigation done by Bolduc and colleagues found that patients who had higher levels of trauma exhibited more dissociative symptoms and decreased ability to attend to internal body states (Bolduc et al., 2018). This deficit in mindfulness supports the idea that mindfulness treatments would be useful in increasing attention and awareness in dissociative PTSD patients. One treatment study examined mindfulness as a treatment for women with persistent childhood trauma, and found that there were significant reductions in dissociative symptoms post treatment (Zerubavel & Messman-Moore, 2015). The results of this study offer further incentive to investigate the efficacy, both biologically and clinically, of mindfulness treatments to address dissociative symptoms, especially in highly traumatized populations.

5. *Addressing a gap in the literature: How mindfulness affects HRV in dissociative PTSD patients*

The clinical, neurological, and psychophysiological characteristics of non-dissociative PTSD have been studied and reviewed extensively. Dissociative PTSD patients display aberrant psychophysiological response patterns. Heart rate variability, a marker of ANS functioning, is one of the measures that differs between dissociative and non-dissociative PTSD patients. Mindfulness can improve autonomic functioning, by measure of HRV, and clinical symptoms in several psychiatric disorders. In the context of PTSD, mindfulness treatment reduced PTSD symptom severity and improved ANS functioning in several studies. However, little research has been done to assess the effects of mindfulness meditation in dissociative populations, and few studies that have investigated this topic assessed the effects of mindfulness on autonomic responses in their participants. This study strives to address this gap in knowledge regarding the association between patients with dissociative PTSD, HRV, and mindfulness intervention. The study objective is to investigate the effects of breath focused mindfulness meditation on HRV and dissociation symptoms in patients with PTSD and dissociation. My hypothesis is that from the first to sixth intervention session we will see an increase in HRV as well and a concurrent decrease in dissociation symptoms from pre to post treatment.

D. Research Question

1. Are changes in autonomic functioning, as seen by heart rate variability, related to changes in dissociation symptoms in patients with PTSD and dissociation following a brief breath focused mindfulness meditation intervention?

II. Methods

A. Participants

A total of 30 African American women aged 18-65 (Mean = 42.8, SD =13.0) were recruited from an ongoing randomized control trial (RCT) examining the effects of a vibro acoustically-augmented BFMM intervention for dissociation and PTSD symptoms (Physiological Augmentation of Mindfulness Meditation, NCT02754557). All participants, apart from one, were recruited through the Grady Trauma Project, an ongoing study of PTSD risk and resilience. The one participant who was not recruited from the Grady Trauma Project learned about our study through community and university flyers. For this project, the participants are approached at random in the waiting rooms of various clinics (e.g. Diabetes, Pharmacy, Ob/Gyn) of Grady Memorial Hospital. If a patient expresses an interest in participating, they undergo an informed consent procedure and subsequently complete a brief battery of measures assessing trauma exposure and PTSD symptoms. One participant was recruited via flyers posted in areas around the community such as Emory University and Georgia State University.

All participants were screened over the phone to assess eligibility for the study. Inclusion criteria for the intervention study are: 1) women between the ages of 18-65 2) experience of one or more Criterion A events; 3) presence of current PTSD symptoms (defined as meeting criteria for at least two of the four other PTSD criteria), and 4) willingness to participate in the study. Exclusion criteria for the intervention study are: 1) diagnoses of HIV/AIDS or other disorders that affect the central nervous system; 2) a history of bipolar disorder, schizophrenia or primary psychotic disorder; 3) a history of neurological conditions or injuries including strokes, seizures and traumatic brain injury. Participants recruited from the community met the Grady Trauma

Project and study inclusion criteria with the exception that they did not need to identify as Black or African-American. Some distinctive features of the population are that more than 50% of the sample had a high school education or less, and 57% of the sample earned less than $1000 a month. Table 1 describes the clinical and demographic characteristics of the population investigated.

Participant Characteristics *N*=30	**Mean (*SD*) or %**
Age	42.8 (*13.0*)
Level of Education (%)	
<12th grade	20
Highschool diploma/GED	36
Some college	10
Technical School	7
College Graduate	17
Graduate School	10
Monthly Household Income (%)*	
$0-$249	10
$250-499	7
$500-999	30
$1,000-1,999	23
$2,000 or more	27
MPSS Total Score	28.4 (8.9)
MPSS Reexperiencing	7.6 (3.9)
MPSS Avoidance/Numbing	11.4 (4.4)
MPSS Anhedonia	9.4 (3.0)
MPSS Hyperarousal	4.8 (2.3)
MDI Total Score	58.6 (17.1)
MDI Disengagement	14.3 (3.7)
MDI Depersonalization	8.5 (4.1)
MDI Derealization	10.1 (4.7)
MDI Emotional Constriction	11.2 (5.3)
MDI Memory Disturbance	9.7 (3.6)
MDI Identity Dissociation	5.8 (1.7)
*Unable to obtain monthly income data for one participant	

Table 1. Participant demographic and clinical characteristics

B. Clinical Measures

The two clinical measures primarily investigated for this study were the Multiscale Dissociation Inventory (MDI) and Modified PTSD Symptom Scale (MPSS). Both of these measures were administered at pre and post intervention.

1. ***The Multiscale Dissociation Inventory (MDI).*** The Multiscale Dissociation Inventory (MDI) is a 30-item self-report evaluation of six dimensions of dissociative symptoms (Brière, 2002). These dimensions include disengagement, identity dissociation, memory disturbance, emotional constriction, depersonalization and derealization (Brière, 2002; Lanius et al., 2010). This measure has been validated in clinical and community populations and has shown good internal consistency reliability ($\alpha = 0.96$) (Taft, Resick, Watkins, & Panuzio, 2009) and convergent validity with other measures of dissociation (all R2s >.63) (Briere, Weathers, & Runtz, 2005).
2. ***Modified PTSD Symptom Scale (MPSS).*** The Modified PTSD Symptom Scale (MPSS) is a 17-item self-report scale used to assess the frequency and intensity of PTSD symptoms (Falsetti, Resnick, Resick, & Kilpatrick, 1993). The scale is widely used, and has been validated in both clinical and community populations who have suffered a variety of Criterion A trauma (Falsetti, Resick, Resnick, & Kilpatrick, 1992). The MPSS is the primary outcome measure of PTSD symptom severity.

C. Breath Focused Mindfulness Meditation (BFMM)

After being screened and consented for the intervention study, participants received a diagnostic interview to confirm PTSD diagnosis and rule out any exclusionary diagnoses such as bipolar disorder or schizophrenia.

At each of six intervention visits spanning approximately three weeks, participants sat in a chair in a booth in front of a computer screen and were monitored by a researcher outside of the booth via a baby monitor. Before the intervention began, participants were told that they were going to either engage in BFMM (breathe into the microphone or focus on their breath away from the microphone) or rest and relax. They were instructed to pay attention to any somatic feelings or sensations they felt while they were breathing (i.e. chest expanding, belly rising, etc.) during the breath focus condition. They were not told to cognitively reappraise these feelings in any way, but to just pay focused attention to their body and breath during the breath focused condition. Additionally, they were told that if they had any intrusive thoughts about anything other than their breath during this condition, that they should acknowledge those thoughts and try to redirect attention back to the body. The study staff ensured that the participant understood the instructions thoroughly prior to starting data collection. The conditions were randomized, each condition lasted 1 minute, and the total session time was 15 minutes.

Participants were also randomly assigned to two groups: BFMM as usual or BFMM augmented with exteroceptive, vibroacoustic feedback, in which breathing into the microphone resulted in a vibration on their sternum that was proportional to their breath; those in the non-augmented group wore the same device but received no vibratory feedback.

D. Psychophysiological Measures

1. ***Electrocardiogram (ECG).*** ECG data were collected during each of the six BFMM sessions throughout the duration of the intervention. Two electrode leads are placed on the left wrist

(radial artery) and the right side of the neck (carotid artery). ECG data were then collected through the AcqKnowledge software (BIOPAC System, Inc.).

2. ***Heart Rate Variability.*** Heart Rate Variability (HRV) data were preprocessed through MATLAB using a toolkit designed by Dr. Greg Siegle at the University of Pittsburgh (https://www.pitt.edu/~gsiegle/). Data for HRV is checked for quality assurance (QA). QA values were set as follows: heart rate between 40 and 120 beats per minute, without significant abrupt spikes or ectopic beats; electrocardiograms that appear normative with distinct R peaks and QRS complexes. The QRS complex corresponds with the depolarization of the ventricles and subsequent contraction (R peak) of the ventricular muscles. Participants' data that fall outside expected values (*i.e.* fail QA) were manually checked and corrected by study staff. Frequency domain analysis was conducted on the data looking primarily at HF HRV values (LF: 0.04 - 0.15Hz, HF: 0.15 - 0.40Hz). HF HRV data were transformed and subsequently analyzed using SPSS version 26. The output of the analysis were averages of variability in five second time blocks for the first minute of each condition (breath focus vs. rest) for sessions one through six. The first minute of each condition was the time period evaluated for HRV since prior analysis determined that this was the time period of the most observable change in HRV.

E. Statistical Analysis

A repeated measures ANOVA was conducted to determine if there was any significant relationship in dissociative symptoms from pre to post intervention (assessed by the MDI) (N=30). The repeated measures ANOVA was also used to determine if there was a significant change between pre and post intervention PTSD symptom severity (assessed by the MPSS) for the participants (N=30). Finally, the repeated measures ANOVA examined if there was a significant change between pre and post intervention HRV values for the participants (N=30).

Pearson correlations were done to assess the relationship between pre and post MDI and pre and post MPSS scores, as well as between pre and post MDI scores with pre and post HRV values. Pearson correlations were also conducted to assess the relationship between change in MDI and MPSS scores as well as between change in MDI and change in HRV values.

A partial correlation was done to compare changes in HRV from pre to post intervention with changes in disengagement dissociative symptoms from pre to post intervention. Covariates included age of participant when enrolled, use of cardiovascular medications, and baseline PTSD symptom severity (assessed by transformed scores on the MPSS taken at pre-intervention). These covariates were included given possible effects on heart rate variability data.

III. Results

A. Changes in dissociation symptoms from pre to post treatment

A repeated measures ANOVA determined that dissociation symptom severity decreased for the majority of subscales and the total score on the MDI from pre to post BFMM treatment (*ps* $< .05$). The means and standard deviations for the MDI scores pre and post treatment as well as the F statistic and significance from the ANOVA test are shown in Table 2. The change in the identity dissociation MDI subscale was not significant from pre to post treatment. I also found significant decreases in PTSD symptom severity for all the subscales and total scores on the MPSS from pre to post BFMM treatment using the repeated measures ANOVA (all *ps* $< .02$). The means and standard deviations for the MPSS and its subscales for pre and post intervention as well as the F statistic and significance from the ANOVA test are shown in Table 3. Figures 3 and 4 show the distribution of scores and the relationship between MDI scores and MPSS scores at pre ($r = .39$, $p = .04$) and post ($r = .61$, $p = .01$) BFMM timepoints for the participants included in the study respectively (N=30). Figure 5 shows the relationship between change in MDI and MPSS scores from pre to post intervention ($r = .32$, $p = .09$).

Multiscale Dissociation Inventory (MDI)				
Subscale	Pre MDI Mean (SD)	Post MDI Mean (SD)	$F_{(1,29)}$	*p*
Disengagement	14.3 (3.7)	11.4 (4.1)	10.4	**.003***
Depersonalization	8.5 (4.1)	6.5 (2.5)	9.0	**.006***
Derealization	10.1 (4.7)	7.8 (3.7)	11.7	**.002***
Emotional Constriction	11.2 (5.3)	8.8 (4.2)	9.5	**.004***
Memory Disturbance	9.7 (3.6)	7.8 (3.5)	12.7	**.001***
Identity Dissociation	5.8 (1.7)	5.5 (1.1)	1.1	.305
Total	58.6 (17.1)	47.8 (15.2)	17.3	**.000***
***Significant change *p* <.05**				

Table 2. Dissociation symptoms significantly improved from pre to post BFMM treatment

Modified PTSD Symptom Scale (MPSS)				
Subscale	Pre MDI Mean (SD)	Post MDI Mean (SD)	$F_{(1,29)}$	*p*
MPSS Re-experiencing	7.6 (3.9)	4.5 (3.7)	15.0	**.001***
MPSS Avoidance	9.4 (4.4)	6.6 (5.6)	26.3	**.000***
MPSS Hyperarousal	11.4 (3.0)	7.1 (4.2)	16.0	**.000***
MPSS Anhedonia	4.8 (2.3)	2.8 (3.0)	21.8	**.000***
MPSS Total	28.4 (8.9)	18.3 (11.7)	27.7	**.000***
***Significant change *p* < .05**				

Table 3. PTSD symptoms significantly improved from pre to post BFMM treatment.

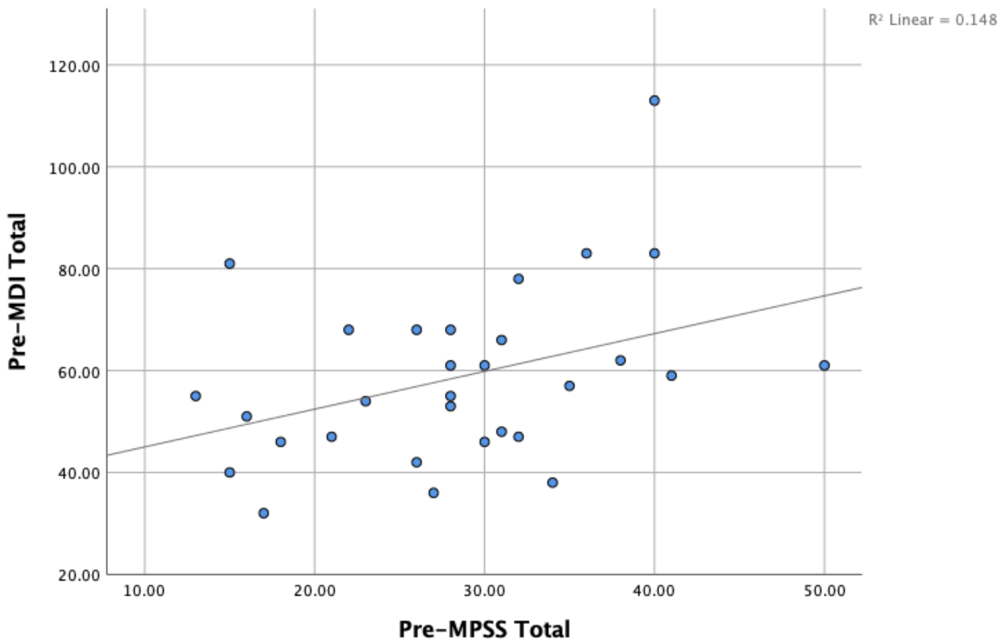

Figure 3. Scatter plot showing relationship between PTSD and dissociation scores at pre-intervention time point (r = .39, p = .04).

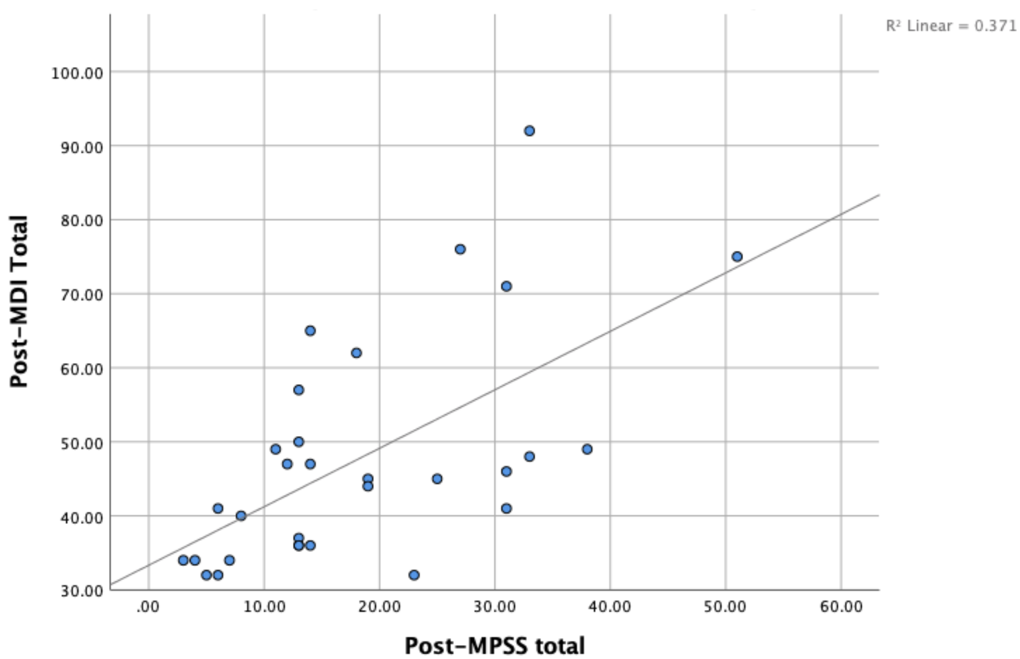

Figure 4. Scatter plot showing relationship between PTSD and dissociation symptoms at post-intervention time point (r = .61, p = .01).

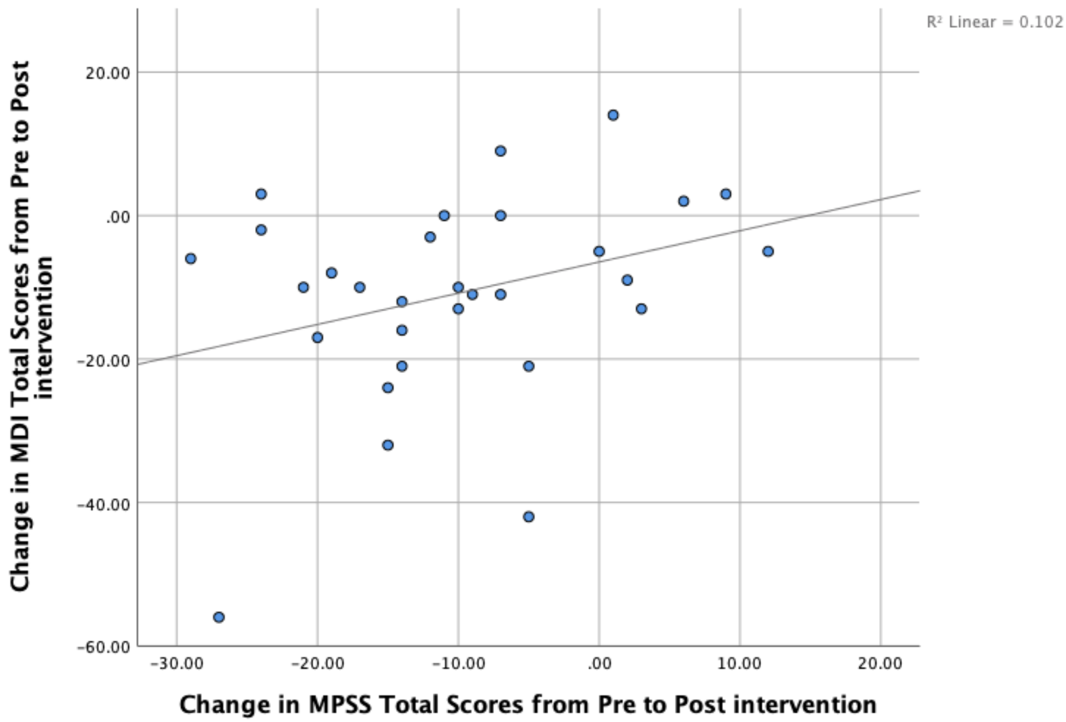

Figure 5. Scatter plot showing change in MDI and MPSS scores from pre to post intervention (r = .32, p = .09).

B. *Dissociation and HRV changes from pre to post treatment*

The repeated measures ANOVA of HRV from pre to post treatment during the breath focus condition yielded no significance (both *ps* > .05). Table 4 shows the mean and standard deviation values for pre and post HRV data as well as the F statistic and significance for the ANOVA. HRV data were taken from the average of the first 5 seconds of the breath focus condition for the first and sixth intervention sessions. Figures 6 and 7 show the relationship between transformed MDI scores and HRV averages during the first 5 seconds of the breath focused condition in BFMM for the first (r = .05, p = .78) and sixth intervention (r = -.24, p = .20) sessions respectively. Figure 8 shows the changes in HRV and MDI scores from pre to post BFMM (r = -.28, p = .13). Figure 9 shows the changes in HRV and MDI scores during the rest condition of the BFMM treatment (r = -.16, p = .40).

Heart Rate Variability (HRV)				
Condition	First BFMM session - 1st 5 sec Mean (SD)	Sixth BFMM session - 1st 5 sec Mean (SD)	$F_{(1,29)}$	*p*
Rest	-.021 (.223)	-.002 (.203)	.145	.706
Breath focus	.109 (.275)	.104 (.300)	.005	.943

Table 4. Changes in HRV from pre to post intervention during 1st 5 seconds of the different conditions

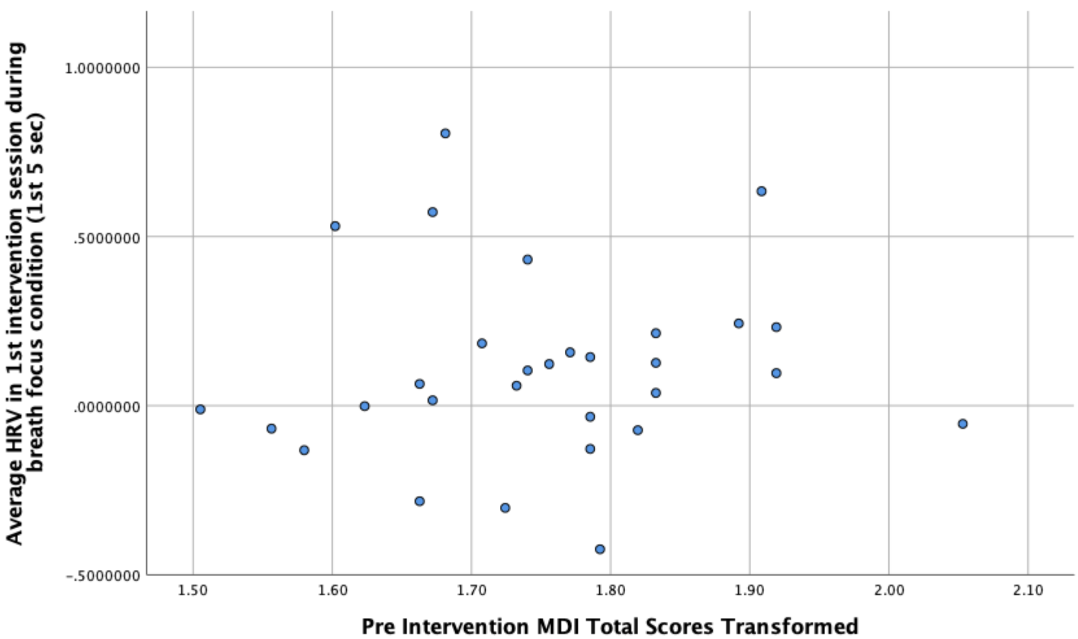

Figure 6. Scatter plot showing HRV averages during first five seconds of breath focus condition in first BFMM session and MDI scores at pre intervention (r = .05, p = .78).

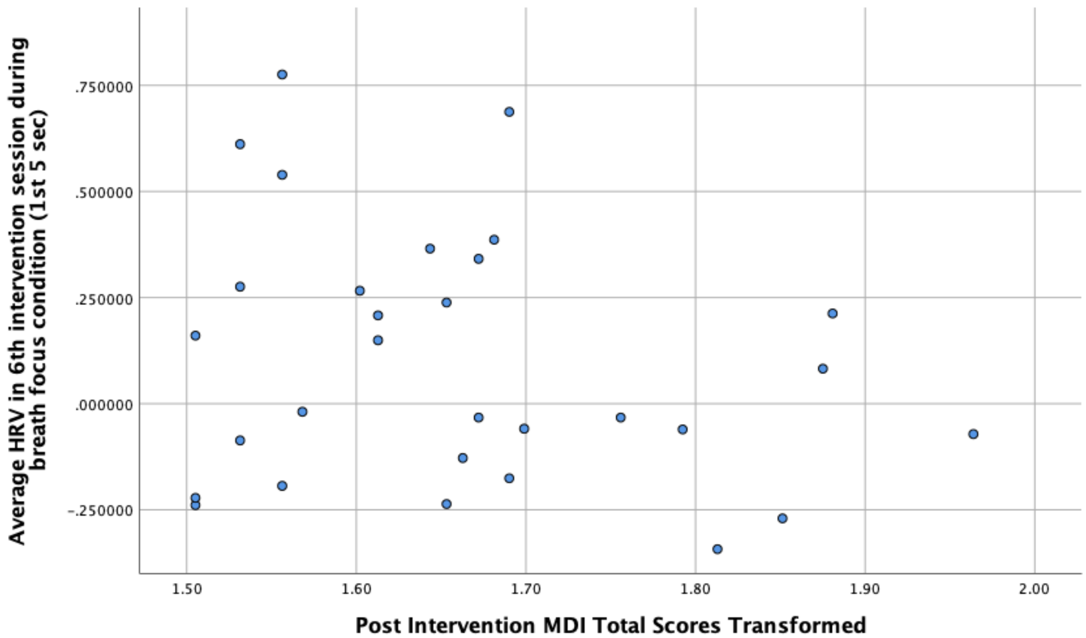

Figure 7. Scatter plot showing HRV averages during first five seconds of breath focus condition in sixth BFMM session and MDI scores at post intervention (r = -.24, p = .20).

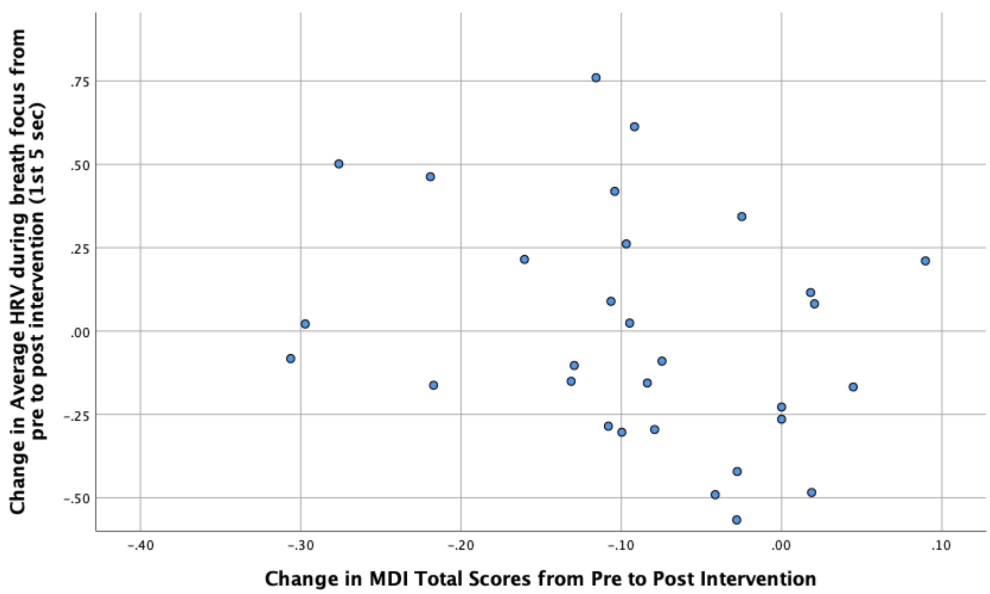

Figure 8. Scatter plot showing change in average HRV during breath focus condition (1st 5 sec) and change in MDI scores from pre to post intervention (r = -.28, p = .13)

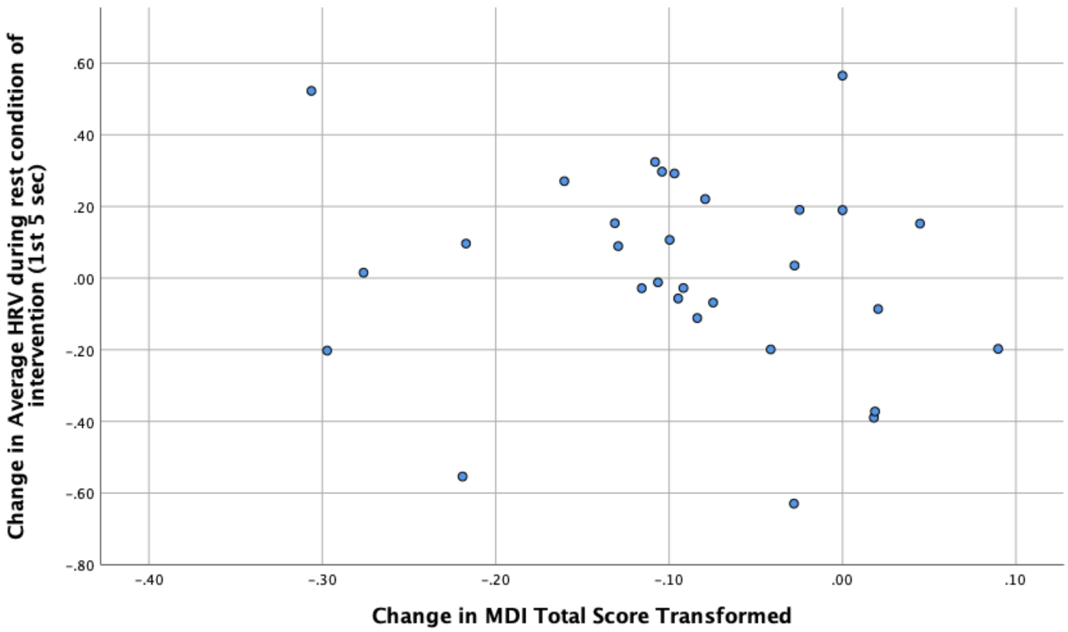

Figure 9. Scatterplot showing change in Average HRV during rest condition and change in MDI scores from pre to post treatment (r = -.16, p = .40)

C. *Changes in HRV and dissociative disengagement after BFMM treatment*

First, bivariate correlations were conducted between the average pre- to post-treatment change in HRV during the first five seconds of the breath focused condition and change in dissociation symptoms. Subscale and total scores were examined. Results from this bivariate correlation showed that there was a significant negative correlation between change in dissociative disengagement symptoms and change in HRV during the first five seconds of the breath focused condition between pre to post treatment (r = -.42, p = .02).

A partial correlation was done to control for certain variables that could have possibly affected HRV. Age of participant when enrolled, use of cardiovascular medication, and baseline MPSS scores did not contribute significantly to the correlation that was found. Modest negative correlations were found between change in HRV and change in dissociative disengagement when controlling for age (*r(27)* = -.40, *p* = .03), use of cardiovascular medication (*r(27)* = -.39, *p* = .04), and baseline MPSS scores (*r(27)* = -.41, *p* = .03) which were all statistically significant. However, zero-order correlations showed that there was a statistically significant, moderate, negative correlation between change in dissociative disengagement symptoms and change in HRV during the first five seconds of the breath focused condition between pre to post treatment (*r(28)* = -.42, *n* = 30, $p < .02$), indicating that the covariates had very little influence in controlling for the relationship between the two variables. Figure 10 shows the significant association found between change in dissociative disengagement and change in HRV during the breath focus condition.

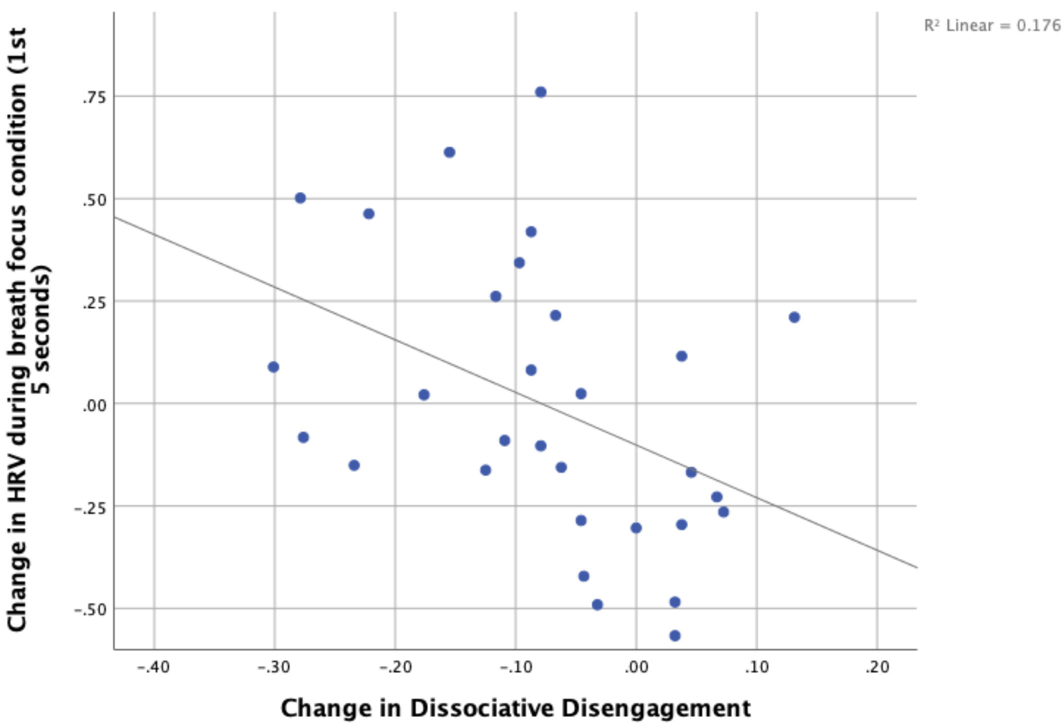

Figure 10. Increase in HRV during breath focus condition is associated with decrease in dissociative disengagement symptoms (*r* = -.42, *p* = .02).

IV. Discussion

A. *Overview of Study*

In the current study, I investigated how changes in ANS functioning, measured by heart rate variability, were associated with changes in dissociation symptoms in patients with PTSD and dissociation following a brief, breath focused mindfulness meditation intervention. My findings suggested that dissociation and PTSD symptoms improved significantly between pre and post BFMM intervention. I did not find any significant changes in HRV during BFMM from pre to post treatment. However, decreases in dissociative disengagement symptoms from pre- to post-treatment were significantly associated with increases in HRV during breath focus. This association remained significant even after controlling for variance associated with potential confounds, including age, use of cardiovascular medications, and baseline PTSD symptom severity.

This intervention study addresses a gap in our knowledge about how mindfulness can affect ANS functioning and dissociation in PTSD patients. These findings have interesting potential clinical application to address dissociative symptoms or autonomic dysregulation in PTSD and other disorders. The results of the study support the idea that breath focused mindfulness may produce changes in dissociative and PTSD symptoms, and that changes in dissociative symptoms are associated with improvements in ANS functioning.

B. *Mindfulness addresses dissociation as a treatment barrier*

One of the main findings of our study was the significant reduction of dissociation symptoms from pre to post BFMM treatment (Table 1). This has exciting clinical implications since dissociation symptoms are shown to be a contributing factor to treatment resistance in the current literature (Foa & Kozak, 1986; Jaycox et al., 1998; Prasko et al., 2016; Resick et al., 2012; Semiz et al., 2014).

Dissociation symptoms are associated with treatment resistance in patients with PTSD and other psychiatric disorders which poses a challenging problem for clinicians. Studies have shown that dissociation may reduce treatment efficacy for a variety of illnesses. A 2016 longitudinal study showed that participants with anxiety disorders and high levels of dissociation responded worse to a treatment combination of psychotherapy and pharmacotherapy in comparison with other clinical populations (Prasko et al., 2016). A separate longitudinal investigation looked at the effects of cognitive behavioral therapy (CBT) on patients with pharmacoresistant obsessive-compulsive disorder (OCD) and found that dissociation was a significant predictor of poor treatment outcome (Prasko et al., 2009). Several studies have found that patients who experience peritraumatic or posttraumatic dissociation symptoms as a result of trauma have a much longer recovery trajectory than patients who experience trauma without dissociation symptoms (Birmes et al., 2001; Galatzer-Levy et al., 2011). Results from a study investigating the efficacy of a 6-week psychotherapy program for patients with neurotic spectrum disorders found that patients with dissociation tended to have a poorer response to treatment (Ociskova et al., 2015). In our current study, Figure 3 shows how patients with higher baseline MPSS scores tended to have higher dissociation symptoms on the MDI as well, indicating that dissociation may be a contributing factor in the maintenance and chronicity of PTSD symptoms. Even after the BFMM treatment, Figure 4 still showed the significant trend that participants with higher dissociation levels exhibited higher levels of PTSD symptoms. These results indicate that dissociation appears to interfere with treatment outcomes which can prevent full recovery for many patients with dissociative symptoms.

Standard therapies such as exposure therapy and CBT may be less effective for patients suffering from dissociative symptoms, although the data are inconsistent. A review of PTSD treatments done by Wolf et al. found that patients with dissociation responded well to psychotherapy, including CBT and exposure therapy (Wolf et al., 2012). Another study found that patients with dissociative symptoms, especially high levels of depersonalization, responded better to cognitive based processing therapy (CBCT) which combines CBT and exposure therapy (Resick et al., 2012). Some research suggests that DBT, a mixture of CBT and mindfulness, may be a potential efficacious treatment for patients with dissociation symptoms since concepts like "grounding" and emotion regulation are stressed in DBT that are missing from CBT (Bohus et al., 2019).

In contrast, reviews on treatments for dissociative disorders suggests that dissociative tendencies impede a patient's ability to benefit from psychotherapy by not being able to reach a "*therapeutic window"*. A "therapeutic window" refers to an ideal state of arousal between overwhelming amounts of exposure and excessive avoidance where psychotherapy is most effective (Briere, 2002; Foa & Kozak, 1986). This window allows clinicians to address a dysregulated emotional response to stimuli and correct maladaptive ways of handling stress by targeting specific fear structures (Foa & Kozak, 1986) This theory was further explored in a different review article which hypothesized that dissociation interferes with fear extinction learning and habituation pathways due to suppressed amygdala response (Lanius et al., 2012) . Therefore, dissociative patients may not be able to benefit as well from exposure therapy as non-dissociative patients since their ability to engage in emotional, amygdala-based learning processes is inhibited due to altered fear extinction processes (Lanius et al., 2010).

One of the critical components of dissociation that can contribute to treatment resistance may be dissociative disengagement. Disengaging from emotional or fearful situations may be a significant factor in preventing patients from recovering fully from PTSD or other disorders through psychotherapy and pharmacological treatments.

C. <u>Dissociative disengagement and treatment resistance</u>

The second main finding of the study was a significant association between a decrease in dissociative disengagement and improvement in ANS functioning as measured by HRV from pre to post BFMM treatment (Figure 10). Dissociative disengagement is characterized by an inability to engage or attend to the present moment and surroundings. This can often manifest as absent mindedness or forgetfulness, being in one's "own world", "spacing out" or staring into space without thinking. Dissociative disengagement is used as a coping mechanism for people who have experienced trauma as a way to avoid thinking about stressful events and therefore inhibit any emotional distress (Briere et al., 2005). All these symptoms are asked about in the current version of the MDI as part of the dissociative disengagement subscale. Current theories about dissociative disengagement indicate that it is a facet of dissociation that contributes to treatment resistance (Ginty, 2013). Thus, BFMM may help in reducing these treatment resistant symptoms to encourage more emotional engagement in therapy.

Patients with dissociative symptoms disengage with emotional stimuli, particularly negatively-valenced stimuli. This emotional avoidance can hinder learning adaptive ways of dealing with emotions, including in a therapy context. Current literature shows that dissociative disengagement can be a particularly challenging barrier to treatment, and the present findings indicate that mindfulness may effectively address this barrier (Cousin & Crane, 2016; Farb et al., 2015; Gibson, 2019).

Dissociative disengagement can predict treatment outcomes for clinical and non-clinical populations. Results from a study investigating disengagement in CBT found that disengaged silences in client-centered therapy dyads were a significant predictor of poor treatment outcome in a nonclinical population (Frankel & Levitt, 2009). The results of this study underscore the influence that emotional disengagement has in terms of treatment resistance. A different cross sectional study in 2004 investigated stress coping strategies in a non-clinical population (Leitenberg et al., 2004). Researchers found that increased dependence on disengagement coping impeded cognitive and emotional processing necessary to overcome negative effects of trauma (Leitenberg et al., 2004). These results demonstrate the impact that disengagement can have in the course of treatment and prevention of recovery.

Disengagement symptoms in particular can act as significant contributors to treatment resistance in patients with PTSD. Theories about trauma treatment suggest that emotional engagement with a traumatic memory is a critical component of successfully processing and recovering from a stressful experience (Foa & Kozak, 1986). In patients with highly dissociative symptoms, this emotional engagement could be impaired due to overmodulation of emotional affect which may result in ineffective exposure therapy (Lanius et al., 2012; Resick et al., 2012). This theory was further supported by results from a study conducted in 1998 examining emotional engagement as a predictor of treatment outcome in PTSD patients. The findings of the study showed those with high emotional engagement and high habituation levels throughout the course of exposure therapy benefited from the treatment more than those with moderate levels of engagement (Jaycox et al., 1998; Resick et al., 2012).

Apart from dissociative disengagement, studies have shown that disengagement coping can be a detrimental behavior that can impair ability to address and correct a negative stressor. Disengagement coping involves reducing negative emotions or stressors in ways that do not include addressing the event or cognitively processing how they feel about it (Taft et al., 2007). For example, drinking in order to avoid thinking about a problem at work would be an example of disengagement coping. A 2007 study examining coping mechanisms in women that have experienced IPV found that disengagement coping was associated with negative psychological outcomes in contrast to engagement coping (Taft et al., 2007). The study also found that disengagement coping mechanisms were disproportionately present in women that had experienced childhood trauma and served as adaptive ways to escape violence. The present findings promote investigation into interventions that work to decrease disengagement coping mechanisms in order to improve overall psychological well-being in patients with extensive trauma.

A cross-sectional study looking at patients with psychogenic dissociative seizures found that persistent trauma can lead to the onset of the disorder by increasing somatic manifestations of emotional distress (Pick et al., 2017). In the same clinical population, disengagement symptoms were significantly elevated suggesting that disengagement may play a role in somatoform dissociations. A separate study looking at somatoform dissociation in nonclinical populations found that patients with high levels of somatoform dissociation responded less to a tactile cue following a trauma film as a result of dissociative disengagement from bodily information. Researchers suggested that using an intervention that promoted increased attention to bodily signals, also known as interoceptive awareness, could help mitigate these disengagement symptoms and promote a more appropriate physical and emotional response to traumatic stimuli.

D. <u>Mindfulness addresses disengagement through interoception</u>

The results of this study showed that breath focused mindfulness practices, which are linked to greater interoceptive awareness, was significantly associated with a decrease in PTSD and dissociative symptoms including disengagement after treatment (Tables 1, 2) (Mehling et al., 2018).

Patients with dissociative symptoms, especially disengagement symptoms, often have a difficult time attending to body signals due to associating these body signals with trauma (Farb et al., 2015). Correlational studies have shown that there is a negative association between trait mindfulness skills and disengagement coping in patients with trauma exposure (Baer et al., 2004). A case study of a patient with dissociative disorder found that a patient with high intensity body disengagement symptoms also had deficits in interoception as supported by clinical and functional connectivity analysis (Sedeño et al., 2014). In these cases, patients with high dissociation tended to disengage from body awareness instead of addressing and cognitively re-appraising these signals to have a better psychological outcome.

Mindfulness based treatments may help in reducing dissociative disengagement symptoms by enhancing interoceptive awareness, a term that refers to the awareness of body signals and sensations. Khalsa et. al (2018) posited that mindfulness based interventions promote interoceptive awareness by systematically attending to breathing sensations and other body states which in turn leads to more intentional attention and less disengagement from therapy (Khalsa et al., 2018).

Mindfulness practices enhance interoceptive awareness which helps patients attend to their body in a focused, non-judgmental way which mitigates disengagement symptoms (Gibson, 2019)**.** Mindfulness enhances focused attention to raw interoceptive signals which is described in a model known as perceptual interference (Farb et al., 2015). Perceptual interference in the context of interoception is defined as paying focused attention, without judgement, to the body. This non-judgmental and accepting component of mindfulness can be a key element in restructuring the relationships that dissociative patients have with their bodies. A study found that women who had a history interpersonal sexual violence and a tendency to dissociate from body sensations learned to engage in perceptual interference during a mindfulness treatment (Farb et al., 2015). This engagement in the therapy allowed them to maintain awareness of their bodies instead of dissociating from the sensations that they were feeling. The women that engaged in this interoceptive behavior found that they were able to feel a greater sense of safety associated with their body, better emotional regulation, better psychological well being, and a greater feeling of empowerment (de Jong et al., 2016; Price & Hooven, 2018). A different study conducted by de Jong et. al (2016) found that mindfulness based cognitive therapy was significantly related to an increase in Self-Regulation and Not-Distracting scales of the Multidimensional Assessment of Interoceptive Awareness (MAIA) measure in comparison to standard CBT treatment (de Jong et al., 2016). The study also found that less disengagement was associated with greater body awareness, suggesting that acting intentionally was linked with greater willingness to attend to unpleasant body sensations. These are exciting findings that support the efficacy of mindfulness based practices in addressing dissociative symptoms like disengagement. Mindfulness effects on emotion regulation can also manifest physiologically by improvement in ANS functioning and other body systems.

E. <u>Mindfulness and adaptive response to stress</u>

This study did not find that HRV improved from pre to post BFMM treatment (Table 4). This finding is inconsistent with the current literature surrounding mindfulness based practices and their effects on ANS functioning (S. H. Kim et al., 2013; Pascoe et al., 2017; Telles et al., 2015). Several factors could have contributed to this finding. One relates to heterogeneity in response within the sample; it is possible that participants who received the vibroacoustic feedback did experience improved HRV. Additionally, it is possible that baseline HRV differed from patient to patient with some patients perhaps having a high baseline HRV while some patients have low HRV. The trajectory of change in HRV is therefore affected by these varied levels of baseline HRV. The changes in HRV may have stayed the same for those with high baseline HRV whereas the changes in HRV may have improved significantly in those with low baseline HRV. Baseline HRV has been correlated with treatment outcome for patients with trauma exposure (Bornas et al., 2011; Soder et al., 2019). An extension of the research could be to categorize these participants based on high or low baseline HRV to both measure the amount of change in HRV between the groups pre to post treatment as well as predict treatment outcome. The sample size of the study is also small, which may have reduced power to detect more subtle changes in HRV. Future directions for the research can involve expanding the sample size to confirm the findings. However, other investigations have shown that, traditionally, mindfulness is associated with better ANS functioning and more adaptive responses to stress. Further research will need to be done with PTSD patients to support or reject the findings of this study.

PTSD patients normally have a chronically activated SNS resulting in a persistent stress response and hyperarousal symptoms (Williamson et al., 2015). Elevated cortisol levels, higher heart rate, lower HRV, and increased respiration are some physiological characteristics that are common amongst non-dissociative PTSD patients (Vieweg et al., 2006).

As mentioned in section 1.C.2, mindfulness can improve ANS functioning by increasing HRV, decreasing serum cortisol levels, and decreasing heart rate and respiration in clinical and non-clinical populations (Austin, 2006; Benson & Klipper, 2000; Cardeña & Carlson, 2011; de la Fuente del Moral et al., 2010; Zeidan et al., 2010). Meta-analyses and reviews have shown that mindfulness can address ANS dysregulation in PTSD populations with hyperarousal by reducing stress reactivity measured by several psychophysiological measures and reduced inflammation (Gallegos et al., 2017; Niles et al., 2018; Pascoe et al., 2017). Within the context of PTSD, mindfulness has been shown to promote a more adaptive response to stress by reducing SNS dominance and enhancing PNS activity (S. H. Kim et al., 2013). Lang et. al (2012) suggests that enhancing PNS activity via mindfulness can give PTSD patients a greater sense of calmness and control over their emotions. This, subsequently, can allow patients to respond more appropriately to stressful stimuli (Lang et al., 2012).

Effects of mindfulness on ANS dysregulation in PTSD patients needs to be studied more to generate more consistent results. Mindfulness could be a useful and accessible treatment to address autonomic aberrations in PTSD patients. However, more data must be collected to support this hypothesis.

F. *Mindfulness and ANS dysregulation in other psychiatric disorders*

A study investigating interoceptive ability in patients with depersonalization and derealization disorder (DPD) found that these patients exhibited an impaired ability to attend to their heartbeat which is an indication of dysregulated interoceptive ability. As a result, these patients exhibited higher parasympathetic tone (decreased heart rate, cortisol, etc.) associated with emotional numbing and disembodiment feelings (Schulz et al., 2015). Mindfulness can help enhance interoceptive ability and help decrease emotional disembodiment feelings to encourage a less dissociative response to stress and/or the environment.

Autonomic dysregulation in psychiatric disorders apart from dissociative disorders could benefit from mindfulness practices. A review of autonomic dysregulation across psychiatric disorders found that patients with depressive, anxiety, psychotic, and/or substance use disorders displayed highly dysregulated ANS functioning by measure of HRV (Alvares et al., 2016). Patients with panic disorders could benefit from breath focused practices to reduce autonomic reactivity and autonomic dysregulation to traumatic stimuli (Cohen et al., 2000). Another study looking at physiological effects of mindfulness in patients with chronic worry saw increased vagal tone and reduced breathing pattern indicating a better autonomic response to mindfulness based practices (Delgado et al., 2010). Mindfulness may have provided a safe and accepting way of attending to and regulating body signals associated with hyperarousal or anxiety. This enhanced interoception could have promoted more adaptive stress responses that manifested physiologically. Patients with anorexia nervosa also display autonomic dysregulation by measure of HRV with a significantly higher parasympathetic system rigidity (Mazurak et al., 2011). Mindfulness can increase interoceptive awareness in patients with eating disorders by promoting greater attention to internal body states that cue signals of hunger or pain (Dunne, 2018). More mindfulness of the physical body can prompt behaviors that can subsequently correct ANS dysregulation. More research should be done to evaluate the effects of mindfulness on autonomic functioning across the spectrum of psychiatric disorders to support mindfulness as a possible treatment for ANS dysregulation.

The cumulative results of this study suggest that mindfulness can be a very useful treatment to address ANS dysregulation in patients with dissociative symptoms. These findings could have possible clinical applications, suggesting that ANS dysregulation in dissociative disorders and other psychiatric disorders could possibly be normalized through mindfulness practices.

V. Limitations

Certain limitations of the study must be taken into consideration when interpreting the results. Firstly, the study was a single group pre/posttest design so the generalizability of the results must be done with caution. The sample size was small for this study so the next steps in this project would be to gather more data from a greater number of participants to validate these results and increase statistical power. The demographics of the population consisted solely of African American women with civilian PTSD with a majority low socioeconomic status. This population is disproportionately more susceptible to developing trauma-related stress disorders and therefore research on mindfulness efficacy for similarly vulnerable populations is necessary (Gillespie et al., 2009). Future research should expand these parameters to include veterans and males as well as a more diverse body of women to ensure that the results are consistent amongst different populations. HRV data were not compared between the augmented (received exteroceptive feedback) and non-augmented participants of the study to determine if exteroceptive feedback had an effect on HRV. HRV data were also not taken at a follow up time to evaluate whether the improvements in HRV remained post treatment. An expansion of the research could be to take physiological data at different time points post treatment as an indicator of the efficacy and long term effects of the treatment. Another limitation of the study was that the data were not compared to a control group of patients with PTSD who did not receive the intervention, so the effect size of the mindfulness meditation in this population could not be determined. Conclusions about the effects of mindfulness on clinical and physiological symptoms of PTSD itself could be more emphatically stated if I was able to compare the data to a control group. Certain confounding factors should be taken into account in this population that could contribute to a PTSD recovery trajectory such as time from trauma, amount of homework practice of mindfulness, and amount of social interaction or social support. Further research should address these confounding variables. Future directions of the research should include comparison to a control group to evaluate whether HRV and dissociation data were proportionately higher or lower in this population.

VI. Future Directions

The participants of this study were recruited from a larger investigation looking at how an exteroceptive feedback device could augment the BFMM intervention with dissociative patients clinically and physiologically. Future directions for this study could be to evaluate whether HRV differed significantly between the augmented and non-augmented experimental groups to see if exteroceptive feedback affected autonomic functioning. Additionally, the study could be expanded to assess the change in HRV from pre to post mindfulness treatment in response to a stressor like a startle procedure or exposure to a negatively valenced image. This could provide insightful information as to whether mindfulness could help improve a stress response on a biological level. The introduction of the exteroceptive feedback device, which generates vibrations on the sternum in tandem with breathing, introduces a bottom-up processing aspect to mindfulness, which is a top-down form of processing. This has interesting implications for mindfulness meditation in the future to determine whether this exteroceptive feedback helps foster better mind-body connection. Another future direction for this study would be to examine whether this BFMM intervention generated the same autonomic responses in other trauma related sequelae such as depression or anxiety.

VII. Conclusion

Overall, the findings of the study suggest that patients with dissociative symptoms benefit from a brief mindfulness meditation intervention, with clinical changes corresponding with changes in ANS functioning. Mindfulness has the potential to generate adaptive responses to stress, both biological and clinically, in populations that have experienced trauma or high levels of dissociation. Mindfulness may be a useful method for improving autonomic responses to stressful stimuli and reduce dissociative disengagement symptoms. Reducing dissociative symptoms can address an important PTSD treatment barrier. Breath focused mindfulness in particular can help reduce disengagement symptoms, an important factor in treatment resistance, while simultaneously improving ANS functioning. Further research into mindfulness' effects on biology and psychiatric symptoms have exciting potential for the treatment of dissociative populations.

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