Navigating the Complex Interactions between Preinjury Characteristics and Postinjury Outcomes

Following Mild Head Injury: Does Trait Mindfulness Play a Role?

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Abstract

Despite increased awareness of the link between mild head injury (MHI) and long-term negative functional outcomes, there is a relative paucity of research investigating modifiable risk factors that contribute to chronic post-injury symptomatology. To address this gap in the literature, the current study sought to examine trait mindfulness as it relates to cognitive functioning after MHI, as well as explore the possible mechanisms underlying the potential benefits of trait mindfulness in this population. In a quasi-experimental, cross-sectional design, levels of trait mindfulness, cognitive functioning, and physiological indices were measured in a sample of 52 university students (38% with a self-reported history of MHI). As expected, trait mindfulness was associated with better cognitive functioning, such that those with higher levels of this trait reported less executive dysfunction and performed better on measures of processing speed. Similar to previous studies (e.g., Baker & Good, 2014), it was also found that those with a history of MHI exhibited physiological ‘underarousal’, as indicated by lower electrodermal activity, than their non-injured peers. Moreover, it was found that trait mindfulness was associated with higher levels of physiological arousal (i.e., greater electrodermal activity). Interestingly, results also showed that MHI participants who displayed low arousal as well as low levels of trait mindfulness obtained the lowest scores on measures of inhibitory control. It was concluded that although the exact causal mechanisms of trait mindfulness remain unclear, it may be that for those who have sustained an MHI, the possible arousal-inducing/awareness-amplifying effects of mindfulness could mitigate postinjury cognitive symptoms, representing a possible target for therapeutic intervention.
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<tr>
<td>ACT</td>
<td>Acceptance and Commitment Therapy</td>
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<tr>
<td>ADHD</td>
<td>Attention-Deficit/Hyperactivity Disorder</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
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<tr>
<td>ATP</td>
<td>Adenosine Triphosphate</td>
</tr>
<tr>
<td>BP</td>
<td>Blood Pressure</td>
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<tr>
<td>BRI</td>
<td>Behavioural Regulation Index</td>
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<tr>
<td>BRIEF-A</td>
<td>Behaviour Rating Inventory of Executive Function - Adult</td>
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<tr>
<td>CT</td>
<td>Computerized Tomography</td>
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<td>CWIT</td>
<td>Colour-Word Interference Test</td>
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<tr>
<td>CWIT-I</td>
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</tr>
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<td>CWIT-III</td>
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<tr>
<td>DBT</td>
<td>Dialectical Behaviour Therapy</td>
</tr>
<tr>
<td>D-KEFS</td>
<td>Delis-Kaplan Executive Function System</td>
</tr>
<tr>
<td>dlPFC</td>
<td>Dorsolateral Prefrontal Cortex</td>
</tr>
<tr>
<td>DSB</td>
<td>Deep and Slow Breathing</td>
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<tr>
<td>DTI</td>
<td>Diffusion Tensor Imaging</td>
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<tr>
<td>EDA</td>
<td>Electrodermal Activity</td>
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<td>ELQ</td>
<td>Everyday Living Questionnaire</td>
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<tr>
<td>FA</td>
<td>Fractional Anisotropy</td>
</tr>
<tr>
<td>FFMQ</td>
<td>Five Facet Mindfulness Questionnaire</td>
</tr>
<tr>
<td>GAD</td>
<td>Generalized Anxiety Disorder</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>GCS</td>
<td>Glasgow Coma Scale</td>
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<td>GEC</td>
<td>Global Executive Composite</td>
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<tr>
<td>IST</td>
<td>Internal Switching Task</td>
</tr>
<tr>
<td>LOC</td>
<td>Loss of Consciousness</td>
</tr>
<tr>
<td>M</td>
<td>Mean</td>
</tr>
<tr>
<td>MBCT</td>
<td>Mindfulness Based Cognitive Therapy</td>
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<td>MBSR</td>
<td>Mindfulness Based Stress Reduction</td>
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<tr>
<td>MDD</td>
<td>Major Depressive Disorder</td>
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<tr>
<td>MHI</td>
<td>Mild Head Injury</td>
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<tr>
<td>MI</td>
<td>Metacognition Index</td>
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<tr>
<td>MRI</td>
<td>Magnetic Resonance Imaging</td>
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<tr>
<td>mTBI</td>
<td>Mild Traumatic Brain Injury</td>
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<tr>
<td>NCR</td>
<td>Neuropsychology Cognitive Research</td>
</tr>
<tr>
<td>PA</td>
<td>Peak Amplitude</td>
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<tr>
<td>PCS</td>
<td>Post-Concussive Syndrome</td>
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<td>PCSC</td>
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<td>PNS</td>
<td>Parasympathetic Nervous System</td>
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<td>Persistent Post-Concussive Syndrome</td>
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<td>PTA</td>
<td>Posttraumatic Amnesia</td>
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<tr>
<td>SCLs</td>
<td>Skin Conductance Levels</td>
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<tr>
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<td>SD</td>
<td>Standard Deviation</td>
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<td>Description</td>
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<tr>
<td>SNS</td>
<td>Sympathetic Nervous System</td>
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<td>SPSS</td>
<td>Statistical Package for the Social Sciences</td>
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<tr>
<td>SSRI</td>
<td>Selective Serotonin Reuptake Inhibitor</td>
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<tr>
<td>TBI</td>
<td>Traumatic Brain Injury</td>
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<tr>
<td>TMT</td>
<td>Trail Making Test</td>
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<tr>
<td>VIF</td>
<td>Variance Inflation Factor</td>
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<td>vmPFC</td>
<td>Ventromedial Prefrontal Cortex</td>
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Navigating the Complex Interactions between Preinjury Characteristics and Postinjury Outcomes Following Mild Head Injury: Does Trait Mindfulness Play a Role?

Brain injuries are sustained at exceedingly high rates by the Canadian population and traumatic brain injury (TBI) represents a major public health issue. In Ontario, Canada, there are an estimated 500,000 individuals currently living with the effects of a brain injury, with approximately 18,000 new cases added per year (OBIA, 2012). Further evidence pointing to heightened incidence and prevalence rates of TBI can be found when examining emergency department visits and hospital admission rates. Over an eight-year period (between 2002/03 and 2009/10) there were a total of 986,194 emergency department visits in Ontario for TBI, which resulted in 49,290 hospitalizations and 1,072 deaths (Fu, Jing, Fu, & Cusimano, 2016). Although considerable progress has been made in terms of TBI awareness, the overall rate of emergency department visits remained largely unchanged over this period, with an estimated incidence of 1,014 per 100,000 population in 2002 compared to 979 per 100,000 population in 2009 (Fu et al., 2016). Also of concern are the rising incidence rates of TBI worldwide, which may be attributed to an increase in motor vehicle use (Roozenbeek, Maas, & Menon, 2013).

In addition to high prevalence and incidence rates, TBI is also associated with substantial medical costs and healthcare utilization. For example, in Ontario alone, it has been estimated that the direct annual medical costs (i.e., costs of health care related to the injury) of patients with TBI are over 120 million dollars for the first follow-up year (Chen et al., 2012). However, the indirect costs of TBI (e.g., reduced productivity from hospitalization or disability) are estimated to be over three times this amount, around 440 million dollars per year (Feinstein & Rapoport, 2000; SMARTRISK, 2009). Moreover, for TBI patients referred to tertiary care in Ontario, it was estimated that during the postinjury interval (prior to gaining access to tertiary care), there
may be unreported healthcare costs of upwards of 11 million dollars annually (Hunt et al., 2016). Evidently, TBI is a significant public health and socioeconomic issue that needs to be addressed, especially with respect to treatment and rehabilitation.

   Importantly, traumatic brain injuries are believed to exist along a continuum of severity, ranging from very mild injuries to catastrophic injuries that can result in severe disability or death (Iverson & Lange, 2009). The vast majority of TBI cases fall within the mild category, with mild traumatic brain injuries (mTBI) accounting for 70% to 90% of all treated brain injuries (Cassidy et al., 2004). The incidence of hospital-treated mTBI in North America has been reported to be approximately 100 to 300 per 100,000 population (Cassidy et al., 2004). However, other estimates of hospital-treated mTBI have been much higher, with a reported incidence of 535 per 100,000 (Ryu, Feinstein, Colantonio, Streiner, & Dawson, 2009). Additionally, because many cases of mTBI do not result in hospital visits or admissions and frequently go unreported, the incidence of these milder injuries is thought to be greatly underestimated (Templer et al., 1992). For example, when assessing rates of mTBI in a group of high school football players, it was found that only 47% of participants reported the event (McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004). Moreover, in a sample of university students, it was found that less than half (39%) of participants with a history of head injury received medical treatment for the injury (Baker & Good, 2014). Therefore, the true population-based incidence of mTBI is likely much higher than previously reported estimates and may exceed 600 per 100,000 population (Cassidy et al., 2004; Ryu et al., 2009). In addition to issues with underreporting and underestimation, the inconsistency between reported incidence rates is partially due to the use of different operational definitions and criteria to assess cases of mTBI.
When using a less stringent set of criteria to determine a history of “mild head injury” (MHI), previous studies have found that 30% to 56% of high-functioning high school and university students retrospectively self-report a history of MHI (Baker & Good, 2014; Laforce & Martin-MacLeod, 2001; McCrea et al., 2004; Segalowitz & Lawson, 1995; van Noordt & Good, 2011). Although traumatic brain injury occurs across all age groups, there is an increased risk of mTBI for men, as well as for adolescents and young adults (Cassidy et al., 2004). Thus, the elevated incidence rate of MHI in the high school and university student population is not surprising. For adolescents and young adults, the most common causes of mTBI include falls, motor vehicle collisions, and sports-related activities (Cassidy et al., 2004). Among the university student population, there is a particularly high incidence rate of sports-related mTBI. For example, in some samples of university students, nearly 60% reported that their head injury was sustained during a sports-related activity (Baker & Good, 2014).

On the mild end of the spectrum, there are several terms which are often used interchangeably to describe either the physical injury to the brain or the symptomatic consequences of the injury, including mild traumatic brain injury (mTBI), concussion, mild head injury (MHI), post-concussive syndrome (PCS), and cerebral concussion (Anderson, Heitger, & Macleod, 2006). The term “concussion” is often used in the sports literature and emphasizes changes in functional status as a result of the head injury (Anderson et al., 2006). In contrast, the terms “mild head injury” and “mild traumatic brain injury” are used to describe the pathophysiologival impact of the biomechanical force to the head or brain and are typically used in the medical literature (Anderson et al., 2006). More specifically, the term “head injury” refers to any injury to the head (e.g., scalp and skin abrasions, bone fractures, etc.), which may not be equivalent to brain injury; however, most head injuries do cause cerebral injury to some extent.
(Anderson et al., 2006). Since a history of head injury was retrospectively self-reported by participants in the current study, the term MHI will be used to reflect a more liberal set of criteria, as described by Kay and colleagues (1993; Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the ACRM). Additionally, for the purposes of this thesis, the review of previous literature includes all classifications of brain injuries on the mild end of the spectrum.

Previous studies have defined an MHI as any physical trauma to the head or neck via a biomechanical force that is sufficient to produce transient neurological dysfunction (Giza & Hovda, 2001). As outlined by Kay and colleagues (1993), the diagnostic criteria for MHI requires an altered state of consciousness (e.g., feeling disoriented, dazed, confused, “seeing stars”, etc.) at the time of the accident. Although a loss of consciousness (LOC) is a diagnostic indicator of MHI, it is not required for an MHI diagnosis (Kay et al., 1993). For the head injury to be classified as “mild” (rather than as moderate or severe), several conditions must be met: (1) any loss of consciousness associated with the injury must be 30 minutes or less in duration, (2) the duration of posttraumatic amnesia (PTA; loss of memory of events occurring immediately before or after the injury) must be less than 24 hours, and (3) the initial Glasgow Coma Scale (GCS) score must fall between 13-15 (Kay et al., 1993).

At the time of injury, the biomechanical impact to the head causes movement of the brain within the skull, causing linear and/or rotational acceleration/deceleration forces on the brain (Anderson et al., 2006). Immediately following the biomechanical impact, a cascade of neurochemical and neurometabolic events take place (Giza & Hovda, 2001). Initially, this involves a disruption of neuronal membranes and axonal stretching/sheering causing an uncontrolled flux of ions (i.e., potassium efflux, as well as sodium and calcium influx) through
previously regulated ion channels (Barkhoudarian, Hovda, & Giza, 2011; Giza & Hovda, 2001). Next, there is a widespread release of excitatory neurotransmitters (e.g., glutamate) leading to further pathological ionic flux (Barkhoudarian et al., 2011; Giza & Hovda, 2001). Subsequently, the activity of the sodium-potassium pump is increased in an attempt to restore ionic and cellular homeostasis; since additional adenosine triphosphate (ATP) is required to use the ionic pumps, this triggers a large increase in glucose metabolism (Barkhoudarian et al., 2011; Giza & Hovda, 2001). This hypermetabolism (or “hyperglycolysis”), in combination with decreased cerebral blood flow, results in an imbalance between glucose supply and demand, thereby depleting energy resources (Barkhoudarian et al., 2011; Giza & Hovda, 2001). Consequently, this “energy crisis” is believed to contribute to postconcussive vulnerability whereby the brain is unable to respond appropriately when a second injury is sustained (Giza & Hovda, 2001). More specifically, these fluctuations in energy levels are believed to cause an altered intracellular redox state and places oxidative stress on the system (i.e., generating damaging free radicals); in response, metabolic pathways are shifted, leaving the brain especially vulnerable to repeated injuries (Giza & Hovda, 2014).

These neurometabolic changes, as well as changes in microstructural integrity, may lead to both acute and longer-lasting impairments, and may underlie the observable symptomology following an MHI. For example, since axons are especially vulnerable to biomechanical stretch, microstructural damage is common after MHI (e.g., damaged neurofilaments and microtubules), which may result in axonal dysfunction and possible disconnection (Giza & Hovda, 2014). Indeed, this pathological finding of damaged white matter tracts, known as “diffuse axonal injury”, is relatively common following MHI and may be associated with subsequent cognitive impairments (Giza & Hovda, 2014). Even in the presence of normal computerized tomography
(CT) scans, it was found that in a subset of the MHI population (approximately 30%), there were abnormalities detected by magnetic resonance imaging (MRI) that were consistent with diffuse axonal injury (Mittl et al., 1994). Moreover, using diffusion tensor imaging (DTI) to index microstructural changes, it was shown that the extent of damage to white matter structures was correlated with reaction time on a cognitive measure (the Attention Network Task), such that greater damage was associated with longer reaction times (Niogi et al., 2008). Similarly, using DTI to assess fractional anisotropy (FA) in MHI patients, it was found that FA was a significant predictor of cognitive performance on a verbal letter fluency task, such that higher FA (perhaps reflecting astrogliosis and compaction of axonal neurofilaments) was associated with lower scores (poorer performance) on the task (Croall et al., 2014).

Immediately following an MHI and during the acute recovery phase (i.e., up to three months post-injury), a sizable number of individuals experience physical, cognitive, and/or emotional symptoms (Rosenbaum & Lipton, 2012; Ruff, 2011). Acute physical symptoms of MHI may include a short period of unconsciousness, fatigue, slowness, headache, pressure in the head, balance problems, dizziness, coordination problems, nausea, vomiting, visual problems (e.g., glassy-eyed, seeing stars, flashing lights, double vision), hearing problems (e.g., ringing in the ears), or slurred speech, among others (Hall, Hall, & Chapman, 2005; Konrad et al., 2011; McCrory et al., 2005). Acute cognitive symptoms such as clouded consciousness (e.g., confusion, haziness, stunned feeling), impaired attention, difficulty concentrating, increased distractibility, or memory problems (i.e., PTA) may also occur after sustaining an MHI, while emotional/affective symptoms may include irritability, displaying inappropriate emotions (e.g., laughing or crying), or emotional lability (Hall et al., 2005; Konrad et al., 2011; McCrory et al., 2005).
Generally speaking, the majority of individuals can expect a resolution of acute MHI-related symptoms within a period of seven to 10 days (Belanger & Vanderploeg, 2005; McCrory et al., 2009). However, it is important to note that recovery rates and trajectories following MHI are heterogeneous in nature. When investigating the rates of acute symptoms after MHI, it was discovered that at one day post-injury, 86% of participants reported the presence of one or more symptoms (Lundin, de Boussard, Edman, & Borg, 2006). At three months post-injury, the estimates of those with at least one symptom remaining are somewhat variable, ranging from 49% of participants still reporting one or more symptoms to 62% of participants (Ingebrigtsen, Waterloo, Marup-Jensen, Attner, & Romner, 1998; Lundin et al., 2006). Initially, somatic symptoms (e.g., headache, fatigue, etc.) tend to predominate, but at three months post-injury, symptoms tend to appear across each symptom domain equally (Lundin et al., 2006). Among the most commonly reported symptoms of MHI at this time include memory problems, headaches, fatigue, poor concentration, dizziness, and sleep disturbances (Lannsjö, Geijerstam, Johansson, Bring, & Borg, 2009; Lundin et al., 2006).

As previously mentioned, most individuals experience a good recovery following an MHI; however, a “miserable minority” (approximately 15% to 30% of MHI patients) continue to suffer from a myriad of chronic symptomology (Alexander, 1995; Rosenbaum & Lipton, 2012; Sterr, Herron, Hayward, & Montaldi, 2006). Given the high incidence rate of MHI, this seemingly small number of cases translates into a substantial number of individuals who experience persistent disabling problems (Marshall, Bayley, McCullagh, Velikonja, & Berrigan, 2012). In some cases, the term “post-concussive syndrome” (PCS) is used to describe symptoms of MHI that persist for more than a week, while the term “persistent post-concussive syndrome” (PPCS) is used to describe symptoms that last for more than three months post-injury (Bigler,
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2008). PCS has been previously defined as a condition that occurs following a head injury that produces impairments in three areas of functioning: (1) psychological (e.g., anxiety, depression, apathy), (2) cognitive (e.g., forgetfulness, processing speed deficits, decreased concentration), and (3) somatic (e.g., headache, dizziness, tinnitus; Hall et al., 2005).

In terms of prevalence rates, symptoms of PCS are more commonly self-reported following mild head injuries, versus moderate and severe injuries (Sigurdardottir, Andelic, Roe, Jerstad, & Schanke, 2009). In response to this finding, some have argued that those with more severe injuries may have less insight or decreased awareness of their deficits, and may consequently under-report symptoms of head injury (Gordon, Haddad, Brown, Hibbard, & Sliwinski, 2000). Therefore, those with milder head trauma don’t necessarily experience greater or more severe PCS than those with moderate or severe injuries, but may be more acutely aware of their deficits and provide more accurate information regarding self-reported symptoms. When investigating the prevalence of post-concussive symptoms in the MHI population only, it was found that 40% of MHI patients met the PCS criteria at three months post-injury, while 27% met the criteria at one year post-injury (Sigurdardottir et al., 2009). Therefore, it appears that post-concussive symptoms are experienced by a relatively large subset of the MHI population and may reflect long-lasting impairments across various domains of functioning.

Psychological (i.e., emotional) symptoms that are commonly encountered following an MHI include irritability, anxiety, and depression (Rosenbaum & Lipton, 2012). In particular, there is a high prevalence of anxiety disorders and development of anxiety symptomatology following MHI. For example, a recent meta-analysis found that approximately 11% of MHI patients are diagnosed with generalized anxiety disorder (GAD), while 53% report clinically significant levels of anxiety (Osborn, Mathias, & Fairweather-Schmidt, 2016). In this case,
clinically significant levels of anxiety reflect those individuals who meet or exceed the defined cutoffs for various self-report measures of anxiety (Osborn et al., 2016). In contrast, previous studies have found that approximately 4.2% of undergraduate university students report a diagnosis of GAD or panic disorder (Eisenberg, Gollust, Golberstein, & Hefner, 2007), while 25% experience moderate to severe levels of anxiety (Beiter et al., 2015). Additionally, it has been previously shown that those who have sustained head trauma are over three times more likely to experience anxiety symptomatology than individuals in the general community (Osborn et al., 2016). These findings are especially concerning given that self-reported anxiety is a significant predictor of functional outcomes 10 years post-TBI (Draper, Ponsford, & Schönberger, 2007). Indeed, when investigating a number of potential predictors (e.g., cognitive functioning, fatigue, depression, etc.), it was found that anxiety was the best predictor of functional outcomes following TBI, such that higher levels of self-reported anxiety predicted greater difficulty in psychosocial reintegration (Draper et al., 2007). Therefore, anxiety symptoms in particular are especially relevant to target when developing treatment strategies.

Following an MHI, there are also high rates of depressive disorders and symptomology. When considering the entire spectrum of brain injury in terms of severity, the prevalence of major depressive disorder (MDD) varies between 6% to 77% in the TBI population, depending on which TBI diagnostic criteria are used (Kreutzer, Seel, & Gourley, 2001). In MHI populations, it has been reported that approximately 15% of patients experience major depression (Rapoport, McCullagh, Streiner, & Feinstein, 2003). However, other studies in the mild to moderate head injury population have found higher rates of depression, with 28% of participants meeting the criteria for MDD (Rapoport, McCullagh, Shammi, & Feinstein, 2005). In contrast, previous reports have found that approximately 13.8% of undergraduate students
experience major depression (Eisenberg et al., 2007) indicating that, like rates of anxiety, the prevalence rates of depression may also be elevated in the MHI population. Moreover, in addition to clinically diagnosed cases of depression, depressive symptomatology is also frequently reported among those with brain trauma. For example, in the mild to moderate head injury population, it was found that 58% of participants endorsed a borderline level of depressive symptoms (Bay & Donders, 2008). Furthermore, depressive symptomatology has been associated with experiencing other post-concussive symptomatology, such as impairments in cognitive functioning (Rapoport et al., 2005). For example, following mild and moderate TBI, major depression is associated with significantly poorer performance on measures of working memory, processing speed, and verbal memory (Rapoport et al., 2005). Thus, symptoms in one domain of functioning may exacerbate or further impair other areas of functioning.

In terms of persistent cognitive challenges that can arise after MHI, some of the most frequently reported cognitive complaints include memory problems, difficulty concentrating, and impaired attention (Rosenbaum & Lipton, 2012). For example, when investigating the prevalence of post-concussive symptoms at three months post-injury, it was found that 16% of MHI patients reported poor memory, 14% reported poor concentration, and 11% reported taking longer to think (Lannsjö et al., 2009). However, other studies have found even higher rates of cognitive-related post-concussive symptoms, with 26% to 44% of MHI patients reporting memory problems and 25% to 38% reporting trouble concentrating, depending on the presence of CT brain abnormalities and duration of PTA (Dikmen, Machamer, Fann, & Temkin, 2010). In the same study, Dikmen and colleagues (2010) found that rates of these cognitive post-concussive symptoms were significantly greater in the MHI group when compared to a general trauma control group (i.e., individuals who had sustained traumatic injuries to the body, but
experienced no head injury), whereby 17% of these control participants reported memory problems, while another 17% reported trouble concentrating.

In addition to being more prevalent among those who have sustained brain trauma, these cognitive impairments may represent long-lasting changes, since previous studies have demonstrated the presence of cognitive symptoms several years following an MHI (Konrad et al., 2011). When controlling for psychiatric conditions and malingering, Konrad and colleagues (2011) found that MHI patients performed significantly worse than controls on a large array of cognitive measures. Specifically, the MHI patients, who sustained their injury six years prior to the study on average, exhibited deficits in learning, long-term memory, executive functioning, attention, and working memory (Konrad et al., 2011). Further studies have shown that compared to their non-injured peers, those who sustain an MHI in early childhood perform significantly poorer on tasks assessing divided attention, even several years (i.e., in this case, at least seven years) after the initial injury (Papoutsis, Stargatt, & Catroppa, 2014). Thus, in addition to producing acute alterations in cognitive functioning, MHI may also lead to persistent impairments across various cognitive domains.

One aspect of cognitive functioning that is especially susceptible to head injury is executive functioning. Across a number of studies, it has been consistently demonstrated that compared to non-head-injured control groups, those with a history of MHI perform significantly worse on neuropsychological tasks assessing executive functions such as working memory, cognitive flexibility, and inhibitory control (Karr, Areshenkoff, & Garcia-Barrera, 2014; Konrad et al., 2011; McDonald, Flashman, & Saykin, 2002). For example, it has been found that a self-reported history of multiple MHIs is associated with worse performance on executive functioning tasks, such as the Trail Making Test – Part B (a measure cognitive flexibility/mental
set-shifting; Reitan & Wolfson, 1985), and the Stroop Neuropsychological Screening Test (a measure that assesses one’s ability to inhibit dominant or automatic responses; Belanger, Spiegel, & Vanderploeg, 2010; Trenerry, Crosson, DeBoe, & Leber, 1989). Additionally, in a sample of female university athletes, it was discovered that even after a single MHI, neuropsychological impairments (namely, problems with executive functioning) were evident (Ellemberg, Leclerc, Couture, & Daigle, 2007). In particular, it was found that when compared to age-matched teammates, those who had sustained an MHI six to eight months earlier exhibited significantly poorer performance (i.e., slowed reaction times) on tasks that required decision-making, planning, inhibition, and cognitive flexibility (Ellemberg et al., 2007). Thus, there is substantive evidence linking MHI to executive functioning impairments as indicated by performance on neuropsychological tests.

Outside of evaluating scores on performance-based measures, those with a previous MHI also self-report many executive functioning challenges. For example, when compared to normative data for healthy adults, college and professional football players self-report significantly more problems with executive functioning in everyday activities (Seichepine et al., 2013). Interestingly, in the same study, there was a correlation between the number of self-reported concussions and perceived emotional control and initiation, such that a greater number of concussions was associated with increased problems in these executive functioning domains (Seichepine et al., 2013). In a sample of college students, it was found that compared to a sex- and age-matched control group, students who reported sustaining a previous MHI endorsed significantly greater executive dysfunction symptoms, across executive cognition, metacognition, and behavioural/affective subcomponents (Martinez & Davalos, 2016). However, self-reported executive dysfunction in the MHI population is generally a poor predictor of
performance on objective measures of executive function (Schiehser et al., 2011). Rather, psychiatric factors (e.g., depressive symptomatology) predict poorer performance on objective cognitive tasks in the MHI population (Schiehser et al., 2011). However, this is also true for the general population, such that MDD is associated with impaired performance on neuropsychological measures of executive functioning (Snyder, 2013).

In addition to challenges with executive functioning, somatic symptoms may also persist after MHI. Among the most frequently reported somatic symptoms include headaches, fatigue, sleeping difficulties, and drowsiness (Rosenbaum & Lipton, 2012). In particular, fatigue is a prominent issue following head injuries, with approximately 30% of MHI patients reporting severe fatigue six months following the injury (Stulemeijer et al., 2006). Moreover, severe fatigue is highly associated with experiencing other symptoms, such as concentration problems, reduced motivation, and reduced activity, as well as limitations in physical and social functioning (Stulemeijer et al., 2006). Additionally, although some reports indicate that sleep duration is comparable between those with and without a history of MHI, other sleep impairments (e.g., lower subjective sleep quality, greater sleep disturbances, greater day time dysfunction, etc.) have been found to occur at significantly higher rates in the MHI population, when compared to normative data (Mani et al., 2015).

Other somatic symptoms following mild head injury include changes in baseline physiological arousal. In the moderate and severe TBI population, it is well-established that these individuals experience a dampened baseline level of physiological arousal, as demonstrated by their significantly lower skin conductance levels (SCLs) when compared to healthy control groups (Fisher, Rushby, McDonald, Parks, & Piguet, 2015; McDonald et al., 2011; Rushby et al., 2016; Rushby, Fisher, McDonald, Murphy, & Finnigan, 2013). This same phenomenon has been
mirrored when investigating head injuries on the milder end of the spectrum. For example, when compared to non-MHI controls, individuals who report a history of MHI have been found to be physiologically underaroused (Baker & Good, 2014; van Noordt & Good, 2011). More specifically, those with a history of MHI exhibit significantly lower baseline electrodermal activity (EDA) compared to those without history of MHI (Baker & Good, 2014; van Noordt & Good, 2011). EDA reflects sympathetic nervous system activation and is often used as an index of emotional arousal (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Baker & Good, 2014; van Noordt & Good, 2011).

In the severe TBI population, it has been found that damage to the ventromedial prefrontal cortex (vmPFC) is associated with reduced EDA, as well as deficits in emotional responding and decision-making (Anderson et al., 1999). Moreover, previous studies have demonstrated that there is an association between physiological arousal and activity in the vmPFC, such that activity in this area is negatively correlated with SCLs (Zhang et al., 2014). Using Granger causality analysis, Zhang and colleagues (2014) found that the activity of the vmPFC causes changes in SCLs, indicating that this area may regulate physiological arousal. Additionally, they found that the stronger the regulatory influence of the vmPFC, the less skin conductance response there was during a cognitive task (Zhang et al., 2014). The authors concluded that the vmPFC may play a critical role in the regulation of arousal during cognitive performance (Zhang et al., 2014). When extending these findings to an MHI population, it may be the case that physiological arousal is dysregulated in these individuals as a result of damage to the vmPFC. Due to its close proximity to the bony protrusions of the skull, the vmPFC is highly susceptible to injury as a consequence of cerebral trauma (Bigler, 2007). Thus, it is not
unreasonable to suspect that this area may be damaged in those who sustain an MHI, which could produce deficits in arousal regulation.

Consequently, this physiological underarousal may contribute to or exacerbate the persistent somatic, emotional, and/or cognitive post-concussive symptoms following MHI. The mechanisms underlying the link between underarousal and MHI-related symptomatology are not fully understood, but two theories that may explain this relationship include the Yerkes-Dodson law (Yerkes & Dodson, 1908) and the Somatic Marker hypothesis (Baker & Good, 2014; Damasio, Everitt, & Bishop, 1996; Damasio, Tranel, & Damasio, 1990; van Noordt & Good, 2011). The Yerkes-Dodson law is often depicted by an inverted-U function of arousal, which illustrates the proposed relationship between arousal and cognitive performance (Yerkes & Dodson, 1908). The Yerkes-Dodson law states that there is an optimal level arousal for an optimum performance on cognitive tasks (Yerkes & Dodson, 1908). When physiological or mental arousal levels are either too high or too low (relative to this optimal level of arousal), performance on cognitive tasks is diminished (Yerkes & Dodson, 1908). Therefore, chronic underarousal may explain the relationship between MHI and cognitive post-concussive symptoms, whereby individuals who have sustained an MHI are cognitively disadvantaged (i.e., poor concentration, reduced attentional capacities, executive functioning deficits, etc.).

The Somatic Marker hypothesis may also explain chronic post-concussive symptomatology experienced after an MHI, particularly emotional symptoms. Generally speaking, the Somatic Marker hypothesis proposes a mechanism by which emotion-generated “somatic markers” (i.e., “gut feelings”) influence behaviour, particularly for decision-making processes (Damasio et al., 1996; Damasio et al., 1990). According to this hypothesis, bioregulatory emotional states are accompanied by changes in visceral states (e.g., electrodermal activity, blood pressure,
respiration, etc.) which then act as somatic markers to guide decision-making, especially during complex situations or times of uncertainty (Damasio et al., 1996; Damasio et al., 1990). The vmPFC is particularly implicated in this process, given its role in the integration of information from higher cortical brain areas with subcortical limbic areas (i.e., emotional input) and sensory regions (Damasio et al., 1996). If the vmPFC is damaged or the relevant afferent connections are disrupted, sympathetic nervous system feedback to and from the vmPFC may be attenuated, which can, in turn, influence emotion regulation (Baker & Good, 2014; Damasio et al., 1996). Therefore, individuals who have sustained an MHI (and possibly damage to the vmPFC) may have a reduced capacity to regulate emotional processes which could contribute to post-concussive symptoms such as anxiety and depression.

Although there is considerable evidence supporting a link between milder injuries to the brain and subsequent psychological, cognitive, and somatic symptomatology, there is a long-standing debate in the literature regarding the origin of these post-concussive complaints, especially among self-reported symptomatology. The argument is largely centered on whether these impairments reflect true neurological dysfunction and/or damage to the brain (i.e., causally related to the injury) or whether they reflect premorbid factors such as psychological/emotional disturbances (Silverberg & Iverson, 2011). Part of the confusion regarding the etiology of certain post-concussive symptoms (e.g., difficulty concentrating, fatigue, memory problems, etc.) stems from the heterogeneous and non-specific nature of these complaints which may arise from other conditions, such as chronic pain, depression, or chronic headaches (Silverberg & Iverson, 2011). Across numerous studies, it has been demonstrated that many of these symptoms are not specific to individuals recovering from MHI and that they are relatively common in a wide variety of clinical samples (such as psychiatric populations) and non-clinical samples (such as healthy
university or college student populations; Ettenhofer & Barry, 2012; Fox, Lees-Haley, Earnest, & Dolezal-Wood, 1995; Gouvier, Uddo-Crane, & Brown, 1988; Iverson & Lange, 2003; Wang, Chan, & Deng, 2006).

Importantly, even though the overall base rates of post-concussive symptoms may be comparable between those with and without a history of MHI, differences in functional outcomes have been noted between healthy control groups and symptomatic versus asymptomatic MHI groups (Fazio, Lovell, Pardini, & Collins, 2007). In particular, it was found that across performance-based measures of verbal memory, processing speed, reaction time, and visual memory, the asymptomatic MHI group performed significantly worse than healthy controls, while the symptomatic MHI group exhibited significantly poorer performance than both asymptomatic and control groups (Fazio et al., 2007). In another study, MHI patients were found to exhibit impaired performance on several neuropsychological measures (i.e., assessing inhibitory control, sustained attention, verbal fluency, etc.) compared to a group of healthy university students who reported high levels of post-concussive symptoms (Wang et al., 2006). Notably, the MHI group experienced greater cognitive challenges (as indicated by poor performance on the tasks), despite endorsing a similar level of post-concussive symptoms as the high symptom reporters in the healthy control group (Wang et al., 2006). These results implicate differing etiology between the subjective complaints of healthy university students and individuals who have sustained an MHI, since neurocognitive impairments were only related to post-concussive symptoms in the head injury group.

Although the exact etiology of post-concussive symptomatology remains unclear, there is an emerging body of evidence supporting an organic origin of these symptoms in the MHI population, related to microstructural white matter damage following injury (Smits et al., 2011).
More specifically, relationships have been found between self-reported post-concussive symptoms and microstructural white matter changes in the MHI population, such that increased mean diffusivity (in the inferior fronto-occipital fasciculus, inferior longitudinal fasciculus, and superior longitudinal fasciculus) was significantly correlated with more severe post-concussive symptoms (Smits et al., 2011). Similarly, Bazarian and colleagues (2007) demonstrated that compared to an orthopedic injury control group, MHI patients exhibited significantly elevated FA values (in the posterior corpus callosum) and that these abnormal DTI indices were strongly associated with increased post-concussive symptoms. Further evidence supporting a link between diffuse axonal abnormalities and post-concussive symptoms comes from studies utilizing proton magnetic resonance spectroscopic imaging which demonstrates increased sensitivity to injury, relative to conventional imaging techniques (Kirov et al., 2013). In this case, MHI patients who reported at least one post-concussive symptom exhibited significantly lower white matter N-acetylaspartate than age- and gender-matched controls, which may reflect lower axonal integrity in these patients (Kirov et al., 2013). These differences were not found when comparing PCS-negative MHI patients (i.e., those who reported no remaining symptoms) to the control group (Kirov et al., 2013).

Taken together, these findings allude to the large variability in recovery outcomes among the MHI population, and imply that there may be a small, but significant subgroup of MHI patients who are at an increased risk of experiencing long-term symptomatology (which may be attributed to ongoing disruptions in axonal functioning). Indeed, there have been a multitude of research studies aimed at determining risk factors that influence post-MHI outcomes. From these studies, it is apparent that there exists a complex set of interactions between preinjury factors, injury characteristics, and postinjury factors that contribute to and predict prolonged
symptomatology following head injury (Silver, McAllister, & Arciniegas, 2009). Among preinjury factors associated with worse post-MHI outcomes are female gender, premorbid psychiatric history (e.g., high levels of anxiety and/or depression), negative perceptions of MHI, elevated levels of stress, and preinjury physical problems (Bazarian et al., 1999; Dischinger, Ryb, Kufera, & Auman, 2009; Hou et al., 2012; Ponsford et al., 2012; Silver et al., 2009). Certain injury characteristics have also been identified as predictors of poor post-injury outcomes, such as the presence of intracranial lesions, both anterograde and retrograde amnesia, and longer duration of PTA (Bazarian et al., 1999; van der Naalt, van Zomeren, Sluiter, & Minderhoud, 1999; Yang, Hua, Tu, & Huang, 2009). Postinjury factors have also been examined in relation to long-term outcomes after MHI and may include certain types of coping strategies (e.g., use of emotion-focused strategies), higher levels of family burden and/or distress, as well as poor social support (Ganesalingam et al., 2008; McCauley, Boake, Levin, Contant, & Song, 2001; Woodrome et al., 2011).

Despite attempts at identifying predictors of prolonged post-concussive symptomatology, neuropsychological outcomes following MHI are still relatively unpredictable, and consequently, treatment options and rehabilitation techniques are limited. Aside from educating MHI patients about symptoms, there is a lack of evidence with regard to successful management of persistent post-concussive symptoms (Marshall et al., 2012). For example, a meta-analysis investigating treatments for MHI indicated that educational interventions may be effective when provided in the early period following injury (Snell, Surgenor, Hay-Smith, & Siegert, 2009). However, it was also concluded that there was insufficient evidence to support the use of cognitive rehabilitation approaches and other active treatments following MHI (Snell et al., 2009). Similarly, in a recent review by Nygren-de Boussard and colleagues (2014), it was concluded that early educational
information is beneficial for recovery following MHI, but there is a lack of good-quality intervention studies targeting post-concussive symptoms. Therefore, continuing research efforts are required to develop alternative interventions and improve outcomes for those who experience persistent symptomology following MHI (Nygren-de Boussard et al., 2014; Snell et al., 2009).

Mindfulness is a relatively new area of research that may provide further insight into alternative treatment strategies to target MHI-related symptoms. Over the past few decades, mindfulness has become the focus of considerable attention for both clinicians and researchers alike (Bishop et al., 2004). Consequently, mindfulness training has been incorporated into a number of clinically oriented treatment programs, such as Mindfulness Based Cognitive Therapy (MBCT; Segal, Williams, & Teasdale, 2002), Mindfulness Based Stress Reduction (MBSR; Kabat-Zinn, 1990), Dialectical Behavior Therapy (DBT; Linehan, 1993), and Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 1999). Broadly conceptualized, mindfulness has been previously described as “paying attention in a particular way, on purpose, in the present moment, and nonjudgmentally” (Kabat-Zinn, 1994, p. 4). However, operational definitions of mindfulness have also been proposed, which suggest that mindfulness is comprised of two components: (1) the self-regulation of attention, and (2) the adoption of a particular orientation towards experiences (Bishop et al., 2004). The first component involves directing one’s attention towards the immediate experience, which is believed to result in increased awareness and alertness (Bishop et al., 2004). The second component is the cultivation of a certain orientation to experience, which involves characteristics such as openness, curiosity, and acceptance (Bishop et al., 2004). These two core components are common across most definitions of mindfulness (Creswell, 2017).
Mindfulness has been conceptualized as both a state that is practiced and maintained while actively engaging in mindfulness meditation and as a trait or “dispositional” characteristic which reflects the general tendency to be mindful in daily life experiences (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Kiken, Garland, Bluth, Palsson, & Gaylord, 2015; Lau et al., 2006). More specifically, state mindfulness has been previously described as the sensory, cognitive, and self-referential awareness changes that can occur while purposefully engaging in mindfulness practice, whereas trait mindfulness is said to reflect the enduring changes in these dimensions that persist even beyond active engagement in mindfulness meditation, thereby influencing the ways in which we perceive, engage with, and respond to our environment (Austin, 1998; Cahn & Polich, 2006; Shapiro, & Walsh, 1984; West, 1987). However, in addition to existing simply as a product of meditation practice, trait mindfulness has also been conceptualized as an inherent and natural capacity that varies among the general population (Brown & Ryan, 2003; Brown & Ryan, 2004). Indeed, it has been shown that across a wide array of samples, individuals exhibit reliable differences in the propensity to be mindful, even with no formal meditation experience or exposure (Baer et al., 2008; Brown & Ryan, 2003; Brown & Ryan, 2004).

These natural individual differences appear to have widespread effects on one’s psychological well-being, such that higher levels of trait or “dispositional” mindfulness are associated with various beneficial and adaptive outcomes (Brown & Ryan, 2004). For example, in normative populations (e.g., university student samples), higher scores on facets of trait mindfulness are associated with higher levels of self-regulation, greater positive affect, greater self-esteem, greater life satisfaction, and higher levels of optimism (Bränström, Duncan, & Moskowitz, 2011; Brown & Ryan, 2003; Hanley, Warner, & Garland, 2015; Lyvers, Makin,
Toms, Thorberg, & Samios, 2014; Rasmussen & Pidgeon, 2011; Short, Mazmanian, Oinonen, & Mushquash, 2016). Additionally, higher trait mindfulness is associated with fewer symptoms of anxiety and depression, less executive dysfunction, less impulsiveness, less hostility, lower negative affect, lower levels of stress, fewer alcohol-related consequences, fewer reported physical symptoms, and a lower frequency of recent medical visits (Brown & Ryan, 2003; LePera, 2011; Lyvers et al., 2014; Pearson, Brown, Bravo, & Witkiewitz, 2015; Short et al., 2016). Therefore, there is robust evidence to support the link between trait mindfulness and beneficial outcomes across various domains of functioning (e.g., cognitive, emotional, psychological, and somatic).

Given the relationships between dispositional mindfulness and positive functional outcomes, researchers have begun to investigate the efficacy of mindfulness-based interventions for increasing trait mindfulness, especially among those who exhibit lower than average levels of this trait. It is generally believed that repeated practice of state mindfulness (i.e., active engagement in mindfulness techniques) will translate into heightened levels of trait mindfulness over time (Kiken, Garland, Bluth, Palsson, & Gaylord, 2015). Indeed, it has been reliably demonstrated that compared to baseline (i.e., pre-test) levels, those who complete mindfulness training interventions (e.g., MBSR, MBCT, etc.) exhibit significantly greater trait mindfulness at post-test (Aikens et al., 2014; Baer, Carmody, & Hunsinger, 2012; Birnie, Speca, & Carlson, 2010; Robins, Keng, Ekblad, & Brantley, 2012). Importantly, some studies found that these increases were maintained at a six-month follow-up, indicating that changes in trait mindfulness may be relatively long-lasting (Birnie et al., 2010). Furthermore, by observing the individual trajectories of state mindfulness over the course of a mindfulness intervention, Kiken and colleagues (2015) found that those who experienced the greatest rates of increase in state
mindfulness also exhibited greater increases in trait mindfulness. Taken together, these findings support the notion that trait mindfulness is modifiable (at least to a certain extent) and that regular engagement in mindfulness practice may be a viable strategy for strengthening this trait.

Mindfulness-based interventions have also been utilized as a means of improving psychological/emotional and cognitive outcomes in healthy populations, and have been applied in various clinical contexts, such as psychiatric samples (e.g., Biegel, Brown, Shapiro, & Schubert, 2009) and in brain-injured patients (e.g., Bédard et al., 2011). Most mindfulness interventions share the same basic program structure and core tenets, but have been adapted to treat specific populations or to target different outcomes (Creswell, 2017). For example, the eight-week Mindfulness Based Stress Reduction program (MBSR; Kabat-Zinn, 1990) is the most frequently cited type of mindfulness training and was originally designed for chronic pain patients. The mindfulness components of the intervention include the body scan exercise (i.e., directing attention sequentially to different areas of the body), Hatha yoga (i.e., becoming aware of bodily sensations during gentle movements and stretching), and sitting meditation, among others (Baer, 2003; Marchand, 2012). In each exercise, participants are asked to focus their attention on the intended object or observation (e.g., the flame of a candle, breathing, walking, etc.) and to be fully aware of it in each moment; when thoughts/emotions/sensations arise, they are observed in a nonjudgemental manner and once the participant takes notice that their mind has wandered, they note the nature or content of the distraction and redirect their attention back to the present moment (Baer, 2003). MBSR also involves the cultivation of specific mindsets, such as becoming an unbiased observer of one’s experiences, accepting things as they are in the current moment, and allowing one’s thoughts to come and go, rather than trying to censor them (Marchand, 2012).
Another well-known mindfulness training intervention is the eight-week Mindfulness Based Cognitive Therapy program (MBCT; Segal, Williams, & Teasdale, 2002), which was originally developed as a way of teaching attentional control skills (via mindfulness-related practices) to prevent relapse of major depressive episodes (Baer, 2003; Marchand, 2012). MBCT utilizes many of the same exercises as MBSR, but more emphasis is placed on principles of cognitive therapy, with the purpose of cultivating a detached or decentered perspective of one’s thoughts, emotions, and bodily sensations (Baer, 2003). The primary focus of MBCT includes teaching participants how to recognize deteriorating moods, as well as teaching individuals how to disengage from self-perpetuating patterns of ruminative and negative thoughts (Marchand, 2012). Participants of MBCT are encouraged to view their thoughts and feelings non-judgmentally, and to consider them as transient mental events that come and go, rather than as accurate reflections of reality or of who they are as a person (Baer, 2003). Thus, although MBCT and MBSR emphasize slightly different training goals, they both involve the core principals of mindfulness-related practice, namely attention being directed to the immediate experience and adoption of a particular orientation to those experiences (Bishop et al., 2004).

In terms of efficacy, both MBCT and MBSR interventions have been found to be effective for their originally intended purposes; MBCT has been shown to reduce the risk of depressive relapse, while MBSR has been shown to improve mental health outcomes, such as reduce levels of self-reported pain, stress, anxiety, and depression (Bohlmeijer, Prenger, Taal, & Cuijpers, 2010; Kabat-Zinn, Lipworth, & Burney, 1985; Ma & Teasdale, 2004; Teasdale et al., 2000). These health-related benefits associated with MBSR and MBCT have also been replicated in a diverse set of populations, such as cancer patients, GAD patients, patients with fibromyalgia, individuals with diabetes, healthy university students, healthy medical school students, as well as
healthy community residents, among many others (Chiesa & Serretti, 2009; Fjorback, Arendt, Ørnbøl, Fink, & Walach, 2011; Hofmann, Sawyer, Witt, & Oh, 2010). Particularly relevant are the mindfulness-based interventions that have been implemented among TBI patients, which support the use of mindfulness techniques for targeting depressive symptomatology following head injury. For example, when comparing the effects of an MBCT intervention to a wait-list control group, TBI participants in the mindfulness intervention group reported significantly fewer depressive symptoms at post-test (Bédard et al., 2014). Furthermore, it was found that the reductions in depression scores were maintained at a three-month follow-up, indicating that the effects of the mindfulness training may be long-lasting (Bédard et al., 2014). In another study, the psychological effects of an MBSR intervention were evaluated in a mixed TBI and stroke patient sample (Johansson, Bjuhr, & Rönnbäck, 2012). Following the MBSR training, participants reported significantly decreased levels of both anxiety and depressive symptoms, as well as lower levels of mental fatigue (Johansson et al., 2012). Similarly, Krzeczkowski, Robb, and Good (2017) found that both MHI and non-MHI participants who endorsed greater trait mindfulness presented with significantly fewer psychological (depressive) and postconcussion symptoms. Therefore, regular engagement in mindfulness practice may be an effective way to combat psychological/emotional post-TBI symptomatology.

Although MBSR and MBCT were originally designed to target health-related outcomes in chronic pain and major depressive disorder patients, these interventions are becoming widely used for other purposes as well, such as improving certain cognitive skills. For example, in normative populations, mindfulness-based practices are associated with improvements in both sustained and selective attention, executive functioning (e.g., cognitive flexibility), and working memory capacity, as evidenced by better performance on objective neuropsychological measures.
following the completion of mindfulness interventions (Chiesa, Calati, & Serretti, 2011; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010). Similar results have also been obtained when investigating the cognitive effects of MBSR interventions in TBI samples (Azulay, Smart, Mott, & Cicerone, 2013; Johansson et al., 2012). For example, one study showed that after partaking in a modified MBSR program (tailored towards those who have sustained a brain injury), the mTBI participants obtained significantly higher scores on performance-based measures of attention and processing speed (Azulay et al., 2013). In another study, it was found that compared to a wait-list control group, mTBI and stroke patients who completed MBSR training exhibited significant greater improvements on neuropsychological measures of processing speed and attention (Johansson et al., 2012). Taken together, these results provide preliminary support for the utilization of mindfulness strategies to target cognitive post-concussive symptoms following head injury.

Compared to the vast body of literature investigating the cognitive, psychological, and emotional effects of mindfulness training interventions, there is a relative paucity of studies focusing on physiological changes associated with mindfulness practice, especially those assessing changes in arousal levels. Notably, although mindfulness meditation is often equated with relaxation, it may be more accurately characterized as a form of attentional control training that involves an active process of monitoring and re-directing one’s focus of attention, requiring a high degree of cognitive effort and an alert vigilant awareness (Britton, Lindahl, Cahn, Davis, & Goldman, 2014; Teasdale, Segal, & Williams, 1995; Tomasino & Fabbro, 2016). Indeed, mindfulness has been previously described as a state of “relaxed alertness”, in which there is a constant balancing act between the extreme states of hyperarousal (e.g., excitation, anxiety, restlessness) and hypoarousal (e.g., drowsiness, sleep, laxity; Britton et al., 2014). More
specifically, mindfulness practices are said to be linked to levels of tonic alertness (i.e., vigilant attention) which reflects a baseline level of arousal, alertness, vigilance, wakefulness, or state of cognitive preparedness to respond to unexpected stimuli (Britton et al., 2014; Langner & Eickhoff, 2013).

Supporting the connection between meditative practice and heightened tonic alertness are the findings from a multitude of neuroimaging studies, which are increasingly being utilized to investigate the neural mechanisms underpinning the benefits of mindfulness. From these studies, it has been shown that mindfulness meditation practice is associated with larger gray matter volumes in the dorsolateral prefrontal cortex (dIPFC), among other frontal areas of the brain (Britton et al., 2014; Lazar et al., 2005; Luders, Toga, Lepore, & Gaser, 2009). Additionally, mindfulness practices have also been linked to increased activity in the dIPFC, during both active engagement in mindfulness exercises, as well as during a wide variety of cognitive tasks (Allen et al., 2012; Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007; Britton et al., 2014; Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012; Tomasino & Fabbro, 2016). Importantly, heightened levels of activity in the dIPFC have been shown to correspond to a state of alert wakefulness, thus supporting the proposed link between mindfulness practice and increased arousal and alertness levels (Braun et al., 1997; Maquet et al., 1990).

Further evidence from neuroimaging studies has emerged when exploring the relationships between long-term mindfulness meditation practice and structural changes in subcortical and brainstem structures. Specifically, it has been found that when compared to age-matched controls, long-term mindfulness meditators exhibit increased gray matter density in arousal-related areas of the brainstem, including the reticular formation (Britton et al., 2014; Vestergaard-Poulsen et al., 2009). In another study, it was shown that compared to a group of
wait-list controls, those who participated in an MBSR intervention exhibited significantly increased gray matter concentration in the left hippocampus (which has been said to play a role in the modulation of cortical arousal) and various brainstem regions, such as the locus coeruleus, nucleus raphe pontis, pontine tegmentum, and the sensory trigeminal nucleus (Hölzel et al., 2011; Newberg & Iversen, 2003). Interestingly, it was shown in a follow-up study that the changes in gray matter concentration were significantly correlated with increases in self-reported psychological well-being, indicating that these morphological changes may be involved in the mechanisms underlying the reported benefits of mindfulness practice (Singleton et al., 2014). Taken as a whole, these findings indicate that mindfulness-related activation or volumetric increases in gray matter closely correspond to a number of tonic alertness-related brain regions (Britton et al., 2014).

Consistent with results from neuroimaging studies, when utilizing other methods of assessing sympathetic arousal levels (e.g., examining heart rate, SCLs, etc.), mindfulness practice can lead to increases in physiological arousal levels. For example, when assessing the physiological effects of different mindfulness-based interventions (i.e., looking specifically at changes in cardiac activity), it was found that heart rate significantly increased following the loving-kindness meditation and observing-thoughts meditation interventions, but not after a breathing meditation intervention (Lumma, Kok, & Singer, 2015). The authors concluded that these increases in sympathetic arousal may have been seen in the former two types of mindfulness training (but not the latter) due to the greater amount of mental effort required and because of the complexity of attentional, cognitive, and affective processes involved in these types of mindfulness practices (Lumma et al., 2015). Therefore, certain types of mindfulness
Changes in sympathetic arousal level have also been discovered when examining SCLs during active engagement in mindfulness-based practices. For example, when comparing the physiological effects of two different deep and slow breathing (DSB) techniques (i.e., an attentive DSB intervention that required a high degree of concentration versus a relaxing DSB intervention), it was found that SCLs were significantly decreased (compared to baseline levels) during the relaxing DSB intervention, but tended to increase during the attentive DSB intervention (Busch et al., 2012). Although the increase was not statistically significant (possibly due to the small sample size of the study), it does imply that when individuals are required to actively regulate their attention (i.e., similar to which occurs during mindfulness practice) physiological arousal may be increased.

**Current Study**

**Part I – MHI, post-injury cognitive outcomes, and mindfulness.** Given the large variability in post-injury recovery rates after MHI, it is important to consider the complex interactions between pre-injury factors, injury characteristics, and post-injury outcomes. However, one problem with this approach is that many of the currently identified risk factors (e.g., sex, age, injury mechanism, length of PTA, etc.) are not directly modifiable, which poses an issue when trying to develop acute and/or long-term management strategies and secondary preventative measures for MHI (Silverberg & Iverson, 2011). To address this problem, further research is needed to identify maladaptive psychological markers, as these may be viable treatment targets (Silverberg & Iverson, 2011). Since trait mindfulness has been linked to various adaptive outcomes (e.g., greater self-regulation ability, lower levels of executive dysfunction,
etc.) in the normative population, mindfulness may serve as a “protective” factor against the development of cognitive symptoms post-injury and may be relevant in predicting recovery outcomes (Short et al., 2016). Therefore, the purpose of the current study was to investigate subtle differences in cognitive functioning (e.g., inhibitory control, attention, cognitive flexibility, working memory, etc.) following MHI (using both self-report and performance-based cognitive measures) in a sample of cognitively-competent university students and to explore the potential role of trait mindfulness.

**Hypotheses:**

(1) Relative to their non-head-injured peers, it is expected that those with a history of MHI will self-report greater cognitive challenges in everyday life, greater post-concussive symptoms in the cognitive domain, as well as exhibit poorer performance on cognitive tasks (i.e., impaired working memory, cognitive flexibility, and attention).

(2) In both non-MHI and MHI groups, it is hypothesized that mindfulness will be associated with these cognitive outcomes. More specifically, overall trait mindfulness is expected to be a significant predictor of cognitive functioning, such that higher levels of mindfulness will be associated with better performance on cognitive tasks and fewer self-reported cognitive challenges.

**Part II – MHI, post-injury outcomes, and mindfulness: Exploring potential mechanisms.** Despite the potential link between mindfulness practice and changes in physiological arousal, very few studies have examined this relationship, especially with respect to increasing arousal levels. Additionally, when investigating the potential benefits of trait or dispositional mindfulness, the focus has largely been centered on psychological (i.e., emotional) and cognitive advantages of greater mindfulness, with relatively fewer studies investigating the
potential physiological correlates of trait mindfulness. Notably, previous researchers have suggested that the arousing and alertness-promoting effects of mindfulness may represent one possible mechanism underlying the benefits of a mindful disposition (Britton et al., 2014). When considering the MHI population, trait mindfulness may act as a compensatory strategy to overcome post-concussive symptoms related to chronic underarousal by boosting baseline or resting levels of physiological arousal.

Therefore, a secondary purpose of the current study was to further explore the relationships between physiological arousal and trait mindfulness and to determine whether physiological arousal is a mediator of the relationship between trait mindfulness and post-injury outcomes following MHI. To address these knowledge gaps in the existing body of literature, a quasi-experimental cross-sectional design was employed to examine cognitive abilities (e.g., inhibitory control, cognitive flexibility, attention, etc.), personality characteristics (e.g., trait/dispositional mindfulness, openness to experience, etc.), post-concussive symptoms (e.g., depressive symptoms, anxiety symptoms, irritability, headache, concentration problems, etc.), and physiological activity (e.g., EDA, heart rate, blood pressure, etc.) in a cognitively-competent university student sample, comprised of both individuals with and without a previous history of MHI.

Hypotheses:

(3) Similar to previous findings in the Neuropsychology Cognitive Research (NCR) laboratory (e.g., Baker & Good, 2014; van Noordt & Good, 2011), it is expected that individuals who report having sustained an MHI will exhibit significantly lower baseline EDA (i.e., physiological arousal) than those without a history of head trauma.
(4) Trait mindfulness is hypothesized to be a significant predictor of baseline physiological arousal level, such that higher levels of trait mindfulness will be associated with greater baseline EDA – it is anticipated that this effect will be similar for both MHI and non-MHI participants.

(5) In the MHI group only, it is expected that baseline physiological arousal (EDA) will mediate the relationship between trait mindfulness and a number of cognitive post-injury outcomes, including self-reported cognitive functioning and performance on neuropsychological tasks.

The hypotheses outlined above will be tested using data collected as part of another research study in the NCR lab. The purpose of this larger study was to investigate the physiological, cognitive, and psychological effects of a brief mindfulness-based intervention in a university student sample, comprised of both students with and without a history of MHI. As part of this research study, participants attended laboratory sessions over the course of five consecutive weeks. The first week (i.e., pre-testing session) and fifth week (i.e., post-testing session) involved a 90-minute individualized laboratory session, whereby participants completed self-report questionnaires and neuropsychological measures, in addition to providing physiological measures. The second, third, and fourth week of the study each involved a half hour group training session in either relaxation or mindfulness-based exercises. In between these sessions, participants completed daily homework exercises (for approximately five minutes per day) that were relevant to the mindfulness or relaxation training for that week. It is important to note that since the current research study examined data exclusively from the pre-testing session, only demographic information and research procedures relevant to the pre-test (week 1) session will be discussed in subsequent sections of this thesis.
Methods

Participants

A total of 52 Brock University undergraduate students (43 women, 9 men) completed the pre-testing session of the larger research study (as described earlier) and served as the sample for the current study. Participants were recruited via the Brock University Psychology Department Research Pool (SONA), advertisement posters (see Appendix A) distributed around the Brock University campus, and standardized recruitment PowerPoint slides (displayed in Psychology courses offering course credit for research participation). Of these, 20 participants (38.5%) self-reported a history of at least one MHI (18 women, 2 men). Importantly, in order to avoid “diagnosis threat”, participants were not actively recruited based on having a history of MHI (Suhr & Gunstad 2002, 2005). Diagnosis threat can occur when the participant is made aware of the intent to investigate head injury and can negatively impact performance on cognitive and neuropsychological measures (Suhr & Gunstad, 2002, 2005). Therefore, to reduce the influence of diagnosis threat and its effect on expectations and performance, participants were not informed that MHI status was a variable of interest for the study. Instead, participants were told that the primary purpose of the research study was to investigate the “Physiological, Cognitive, and Psychological Effects of a Cognitive-Based Intervention”.

Ages for participants across the entire sample ranged between 18 and 51 (M age = 22.37, SD = 7.208). Table 1 provides the means and standard deviations for the age of participants, as well as descriptive statistics with respect to sex, handedness, years of education, and ethnicity as a function of head injury status. As observed, the non-MHI and MHI groups did not differ considerably in any of these variables: across both groups, most participants were right-handed Caucasian women, with one or two years of post-secondary education (mostly university level).
Table 1

Descriptive Statistics of Age, Sex, Handedness, Years of Education, and Ethnicity

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-MHI</th>
<th>MHI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(M = 32)</td>
<td>(n = 20)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>21.28</td>
<td>24.10</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>25 (78.1%)</td>
<td>18 (90.0%)</td>
</tr>
<tr>
<td>Handedness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>29 (90.6%)</td>
<td>18 (90.0%)</td>
</tr>
<tr>
<td>Years of Education Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than High School</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>High School/Grade 12</td>
<td>5 (15.6%)</td>
<td>2 (10.0%)</td>
</tr>
<tr>
<td>College – 1 Year</td>
<td>1 (3.1%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>College – 2 Years</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>College – 3 Years</td>
<td>1 (3.1%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>College – 4+ Years</td>
<td>0 (0%)</td>
<td>1 (5.0%)</td>
</tr>
<tr>
<td>University – 1 Year</td>
<td>12 (37.5%)</td>
<td>7 (35.0%)</td>
</tr>
<tr>
<td>University – 2 Years</td>
<td>6 (18.8%)</td>
<td>3 (15.0%)</td>
</tr>
<tr>
<td>University – 3 Years</td>
<td>3 (9.4%)</td>
<td>4 (20.0%)</td>
</tr>
<tr>
<td>University – 4+ Years</td>
<td>4 (12.6%)</td>
<td>3 (15.0%)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>18 (56.3%)</td>
<td>13 (65.0%)</td>
</tr>
<tr>
<td>European</td>
<td>1 (3.1%)</td>
<td>4 (20.0%)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3 (9.4%)</td>
<td>1 (5.0%)</td>
</tr>
<tr>
<td>African</td>
<td>2 (6.3%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>East Indian</td>
<td>1 (3.1%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Other</td>
<td>7 (21.9%)</td>
<td>2 (10.0%)</td>
</tr>
</tbody>
</table>
Indeed, while participants in the MHI group ($M = 24.10, SD = 8.57$) were older on average than those in the non-MHI group ($M = 21.28, SD = 6.11$), they were not significantly different from one another, $t(50) = -1.38, p = .172$. Additionally, a Fisher’s exact test\(^1\) determined that there was no significant difference in the distribution of sex across MHI and no-MHI groups, $\chi^2 (1) = 1.21, p = .454$.

Table 2 depicts descriptive statistics related to the level of parental education achieved, as well as the overall average household income of parents/guardians as a function of head injury status. As can be seen in Table 2, these variables were relatively consistent across the non-MHI and MHI groups. The majority of participants had parents who achieved at least some post-secondary education (either college or university) and who were predominately upper middle class.

Table 3 contains a list of all sports-related activities currently played by participants (at the university level) and their corresponding demographic frequencies. In terms of athletic status, 35 (67.3%) participants identified as non-athletes, while the remaining 17 (32.7%) participants reported that they currently played a university level sport. Of those who reported current sports participation, 9 were classified as low-risk athletes (17.3%), while the remaining 8 participants were classified as high-risk athletes (15.4%). Athletic groups were derived by examining sports participation history reported by participants. More specifically, the primary sport that participants currently played (either recreationally or competitively) was used to create these categorizations.

\(^1\) Fisher’s exact tests were used in place of Pearson’s Chi-square tests when cell sample sizes were too small (i.e., cell values of $n$’s < 5).
Table 2

*Descriptive Statistics of Parental Education and Parental Income as a Function of Head Injury Status*

<table>
<thead>
<tr>
<th>Variable:</th>
<th>Non-MHI (n = 32)</th>
<th>MHI (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (percentage)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Years of Education Mother Completed**
- Less than High School: 4 (12.5%) | 1 (5.0%)
- High School/Grade 12: 2 (6.3%) | 3 (15.0%)
- College: 12 (37.5%) | 8 (40.0%)
- University: 13 (40.6%) | 8 (40.0%)
- Unsure: 1 (3.1%) | 0 (0%)

**Years of Education Father Completed**
- Less than High School: 1 (3.1%) | 3 (15.0%)
- High School/Grade 12: 4 (12.5%) | 1 (5.0%)
- College: 8 (25.0%) | 9 (45.0%)
- University: 14 (43.8%) | 6 (30.0%)
- Unsure: 5 (15.6%) | 1 (5.0%)

**Parental Income**
- Under $25,000: 0 (0%) | 2 (10.0%)
- $25,000 to $49,999: 5 (15.6%) | 0 (0%)
- $50,000 to $74,999: 7 (21.9%) | 3 (15.0%)
- $75,000 to $99,999: 3 (9.4%) | 4 (20.0%)
- $100,000 to $124,999: 7 (21.9%) | 2 (10.0%)
- $125,000 to $149,999: 1 (3.1%) | 4 (20.0%)
- $150,000 or more: 7 (21.9%) | 5 (25.0%)
Table 3

*Self-reported Sport-related Activities Currently Played in University (n= 17)*

<table>
<thead>
<tr>
<th>Sport-related activity</th>
<th>High-Risk Athletes (n= 8)</th>
<th></th>
<th>Low-Risk Athletes (n= 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>% of total</td>
<td>n</td>
</tr>
<tr>
<td>Ice Hockey</td>
<td>2</td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>Soccer</td>
<td>2</td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>Figure Skating</td>
<td>2</td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>Power/Olympic Lifting</td>
<td>2</td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Table 4 displays a number of health-related descriptive statistics, such as rates of hospital admissions, use of medications, diagnoses of psychiatric and neurological conditions, and learning disabilities as a function of head injury status. As observed, rates of hospitalization were comparable across the non-MHI and MHI groups; Pearson’s Chi-square tests revealed no significant differences in self-reported hospitalizations for fractures, $\chi^2 (1) = 0.79, p = .374$, illness, $\chi^2 (1) = 2.83, p = .093$, or surgery, $\chi^2 (1) = 0.60, p = .439$, while Fisher’s exact tests showed no significant differences in rates of hospitalization for neurological complications, $\chi^2 (1) = 4.03, p = .066$, or other reasons, $\chi^2 (1) = 0.76, p = .362$.

Across the entire sample, ten participants (19.2%) reported being diagnosed with a psychiatric condition ($M$ age = 22.70, $SD$ = 8.30), nine of whom were female (90%); three of these participants also reported a history of MHI (30%). Moreover, there were a minimal number of reported neurological conditions and learning disabilities. Four participants (7.7%) reported being diagnosed with a neurological condition ($M$ age = 20.25, $SD$ = 2.06), all of whom were female (100%); three of these participants also reported a history of MHI (75%). Similarly, four
participants (7.7%) reported being diagnosed with a learning disability ($M_{age} = 27.0$, $SD = 12.19$), three of whom were female (75%); two of these participants also reported a history of MHI (50%). However, using Fisher’s exact tests, it was found that rates of psychiatric diagnoses, $\chi^2 (1) = 0.28$, $p = .725$, neurological diagnoses, $\chi^2 (1) = 2.65$, $p = .140$, and diagnoses of learning disorders, $\chi^2 (1) = 0.24$, $p = .634$, did not significantly differ as a function of MHI status.

Similarly, using Fisher’s exact test, it was also demonstrated that the MHI and non-MHI groups did not significantly differ in rates of medication use (for a psychiatric or neurological condition), $\chi^2 (1) = 0.53$, $p = .695$.

Table 4

Descriptive Statistics of Health-related Variables and Diagnoses of Interest as a Function of Head Injury Status

<table>
<thead>
<tr>
<th>Variable: Health-related Variables or Diagnoses</th>
<th>Non-MHI ($n = 32$)</th>
<th>MHI ($n = 20$)</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitalizations for Fractures</td>
<td>10 (31.3%)</td>
<td>4 (20.0%)</td>
<td>.374</td>
</tr>
<tr>
<td>Hospitalizations for Illness</td>
<td>6 (18.8%)</td>
<td>8 (40.0%)</td>
<td>.093</td>
</tr>
<tr>
<td>Hospitalizations for Surgery</td>
<td>8 (25.0%)</td>
<td>7 (35.0%)</td>
<td>.439</td>
</tr>
<tr>
<td>Hospitalizations for Neurological Complications</td>
<td>1 (3.1%)</td>
<td>4 (20.0%)</td>
<td>.066</td>
</tr>
<tr>
<td>Hospitalizations for Other</td>
<td>4 (12.5%)</td>
<td>1 (5.0%)</td>
<td>.362</td>
</tr>
<tr>
<td>Diagnosed Psychiatric Condition</td>
<td>7 (21.9%)</td>
<td>3 (15.0%)</td>
<td>.725</td>
</tr>
<tr>
<td>Medication for a Psychiatric or Neurological Condition</td>
<td>4 (12.5%)</td>
<td>4 (20.0%)</td>
<td>.695</td>
</tr>
<tr>
<td>Diagnosed Neurological Condition</td>
<td>1 (3.1%)</td>
<td>3 (15.0%)</td>
<td>.140</td>
</tr>
<tr>
<td>Diagnosed Learning Disability</td>
<td>2 (6.3%)</td>
<td>2 (10.0%)</td>
<td>.634</td>
</tr>
</tbody>
</table>
Table 5 shows descriptive statistics with respect to various injury characteristics of self-reported MHI, such as the location and cause of injury, the age at injury for the first MHI sustained, as well as the time since injury. For participants who reported a history of MHI, the most common location of injury was the front of the head (36.8%), followed by the back of the head (26.3%). In terms of etiology, the majority of head injuries were caused by either sports-related activities (42.1%) or falls (31.6%); these rates are consistent with previously reported data from the NCR laboratory (Baker & Good, 2014). It is also interesting to note that of the sports-related MHIs, 7 (87.5%) were sustained during high-risk sports. Moreover, as can be seen in Table 5, age at injury (for the first MHI) ranged from infancy to 25 years of age. The majority of participants were between 11 to 15 years of age when they sustained their first MHI (36.8%), followed closely by the 16 to 20 years of age category (31.6%). Moreover, all 20 individuals who self-reported a history of MHI reported that they experienced their most recent MHI at least three months previously, indicating that they were no longer in the acute post-injury recovery phase. Additionally, 17 participants (89.5%) were at least one year post-injury.

Table 6 displays various indicators of injury severity, such as details regarding LOC, medical treatment, length of MHI-related symptomatology, and number of self-reported MHIs. As can be seen in Table 6, ten participants with a history of MHI reported experiencing symptoms for longer than 20 minutes (52.6%). Moreover, eight individuals reported experiencing LOC (42.1%), with most of these participants stating that it lasted less than five minutes in duration (31.6%). Interestingly, although nearly half of participants received medical treatment (47.4%), only two were required to stay overnight at a medical facility (10.5%). Furthermore, seven participants reported a history of more than one head injury (13.5% of the total sample; 36.8% of those with a history of MHI).
Table 5

*Injury Characteristics of Self-Reported MHI (n = 19)*

<table>
<thead>
<tr>
<th>Location of injury</th>
<th>Total n = 19</th>
<th>n</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front of head</td>
<td></td>
<td>7</td>
<td>36.8%</td>
</tr>
<tr>
<td>Right side of head</td>
<td></td>
<td>4</td>
<td>21.1%</td>
</tr>
<tr>
<td>Left side of head</td>
<td></td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td>Back of head</td>
<td></td>
<td>5</td>
<td>26.3%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>2</td>
<td>10.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Etiology of first MHI</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports-related activity</td>
<td></td>
<td>8</td>
<td>42.1%</td>
</tr>
<tr>
<td>High-risk sport</td>
<td></td>
<td>7</td>
<td>36.8%</td>
</tr>
<tr>
<td>Low-risk sport</td>
<td></td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td>Falling</td>
<td></td>
<td>6</td>
<td>31.6%</td>
</tr>
<tr>
<td>Motor vehicle collision</td>
<td></td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>4</td>
<td>21.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age at first MHI</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td></td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td>6-10</td>
<td></td>
<td>3</td>
<td>15.8%</td>
</tr>
<tr>
<td>11-15</td>
<td></td>
<td>7</td>
<td>36.8%</td>
</tr>
<tr>
<td>16-20</td>
<td></td>
<td>6</td>
<td>31.6%</td>
</tr>
<tr>
<td>21-25</td>
<td></td>
<td>2</td>
<td>10.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time since injury</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4-6 months</td>
<td></td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td>7-11 months</td>
<td></td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td>1-2 years</td>
<td></td>
<td>3</td>
<td>15.8%</td>
</tr>
<tr>
<td>3-5 years</td>
<td></td>
<td>4</td>
<td>21.1%</td>
</tr>
<tr>
<td>6-9 years</td>
<td></td>
<td>4</td>
<td>21.1%</td>
</tr>
<tr>
<td>10+ years</td>
<td></td>
<td>6</td>
<td>31.6%</td>
</tr>
</tbody>
</table>

*Note.* While 20 participants indicated “yes” to the question determining head injury status, 1 of these participants did not disclose information regarding injury characteristics. Therefore, the corresponding descriptive statistics for these variables are based on the 19 participants who provided such information.
Given their relevance to the current study, other demographic variables related to relaxation/meditation practice were also examined across MHI and non-MHI groups. Using Pearson’s Chi-square tests, it was found that rates of regular engagement in relaxation/meditation techniques did not significantly differ across MHI and non-MHI groups, $\chi^2 (1) = 3.09, p = .079$, although there was a marginally significant trend for higher rates of relaxation technique use in the MHI group. Moreover, it was also shown that there were no significant differences in terms of frequency of relaxation technique use (per week) across MHI and non-MHI participants, $\chi^2 (1) = 4.39, p = .356$.

### Table 6

*Injury Severity Indicators of Self-Reported MHI (n = 19)*

<table>
<thead>
<tr>
<th>Injury Severity Indicators</th>
<th>n</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms &gt; 20 minutes</td>
<td>10</td>
<td>52.6</td>
</tr>
<tr>
<td>Loss of consciousness (LOC)</td>
<td>8</td>
<td>42.1</td>
</tr>
<tr>
<td><strong>Duration of LOC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5 minutes</td>
<td>6</td>
<td>31.6</td>
</tr>
<tr>
<td>&lt; 30 minutes</td>
<td>2</td>
<td>10.5</td>
</tr>
<tr>
<td>&lt; 24 hours</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Diagnosed concussion</td>
<td>12</td>
<td>63.2</td>
</tr>
<tr>
<td>Required stitches</td>
<td>2</td>
<td>10.5</td>
</tr>
<tr>
<td>Received medical treatment</td>
<td>9</td>
<td>47.4</td>
</tr>
<tr>
<td>Overnight at medical facility</td>
<td>2</td>
<td>10.5</td>
</tr>
<tr>
<td>More than one injury</td>
<td>7</td>
<td>36.8</td>
</tr>
</tbody>
</table>

*Note.* While 20 participants indicated “yes” to the question determining head injury status, 1 of these participants did not disclose information regarding indicators of injury severity. Therefore, the corresponding descriptive statistics for these variables are based on the 19 participants who provided such information.
Materials

Materials included non-invasive physiological measures, performance-based measures (i.e., standardized neuropsychological tests), as well as various self-report questionnaires (in a paper-based format). All self-report questionnaires relevant to the current study can be found in Appendix A.

Physiological Measures. Measures of EDA, heart rate, and respiration were obtained using Polygraph Professional equipment and the Polygraph Professional Suite Software program, which was ran on a 16-inch Acer laptop computer (Limestone Technologies, 2008). Other physiological indices, such as blood pressure (BP) and pulse were obtained using an automatic BP monitor (model: HEM-711DLXCAN; Omaron Healthcare Inc.).

Electrodermal activity (EDA) is a term used to describe the continuous autonomic fluctuations in the electrical characteristics of the skin and is typically measured by running a small electrical current between two areas of skin contact and measuring the resulting changes in skin resistance (Braithwaite, Watson, Jones, & Rowe, 2013). EDA is comprised of both tonic or “resting” levels of skin conductance (SCLs), as well as phasic fluctuations in skin conductance (skin conductance responses; SCRs) that arise due to sympathetic neuronal activity (Braithwaite et al., 2013). Indeed, previous studies have found that EDA is especially sensitive to sympathetic nervous system (SNS) activity, which produces subtle changes in sweat gland response (Tranel, 2000). Furthermore, since EDA remains relatively unaffected by parasympathetic nervous system (PNS) activity, it is often considered to be one of the most reliable and useful indices of SNS arousal changes related to cognitive and emotional processing (Braithwaite et al., 2013).

For the current study, baseline EDA was the primary physiological variable of interest and was used as an index of sympathetic nervous system arousal. Specifically, EDA
measurements were derived by calculating the average peak amplitude (PA) over a three-minute recording and were measured in units of microSiemens (µS). The materials used to record EDA included the Datapac USB 16-bit Data Acquisition Instrument, as well as two silver-silver chloride (Ag-AgCl) electrodes, which were positioned on the distal end of the index and fourth fingers of the participant’s non-dominant hand.

Other physiological variables such as heart rate, respiration rate, and BP were also included as part of the current study. To record heart rate (i.e., in terms of beats per minute; bpm), a pulse oximeter was attached to the distal part of the participant’s middle finger of the non-dominant hand. To record respiration rate, one pneumatic chest band was placed around the participant’s chest, while a second one was placed around the participant’s abdomen. Lastly, BP was recorded using an automatic blood pressure monitor that was placed on the participant’s non-dominant upper arm.

Neuropsychological Measures.

Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001). The D-KEFS is a neuropsychological test battery comprised of nine performance-based measures that assess higher-order cognitive functions (i.e., executive functioning), understood to be predominantly subserved by the frontal lobe. Two subtests of the D-KEFS (i.e., the trail making test and colour-word interference test) were used to measure levels of executive functioning among participants of the present study. The D-KEFS demonstrates adequate levels of both reliability and validity (Delis et al., 2001; Delis, Kramar, Kaplan, & Holdnack, 2004).

The Trail Making Test (TMT; Delis et al., 2001). The TMT primarily assesses visual scanning, set-switching ability (i.e., cognitive flexibility), processing speed, and working memory during a visual-motor task, and consists of five test conditions. Since the present study
included a sample of competent university students, only conditions 3 and 4 were included (as the other conditions are primarily used as control tests to detect the presence of visual scanning or motor impairments). In both condition 3 and 4 of the TMT, participants are presented with a page that includes a random distribution of numbers and letters. Condition 3 measures letter sequencing and requires the participant to draw a trail connecting the letters in the correct alphabetical order, as quickly and as accurately as possible. Condition 4 involves number-letter switching (i.e., cognitive flexibility) and requires the participant to draw a trail by switching back and forth between the numbers and letters in the correct chronological or alphabetical order (e.g., 1, A, 2, B, 3, C, etc.), as quickly and as accurately as possible. In both conditions, the dependent variables include the task completion time (in seconds), as well as the total number of errors made.

The Colour-Word Interference Test (CWIT; Delis et al., 2001). The CWIT is a measure of inhibitory control that utilizes the "Stroop Effect" and consists of four test conditions. Similar to the previous subtest, only the conditions relevant to the current sample were included as part of the study (i.e., conditions 1 and 3). In condition 1, participants are presented with a page of various coloured squares (blue, green, or red) and are instructed to state the ink colour of the squares to the examiner, as quickly and as accurately as possible. In condition 3, participants are presented with a page of various colour names that are printed in either a congruent ink colour (i.e., the word “red” printed in red ink) or an incongruent ink colour (e.g., the word “red” printed in green ink). For this condition, participants are instructed to inhibit reading the colour word and are to instead name the ink colour that the words are printed in, as quickly and as accurately as possible. For both conditions of the CWIT, the dependent variables include the task completion time (in seconds), as well as the total number of errors made.
Self-Report Measures.

The Everyday Living Demographic Questionnaire (ELQ; Brock University, Neuropsychology Cognitive Research Laboratory, 2008). The ELQ was used to collect a wide variety of demographic information such as age, sex, educational/academic history, lifestyle (e.g., exercise history, sleep habits, etc.), sports participation history, medical history, indices of stressful life events/changes, and history of MHI, among other demographic variables. Importantly, the questions in the ELQ regarding MHI status were embedded among other health-related questions (e.g., past hospitalizations, neurological diagnoses, etc.). The specific question used to determine a history of MHI is as follows “Have you ever sustained an injury to your head with a force sufficient to alter your consciousness (e.g., dizziness, vomiting, seeing stars, or loss of consciousness, or confusion)?”. If participants indicated “yes” to this question, they were then asked to provide detailed information regarding the injury, such as LOC duration (if applicable), number of head injuries sustained, cause of the head injury, duration of symptom experience, and other injury-related information. From these injury characteristics, a composite score of injury severity was derived.

Post-Concussion Syndrome Checklist (PCSC; Gouvier, Cubic, Jones, Brantley, & Cutlip, 1992). A slightly modified version of the PCSC was attached to the ELQ. The PCSC is a 10-item scale that assesses self-reported post-concussive symptoms across somatic, cognitive,
and emotional symptom domains (Gouvier et al., 1992). The participant is asked to rate the frequency, intensity, and duration for each of the symptoms listed (e.g., fatigue, memory problems, irritability, headache, etc.). Responses are rated on a five-point Likert-type scale, with frequency of symptoms ranging from 1 (not at all) to 5 (all the time), intensity of symptoms ranging from 1 (not at all) to 5 (crippling), and duration of symptoms ranging from 1 (not at all) to 5 (constant).

Behavior Rating Inventory of Executive Function – Adult (BRIEF-A; Roth, Isquith, & Gioia, 2005). The BRIEF-A is a 75-item self-report measure that assesses executive dysfunction in everyday activities. The BRIEF-A produces an overall score (i.e., global executive composite; GEC), which is comprised of two index scores: the metacognition index (MI) and behavioural regulation index (BRI). In turn, these two indices are composed of several smaller subscales including, inhibit (e.g., “I have problems waiting my turn”), self-monitor (e.g., “When people seem upset with me I don’t understand why”), plan/organize (e.g., “I don’t plan ahead for future activities”), shift (e.g., “I get disturbed by unexpected changes in my daily routine”), initiate (e.g., “I have trouble getting ready for the day”), task-monitor (e.g., “I don’t check my work for mistakes”), emotional control (e.g., “I get emotionally upset easily”), working memory (e.g., “I have trouble staying on the same topic when talking”), and organization of materials (e.g., “People say that I am disorganized”). Responses are indicated using a three-point Likert-type scale, ranging from 1 (never a problem) to 3 (often a problem), with higher scores reflecting greater executive dysfunction. The BRIEF-A demonstrates good validity and reliability in both clinical and non-clinical populations, with internal consistencies ranging from .73 to .90 for the nine subscales and from .93 to .96 for the two broader indices and global executive component (Ciszewski, Francis, Mendella, Bissada, & Tasca, 2014; Roth et al., 2005).
The Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). The FFMQ is a 39-item self-report measure of mindfulness that measures the extent to which individuals are mindful in everyday life (i.e., “trait” or “dispositional” mindfulness). This questionnaire was derived from a factor analysis of several existing measures of mindfulness and produces a total of 5 subscales: observing (e.g., “When I take a shower or bath, I stay alert to the sensations of water on my body”), describing (e.g., “I can easily put my beliefs, opinions, and expectations into words”), acting with awareness (e.g., “I find myself doing things without paying attention”), non-judging of inner experience (e.g., “I believe some of my thoughts are abnormal or bad and I shouldn’t think that way”), and non-reactivity to inner experience (e.g., “In difficult situations, I can pause without immediately reacting”). Responses are rated on a five-point Likert-type scale ranging from 1 (never/almost never) to 5 (very often/always true), such that higher scores reflect higher levels of trait mindfulness. The FFMQ shows adequate to good psychometric properties, with internal consistencies ranging from .75 to .91 for the five subscales (Baer et al., 2006).

Procedure

Participants attended lab sessions during one of three time slots (morning: 8:30 – 11:59 am, afternoon: 12:00 – 3:59 pm, or evening: 4:00 – 8:00 pm) by one of two examiners. Prior to running participants, both examiners were trained on how to administer the paper and pencil neuropsychological tests and followed the same verbal script and set of standardized instructions (see Appendix A). Participants were also directly trained on the procedure for collecting physiological data. No significant differences in performance on the neuropsychological tests were observed across the different examiners or lab session times (ps > .05).

Upon arriving to the testing room, participants were greeted by one of the two examiners and were provided with a consent form to read over. The examiner verbally repeated the main
points from the consent form and reminded participants of their right to withdraw from the study, procedures related to confidentiality and anonymity, as well as the option to receive research participation credits (0.5 credits per each half-hour of participation) or to have their name entered into a series of cash draws ($10 per each half-hour of participation). Once consent was obtained, participants were then asked a self-report question regarding their current state of arousal (i.e., “On a scale from one to 10, with one being very relaxed/calm and 10 being very stressed, how are you currently feeling?”). Afterwards, the participants were guided by the examiner on how to properly place the physiological equipment, including two silver-silver chloride electrodes, a pulse oximeter, and two pneumatic chest bands. The participant was then asked to sit in a comfortable position and to remain as still as possible while a three-minute baseline recording of EDA, heart rate, and respiration was obtained. Upon removing the aforementioned physiological equipment, participants were then assisted with the placement of a BP cuff on the upper part of their non-dominant arm. Systolic and diastolic BP values were then provided by the automatic BP monitor and were recorded by the examiner. The BP cuff was then removed from the participant’s arm.

Subsequently, the examiner administered each of the performance-based neuropsychological measures in the following order: TMT – condition 3, TMT – condition 4, CWIT – condition 1, CWIT – condition 3. All tasks were timed using a stopwatch and afterwards, the examiner recorded the task completion times on the corresponding test booklets. Afterwards, participants were asked to accompany the examiner to a separate testing room to complete the paper-based self-report questionnaires in the following order: FFMQ, BRIEF-A, & ELQ. Lastly, participants were thanked for their participation in the first testing session, received compensation (i.e., either research participation credits or their name entered into a series of
draws), and were contacted afterwards to participate in the following parts of the study. Participants were not fully debriefed until the final testing session, but were provided with a general description about the nature of the study and relevant contact information, to serve as an “interim” debriefing.

Statistical Analyses

Data obtained from the current study was analyzed using the Statistical Package for the Social Sciences (SPSS; Version 24, 2016). Unless otherwise stated, all assumptions for statistical tests have been checked and can be assumed to have been met. If any assumptions were found to be violated, conservative non-parametric tests such as the Mann-Whitney Test or the Spearman’s rho coefficient were conducted. For all analyses, a significance value of \( p < .05 \) was used; however, trends that approached significance (i.e., \( p < .10 \)) are also discussed.

To examine group categorical differences according to MHI status, Pearson Chi-square tests of independence were conducted. To examine mean differences between MHI and no-MHI groups across the relevant dependent variables (i.e., scores on the BRIEF-A, EDA values, and completion times on the TMT and CWIT), independent \( t \)-test statistics were used. Given the exploratory nature of the current study and relative subtlety of the expected differences between MHI and no-MHI groups, corrections were not made for conducting multiple analyses. Moreover, to examine the effects of trait mindfulness, as well as injury severity, several linear regression analyses were conducted. Lastly, to examine if physiological arousal mediated the

\[ \text{Assumptions of Normality (using Histograms, P-P Plots, and Box-plots) and Homogeneity of Error Variances (using Levene’s Test) were assessed for independent } t \text{-tests and Analysis of Variance (ANOVA) statistics. Assumptions of Linearity (using scatterplots and residual partial plots), Homoscedasticity (using residual plots), Independence of Residuals (using Index Plots and Durbin Watson Tests), and Normality of Residuals (using Histograms and P-P Plots) were} \]

\[ \text{assessed for linear regression and mediation analyses.} \]

\[ ^{3} \text{Assumptions of Normality (using Histograms, P-P Plots, and Box-plots) and Homogeneity of Error Variances (using Levene’s Test) were assessed for independent } t \text{-tests and Analysis of Variance (ANOVA) statistics. Assumptions of Linearity (using scatterplots and residual partial plots), Homoscedasticity (using residual plots), Independence of Residuals (using Index Plots and Durbin Watson Tests), and Normality of Residuals (using Histograms and P-P Plots) were assessed for linear regression and mediation analyses.} \]
relationship between trait mindfulness and cognitive functioning, mediation analyses were conducted using the PROCESS macro add-on for SPSS (Preacher & Hayes, 2004).

**Results**

**Hypothesis 1: MHI will be Associated with Poorer Cognitive Functioning**

The hypothesis that those with a history of MHI would exhibit poorer performance on cognitive tasks (as indicated by the TMT and CWIT) and self-report greater cognitive challenges (as indicated by the BRIEF-A) relative to their non-injured peers was mostly unsupported by the current results. When examining the total completion times for the performance-based cognitive measures, it was found that participants in the non-MHI group ($M = 36.71$, $SD = 11.45$) took longer on average to complete the TMT-III task than those in the MHI group ($M = 33.61$, $SD = 7.69$), but this was not significant, $t(50) = 1.07$, $p = .291$. Similarly, it was found that participants in the non-MHI group ($M = 69.69$, $SD = 13.83$) took longer on average than the MHI group ($M = 62.73$, $SD = 14.30$) to complete the TMT-IV task, but this too was not significant$^4$, $t(50) = -1.28$, $p = .208$.

When examining performance on the CWIT-I, it was found that while those in the MHI group ($M = 29.60$, $SD = 4.86$) took longer on average to complete the task than non-MHI participants ($M = 27.97$, $SD = 4.24$), this difference was only marginally significant, $t(49) = 1.73$, $p = .089$. As well, those in the MHI group ($M = 49.94$, $SD = 11.07$), took longer to complete the CWIT-III task than non-MHI participants ($M = 46.01$, $SD = 6.75$), but no significant difference was found, $t(50) = -1.59$, $p = .117$. See Table C1 for relevant descriptive statistics.

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$^4$ One outlier on the TMT-IV task was removed from the independent $t$-test analysis since it was found to alter the normality of the distribution [i.e., the Shapiro-Wilk test was significant ($p < .05$) when including the outlier, but was not significant ($p = .594$) when the outlier was removed from the analysis]. Results of the $t$-test did not differ when the outlier was included or excluded.
Interestingly, when excluding participants who self-reported having a psychiatric diagnosis \((N = 10)\) from the analyses, it was found that those with a history of MHI \((M = 30.28, SD = 4.86)\) had greater total completion times for the CWIT-I than their non-injured peers \((M = 27.74, SD = 3.62)\), representing a marginally significant difference between the two groups, \(t(39) = -1.92, p = .063\). It was also found that when excluding those with a psychiatric diagnosis, participants in the MHI group \((M = 52.04, SD = 10.47)\) had significantly higher total completion times for the CWIT-III than their non-injured peers \((M = 45.11, SD = 7.12)\), \(t(39) = -2.53, p < .05\) (see Figure 1). However, no other significant group differences were observed when conducting the same analyses for the TMT-III and TMT-IV \((p > .05)\).

![Figure 1](image-url).

*Figure 1. Total completion times for the CWIT-III (in seconds), as a function of head injury status (error bars represent standard errors of the mean).*

In addition to total completion times for neuropsychological measures, the number of errors made on each task was also analyzed\(^5\) to examine potential differences across MHI and

\(^5\) Given the relatively low amount of errors made across each of the tasks (TMT-III, TMT-IV, CWIT-I, and CWIT-III), the data for the number of errors made was not normally distributed and consequently, each occurrence of an error was flagged an “extreme” outlier. Therefore, a dichotomous categorical variable was created for each task, reflecting the presence or absence of errors on the task \([0 = \text{no errors made}; 1 = \text{one or more errors made}]\).
no-MHI groups. Using Pearson’s Chi-square tests, it was determined that there was no association between MHI status and the presence of one of more errors on the TMT-III, \(\chi^2(1) = 1.36, p = .242\). Similarly, no association was observed when examining the TMT-IV, \(\chi^2(1) = 1.02, p = .234\). Furthermore, there were no significant associations between MHI status and errors made on the CWIT-I, \(\chi^2(1) = 1.83, p = .176\), or CWIT-III, \(\chi^2(1) = 0.38, p = .408\). Thus, the frequency with which errors were made on each task was comparable across MHI and no-MHI groups (see Table C2 for descriptive statistics of errors)\(^6\).

When investigating self-reported cognitive functioning, results indicated no significant differences between MHI participants (\(M = 57.95, SD = 11.16\)) and non-MHI participants (\(M = 57.16, SD = 11.75\)), for the GEC subscale (i.e., the overall score) of the BRIEF-A, \(t(48) = -0.23, p = .816\) (refer to Table C3 for BRIEF-A descriptive statistics). Independent \(t\)-tests were also conducted to analyze differences across the two broader index scores of the BRIEF-A, as a function of MHI status. When examining the MI subscale of the BRIEF-A, no differences were found between MHI (\(M = 58.32, SD = 10.78\)), and non-MHI groups (\(M = 57.39, SD = 11.60\)), \(t(48) = -0.28, p = .779\). Similarly, no significant differences were found between MHI (\(M = 56.26, SD = 11.44\)), and non-MHI groups (\(M = 55.71, SD = 12.14\)), for the BRI subscale of the BRIEF-A, \(t(48) = -0.16, p = .874\).

When examining self-reported post-concussive symptoms in the cognitive domain (i.e., using the PCSC), participants in the MHI group (\(Mdn = 8.50\)) reported significantly greater memory problems than their non-injured cohort (\(Mdn = 4.50\), \(U = 429.00, z = 2.12, p < \)).

\(^6\) Additional analyses were performed for CWIT scores, whereby CWIT-I completion times were subtracted from CWIT-III completion times to derive a measure of Stroop interference and to better isolate cognitive interference effects. However, no differences in Stroop interference were observed across MHI and non-MHI groups [\(t(50) = -1.13, p = .265\); see Table C1].
When investigating other cognitive symptoms of the PCSC (e.g., difficulty concentrating), no significant group differences emerged ($ps > .05$). However, it is interesting to note that those in the MHI group ($M = 69.28$, $SD = 17.16$) also exhibited significantly higher total PCSC scores than non-MHI participants ($M = 59.38$, $SD = 15.38$), $t(50) = -2.16$, $p < .05$.

**Hypothesis 2: Trait Mindfulness will be Associated with Better Cognitive Functioning**

Prior to analyzing relationships between cognitive functioning and mindfulness, several independent $t$-tests were conducted to determine if there were any differences in trait mindfulness between MHI participants and their non-MHI peers (see Table C4 for relevant descriptive statistics). The results demonstrated that the non-MHI group ($M = 123.68$, $SD = 17.36$) and MHI group ($M = 122.26$, $SD = 17.02$) did not significantly differ in terms of total FFMQ score, $t(48) = 0.28$, $p = .779$. Similarly, when examining the five facets of the FFMQ, no significant differences were observed across MHI and non-MHI groups ($ps > .05$). Interestingly, it was found that injury severity was a significant predictor of FFMQ scores, $F(1, 17) = 4.79$, $p < .05$, $r = .47$ (see Figure 2), such that greater injury severity was associated with lower total FFMQ scores (refer to Table C5 for regression summary table). When examining the FFMQ facets separately, it was discovered that injury severity was a marginally significant predictor of the acting with awareness subscale, $F(1, 17) = 3.16$, $p = .093$, $r = .40$, but did not significantly predict scores on any of the other facets ($ps > .10$).

To investigate whether trait mindfulness was associated with better cognitive performance (across the entire sample), linear regression analyses were conducted, such that completion times for the TMT and CWIT were regressed on FFMQ total scores.

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$^7$ Since the assumption of normality was violated for the PCSC Memory Problems scale, a Mann-Whitney test was used in place of an independent $t$-test.
Results indicated that FFMQ total scores did not significantly predict total time on the TMT-III, TMT-IV, CWIT-I, or CWIT-III ($p$s > .05). However, when examining the five facets of the FFMQ separately, it was found that the non-reactivity subscale was a significant predictor of total time on the CWIT-I, $F(1, 48) = 5.07, p < .05, r = .31$, such that higher non-reactivity scores were associated with lower completion times for the task (see Figure 3). The non-reactivity subscale was also found to be marginally significant predictor of total time on the TMT-III, $F(1, 48) = 3.71, p = .060, r = .27$, such that higher scores on the subscale were associated with faster completion times (see Figure 3). See Tables C6 and C7 for linear regression summaries. When examining the remaining four facets of the FFMQ (i.e., observing, describing, acting with awareness, and non-judgment of inner experience), none were found to be significant predictors of cognitive performance ($p$s > .05)\(^8\).

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\(^8\) Cognitive interference effects (i.e., difference scores for completion times on the CWIT-I versus CWIT-III) were also examined in relation to FFMQ scores. However, neither the total FFMQ scores or individual facets were found to be predictors of cognitive interference ($p > .05$).
To further investigate the relationships between trait mindfulness and cognitive functioning (across the entire sample), additional linear regression analyses were conducted, such that self-reported BRIEF-A scores were regressed on FFMQ total scores. Results indicated that FFMQ total scores significantly predicted GEC T-scores, $F(1, 47) = 16.79, p < .001, r = .51$, such that higher FFMQ (trait mindfulness) scores were associated with lower GEC (lower executive dysfunction) scores (see Figure 4).

![Figure 3. Total completion time (in seconds) for the CWIT-I and TMT-III (respectively), as a function of Non-Reactivity subscale scores of the FFMQ.](image)

Similar results were obtained when examining the two broad index scores of the BRIEF-A [i.e., the metacognition index (MI) and behavioural regulation index (BRI)] whereby FFMQ total scores significantly predicted both MI T-scores, $F(1, 47) = 23.90, p < .001, r = .58$, as well as BRI T-Scores, $F(1, 47) = 6.25, p < .05, r = .34$ (see Figure 5). In both cases, higher FFMQ scores were associated with lower T-scores (i.e., less executive dysfunction). See Tables C8 to C10 for linear regression summaries.
Figure 4. BRIEF-A Global Executive Composite (GEC) T-scores, as a function of total FFMQ scores.

Figure 5. BRIEF-A Metacognition Index (MI) and Behavioural Regulation Index (BRI) T-Scores (respectively), as a function of total FFMQ scores.
To further explore the relationships between trait mindfulness and self-reported executive functioning, additional linear regression analyses were conducted to determine which facets of the FFMQ were the best predictors of scores on the BRIEF-A. As shown in Table 7, the Acting with Awareness facet was found to be the best predictor of GEC scores, ($\beta = -0.41, p < .01$), followed by the Non-Reactivity facet, ($\beta = -0.32, p < .05$), such that higher scores on these subscales were associated with lower GEC scores (i.e., less executive dysfunction). Both the Observing and Describing facets of the FFMQ did not significantly predict GEC scores ($ps > .05$), but the Non-Judging facet was found to be a marginally significant predictor of executive dysfunction ($\beta = -0.27, p = .065$), such that higher scores on this facet were associated with less executive dysfunction.

Table 7

**Summary of Multiple Linear Regression Analysis for BRIEF-A GEC T-Scores (n = 49)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observing</td>
<td>.52</td>
<td>.81</td>
<td>.10</td>
<td>0.64</td>
<td>.525</td>
</tr>
<tr>
<td>Describing</td>
<td>.38</td>
<td>.69</td>
<td>.08</td>
<td>0.56</td>
<td>.582</td>
</tr>
<tr>
<td>Acting with Awareness</td>
<td>-1.78</td>
<td>.60</td>
<td>-0.41</td>
<td>-2.95</td>
<td>.005**</td>
</tr>
<tr>
<td>Non-Judging</td>
<td>-0.94</td>
<td>.49</td>
<td>-0.27</td>
<td>-1.90</td>
<td>.065</td>
</tr>
<tr>
<td>Non-Reactivity</td>
<td>-2.09</td>
<td>.85</td>
<td>-0.32</td>
<td>-2.44</td>
<td>.019*</td>
</tr>
</tbody>
</table>

*Note. $R^2 = .42$, *$p < .05$, **$p < .01$.  

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9 Multiple linear regression analyses were conducted using the forced entry method, such that all five facets of the FFMQ were entered as predictors into the model simultaneously.
When investigating the MI and BRI subscales of the BRIEF-A separately, similar results were obtained. For the MI subscale, the Acting with Awareness facet remained the best predictor of executive dysfunction, ($\beta = -0.42$, $p < 0.01$), while the Non-Judging facet ($\beta = -0.25$, $p = 0.090$) and Non-Reactivity facet ($\beta = -0.25$, $p = 0.063$) were marginally significant predictors of MI scores. Consistent with earlier findings, the Observing and Describing facets were not significant predictors of the MI subscale ($ps > .05$). When examining the BRI subscale, it was found that the Non-Reactivity facet was the best predictor of executive dysfunction ($\beta = -0.42$, $p < 0.01$), followed by the Acting with Awareness facet, ($\beta = -0.31$, $p < .05$). Again, the Non-Judging facet was found to be a marginally significant predictor of BRI scores ($\beta = -0.27$, $p = 0.069$), while the Observing and Describing facets remained non-significant predictors ($ps > .05$). Refer to Tables C11 and C12 for linear regression summary tables.

To further elucidate the relationships between trait mindfulness and cognitive functioning, multiple linear regression analyses were conducted (using the forced entry method) to investigate whether these relationships differed depending on MHI status. In other words, these analyses were conducted to examine potential interaction effects between MHI status and trait mindfulness. As shown in Table C13 to C19, a significant main effect was observed for total FFMQ scores (over and above the effects of MHI status) such that higher scores on the FFMQ were associated with lower GEC T-scores on the BRIEF-A ($p < .05$), consistent with previously reported results. Similarly, significant main effects of total FFMQ score also emerged when examining T-scores of the MI and BRI subscales ($ps < .05$). However, across all measures of cognitive functioning (both performance-based and self-report), no other significant main effects were found and no significant interaction effects were observed between MHI status and FFMQ total scores (all $ps > .05$).
Hypothesis 3: MHI will be Associated with Reduced Baseline Physiological Arousal

To replicate previous findings in the NCR laboratory (e.g., Baker & Good, 2014; van Noordt & Good, 2011), independent *t*-tests\(^{10}\) were conducted to determine if there were any significant differences in physiological arousal levels between those with and without a history of MHI. As expected, results showed that participants in the MHI group \((M = .96, SD = .53)\) exhibited significantly lower baseline EDA levels than those in the non-MHI group \((M = 1.36, SD = .86)\), \(t(49.99) = 2.08, p < .05\) (see Figure 6). However, when investigating self-reported arousal levels, no significant differences were observed between MHI \((M = 3.80, SD = 1.99)\) and non-MHI \((M = 3.77, SD = 1.53)\) groups, \(t(50) = -.07, p = .944\). Contrary to expectation, further results showed that injury severity did not significantly predict baseline EDA, \(F(1, 49) = 2.14, p = .150, r = .21\), or self-reported levels of arousal, \(F(1, 49) = 2.14, p = .150, r = .21\).

\[ \begin{align*} 
\text{MHI} & \quad \text{No-MHI} \\
0 & \quad \text{Baseline EDA (µS)} \\
1 & \quad \star \\
1.5 & \\
2 & \\
\end{align*} \]

\[ \begin{align*} 
\text{MHI Status} & \quad \text{Baseline EDA (µS)} \\
\text{MHI} & \quad \text{No-MHI} \\
0 & \quad \text{Baseline EDA (µS)} \\
1 & \quad \star \\
1.5 & \\
2 & \\
\end{align*} \]

Figure 6. Baseline electrodermal activation (EDA) peak amplitude (µS) as a function of head injury status (error bars represent standard errors of the mean).

\(^{10}\) Note. The homogeneity of variance assumption was violated for EDA values between MHI and no-MHI groups, as indicated by a significant Levene’s test \((p < .05)\). Therefore, equal variances were not assumed when reporting *df*, *t*-test statistics, and *p*-values.
Hypothesis 4: Mindfulness will be Associated with Greater Baseline Physiological Arousal

To investigate the relationship between trait mindfulness and physiological arousal, linear regression analyses were conducted, such that baseline EDA was regressed on FFMQ scores. As expected, total FFMQ scores significantly predicted baseline EDA peak amplitude, $F(1, 48) = 6.33, p < .05, r = .34$, such that higher FFMQ scores were associated with greater EDA (see Figure 7). However, this same relationship was not found when self-reported arousal levels were regressed on FFMQ total scores, $F(1, 48) = 0.65, p = .424, r = .12$. See Table C20 and C21 for linear regression summaries. Additional linear regression analyses were used to explore which facet of the FFMQ was the best predictor of physiological arousal. It was found that while no individual facet was a significant predictor of EDA, the observe facet was the best predictor ($\beta = .30, p = .109$), followed by the non-judgment facet ($\beta = .16, p = .341$). Refer to Table C22 for the corresponding multiple linear regression summary.

![Figure 7](image.png)

*Figure 7.* Baseline electrodermal activation (EDA) peak amplitude (µS), as a function of total FFMQ scores.
To determine if the relationship between arousal and trait mindfulness was the same across MHI and non-MHI participants, multiple linear regression analyses were employed (using the forced entry method) to examine potential interaction effects. Results revealed a significant main effect of FFMQ total score ($\beta = .33, p < .05$), over and above the effects of MHI status, such that higher FFMQ scores were associated with greater EDA. However, there was no significant main effect of MHI status ($\beta = -.22, p = .108$), nor a significant interaction between MHI status and FFMQ scores ($\beta = -.82, p = .436$). Moreover, there were no main effects or interaction effects found when examining self-reported levels of arousal ($ps > .05$). Refer to Table C23 and C24 for multiple linear regression summaries.

**Hypothesis 5: Physiological Arousal will Mediate the Relationship Between Trait Mindfulness and Post-Injury Outcomes in the MHI Group Only**

Using the PROCESS macro add-on for SPSS, several moderated mediation models were used to assess the indirect effects of physiological arousal (as indicated by EDA peak amplitude) on the relationship between trait mindfulness (FFMQ total scores) and cognitive functioning (both self-report and performance-based measures), with MHI status serving as a moderator of this relationship. Moreover, separate mediation analyses (i.e., examining the MHI and non-MHI groups individually) were also carried out. However, the findings did not provide support for any of the mediation hypotheses\(^{11}\). Results indicated that EDA did not significantly mediate the

\(^{11}\) Considering the small sample size ($N = 52$) of the current research study, the nonsignificant mediation results are not surprising, since mediation analyses typically require large sample sizes, especially for detecting relatively subtle mediation effects (Fritz & MacKinnon, 2007). Furthermore, the mediation results obtained were somewhat expected, since the mediator (EDA) was not found to be a significant predictor of any outcome variables (i.e., for both self-reported and performance-based measures of cognitive functioning; see Tables C25-C32 for linear regression summaries).
relationship between FFMQ total scores and any of the performance-based dependent variables (TMT-III, TMT-IV, CWIT-I, CWIT-III, and Stroop Interference) or self-reported dependent variables (GEC, MI, and BRI subscales) of the BRIEF-A (i.e., all ps > .05; for all indirect effects, the upper and lower bounds of bias-corrected 95% confidence intervals contained zero, indicating non-significant mediation effects).

Although no significant mediation effects were found, to further explore the relationships and potential interactions between head injury, physiological arousal, and trait mindfulness, a 2 (MHI versus no-MHI) by 2 (high versus low EDA) by 2 (high versus low FFMQ scores) ANOVA was conducted for each dependent variable of interest\(^\text{12}\). When investigating CWIT-III total completion times, a significant main effect was found for MHI status, such that those in the MHI group took significantly longer to complete the CWIT-III than their non-injured peers, \(F(1, 42) = 7.64, p < .01, \eta^2 = .091\). There was also a significant main effect for FFMQ scores, such that those with high levels of trait mindfulness completed the CWIT-III task significantly faster than those with low levels of mindfulness, \(F(1, 42) = 6.13, p < .05, \eta^2 = .073\). Moreover, a significant main effect for EDA was found, such that participants with low levels of EDA took significantly longer to complete the task than those with high levels of EDA, \(F(1, 42) = 18.29, p < .001, \eta^2 = .218\).

\(^{12}\) Median splits were used to create dichotomous variables (i.e., 0 = low levels; 1 = high levels) for both EDA and FFMQ total scores. Although median splits have been said to reduce power and increase the occurrence of type I errors, others have demonstrated that in the absence of multicollinearity between independent variables, median splits are relatively robust and do not produce misleading results (see Iacobucci, Posavac, Kardes, Schneider, & Popovich, 2015). For the current model, median splits were used since multicollinearity was not found to be an issue for the independent variables included in the model; all values of the variance inflation factor (VIF; ranging from 1.002 and 1.197) and all tolerance values (ranging from .836 to .998) for the current model were within acceptable limits (for VIF and tolerance guidelines, see Bowerman & O’Connell, 1990; Field, 2013; Menard, 1995).
No significant two-way interactions were found between MHI status and FFMQ total scores or between EDA and FFMQ total scores \((ps > .05)\). However, further results revealed a significant interaction between MHI status and EDA, \(F(1, 42) = 4.72, p < .05, \eta^2 = .056\), such that those with low EDA took significantly longer to complete the CWIT-III than those with high EDA, but only in the MHI group \((p < .001)\). A marginally significant three-way interaction was found between EDA, MHI Status, and FFMQ total scores, \(F(1, 42) = 3.01, p = .090, \eta^2 = .036\), such that those with low levels of EDA performed significantly worse on the CWIT-III \((i.e., had longer completion times)\) than those with high levels of EDA, but only in the MHI group that had low FFMQ scores \(p < .001; \text{see Figure 8}\). Refer to Table C33 for ANOVA summary table.

![Figure 8](image)

*Figure 8.* Estimated marginal means of CWIT-III total time (in seconds), as a function of EDA, FFMQ scores, and MHI status (Error bars represent standard errors of the mean).

A 2 (MHI versus no-MHI) by 2 (high versus low EDA) by 2 (high versus low FFMQ scores) ANOVA was also conducted to investigate performance on the TMT-IV. However, no
significant main effects or interaction effects were found \((ps > .05)\). See Table C34 for ANOVA summary. Moreover, a 2 (MHI versus no-MHI) by 2 (high versus low EDA) by 2 (high versus low FFMQ scores) ANOVA was also used to examine self-reported GEC T Scores. A main effect for FFMQ scores was found, \(F(1, 41) = 6.98, p < .05, \eta^2 = .136\), such that those with high FFMQ scores had significantly lower GEC T scores than those with low FFMQ scores (see Figure 9). However, no other main effects or interaction effects were found \((ps > .05)\). See Table C35 for ANOVA summary\(^{13}\).

![Figure 9](image)

**Figure 9.** Estimated marginal means of BRIEF-A GEC T scores as a function of EDA, FFMQ scores, and MHI status (Error bars represent standard errors of the mean).

\(^{13}\) As a follow-up analysis, an additional 2 (MHI versus no-MHI) by 2 (high versus low EDA) by 2 (high versus low FFMQ scores) ANOVA was conducted to investigate Stroop interference effects. This analysis revealed a significant main effect of EDA, \(F(1, 42) = 9.30, p < .01, \eta^2 = .147\), such that those with low levels of EDA experienced significantly greater cognitive interference during the CWIT than those with high EDA. However, no other main effects or interaction effects were found (see Table C36 for ANOVA summary).
Lastly, a set of follow-up analyses were conducted to determine if the pattern of results obtained would differ with the inclusion of relevant covariates (i.e., variables that may influence the dependent cognitive measures), such as age, sex, and psychiatric condition. Moreover, since there were trending group differences for hospitalizations for illness ($p = .093$), hospitalizations for neurological complications ($p = .066$), and regular use of relaxation/meditation techniques ($p = .079$) between MHI and no-MHI groups, these variables were also considered as relevant covariates. Thus, all statistical analyses were conducted a second time, including age, sex, psychiatric condition, hospitalizations for illness, hospitalizations for neurological complications, and use of relaxation/meditation techniques as covariates in the model.

In general, the overall pattern of results remained unchanged with the inclusion of the aforementioned covariates, with three exceptions. The non-reactivity facet of the FFMQ was no longer a significant predictor of completion times for the TMT-III ($p = .139$), and total FFMQ scores did not significantly predict scores on the BRI subscale of the BRIEF-A ($p = .196$). Interestingly, it was found that when controlling for the effects of age, sex, psychiatric condition, hospitalizations for illness, hospitalizations for neurological complications, and use of relaxation/meditation techniques, there was a significant three-way interaction between EDA, MHI status, and FFMQ total scores, $F(1, 35) = 5.33, p = .027$ (i.e., in contrast to the marginally significant three-way interaction effect found in the first set of analyses)\(^{14}\). Otherwise, all follow-up analyses produced results consistent with those obtained in the earlier set of analyses.

\(^{14}\)Note. All main effects, two-way interaction effects, and post-hoc comparisons were similar to previously reported results and did not differ substantially when including covariates in the model.
Discussion

The primary purpose of the current study was to investigate the influence of trait or dispositional mindfulness on post-injury cognitive outcomes in the MHI population, as well as to explore the potential mechanisms underlying the observed benefits of trait mindfulness in this population. Using a quasi-experimental design, levels of trait mindfulness, physiological arousal, and cognitive functioning (both self-reported and performance-based) were examined in a group of university students, both with and without a self-reported history of MHI. Importantly, to avoid diagnosis threat and its negative influence on symptom reporting and performance on cognitive measures (Suhr & Gunstad 2002, 2005), participants of the current study were not recruited on the basis of head injury status and were not told that head injury was a primary variable of interest for the study. Instead, participants were informed of the general purpose of the study and were told that it would involve “Investigating the Physiological, Cognitive, and Psychological Effects of a Cognitive-Based Intervention”.

Despite no active participant recruitment based on head injury, approximately 38% of participants self-reported a history of MHI that was sufficient to produce an altered state of consciousness, with approximately 37% of the MHI group reporting a history of multiple head injuries. The rate of MHI found in the current sample falls within the lower range of previously reported MHI incidence rates (30% to 56%) for high school and university student samples (Baker & Good, 2014; Laforce & Martin-MacLeod, 2001; McCrea et al., 2004; Segalowitz & Lawson, 1995; van Noordt & Good, 2011). Also similar to previous findings in the university student population (e.g., Baker & Good, 2014), most MHIs (42%) were sustained during sports-related activities, with falls (32%) being the second most common cause of head injury. Of particular importance is the finding that no participants in the MHI group were in the acute
recovery phase (i.e., within three months post-injury). In fact, approximately one third of individuals in the MHI group sustained their injury at least 10 years prior to participating in the current study. Additionally, it is interesting to note that only 63% of those with a history of MHI indicated that they had been diagnosed with a concussion, while an even smaller number (47%) reported receiving medical treatment for the injury. These findings provide further evidence for the underestimation of MHI incidence rates and are consistent with earlier findings that many cases of MHI go unreported and do not result in hospital admissions (Templer et al., 1992).

The first hypothesis, that those with a history of MHI would self-report greater executive dysfunction in everyday life, as well as perform worse on cognitive measures than their non-injured peers, was mostly unsupported by the results of the current study. When examining the sample as a whole, no significant differences between MHI and non-MHI groups were found for any self-report or performance-based cognitive measures. Thus, upon initial examination, it appeared that the current results were inconsistent with earlier studies showing a wide range of executive functioning impairments associated with MHI (e.g., McDonald et al., 2002). However, when participants with psychiatric diagnoses were excluded from the analysis, significant group differences emerged, such that the MHI group took significantly longer to complete the CWIT-III than their non-injured cohort. Additionally, a marginally significant difference was observed between MHI and non-MHI groups for CWIT-I total completion times, such that the MHI group took longer to complete the task than their non-injured peers.

One explanation for these inconsistent findings could be that those with a psychiatric diagnosis are more likely to be taking medications that may alter their cognitive functioning. Indeed, when investigating treatment outcomes using selective serotonin reuptake inhibitor (SSRI) antidepressants (i.e., sertraline) in a group of mild TBI patients with comorbid major
depression, significant improvements were observed for measures of psychomotor speed, cognitive efficiency, cognitive flexibility, and recent memory ability following an eight-week treatment (Fann, Uomoto, & Katon, 2001). Furthermore, in a group of moderate to severe TBI patients with comorbid symptoms of attention-deficit/hyperactivity disorder (ADHD), it was found that following a 12-week treatment with Vyvanse (i.e., a psychostimulant in the amphetamine class), improvements in cognitive functioning were seen in the domains of sustained attention, working memory, and processing speed (Tramontana, Cowan, Zald, Prokop, & Guillamondegui, 2014). Based on these findings, it may be the case that in the current study, the subtle differences in cognitive functioning between those with and without a history of MHI may have been masked if those with psychiatric disorders were also taking medications that inadvertently relieved MHI-related cognitive symptoms. However, given the lack of information collected regarding specific psychiatric diagnoses and details regarding past and current medication use in the current sample\textsuperscript{15}, it was not feasible to further investigate this possibility.

Another explanation for the nonsignificant findings on neuropsychological measures (across the whole sample) could be that the measures were not sensitive enough to detect subtle differences between MHI and non-MHI participants. For example, Bigler (2013) argued that while some neuropsychological methods may be sensitive enough to detect acute post-injury changes, they may be relatively insensitive to long-term cognitive and neurobehavioural effects of MHI. In fact, it has been shown that while performance on neuropsychological tasks may

\textsuperscript{15} The ELQ question regarding medication use asks participants if they are currently taking prescribed medications for a psychiatric or neurological condition. Therefore, it was not possible to isolate medication use for psychiatric conditions only, since some participants ($N = 2$) indicated “yes” to this question, but did not disclose any information regarding psychiatric or neurological diagnoses.
return to baseline following an acute recovery period, the physiological alterations of MHI persist well beyond this time and subjectively, MHI patients continue to experience post-concussive symptoms (Bigler, 2013; Henry et al., 2011; Talavage et al., 2014). These findings are particularly relevant when considering the current sample of participants, all of whom were well beyond the acute recovery stage of MHI. A related point of consideration is that the sample was comprised exclusively of high functioning university students. Therefore, a sampling bias may have been present from the beginning of the study, such that those who experienced more pervasive MHI-related cognitive impairments may not have pursued a university education – thus biasing the sample to include only those individuals who experienced a favorable recovery from MHI.

The second hypothesis, that trait mindfulness would be associated with better cognitive outcomes (i.e., lower executive dysfunction and better performance on cognitive measures) across the entire sample, was mostly supported by the results. Similar to findings from previous studies (e.g., Short et al., 2016), higher trait mindfulness was associated with significantly lower levels of overall self-reported executive dysfunction, as well as fewer problems across metacognition and behavioural regulation subscales. When examining facets of mindfulness separately, the acting with awareness and non-reactivity facets emerged as the best predictors of overall scores on the BRIEF-A. Consistent with these results, previous studies have reliably demonstrated that among the five facets of trait mindfulness, the acting with awareness facet is most strongly related to self-reported measures of executive functioning, self-regulation/self-control, and impulsivity (Bowlin & Baer, 2012; Peters, Erisman, Upton, Baer, & Roemer, 2011; Short et al., 2016). Additionally, other studies have shown that individuals with higher levels of non-reactivity exhibit greater cognitive flexibility (Anicha, Ode, Moeller, & Robinson, 2012).
Thus, it appears that the acting with awareness and non-reactivity facets may play a larger role in cognitive processing than other trait mindfulness facets.

Moreover, although total trait mindfulness scores did not predict performance on any of the performance-based cognitive measures, one of the mindfulness facets (non-reactivity) was a significant predictor of CWIT-I total time and a marginally significant predictor of TMT-III total time. In both cases, higher non-reactivity was associated with better performance on the tasks (i.e., lower total completion times). Notably, although these conditions are often considered as “control” measures and serve as precursors to the administration of inhibition and cognitive switching conditions (respectively), both tasks have been shown to be reliable measures of processing speed (Bowie & Harvey, 2006; Genova, DeLuca, Chiaravalloti, & Wylie, 2013). Additionally, similar versions of these tasks (i.e., the Trail-Making Test – Part A and the Stroop Color task) have been shown to discriminate between those with frontal lobe damage and those with damage to posterior brain regions (Demakis, 2004). Interestingly, some researchers have suggested that processing speed may be one of the reasons why these tests are especially sensitive to frontal lobe damage, since successful performance on these tasks requires speeded cognitive processing (Demakis, 2004). Indeed, results of the present study provide further evidence for these claims, given that those with a history of MHI exhibited slowed performance on the CWIT-I task (when excluding those with a self-reported psychiatric diagnosis), indicating that these individuals may experience deficits in processing speed ability.

In contrast, high levels of trait mindfulness may confer an advantage when it comes to speeded information processing, since individuals with higher non-reactivity scores completed the TMT-III and CWIT-I tasks significantly faster than those with low non-reactivity scores in the current study. In fact, when utilizing other cognitive tasks, previous research studies have
also identified relationships between trait mindfulness and improved processing speed ability. For example, when investigating differences in cognitive functioning across a group of experienced meditators and a meditation-naïve control group, Moore and Malinowski (2009) found that in addition to reporting significantly higher levels of trait mindfulness, the experienced meditation group also performed significantly better on all of the cognitive tasks used in the study (i.e., the Stroop task and the d2-concentration and endurance test). In particular, positive correlations were found between total trait mindfulness scores and the number of items processed/scanned during both of the tasks, indicating that higher trait mindfulness is associated with more efficient information processing (Moore & Malinowski, 2009).

Similar findings have also been reported when investigating the outcomes of mindfulness-based interventions. For example, Zeidan and colleagues (2010) found that after a brief four-day mindfulness training program, participants exhibited significantly improved executive processing efficiency (i.e., higher scores on the Symbol Digit Modalities Test; Smith 1982), when compared to an active control group. Moreover, Chambers, Lo, and Allen (2008) found that although no differences in cognitive ‘switching’ ability were observed following the completion of a ten-day mindfulness intervention, there were significant reductions in reaction time for the Internal Switching Task (IST), such that improvements were observed in the mindfulness group only (while no significant changes were found in the control group). Taken together, these findings are consistent with those of the current study and indicate that the effects of mindfulness practice, as well as the possession of a more “mindful” disposition, may have the strongest impact on processing speed as opposed to other cognitive abilities (such as inhibitory control or cognitive flexibility).
The third hypothesis, that individuals with a history of MHI would exhibit significantly lower physiological arousal than their non-injured peers, was supported by the results of the present study and replicates previous findings in the NCR laboratory (e.g., Baker & Good, 2014; van Noordt & Good, 2011). As expected, those who self-reported a history of MHI exhibited dampened baseline levels of arousal, as indicated by significantly lower EDA than those without such a history. Since previous studies have demonstrated the sensitivity and accuracy of using EDA as an index of SNS activity (Lazarus, Speisman, & Mordkoff, 1963), the current findings imply that individuals with MHI may experience subtle, albeit significant SNS dysfunction. Moreover, in contrast to previous studies that have found lower self-reported arousal levels in the MHI population (e.g., Baker & Good, 2014), further analyses revealed no significant group differences in self-reported arousal for the current study.

The fourth hypothesis, that higher trait mindfulness would significantly predict greater baseline physiological arousal (for both MHI and non-MHI participants), was supported by the results of the present study and represents a novel finding among the current body of literature on trait mindfulness. In contrast to the widely-assumed belief that mindfulness practice leads to relaxation or states of hypoarousal, there is an increasing focus on the potential arousing and alertness-promoting effects of mindfulness (Britton et al., 2014). Indeed, it has been shown that certain types of mindfulness meditation exercises (i.e., those that are more complex and require a greater degree of cognitive effort) may produce increased SNS activity, as indexed by increases in heart rate during active engagement in these exercises (Lumma et al., 2015; Peng et al., 2004). The results of the current study are consistent with and extend these findings by demonstrating that even dispositional levels of mindfulness may influence indices of sympathetic activity (in this case, electrodermal activation).
Unexpectedly, it was found that no individual facet of trait mindfulness was a significant predictor of physiological arousal, although the observe facet emerged as the best predictor among the five facets. The observe facet is said to be characterized by noticing or attending to internal experiences (e.g., sensations, cognitions, emotions), as well as to external sensory experiences (e.g., sights, sounds, smells; Baer et al., 2008). Additionally, the observe facet involves the ability to notice perceptual events that likely go undetected by others (e.g., “I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing”) and those with higher levels of this facet have been found to exhibit greater perceptual accuracy compared to those with low levels of the observe trait (Anicha et al., 2012). Therefore, it may be that the observe facet is most strongly linked to physiological arousal levels since it is purported to capture the ability to remain alert and oriented to one’s immediate surroundings (i.e., it may coincide with tonic alertness/arousal levels).

The fifth and final hypothesis, that physiological arousal would mediate the relationship between trait mindfulness and both self-reported and performance-based cognitive functioning (in the MHI group only), was not supported by the results. No mediation models in the current study were found to be significant, indicating that the mechanism underlying the benefits of trait mindfulness may be unrelated to increased arousal levels; however, it is also possible that due to the small sample size of the current study, there may have been an insufficient amount of power to detect such effects. Regardless, further analyses were carried out and a significant two-way interaction was found between physiological arousal and MHI status, such that lower EDA was associated with worse performance on inhibitory control tasks (i.e., longer completion times for the CWIT-III), but only in the MHI group. This pattern of results is consistent with the Yerkes-Dodson Law (1908) regarding the relationship between arousal and cognitive abilities, which
proposes that arousal levels below an optimal threshold result in hindered performance on cognitive tasks. Consistent with this theoretical account, the findings of the current study imply that the chronic state of underarousal observed post-MHI may place these individuals at a subtle cognitive disadvantage compared to their non-injured cohort, which in turn may impact their ability to perform tasks requiring inhibitory control.

Particularly noteworthy is the finding of a marginally significant three-way interaction between physiological arousal, MHI status, and trait mindfulness, such that in the MHI group only, those with low physiological arousal combined with low trait mindfulness exhibited the most impaired performance on measures of inhibitory control (i.e., the CWIT-III). In contrast, it was found that MHI participants who exhibited low levels of EDA, but high levels of trait mindfulness, performed similarly to those with no reported history of head trauma. Consistent with these results, others have demonstrated that long-term meditators exhibit both increased sympathetic activation (as measured by electrocardiogram activity), as well as enhanced performance on cognitive tasks (i.e., mental rotation and visual memory tasks) after engaging in complex forms of mindfulness meditation (i.e., those that involve the use of visualization or those that require attention to be distributed towards various stimuli at once; Amihai & Kozhevnikov, 2014). Notably, Amihai & Kozhevnikov (2014) attributed the improvements in cognitive performance to heightened alertness and arousal levels, which presumably granted the meditators an enhanced preparedness to process and respond to stimuli (Amihai & Kozhevnikov, 2014). Although no evidence was found to support arousal as a mediator of the relationship between mindfulness and cognitive performance, the findings of the current study remain consistent with the conceptual model concerning hypothesis five, since the combined effects of low arousal and low trait mindfulness were associated with reduced inhibitory control.
Limitations

It is important to acknowledge that the present study had several limitations. First, MHI status (as well as information regarding injury characteristics) was determined using self-report methods, in the absence of any medical records or other collateral sources (e.g., family members, witnesses of the head injury, etc.). Since self-reported information relies on memory and accuracy of description, medical records may have provided more accurate or reliable information regarding the head injuries. Thus, the self-report nature of MHI status may limit the ability to infer the true incidence rates of MHI in the present sample. However, it should also be noted that previous studies have employed self-report methodology for determining head injury status and demonstrated the validity of such methods in this context (e.g., Belanger et al., 2010). Furthermore, since less than half (47%) of MHI participants sought medical treatment for their injuries, it is also possible that had the current study utilized only information from medical reports, the rates of MHI may have been vastly underestimated. Indeed, previous studies have shown that in a group of high school athletes, only 40% of concussion incidents were disclosed (Register-Mihalik et al., 2013). Similarly, others have found that among university student athletes, fewer than 25% realized that they had sustained a concussion in the first place, making it very unlikely that they reported the incident or sought medical attention (Delaney, Lacroix, Leclerc, & Johnston, 2002). Given the challenges with both the recognition and reporting of MHIs, it is probable that the incidence of MHI in the present sample represents an underestimate, thereby attenuating the observed effects.

Second, the generalizability of results may be limited due to the demographic characteristics of the current sample, which consisted of predominantly Caucasian female university students. In particular, the sample may not be representative of the general population
since university students tend to be younger, have more years of education, and have a higher socioeconomic status on average. Furthermore, no significant differences in MHI rates were observed as a function of sex, whereas previous studies have found that rates of MHI are much higher for men than women, especially among those aged 15-19 (Kraus & Nourjah, 1988). This finding is likely a result of over 80% of the current sample being comprised of women, which is representative of the university population, but under-represents the head injury population. Additionally, while the patterns of MHI etiology observed in the current study are comparable to previous reports in university samples (e.g., Baker & Good, 2014), such that most MHIs were sustained during sports-related activities, these findings are not consistent with others that have found motor vehicle collisions and falls to be the most common causes of MHI (Cassidy et al., 2004; Kraus & Nourjah, 1988). Again, this may be a consequence of the university student sample, who presumably have greater rates of sports participation than the general population; indeed, approximately one third of students in the current sample reported currently playing sports at the university level. Thus, the results of the current study may not extend to the larger MHI population.

A third limitation is that the quasi-experimental and cross-sectional nature of the current study restricts the ability to make causal inferences regarding the relationship between MHI and the observed neurocognitive deficits, as well as the roles of trait mindfulness and arousal. Part of the issue stems from the small sample size of the current study ($N = 52$), which reduces the likelihood of detecting mediation effects, since large sample sizes are needed to obtain an adequate amount of power in mediation analyses (Fritz & MacKinnon, 2007). Therefore, although the current study demonstrated an association between trait mindfulness and physiological arousal, the directionality of the effect remains unknown. Although previous
researchers have argued that mindfulness practice increases sympathetic activation and alertness/arousal levels (e.g., Amihai & Kozhevnikov, 2014), another possibility is that those who experience physiological underarousal may be unable to engage in effective mindfulness, perhaps due to the large degree of cognitive effort required for such practices.

To address these limitations, future studies would benefit from employing a longitudinal study design, which would permit researchers more insight into post-MHI impairments, as well as to further explore the causal mechanisms of these changes. Additionally, it would also be ideal to introduce a mindfulness-based intervention as a means of modifying trait levels of mindfulness in the MHI population, thereby allowing a more direct examination between trait mindfulness and physiological arousal level. In particular, by demonstrating if changes in trait mindfulness are accompanied by changes in physiological arousal, one could make more definitive claims regarding the directionality of the observed effects.

Conclusions

The overall pattern of results implies that within the MHI population, there exists a subgroup of individuals who experience persistent physiological alterations (i.e., underarousal), as well as long-term cognitive sequelae after injury, namely problems with inhibitory control. Importantly, trait mindfulness may represent one pre-injury characteristic that influences post-injury recovery rates for MHI-related cognitive symptoms; this is evidenced by the finding that cognitive performance differed as a function of trait mindfulness in MHI participants with lower levels of physiological arousal, such that those with higher trait mindfulness appeared to exhibit a cognitive advantage over those with lower levels of this trait. Given the positive association found between arousal and trait mindfulness, one interpretation of this finding is that trait...
mindfulness may act as a compensatory strategy to account for issues with underarousal following MHI.

An important implication of the current research study is that it provides insight into possible treatment strategies to target MHI-related symptomatology. Currently, there are limited treatment options for mitigating chronic symptoms following MHI, necessitating the need for research into alternative treatments (Snell et al., 2009). This study provides preliminary evidence to support the use of mindfulness-based practices in an MHI treatment or rehabilitation context. As noted previously, those with higher levels of trait mindfulness in the MHI group exhibited both higher levels of physiological arousal, as well as more efficient cognitive functioning. Since mindfulness training has been previously shown to increase levels of trait mindfulness (Kiken et al., 2015), introducing a mindfulness intervention to those with head trauma may serve as a means of boosting physiological arousal levels and in turn, may reduce post-concussive symptoms related to underarousal.

Taken together, the present study underscores the heterogeneous and complex nature of post-MHI symptom profiles and reveals yet another pre-injury characteristic that appears to modify post-injury outcomes. Moreover, results from the current study indicate that the physiological and cognitive deficits observed in the moderate to severe TBI population may be mirrored in those who sustain more mild injuries to the brain. Evidently, even these “mild” injuries to the brain can have lasting, albeit subtle effects on one’s cognitive and physiological functioning.
References


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Appendix A

Data Collection and Testing Materials
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Participants Needed!

Investigating the Physiological, Cognitive, and Psychological Effects of a Cognitive-Based Intervention

For a research study...

Participation will include:
- 2 testing sessions: questionnaires, cognitive tasks, and physiological measures (e.g., heart rate, skin conductance)
- 3 cognitive training sessions: group format + brief computer-based "homework"

Earn up to 6 research participation hours! &/or be entered into a series of draws (x12) for up to $120!

SONA LINK:

For more information or to sign up please visit SONA or contact:
Bradey Alcock, ba09bd@brocku.ca
905-688-5550, ext. 3034

Supervisor: Dr. Dawn Good, Dawn.Good@brocku.ca (ext. 3556)

This study has been reviewed by and received ethics clearance through the Office of Research Ethics, Brock University (REB #16-047) 905-688-5550 ext. 3035
**Informed Consent**

**Investigating the Physiological, Cognitive, and Psychological Effects of a Cognitive-Based Intervention**

25 October 2016

**Principal Student Investigator:**
Brady Alcock, B.A., M.A. Candidate
Psychology Department
Brock University
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(905) 688-5550 x 3034

**Principal Investigator:**
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**INVITATION**

You are invited to participate in a study that involves research. The purpose of this study is to examine the physiological, cognitive, and psychological effects of a cognitive-based intervention.

**WHAT'S INVOLVED**

Participation will take approximately 6 hours of your time in total, over the course of 5 weeks. Your participation will involve three different types of commitment: individual testing, attendance at group training sessions and the completion of 'at home' exercises at different stages of the study. The first and last week will involve the individualized testing sessions during which we will review consent and ask you to be involved in providing us with physiological measures (i.e., measures of heart rate, respiration, blood pressure and skin conductance [sweat response]) and two cognitively demanding pencil and paper tasks (~30 minutes). You will then be escorted by one of our lab Research Assistants (RAs) to another nearby seminar testing room where you will join up to as many as 14 other students and be asked to complete 6 self-report measures (i.e., questionnaires related to demographics [e.g., sex, age, medical history, lifestyle] of personality and cognition, including questions asking directly about thoughts of suicide or self-harm) (~45 minutes). A RA from the lab will be in attendance at all times. The second, third, and fourth weeks will involve a 3 one-half hour group sessions during which we will ask you to participate in one of two types of cognitively-based exercises. During some of these exercises, amongst the different training presented, you may be offered food items (you can choose to not accept). In addition, during these three weeks, you will be asked to complete a set of daily “homework” exercises on your own time through computer access (~5 minutes each day). Finally, you will return to complete physiological measures again and an additional set of follow-up self-report measures one week later (~1 hour).

During the testing sessions, we will obtain baseline physiological measures which will be collected via electrodes and other recording equipment. The application of the recording equipment will be described to you during the application process and the researcher will role-model the placing of the two electrodes on your fingers for skin conductance, as well as a pulse oximeter, to measure heart rate, a blood pressure cuff on your upper arm, and respiration bands on your abdomen and chest. The researcher will wear gloves during this procedure should you request any assistance with the equipment. You will be provided cleansing pads for your hands and fingers prior to, and after, electrode placement. In order to reduce physical contact between yourself and the researcher you will be asked to complete the placement and adjustment of the physiological recording equipment independently.

You will also be asked to complete various questionnaires and several paper and pencil cognitive tests. You will be asked to provide background information about yourself such as sex, age, and level of education. As a result, you may find some of the questions to be personal or sensitive in nature, and you may choose to omit any question you prefer not to answer. Once you have completed all sessions of the research study, further details regarding the specific purposes of the study will be explained to you by the researcher and you will be provided a debriefing form.

**VOLUNTARY PARTICIPATION**

Your participation is completely voluntary. You may withdraw from this study at any time without penalty or loss of benefits to which you are entitled. If you choose to withdraw at any time please verbally inform the researcher; should you decide at completion of the study that you would like to withdraw your data from the study, please contact the Principal Investigator and advise her of this. All participants will qualify for one of 12 draws which will also be commensurate with the number of half hour increments (or part thereof) of participation, not otherwise applied to course credit. The draws (12) will be for the equivalent of $10 per half hour participation (to a maximum of $120).

All information obtained in this study will be kept strictly confidential. All data will be coded with an alphanumeric code so that no data will have your personal identification associated with it. However, there will be a master list advising the Principal Researchers (Dr. Dawn Good, Bradye Alcock, M.A. candidate) of each participant’s identity so that we can correctly match your data across the various tests and multiple sources of collection (i.e., computer collected physiological measures, paper-based task performance). This restricted access list will be held in a separate, secure and locked location.

Received clearance from Office of Research Ethics Board: #16-047
Further, the results of the study will be presented in a statistical format and as a group - no individual participant information will be published or identified. The information you provide (your data, answers, with only an alphanumeric code identifier) will be kept locked in a secure location for ten years, to which only researchers and research assistants have access. Data will be subsequently destroyed (shredded or electronically deleted). If you choose to withdraw from the study prior to completion, your data will not be used in the analyses and will be destroyed. The Brock researcher will only use data for research purposes; that said, for the health-related information only, the data you provide will only be accessible or provided to another resource (e.g., health care professional), if directed by you though your explicit and formal request and/or consent (in this event an additional consent form that is consistent with the guidelines of PHIPA [2004] for release of information would be required and signed by you).

POTENTIAL BENEFITS AND RISKS
A potential risk of the current study is if you have an unknown allergy to the conductive gel used to measure skin conductance. If this is the case, you will immediately be provided sanitary wipes and antibacterial lotion (otherwise, you will use this upon removal of the electrodes at the end of the testing). Another potential risk is if you have an allergy to the food products involved in one of the training sessions. If this is the case, you will have the option to refrain from consuming the food products or to choose an alternative food product that is available. Additionally, you may also feel challenged, embarrassed or disquieted, when completing neuropsychological measures (reading/responding to sensitive questions, completing tasks that are cognitively demanding); however, know that the tests do not reflect your intellectual capacity and are intentionally challenging. Individual performance and scores will not be included in any analyses. Finally, should you experience any concerns or emotional responses that arise as a result of your participation in this research study, you will be provided with contact information (e.g., counselling) at the end of the testing session. Your performance, responses, experience and concerns will remain confidential. Should there be any physical and/or mental health-related concerns or responses that require further addressing, the Principal Investigator will contact you directly and advise you of such, while respecting confidentiality and privacy as dictated by the Personal Health Information Protection Act, PHIPPA, legislation (e.g., https://www.ontario.ca/laws/statute/04p03).

You will receive a detailed debriefing form about the study at the end of testing. You may receive course credit compensation for your participation. Or, you may have your name entered into a series of draws as compensation for your participation. Also, you may contact the researchers via e-mail if you wish to view the results of the study, or a summary poster, of this study.

CONFIDENTIALITY
Your name will be associated only with this consent form. All information collected will be confidential and kept separately from this consent form, and coded by an alpha-numeric code assignment. As noted above, a master list will be kept linking data codes to individuals’ data. Only Dr. Dawn Good and Bradey Alcock will have access to this the master list and this list is necessary to link names to participant’s data as we are using clinical measures that may require follow-up. If scores on any measures indicate that the individual is at risk of self-harm or there are significant health concerns identified, we will need to follow appropriate procedures which involve contacting the participant. If an individual has an elevated score on any test, the Principal Investigator, Dr. Dawn Good, C. Psych., or Student Investigator, Bradey Alcock, will be contacted immediately. Either the Student Investigator (Bradey Alcock) or Principal Investigator (both of whom have access to the master list) will match the participant’s coded number to his/her name and review the results. Note that all test scores will be evaluated for his/her status by the Principal Investigator (according to established protocol – e.g., Distress Centre of Ontario; and Brock University’s Student Development Centre’s “Students-at-risk” protocol) and provided facilitated access to services as needed. If there is an elevated score, our protocol is for the participant to be contacted within 24 hours. The Student or Principal Investigator will advise the participant as to why s/he is being contacted and will engage in discussion that ultimately provides the participant with psychological/psychiatric resources and contact information.

All task data and notes taken will be kept in a locked, secure lab at all times and will be destroyed after 10 years. Only Bradey Alcock, Dr. Good, and their research assistants will have access to the data. All research assistants have completed confidentiality agreements. In addition, any information gathered from this study that is presented at conferences or is published is summarized and group results (rather than individuals) are emphasized which preserves anonymity.

VOLUNTARY PARTICIPATION
This study forms part of research projects associated with Faculty Research and an M.A. thesis. Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time and may do so without any penalty or loss of benefits to which you are entitled. If you choose to withdraw at any time please verbally inform the researcher.

PUBLICATION OF RESULTS

Received clearance from Office of Research Ethics Board: #16-047
This study forms part of an M.A. research project associated with Faculty Research and an M.A. thesis. Statistical results of this study may be published in professional journals and presented at conferences. Feedback about the aggregate (not individual) results of this study will be available after August, 2017. Please contact the principal faculty or student investigators (Dr. Dawn Good or Bradey Alcock) via the contact information provided on this form.

CONTACT INFORMATION AND ETHICS CLEARANCE
If you have any questions about this study or require further information, please contact Dr. Dawn Good or Bradey Alcock at Brock University using the contact information provided above. This study has been reviewed and received ethics clearance through the Brock University Research Ethics Board [#16-047]. If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Thank you for your assistance in this project. Please keep a copy of this form for your records.

CONSENT FORM
I have read the information presented about the current study being conducted by Dr. Dawn Good and Bradey Alcock investigating the physiological, cognitive, and psychological effects of a cognitive-based intervention.
I have read and understand the above information regarding this study.
I have received a copy of this form.
I understand that I may ask questions at any time during the study and in the future.
I understand that I may withdraw from this study at any time.
I agree to participate in this study.
I give permission to be contacted regarding this study or future studies

Name: ____________________________________________
Signature: ___________________________ Date: ______________________
Phone #: ______________________________

COURSE CREDIT (indicate the # of credits in the blank space):

PSYC 1F90 ___ 2P12 ___ 2P20 ___ 2F23 ___ 2P36 ___ 2P37 ___ 3P39 ___ Other: ____________

SUBMIT NAME FOR THE DRAW – for number of credit half hours of participation, not otherwise applied to course credit:

NO YES – number of credit half hours, not otherwise applied to course credit = _____ (0.5 to 12)

Researcher Signature: ___________________________ Date: ______________________

THANK YOU FOR YOUR TIME AND PARTICIPATION IN THIS STUDY!!!!

Principal Student Investigator:
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Received clearance from Office of Research Ethics Board: #16-047
PURPOSE AND BACKGROUND

Thank you for your participation in this research study. This research was conducted by Dr. Dawn Good and Bradey Alcock, M.A. candidate, in the Department of Psychology at Brock University. As part of this study, you were randomly placed into one of two different cognitive interventions: either a mindfulness training group or a relaxation control group. We were unable to advise you of our interest in mindfulness prior to your participation, since preconceived notions surrounding mindfulness and meditation practice may bias recruitment of participants.

The primary purpose of this study is to investigate the physiological, cognitive, and psychological effects of a mindfulness-based intervention in university students who have, and have not, experienced a previous mild head injury (MHI; concussion). More specifically, we plan to examine any changes in post-concussive symptoms and physiological arousal levels before and after the cognitive intervention. We were unable to advise you of our added interest in concussion prior to your participation, since previous research has demonstrated that disclosing this factor can bias recruitment of participants and the reporting (or expression) of its respective symptoms (Suhr & Gunstad, 2002).

Numerous young adults sustain head injuries every year and the majority of these injuries are mild in nature. Approximately 25 to 45 percent of university students have sustained a concussion (often through sports or falls), with a small proportion experiencing persistent symptoms after three months (the majority will have resolved fully within 3 weeks). Most effects of mild injuries to the head are temporary, and otherwise, subtle. As popularized by the press on sports injuries, some can be more permanent.

While considerable research has examined treatment and rehabilitation strategies for those with moderate to severe injuries, fewer studies have targeted the mild head injury population. Given the potential for long-lasting post-concussive symptoms, further research is needed to determine effective treatment strategies. The results from this research study could provide preliminary evidence to support the use of mindfulness techniques in a treatment or rehabilitation setting.
FINAL REPORT

All of the data collected within this study will be in the form of aggregate data and averages and will not, in any way, reflect or indicate the performance of any single participant. To ensure confidentiality and privacy, individual names, while collected, are not associated with data or files used in this study, with the exception of a master list to which only the Principal Researchers have access. As a result, individual results cannot be provided. All data will be summarized and presented as a group in a thesis project, in publishable journals, and at conferences. You are invited to view the results at the time of completion in August 2017. Should there be any need or request for health-related data to be released to another Regulated Health Professional or person of your preference, a “Consent to Release Personal Information” form would be required and would need to be explicitly requested by you. If you are interested in obtaining a copy of the final report, or a summary poster, of this study, contact the NCR lab at Brock University (905) 688-5550 ext. 3556, or 5523 - the lab offices of the primary investigator, Dr. Dawn Good [dawn.good@brocku.ca].

CONTACT

It is our intention to confirm with you that your experience in this study has been a rewarding one and you are thanked for your contribution to this research endeavour. However, if you had any negative experiences (e.g., reading/responding to sensitive questions, increased cognitive demands) as a result of participating in this research study, please contact either of the Principal Investigators (listed below). If you wish to speak with a counsellor please contact: Brock University Counselling Services, Schmon Tower 400, (905) 688-5550 extension 4750, http://www.brocku.ca/personal-counselling or the Principal Investigator, Dr. Dawn Good, Department of Psychology, B308 MC, extension 3869, dawn.good@brocku.ca. Community-based Mental Health Programs and Services in Niagara can be accessed via: www. Familysupportniagara.com/resources/Niagara-mental-health-programs-services-directory/; Canadian Mental Health Association (CMHA) Niagara branch – [905] 688-2543; Distress Centre Niagara – [905] 688-3711, or your family physician or Brock’s Student Health Services [brocku.ca/health-services].

Your performance, responses, experience and concerns will remain confidential. Should there be any health-related concerns or responses (e.g., blood pressure, psychological health) that require further addressing, the Principal Investigator will contact you directly and advise you of such, while respecting confidentiality and privacy as dictated by the Personal Health Information Protection Act, PHIPPA, legislation (e.g., https://www.ontario.ca/laws/statute/04p03). You will also been encouraged to contact your family physician or Brock’s Student Health Services [brocku.ca/health-services] as additional resources.

Should you like more information regarding head trauma, or its sequelae, please visit the following

Received clearance from Office of Research Ethics Board: #16-047

This project has been reviewed and received ethics clearance through the Office of Research Ethics Board #16-047. If you have any pertinent questions regarding your rights as a participant, or feel your rights have been violated, please contact the Research Ethics Officer via e-mail at reb@brocku.ca or you may call (905) 688-5550 extension 3035.

Thank you again for your time and participating in this study!!!

If you have any questions or concerns please feel free to contact us at the Brock University Neuropsychology Cognitive Research Lab:

**Principal Investigator:**
Dr. Dawn Good, PhD., C. Psych.
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**Principal Student Investigator:**
Bradey Alcock, B.A., M.A. Candidate
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St. Catharines, ON L2S 3A1
ba09bd@brocku.ca
(905) 688-5550 x 3034
Pre- and Post-Testing Sessions
(Week 1 & Week 5) ~ 1.5 hrs each

*Before the Participant Arrives:

Gather Equipment/Materials (from PL 621): Key for Physio Room, Participant Folder*, Stopwatch/Timer, D-KEFS Stimulus Book, Pens/Pencils, etc.

*Ensure all Materials are in Folder (in the following order):

- Pre-test: 2 Consent Forms, Trail Making Test (Condition 3 & 4), Colour-Word Interference Test (Condition 1 & 3), FFMQ, BRIEF-A, BDI-II, HEXACO, BAI, & ELQ

- Post-test: Trail Making Test (Condition 3 & 4), Colour-Word Interference Test (Condition 1 & 3), FFMQ, BRIEF-A, BDI-II, HEXACO, BAI, short-form ELQ, & Debriefing Form

**STEP 1: Set up the Physio Program** (while waiting for participant to arrive).

a) Turn on the laptop and select ncrlab as the user and enter the password: ncrlab. On the desktop, select Polygraph Professional.

b) A dialogue box will appear, select **BradeyMA** from the scroll menu and type in the password: **bradeyMA** (no caps).

c) Click “New” to add a participant.

d) Fill in the information as follows: Session ID = participant # (e.g., b100) 
Examiner = your initials 
Examinee = participant # (e.g., b100)

e) Select “Add” to add the question set for this study. Click on **BradeyMA** (if not in the destination that pops up, go to Documents, Question Sets, Templates, and you should then see **BradeyMA**. Open. Hit “Apply”.

f) Click on newly created participant at top of the screen. Then click “Add Chart”. The physio graph screen will then pop up.

c) Locate the participant’s file according to their participant # (e.g., b100). **Make sure this number matches the one on the participant’s file folder.**

d) Click on the participant’s file and then select “Add Chart”. The physio screen will then pop up.

*Note: when you look at the participant’s file, you should see an existing chart from the Pre-test session.
RESEARCH ASSISTANT SCRIPT – MINDFULNESS & MHI

→ Testing Procedure:

**Note:** SKIP **STEP 2** during the Post-Test session and go straight to **STEP 5** (physio measures).

**STEP 2:** Greet participant, and have him/her read the **Consent Form**.

Example:

Hello! Thank you for signing up to participate in the Cognitive Training Study. Before getting started, the first thing I'm going to have you do is read over the consent form. Please read it carefully and let me know if you have any questions or concerns.

**STEP 3:** Review the **Consent Form** with the participant (read the script below):

Now I’m going to review the Consent Form with you once again. The purpose of this study is to investigate the effects of a cognitive-based intervention. Participation will take approximately 6 hours of your time in total – this will take place over 5 weeks.

The first and last week will involve individualized sessions, during which we will ask you to provide us with physiological measures (such as heart rate, respiration, blood pressure and skin conductance) and two cognitively-demanding pencil and paper tasks. Afterwards, we’ll ask you to go to another testing room to complete several self-report measures – this will include questionnaires related to demographics, personality, and cognition, including questions asking directly about thoughts of suicide or self-harm.

The second, third, and fourth weeks will involve 3 half hour group sessions during which we will ask you to participate in cognitive-based exercises. In addition, during these three weeks, you will be asked to complete a set of daily home exercises on your own time through computer access (~ 5 minutes each day).

The physiological measures will be recorded via electrodes and other recording equipment. Specifically, two electrodes will be placed on your fingers for skin conductance, as well as a pulse oximeter, to measure heart rate. A blood pressure cuff will later be placed on your upper arm, and respiration bands on your abdomen and chest. To reduce physical contact, you will be asked to complete the placement and adjustment of the physiological recording equipment independently; however, should you request it, I can provide assistance.

When completing the questionnaires and assessments, you will be asked to provide background information about yourself; as a result, you may find some of the questions to be personal or sensitive in nature, and you may choose to omit any question you prefer not to answer.

When completing the cognitive measures, you may feel challenged, embarrassed or disquieted; however, know that the tests do not reflect your intellectual capacity and are intentionally challenging. Individual scores will not be included in any analyses.

Once you have completed the study, I will provide you with a debriefing form, which will include further details regarding the specific purposes of the study. Should you experience any concerns or emotional responses as a result of your participation, you will also be provided with contact information (e.g., counselling services) at the end of the testing session.
Your participation is completely voluntary. You may withdraw from this study at any time without penalty or loss of benefits to which you are entitled. If you choose to withdraw at any time please verbally inform me; should you decide at completion of the study that you would like to withdraw your data from the study, please contact the Principal Investigator and advise her of this. If you choose to withdraw, you will receive participation credit proportionate with your length of participation.

All information collected will be kept strictly confidential. Your data will be coded with an alphanumeric code so that no data will have your personal identification associated with it. However, there will be a master list advising the Principal Researchers of each participants’ identity so that we can correctly match your data across the various tests and multiple sources of collection. Further, the results of the study will be presented in a statistical format and as a group, so no individual participant information will be published or identified.

If scores on any measures indicate that the individual is at risk of self-harm or there are significant health concerns identified (such as high blood pressure), we will need to follow appropriate procedures which involve contacting the participant. If an individual has an elevated score on any test, the Principal Investigator, Dr. Dawn Good, or Student Investigator, Bradey Alcock, will be contacted immediately.

If you have any questions or require further information, please contact Dr. Dawn Good or Bradey Alcock at Brock University using the contact information provided on your consent form. Do you have any questions before we begin?

**STEP 4:** Ask him/her to sign the last page of **both Consent Forms** (keep one in the participant’s file and give them the other). Sign their consent forms under “Researcher Signature”.

**STEP 5:** Inform the participant that you will now be moving on to complete the physiological measures. Ask the participant the following and record their response on the attached **Self-Report Arousal Ratings/Blood Pressure sheet**:

| On a scale from 1 to 10, with one being very relaxed and calm, and 10 being very stressed, how are you currently feeling? |

**STEP 6:** Take the participant’s blood pressure using the blood pressure cuff. Have the participant rest his/her **left arm** on the table and place the cuff on his/her **upper left arm**. Hit Start. Once the machine has stopped, record their systolic, diastolic, and pulse on the attached **Self-Report Arousal Ratings/Blood Pressure sheet**. Have them remove the blood pressure cuff.

**STEP 7:** Ask the participant to put on the recording equipment. Make sure the participant is not wearing anything bulky (e.g., sweater, jacket) – if they are, ask them to remove it (if they are comfortable doing so).
RESEARCH ASSISTANT SCRIPT – MINDFULNESS & MHI

- **Respiration Bands**: Put on the bottom band first (silver piece – RESP2). The band should fall just around the participant’s bellybutton and the black wire/cord should be pointing downwards. Next, put on the top band (black piece – RESP1). The band should fall across the participant’s chest and the black wire/cord should be pointing downwards. Make sure the bands are snug, but not too tight (not stretched out/uncoiled).

- **Electrodes**: Ask the participant to rest their left hand on the table. Place the two electrodes on the index finger and ring finger of their left hand. Make sure the electrodes are snug enough but not too tight either.

- **Pulse Oximeter**: Clip the oximeter on the participant’s middle finger (with the image of the finger on the clip facing up).

**STEP 8**: Take the 3-minute baseline recording. State the following:

```
Please sit in a comfortable and relaxed position because I will now take a 3-minute recording. During this time, you will need to sit as quietly and as still as possible.
```

a) In the chart file, click in the bottom text box.

b) **Hit Enter** then click on all 5 of the arrows on the right side of the screen.

c) When you are ready to record, hit **spacebar** and the **timer** at the same time.

d) After 3-minutes has elapsed, hit **spacebar** again.

e) **Hit Enter** to end the chart.

f) Close chart (it will save automatically).

g) Ask participant to remove all equipment (assist them if necessary). Provide participant with hand sanitizer.

**STEP 9**: Administer the neurocognitive tasks (in the following order):

- a) Trail Making Test – Condition 3
- b) Trail Making Test – Condition 4
- c) Colour-Word Interference – Condition 1
- d) Colour-Word Interference – Condition 3

Inform the participant that you will now be moving on to complete some paper and pencil tasks. Provide the participant with a **pen** (not a pencil).
a) **Trail Making Test – Condition 3:** Place the Test Booklet in front of the participant (facing them) and state the following:

Here are some numbers and letters. For this task, I want you to connect *just* the letters.

Begin at the letter A (point to the A) and draw a line from A to B (trace this connection with your finger), B to C (trace this connection with your finger), C to D (trace this connection with your finger), and so on, in order, until you reach the end (point to the letter E). **Draw the lines as quickly as you can without making mistakes. Go ahead.**

Note. If the participant makes an error, stop him or her right away (after the connection has been made) – explain the error and point to the correct connection.

Once the participant has correctly completed the practice page, say “**Good. Now let’s try this one**”. Open the booklet.

Do this the same way by connecting *just the letters*. Begin at A (point to the A) and draw a line from A to B (trace this connection with your finger), B to C (trace this connection with your finger), C to D (trace this connection with your finger), and so on, in order, until you reach the end (point to the letter P). **Draw the lines as quickly as you can without making mistakes. Ready? Begin. *As you say “Begin”, START TIMING***

Note. If the participant makes an error, stop him or her right away (after the connection has been made). Inform the participant that they have made an error (**without explaining the error**) and ask them to start from the last correctly connected letter.

When the participant completes the last connection (to the letter P), **STOP TIMING**. Record the total time in **seconds** on the bottom right hand corner of the booklet.
b) Trail Making Test – Condition 4: Place the Test Booklet in front of the participant (facing them) and state the following:

This time, I want you to do something different. I want you to switch between connecting the numbers and letters.

Begin at number one (point to the 1) and draw a line from one to A (trace this connection with your finger), A to two (trace this connection with your finger), two to B (trace this connection with your finger), B to three (trace this connection with your finger), and so on, in order, until you reach the end (point to the D).

In other words, you will draw a line from a number to a letter, to a number, and so on, in order, until you reach the end. Do you have any questions? Draw the lines as quickly as you can without making mistakes. Go ahead.

Note. If the participant makes an error, stop him or her right away (after the connection has been made) – explain the error and point to the correct connection.

Once the participant has correctly completed the practice page, say “Good. Now let’s try this one”. Open the booklet.

On this page are more numbers and letters. Do this the same way by switching between numbers and letters.

Begin at number one (point to the 1) and draw a line from one to A (trace this connection with your finger), A to two (trace this connection with your finger), two to B (trace this connection with your finger), B to three (trace this connection with your finger), and so on, in order, until you reach the end (point to the P).

In other words, you will draw a line from a number to a letter, to a number, and so on, in order, until you reach the end.

Draw the lines as quickly as you can without making mistakes. Ready? Begin. *As you say “Begin”, START TIMING*

Note. If the participant makes an error, stop him or her right away (after the connection has been made). Inform the participant that they have made an error (without explaining the error) and ask them to start from the last correctly connected letter.

When the participant completes the last connection (to the letter P), STOP TIMING. Record the total time in seconds on the bottom right hand corner of the booklet.
c) Colour-Word Interference – Condition 1: Place the Stimulus Booklet in front of the participant (facing them) and state the following:

This page has patches of colour on it. I'd like you to say the colours as quickly as you can without skipping any or making mistakes.

When you finish this line (sweep across the first practice line of five squares with your finger) go on to this one (point to the first square of the second row).

Now try these first two lines for practice.

Once the practice is completed, say Good. Now, when I say begin, I want you to say the rest of the colours. Begin here (point to the first square on the first line of 10 squares below the practice lines) and say each colour, one after the other, without skipping any. When you finish this line (sweep across the first row with your finger), go on to this one (point to the first square of the second row).

Keep saying the colours until you reach the end of the last line (point). Say the colours as quickly as you can without making mistakes. Ready? Begin. *As you say “Begin”, START TIMING*

Follow along with the participant item by item, using the record form (with the correct responses listed). *Record errors by writing the first letter of the incorrect colour name beneath the correct response* (as shown below).

```
Recording     green  red  blue  green  blue
ERRORS (uncorrected) R        G
```

Record any nonsense words (e.g., “bleen”) verbatim.

Indicate self-corrections by drawing a slash mark through the letter or word.

```
Recording     green  red  blue  green  blue
ERRORS (self-corrected) R        G
```

Record the total completion time in seconds.

Record the total number of Uncorrected Errors and Self-Corrected Errors in the appropriate boxes on the record form.
d) **Colour-Word Interference – Condition 3:** Place the Stimulus Booklet in front of the participant (facing them) and state the following:

Now look at this page. It’s going to be a little harder than the other page because the colour names are printed in a different-coloured ink.

For example, (point to the first word on the first practice line of five words), do you see how the word *red* is printed in *green* ink here? This time, you are to name the *colour of the ink* that the letters are printed in and *not read the word*.

So, what would you say for this one? (Point again to the first word on the first practice line and allow the participant to respond. Correct any errors.) Good. And this one? (Point to the next two practice items. Correct any errors.) Good. Now try these first two lines for practice.

Once the practice is completed, say Good. Now, when I say begin, I want you to do the same thing for the rest of them. Say the colour of the ink the letters are printed in; do not read the words.

Begin here (point to the first word on the first line of 10 words below the practice lines) and say each ink colour, one after the other, without skipping any. Keep saying the ink colours until you reach the end (point to the last word of the last line).

Say the ink colours as quickly as you can without making mistakes. Ready? Begin. *As you say “Begin”, START TIMING*

Follow along with the participant item by item, using the record form (with the correct responses listed). *Record errors by writing the first letter of the incorrect colour name beneath the correct response* (as shown below).

```
Recording          green(r) red(b) blue(g) green(b) red(g)
ERRORS (uncorrected) R     B
```

Record any nonsense words (e.g., “bleen”) verbatim.

Indicate self-corrections by drawing a slash mark through the letter or word.

```
Recording          green(r) red(b) blue(g) green(b) red(g)
ERRORS (self-corrected) R      B
```

Record the total completion time in seconds.

Record the **total number** of Uncorrected Errors and Self-Corrected Errors in the appropriate boxes on the record form.
RESEARCH ASSISTANT SCRIPT – MINDFULNESS & MHI

STEP 10: Accompany the participant to another nearby testing room to complete the questionnaire package. Ensure that the correct set of questionnaires is completed (either the Pre-test set or Post-test set).

STEP 11:

Pre-Test Session

- Inform the participant that there are 4 remaining parts of the study: 3 Cognitive Training Sessions and a Post-test session.
- Have the participant sign up for either Cognitive Training Session 1 (if they have a purple folder) or Cognitive Training Session 2 (if they have a green folder).
- Thank the participant for completing the Pre-test session of the Cognitive Training Study.

Post-Test Session

- Ask the participant to read over the Debriefing Form. Once completed, read the script below:

Thank you for participating in this research study. This research was conducted by Dr. Dawn Good and Bradely Alcock in the Department of Psychology. As part of this study, you were randomly placed into one of two different cognitive interventions: either a mindfulness training group or a relaxation control group.

We were unable to advise you of our interest in mindfulness prior to your participation, since preconceived notions surrounding mindfulness and meditation practice may bias recruitment of participants.

The purpose of this study is to investigate the physiological, cognitive, and psychological effects of a mindfulness-based intervention in university students who have, and have not experienced a previous mild head injury (also known as a concussion). We were unable to advise you of our added interest in concussion prior to your participation, since previous research has demonstrated that disclosing this factor can bias recruitment of participants and symptom reporting.

If you are interested in receiving a copy of the final report, or a summary poster of this study, contact the NCR Lab at Brock University, Dr. Dawn Good, or Bradely Alcock. If you wish to speak to a counsellor or would like more information about head injuries, informational resources (including contact numbers) can be found in the Debriefing Form. This form is yours to take with you.

Thank you again for your participation in this study!
**Self-Report Arousal Ratings/Blood Pressure**

*Note:* Optimal blood pressure is less than 120/80 mm Hg (systolic is 120 and diastolic is less than 80). If you get a high reading, take the participant’s blood pressure again *at the end of the individual testing session* and text me if it is still high (905-650-0380).

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RESEARCH ASSISTANT SCRIPT – MINDFULNESS & MHI

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Everyday Living Questionnaire

Please fill in, check off, or circle an answer for each of the following. If you have any questions regarding clarification, please ask the researcher. Thank you for your time and effort!

1. How old are you? ______

2. Sex: Male □ Female □

3. What is the highest level of education you have presently completed?
   a. Less than high school □
   b. High School/Grade 12 □
   c. College (years)  1  2  3  4+
   d. University (years)  1  2  3  4+

4. What is the highest level of education your mother has received?
   a. Less than high school □
   b. High School/Grade 12 □
   c. College (years)  1  2  3  4+
   d. University (years)  1  2  3  4+
   e. Unsure □

5. What is the highest level of education your father has received?
   a. Less than high school □
   b. High School/Grade 12 □
   c. College (years)  1  2  3  4+
   d. University (years)  1  2  3  4+
   e. Unsure □

6. What is the overall average income your parent(s)/guardian(s)?
   a. Under $25,000 □
   b. $25,000 – $49,999 □
   c. $50,000 – $74,999 □
   d. $75,000 - $99,999 □
   e. $100,000 – $124,999 □
   f. $125,000 - $149,999 □
   g. $150,000 or more □

7. With which ethnicity do you identify most with:
   a. Hispanic □
   b. Caucasian □
   c. European □
   d. African □
   e. Chinese □
   f. East Indian □
   g. West Indian □
   h. Japanese □
   i. Other □

   Specify: _______________
T1

8. Which faculty is your major affiliated with?
- a. Social Sciences
- b. Humanities
- c. Maths and Sciences
- d. Education
- e. Applied Health Sciences
- f. Business
- g. Undeclared

9. Which hand is your dominant hand (i.e., are you right or left-handed)?
- a. Right
- b. Left
- c. Both

10. Have you ever been hospitalized for (circle any that apply)?
- a. Fractures
- b. Illness
- c. Surgery
- d. Neurological complications
- e. Other

If you answered Y to any of the above, briefly please provide details:
- e.g., How old were you? How did it happen?

11. Have you ever been diagnosed with a neurological condition?
  Y   N

12. Have you ever been diagnosed with a psychiatric condition?
  Y   N

13. Are you currently taking any prescribed medications for a neurological or psychiatric condition?

  a. If yes, if you wish to disclose what medication please do so:

14. Are you currently taking any prescribed medication for a thyroid condition?

  a. If yes, explain if you feel comfortable:

15. Are you currently taking any oral contraception?
  Y   N   N/A

16. Do you take medication for asthma such as an inhaler?
  Y   N
17. Have you ever sustained an injury to your head with a force sufficient to alter your consciousness (e.g. dizziness, vomiting, seeing stars, or loss of consciousness, or confusion)?

If you answered no to this question, move ahead to question 31

If yes to question 17, please answer the following questions (if you have had more than one injury, please refer to the \textit{most recent} time you injured your head):

18. If you answered yes to question 17, did you experience these symptoms for more than 20 minutes? Y N

19. Did you experience a loss of consciousness associated with the head injury? Y N

\hspace{0.5cm} a. If so, how long was the loss of consciousness?
\hspace{1cm} 1. < 5 minutes \hspace{0.5cm} \square
\hspace{1cm} 2. < 30 minutes \hspace{0.5cm} \square
\hspace{1cm} 3. < 24 hours \hspace{0.5cm} \square
\hspace{1cm} 4. < 1 week \hspace{0.5cm} \square
\hspace{1cm} 5. < 1 month \hspace{0.5cm} \square
\hspace{1cm} 6. > 1 month \hspace{0.5cm} \square

20. If applicable, where did you strike your head?
\hspace{1cm} a. Front of the head \hspace{0.5cm} \square
\hspace{1cm} b. Right side of the head \hspace{0.5cm} \square
\hspace{1cm} c. Left side of the head \hspace{0.5cm} \square
\hspace{1cm} d. Other \hspace{0.5cm} \square \hspace{0.5cm} Provide brief details: ______________________________
\hspace{1cm} e. I can’t remember \hspace{0.5cm} \square

21. How did you injure your head?
\hspace{1cm} a. Motor vehicle collision \hspace{0.5cm} \square
\hspace{1cm} b. Sports-related injury \hspace{0.5cm} \square \hspace{0.5cm} Please specify sports: ______________________________
\hspace{1cm} c. Falling \hspace{0.5cm} \square
\hspace{1cm} d. Other \hspace{0.5cm} \square \hspace{0.5cm} Please specify: ______________________________

22. Please briefly describe the incident during which the head injury occurred:

\hspace{1cm} ______________________________________________________________
\hspace{1cm} ______________________________________________________________
\hspace{1cm} ______________________________________________________________

23. Please answer the following questions:

\hspace{1cm} a. Did the head injury result in a concussion? Y N
T1

b. Did it require stitches? Y N
c. Did you receive medical treatment for your injury? Y N
d. Did you stay overnight at a medical care facility? Y N
e. Approximately how old were you at the time? _______
f. How many months or year(s) have passed since you hit your head? _______
g. Did the injury result in any litigation process? Y N

24. Have you sustained more than one injury to your head with a force sufficient to alter your consciousness (e.g., dizziness, vomiting, seeing stars, loss of consciousness, or confusion)? Y N
   a. If yes, how many times? _______

If you answered no to this question, you may move ahead to question 31

If yes to question 24, please answer the following with respect to your least recent head injury:

25. If you answered yes to question 24, did you experience these symptoms for more than 20 minutes? Y N

26. Did you experience a loss of consciousness with the head injury? Y N
   a. If so, how long was the loss of consciousness?
      1. < 5 minutes ☐
      2. < 30 minutes ☐
      3. < 24 hours ☐
      4. < 1 week ☐
      5. < 1 month ☐
      6. > 1 month ☐

27. If applicable, where did you strike your head?
   a. Front of the head ☐
   b. Right side of the head ☐
   c. Left side of the head ☐
   d. Other ☐ Provide brief details: __________________________
   e. I can’t remember ☐

28. How did you injure your head?
   a. Motor vehicle collision ☐
   b. Sports-related injury ☐ Please specify sports: __________________________
   c. Falling ☐
   d. Other ☐ Please specify: __________________________
29. Please briefly describe the incident during which the least recent head injury occurred:


30. Please answer the following questions:
   a. Did the head injury result in a concussion? Y N
   b. Did it require stitches? Y N
   c. Did you receive medical treatment for your injury? Y N
   d. Did you stay overnight at a medical care facility? Y N
   e. Approximately how old were you at the time? ______
   f. How many months/year(s) have passed since the injury? ______
   g. Did the injury result in any litigation process? Y N

If you were instructed to move ahead to question 31 please begin here

31. Have you ever been involved in a litigation process of any sort? Y N

32. Have you ever experienced any other neural trauma (e.g. stroke, anoxia)? Y N
   a. If yes, please explain:

33. Do you smoke cigarettes? Y N
   a. If yes, approximately how many a day? ______

34. Do you regularly engage in consuming alcohol? Y N
   a. If yes, how many drinks per week do you consume? ______
   b. On average how many drinks would you consume in one outing? ______

35. Do you engage in recreational drug use? Y N
   a. Do you smoke marijuana? Y N
If yes to question 35 a., please answer the following. If no, please advance to question 36.

i. How long have you been smoking marijuana (months/years)? ________

ii. In your lifetime, how many instances have you smoked?
   a. 0
   b. 1-2
   c. 3-10
   d. 11-30
   e. 31-50
   f. 51-100
   g. 101-300
   h. 301+

iii. Please rate your marijuana use in the past 30 days.
   1. No use
   2. Once or Twice
   3. Weekly
   4. Daily

iv. Have you had symptoms in the past you believe were caused, aggravated, or ameliorated by marijuana smoking? Y N
   If yes, please explain: ____________________________________

v. Do you have current symptoms that you believe are caused or aggravated by marijuana use? Y N
   If yes, please explain: ____________________________________

vi. What are your general motives for using marijuana? Select all that apply.
   1. To deal with anxiety
   2. To cope with pain
   3. For pleasure
   4. Other Please explain: ________________________________

=> => If you were instructed to move ahead to question 36 please begin here

36. Do you take any performance enhancing drugs (e.g., ergogenic drugs such as anabolic steroids, hormones; stimulant drugs – other than caffeine-based products, see below – such as amphetamine, ephedrine)? Y N

37. Did you consume caffeine today (e.g., coffee, tea, energy drink, chocolate)? Y N
T1

a. **If yes**, how much (i.e., how many cups, cans, etc.)?
   1  2  3  > 3

b. **If yes**, how much time has passed since you last consumed caffeine today?
   Less than 1 hour  
   1 hour or More  

38. Do you have sensitivity to perfumes or scents?  
   a. **If yes**, please rate your sensitivity:
      Not at all
      1  2  3  4  5  6  7  8  9

39. Do you have a valid driver’s license?  
   a. **If yes**, how long have you had a driver’s license?
      a. 1-3 years  
      b. 4-6 years  
      c. 7+ years  
      d. N/A  

40. Do you wear glasses or contacts?  

41. Do you live:
   a. On your own  
   b. With roommates  
   c. With partner  
   d. With parents/guardians  
   e. Other  

42. How many university credits are you taking this semester?
   0  0.5  1  1.5  2  2.5  3  3.5  4  4.5  5  5.5  6  N/A

43. On a scale of 1 to 9 rate your enjoyment of academics:
   Not at all  
   1  2  3  4  5  6  7  8  9

44. Have you ever received any extra assistance during your educational history?  
   Y  N
T1

Please circle any that apply and indicate when you received the assistance:
E = Elementary school   H = High school   U = University

a. Learning resource teacher
b. Tutor
c. Educational assistant
d. Speech Language Pathologist
e. Occupational Therapist
f. Physical Therapist
g. Other: Please specify: _______________________

45. Have you ever been diagnosed or classified as having a Learning Disorder?  Y  N

46. Do you consider yourself a musician?  Y  N

47. Have you ever considered yourself to be a musician?  Y  N

48. If you answered yes to either question 46 or 47, do/ did you play/perform:
   a. Professionally
   b. Recreationally
   c. N/A

49. If you answered yes to either question 46 or 47, how long do/ did you play/perform for?  _______ years  N/A

50. If you answered yes to either question 46 or 47, what age did you start playing/performing at?  _______ years  N/A

51. How often do you listen to music? _______ hours per week

52. Please indicate the type of music you listen to most often?
   a. Country
   b. Classical
   c. Rock
   d. R&B
   e. Blues
   f. Independent (Indie)
   g. Jazz
   h. Pop
   i. Electronic (house/dance)
   j. Folk
   k. Opera
   l. Acoustic/Soft Rock
   m. Other  Provide brief details: ________________
53. On a scale of 1 to 9, please rate your enjoyment of your life situation:

<table>
<thead>
<tr>
<th>Not at all</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Enjoy Very Much</th>
<th>9</th>
</tr>
</thead>
</table>

54. On a scale of 1 to 9, how stressful would you rate your day-to-day life?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Very</th>
<th>9</th>
</tr>
</thead>
</table>

55. What extracurricular sport(s) did you play in:
   a. Elementary/ middle school:
      i. Please describe/ name the sport(s) AND indicate if it was recreational (R) or competitive (C) for each sport listed.

      ________________________________

      ii. How often did you play sports (per week)?_________________________

      iii. For each sport listed above, please indicate the last time you played each (e.g., indicate how long ago you played elementary school soccer).

      ________________________________

      iv. For each sport listed above, please rank them in order from your favourite (most amount of time playing) to your least favourite (least amount of time playing).

      1. 3. 5. 2. 4. 6.

   b. High school:
      i. Please describe/name the sport(s) AND indicate if it was recreational (R) or competitive (C) for each sport listed.

      ________________________________

      ii. How often did you play sports (per week)?_________________________

      iii. For each sport listed above, please indicate the last time you played each (e.g., indicate how long ago you played high school soccer).

      ________________________________

      iv. For each sport listed above, please rank them in order from your favourite (most amount of time playing) to your least favourite (least amount of time playing).

      1. 3. 5. 2. 4. 6.
T1

c. University:
i. Please describe/name the sport(s) AND indicate if it was/is recreational (R) or competitive (C) for each sport listed.

ii. How often do/did you play sports (per week)?

iii. For each sport listed above, please indicate the last time you played each (e.g. indicate how long ago you played university soccer, if still play indicate “currently play”).

iv. For each sport listed above, please rank them in order from your favourite (most amount of time playing) to your least favourite (least amount of time playing).

v. For your favourite sport ranked above, please indicate the primary position that you play/played.

vi. For your favourite sport ranked above, please indicate the average percentage of time that you play each game? (e.g., 50%, 80%, etc.)

56. Do you exercise regularly? Y N
   a. If yes, how many times a week do you exercise? _____

   Please describe: ______________________________________________________

57. When you ride a bike/skate/etc. do you wear a helmet? Y N N/A

58. Do you regularly engage in relaxation techniques (e.g., deep breathing or yoga): Y N
   a. If yes, how many times a week do you engage in relaxation methods? _____

   Please describe: ______________________________________________________

59. Was last night’s sleep typical for you? Y N
   If No, what was different (better, worse)? ______________________________

   Why was it different (stress, room temperature, noise, etc.)?______________________
60. Please indicate how well you slept last night by circling a number:

<table>
<thead>
<tr>
<th>Worst Possible Sleep</th>
<th>Best Possible Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

61. Please indicate how you feel right now by circling a number:

<table>
<thead>
<tr>
<th>Very Sleepy</th>
<th>Very Alert</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

62. Are you a shift worker?  Y  N

63. Have you had anything out of the ordinary occur in the past day or so?  Y  N
   If yes, please explain:

64. Check any of the following that apply to your experience over the past 6 months:

- Moved
- New Job
- Loss of Job
- Loss of Relationship
- New Relationship
- Reconciliation with partner
- Reconciliation with family
- Divorce (of self or parents)
- Entered 1st year at University
- Death of a family member
- Death of a close friend
- Financial difficulties
- Illness of someone close to you
- Personal illness/injury
- New Baby
- Wedding/Engagement (self)
- Vacation
- Disrupted Sleep


65. Please indicate how your day has been so far by circling a number:

<table>
<thead>
<tr>
<th>Calm</th>
<th>1 2 3 4 5 6 7 8 9 10</th>
<th>Busy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleasant</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>Unpleasant</td>
</tr>
<tr>
<td>NOT Stressful</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>VERY Stressful</td>
</tr>
</tbody>
</table>
66. Please rate each of the following symptoms based on how you may have been affected during the past week according to the following scale.

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>INTENSITY</th>
<th>DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Not at all</td>
<td>1 = Not at all</td>
<td>1 = Not at all</td>
</tr>
<tr>
<td>2 = Seldom</td>
<td>2 = Seldom</td>
<td>2 = A Few Seconds</td>
</tr>
<tr>
<td>3 = Often</td>
<td>3 = Clearly Present</td>
<td>3 = A Few Minutes</td>
</tr>
<tr>
<td>4 = Very Often</td>
<td>4 = Interfering</td>
<td>4 = A Few Hours</td>
</tr>
<tr>
<td>5 = All of the time</td>
<td>5 = Crippling</td>
<td>5 = Constant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symptom</th>
<th>FREQUENCY</th>
<th>INTENSITY</th>
<th>DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irritability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory Problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty Concentrating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Disturbance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggravated by Noise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Judgment Problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Question 66 from Gouvier et al. (1992)*

Thank you for your time and consideration in completing this questionnaire!
Please rate each of the following statements using the scale provided. Write the number in the blank that best describes your own opinion of what is generally true for you.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>never or very rarely true</td>
<td>rarely true</td>
<td>sometimes true</td>
<td>often true</td>
<td>very often or always true</td>
</tr>
</tbody>
</table>

1. When I’m walking, I deliberately notice the sensations of my body moving.
2. I’m good at finding words to describe my feelings.
3. I criticize myself for having irrational or inappropriate emotions.
4. I perceive my feelings and emotions without having to react to them.
5. When I do things, my mind wanders off and I’m easily distracted.
6. When I take a shower or bath, I stay alert to the sensations of water on my body.
7. I can easily put my beliefs, opinions, and expectations into words.
8. I don’t pay attention to what I’m doing because I’m daydreaming, worrying, or otherwise distracted.
9. I watch my feelings without getting lost in them.
10. I tell myself I shouldn’t be feeling the way I’m feeling.
11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
12. It’s hard for me to find the words to describe what I’m thinking.
13. I am easily distracted.
14. I believe some of my thoughts are abnormal or bad and I shouldn’t think that way.
15. I pay attention to sensations, such as the wind in my hair or sun on my face.
16. I have trouble thinking of the right words to express how I feel about things.
17. I make judgments about whether my thoughts are good or bad.
18. I find it difficult to stay focused on what’s happening in the present.
19. When I have distressing thoughts or images, I “step back” and am aware of the thought or image without getting taken over by it.
20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.
21. In difficult situations, I can pause without immediately reacting.
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never or very rarely true</td>
<td>rarely true</td>
<td>sometimes true</td>
<td>often true</td>
<td>very often or always true</td>
</tr>
</tbody>
</table>

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

23. It seems I am “running on automatic” without much awareness of what I’m doing.

24. When I have distressing thoughts or images, I feel calm soon after.

25. I tell myself that I shouldn’t be thinking the way I’m thinking.

26. I notice the smells and aromas of things.

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

28. I rush through activities without being really attentive to them.

29. When I have distressing thoughts or images I am able just to notice them without reacting.

30. I think some of my emotions are bad or inappropriate and I shouldn’t feel them.

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

32. My natural tendency is to put my experiences into words.

33. When I have distressing thoughts or images, I just notice them and let them go.

34. I do jobs or tasks automatically without being aware of what I’m doing.

35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.

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

37. I can usually describe how I feel at the moment in considerable detail.

38. I find myself doing things without paying attention.

39. I disapprove of myself when I have irrational ideas.
**BRIEF-A**

Please read each statement and circle a number 1, 2 or 3 that indicates how often these behaviours have been a problem for you over the *past week*. There are no right or wrong answers. Do not spend too much time on any statement.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Never a problem</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Sometimes a problem</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Often a problem</td>
<td>3</td>
</tr>
</tbody>
</table>

1. I have angry outbursts. | 1 | 2 | 3 |
2. I make careless errors when completing tasks. | 1 | 2 | 3 |
3. I am disorganized. | 1 | 2 | 3 |
4. I have trouble concentrating on tasks (such as chores, reading, or work). | 1 | 2 | 3 |
5. I tap my fingers or bounce my legs. | 1 | 2 | 3 |
6. I need to be reminded to begin a task even when I am willing. | 1 | 2 | 3 |
7. I have a messy closet. | 1 | 2 | 3 |
8. I have trouble changing from one activity or task to the next. | 1 | 2 | 3 |
9. I get overwhelmed by large tasks. | 1 | 2 | 3 |
10. I forget my name. | 1 | 2 | 3 |
11. I have trouble with jobs or tasks that have more than one step. | 1 | 2 | 3 |
12. I overreact emotionally. | 1 | 2 | 3 |
13. I don't notice when I cause others to feel bad or get mad until it is too late. | 1 | 2 | 3 |
14. I have trouble getting ready for the day. | 1 | 2 | 3 |
15. I have trouble prioritizing activities. | 1 | 2 | 3 |
16. I have trouble sitting still. | 1 | 2 | 3 |
17. I forget what I am doing in the middle of things. | 1 | 2 | 3 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.</td>
<td>I don't check my work for mistakes.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>I have emotional outbursts for little reason.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>I lie around the house a lot.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>I start tasks (such as cooking, projects) without the right materials.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>I have trouble accepting different ways to solve problems with work, friends, or tasks.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>I talk at the wrong time.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>I misjudge how difficult or easy tasks will be.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>25.</td>
<td>I have problems getting started on my own.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>I have trouble staying on the same topic when talking.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>I get tired.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>I react more emotionally to situations than my friends.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td>I have problems waiting my turn.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>People say that I am disorganized.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.</td>
<td>I lose things (such as keys, money, wallet, homework, etc.).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.</td>
<td>I have trouble thinking of a different way to solve a problem when stuck.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33.</td>
<td>I overreact to small problems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.</td>
<td>I don't plan ahead for future activities.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.</td>
<td>I have a short attention span.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36.</td>
<td>I make inappropriate sexual comments.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.</td>
<td>When people seem upset with me I don't understand why.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38.</td>
<td>I have trouble counting to three.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Never</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>------</td>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>39.</td>
<td>I have unrealistic goals.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>40.</td>
<td>I leave the bathroom a mess.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>41.</td>
<td>I make careless mistakes.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>42.</td>
<td>I get emotionally upset easily.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>43.</td>
<td>I make decisions that get me into trouble (legally, financially, socially).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>44.</td>
<td>I am bothered by having to deal with changes.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>45.</td>
<td>I have difficulty getting excited about things.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>46.</td>
<td>I forget instructions easily.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>47.</td>
<td>I have good ideas but cannot get them on paper.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>48.</td>
<td>I make mistakes.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>49.</td>
<td>I have trouble getting started on tasks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>50.</td>
<td>I say things without thinking.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>51.</td>
<td>My anger is intense but ends quickly.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>52.</td>
<td>I have trouble finishing tasks (such as chores, work).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>53.</td>
<td>I start things at the last minute (such as assignments, chores, tasks).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>54.</td>
<td>I have difficulty finishing a task on my own.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>55.</td>
<td>People say that I am easily distracted.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>56.</td>
<td>I have trouble remembering things, even for a few minutes (such as directions, phone numbers).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>57.</td>
<td>People say that I am too emotional.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>58.</td>
<td>I rush through things.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>59.</td>
<td>I get annoyed.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>----------------------------------------------------------------</td>
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</tr>
<tr>
<td>60.</td>
<td>I leave my room or home a mess.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>61.</td>
<td>I get disturbed by unexpected changes in my daily routine.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>62.</td>
<td>I have trouble coming up with ideas for what to do with my free time.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>63.</td>
<td>I don’t plan ahead for tasks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>64.</td>
<td>People say that I don’t think before acting.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>65.</td>
<td>I have trouble finding things in my room, closet, or desk.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>66.</td>
<td>I have problems organizing activities.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>67.</td>
<td>After having a problem, I don’t get over it easily.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>68.</td>
<td>I have trouble doing more than one thing at a time.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>69.</td>
<td>My mood changes frequently.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>70.</td>
<td>I don’t think about consequences before doing something.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>71.</td>
<td>I have trouble organizing work.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>72.</td>
<td>I get upset quickly or easily over little things.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>73.</td>
<td>I am impulsive.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>74.</td>
<td>I don’t pick up after myself.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>75.</td>
<td>I have problems completing my work.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Appendix B

Brock University Research Ethics Board (REB) Clearance and Application Form
Brock University
Research Ethics Office
Tel: 905-688-5550 ext. 3035
Email: reb@brocku.ca

Bioscience Research Ethics Board

Certificate of Ethics Clearance for Human Participant Research

DATE: 10/25/2016

PRINCIPAL INVESTIGATOR: GOOD, Dawn - Psychology

FILE: 16-047 - GOOD

TYPE: Masters Thesis/Project

STUDENT: Bradey Alcock

SUPERVISOR: Dawn Good

TITLE: Investigating the Physiological, Cognitive, and Psychological Effects of a Cognitive-Based Intervention

ETHICS CLEARANCE GRANTED

Type of Clearance: NEW  Expiry Date: 10/31/2017

The Brock University Bioscience Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement. Clearance granted from 10/25/2016 to 10/31/2017.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before 10/31/2017. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;

b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;

c) New information that may adversely affect the safety of the participants or the conduct of the study;

d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved:

____________________________
Jan Frijters, Acting Chair
Social Science Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.
Brock University Research Ethics Board (REB)

Application for Ethical Review of Research Involving Human Participants

If you have questions about or require assistance with the completion of this form, please contact the Research Ethics Office at (905) 688-5550 ext. 3035, or reb@brocku.ca.

Selecting a Research Ethics Board

Files will be allocated to one of two REB panels based upon the type of research to be undertaken.

If your research involves any of the following, submit to the Bioscience Research Ethics Board (BREB):

- physiological measures such as EEGs, heart rate, GSR, temperature, blood pressure, respiration, vagal tone, x-rays, MRIs, CT or PET scans;
- ingestion or other use of food, beverages, food additives, or drugs, including alcohol and tobacco;
- medical techniques or therapies, including experimental medical devices;
- physical exertion beyond normal walking;
- physical movement in participants who have medical vulnerabilities (e.g., spinal cord injury, osteoporosis);
- human biological materials (e.g., tissues, organs, blood, plasma, skin, serum, DNA, RNA, proteins, cells, hair, nail clippings, urine, saliva, bodily fluids);
- interventions with the potential for physiological effects (e.g., diet, exercise, sleep restriction); and/or
- use of medical or official health records (e.g., hospital records).

If none of the above points are characteristic of your research, submit to the Social Science Research Ethics Board (SREB)

Indicate which REB panel is appropriate for this application:

☑ Bioscience (BREB) OR ☐ Social Science (SREB)
Return your completed application and all accompanying material to reb@brocku.ca

Researchers may submit new REB applications electronically (as PDF or Word attachments), provided that they include digital or scanned signatures. Alternatively, Principal Investigators (i.e., faculty only) may email REB applications with a note in lieu of signatures, provided that the application is sent from their Brock University email addresses. Hard copies will be accepted by the Research Ethics Office (Mackenzie Chown D250A) until January 2015. Handwritten Applications will not be accepted. Please ensure all necessary items are attached prior to submission, otherwise your application will not be processed (see checklist below).

No research with human participants shall commence prior to receiving approval from the REB.

<table>
<thead>
<tr>
<th>DOCUMENT CHECKLIST</th>
<th>✔ if applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 complete sets of the following documents (one original + one copy)</td>
<td></td>
</tr>
<tr>
<td><strong>Recruitment Materials</strong></td>
<td></td>
</tr>
<tr>
<td>- Letter of invitation</td>
<td>❌</td>
</tr>
<tr>
<td>- Verbal script</td>
<td></td>
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<tr>
<td>- Telephone script</td>
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<tr>
<td>- Advertisements (newspapers, posters, SONA)</td>
<td>❌</td>
</tr>
<tr>
<td>- Electronic correspondence guide</td>
<td>❌</td>
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<tr>
<td><strong>Consent Materials</strong></td>
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<tr>
<td>- Consent form</td>
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<tr>
<td>- Assent form for minors</td>
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<tr>
<td>- Parental/3rd party consent</td>
<td></td>
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<tr>
<td>- Transcriber confidentiality agreement</td>
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<tr>
<td><strong>Data Gathering Instruments</strong></td>
<td></td>
</tr>
<tr>
<td>- Questionnaires</td>
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<tr>
<td>- Interview guides</td>
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<tr>
<td>- Tests</td>
<td></td>
</tr>
<tr>
<td><strong>Feedback Letter</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Letter of Approval for research from cooperating organizations, school board(s), or other institutions</strong></td>
<td>❌</td>
</tr>
<tr>
<td><strong>Any previously approved protocol to which you refer</strong></td>
<td>❌</td>
</tr>
<tr>
<td><strong>Request for use of human tissue sample in research</strong> Please Note: this form is required for all research projects involving human tissue, bodily fluids, etc.</td>
<td>❌</td>
</tr>
<tr>
<td><strong>Signed Application Form</strong></td>
<td>❌</td>
</tr>
</tbody>
</table>
SIGNATURES

PLEASE NOTE: The title “principal investigator” designates the person who is “in charge” of the research. In this position, the principal investigator is assumed to have the abilities to supervise other researchers, be responsible for the financial administration of the project, have the authority to ensure that appropriate guidelines and regulations are followed, and be competent to conduct the research in the absence of faculty supervision. The restriction of the term “principal investigator” to faculty or postdoctoral fellows does not have implications for ownership of intellectual property or publication authorship.

Given the above consideration, a student cannot be identified as a “principal investigator”. However, for the purpose of recognizing a student’s leadership role in the research, a faculty member may designate a “principal student investigator” below.

INVESTIGATORS:

Please indicate that you have read and fully understand all ethics obligations by checking the box beside each statement and signing below.

☒ I have read Section III: 8 of Brock University’s Faculty Handbook pertaining to Research Ethics and agree to comply with the policies and procedures outlined therein.
☒ I will report any serious adverse events (SAE) to the Research Ethics Board (REB).
☒ Any additions/changes to research procedures after approval has been granted will be submitted to the REB.
☒ I agree to request a renewal of approval for any project continuing beyond the expected date of completion or for more than one year.
☒ I will submit a final report to the Office of Research Services once the research has been completed.
☒ I take full responsibility for ensuring that all other investigators involved in this research follow the protocol as outlined in this application.

Principal Investigator
Signature _____________________________________________ Date:

Principal Student Investigator (optional)
Signature _______________________________ Date: August 22nd, 2016

Co-Investigators:
Signature _____________________________________________ Date:
Signature _____________________________________________ Date:

FACULTY SUPERVISOR:

Please indicate that you have read and fully understand the obligations as faculty supervisor listed below by checking the box beside each statement.

☒ I agree to provide the proper supervision of this study to ensure that the rights and welfare of all human participants are protected.
☒ I will ensure a request for renewal of a proposal is submitted if the study continues beyond the expected date of completion or for more than one year.
☒ I will ensure that a final report is submitted to the Office of Research Services.
☒ I have read and approved this application and proposal.

Signature _____________________________________________ Date:

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Research Ethics Office
Brock University  500 Glennidae Ave  St. Catharines, ON  L2S 3A1  Fax: 905-688-0748
SECTION A – GENERAL INFORMATION

1. Title of the Research Project: Investigating the Physiological, Cognitive, and Psychological Effects of a Cognitive-Based Intervention

2. Investigator Information:

<table>
<thead>
<tr>
<th>Name</th>
<th>Position (e.g., faculty, student, visiting professor)</th>
<th>Dept./Address</th>
<th>Phone No.</th>
<th>E-Mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Dawn Good</td>
<td>Associate Professor</td>
<td>Department of Psychology, Centre for Neuroscience, Brock University, 1812 Sir Isaac Brock Way, St. Catharines, ON L2S 3A1</td>
<td>905 688-5550 x 3869, 3556, 5523</td>
<td><a href="mailto:dawn.good@brocku.ca">dawn.good@brocku.ca</a></td>
</tr>
<tr>
<td>Bradey Alcock</td>
<td>MA Student Candidate</td>
<td>Department of Psychology, Centre for Neuroscience, Brock University, 1812 Sir Isaac Brock Way, St. Catharines, ON L2S 3A1</td>
<td>905 688-5550 x 3034</td>
<td><a href="mailto:ba09bd@brocku.ca">ba09bd@brocku.ca</a></td>
</tr>
</tbody>
</table>

3. Proposed Date of commencement: ☑ upon approval, OR ☐ other. Please provide date (dd/mm/yyyy)

   Proposed Date of completion (dd/mm/yyyy): 30/04/2017

4. Indicate the location(s) where the research will be conducted:

   - Brock University ☑
   - Community Site ☐ Specify ______
   - School Board ☐ Specify ______
   - Hospital ☐ Specify ______
   - Other ☐ Specify ______

5. Other Ethics Clearance/Permission:

   (a) Is this a multi-centered study? ☐ Yes ☑ No
   (b) Has any other University Research Ethics Board approved this research? ☐ Yes ☑ No

Research Ethics Office
If YES, there is no need to provide further details about the protocol at this time, provided that all of the following information is provided:

- Title of the project approved elsewhere: _____
- Name of the Other Institution: _____
- Name of the Other Board: _____
- Date of the Decision: _____
- A contact name and phone number for the other Board: _____

Please provide a copy of the application to the other institution together with all accompanying materials, as well as a copy of the clearance certificate / approval.

If NO, will any other University Research Ethics Board be asked for approval? □ Yes □ No

(c) Has any other person(s) or institutions granted permission to conduct this research? □ Yes □ No

If yes, specify (e.g., hospital, school board, community organization, proprietor) provide details and attach any relevant documentation. _____

If NO, will any other person(s) or institutions be asked for approval? □ Yes □ No

Specify (e.g., hospital, school board, community organization, proprietor) _____

6. Level of the Research:

- Undergraduate Thesis □ Masters Thesis/Project ☑
- Post Doctorate ☑ Faculty Research □
- Undergraduate Course □ Graduate Course Assignment □
- Assignment (specify course) □
- Ph.D □ Administration □

7. Funding of the Project:

(a) Is this project currently being funded □ Yes □ No
(b) If No, is funding being sought □ Yes □ No

If Applicable:
(c) Period of Funding (dd/mm/yyyy): From: 01/09/2016 To: 31/08/2017
(d) Agency or Sponsor (funded or applied for)

- CIHR ☑ NSERC □ SSHRC □ Other (specify): _____
(e) Funding / Agency File # (not your Tri-Council PIN) 273094

8. Conflict of Interest:

(a) Will the researcher(s), members of the research team, and/or their partners or immediate family members receive any personal benefits related to this study – Examples include financial remuneration, patent and ownership, employment, consultancies, board membership, share ownership, stock options. Do not include conference and travel expense coverage, possible academic promotion, or other benefits which are integral to the general conduct of research.

□ Yes ☑ No

If Yes, please describe the benefits below.

N/A
(b) Describe any restrictions regarding access to or disclosure of information (during or at the end of the study) that the sponsor has placed on the investigator(s).

N/A

**SECTION B – SUMMARY OF THE PROPOSED RESEARCH**

9. **Rationale:**

Briefly describe the purpose and background rationale for the proposed project, as well as the hypothesis(es)/research question(s) to be examined.

The primary purpose of this study is to investigate the effectiveness of a brief mindfulness-based intervention for targeting chronic physiological underarousal and post-concussive symptoms following a mild head injury (MHI), as self-reported by undergraduate university students. For the purposes of this study, MHI is defined (and identified) through our demographic questionnaire as a traumatic-based injury to the head - “Have you ever hit your head with a force sufficient to alter your state of consciousness” (consistent with the Kay et al., 1993 criteria/definition; American Congress of Rehabilitation Medicine - ACRM). We exclude congenital or genetic injuries.

Brain injuries are sustained at exceedingly high rates by the Canadian population and MHI in particular represents a major public health and socioeconomic issue. “Mild” brain injuries account for the vast majority (70% to 90%) of all treated brain injury cases, and the incidence of MHI in Ontario, Canada is believed to be between 493 to 653 per 100,000 population (Cassidy et al., 2004; Ryu, Feinstein, Colantonio, Streiner, & Dawson, 2009). Following an MHI, there are a number of commonly self-reported cognitive, emotional, behavioural, and physical symptoms, such as impaired attention, memory problems, executive functioning deficits, depression, anxiety, irritability, headache, and dizziness (Gouvier et al., 1992; Silver, McAllister, & Arciniegas, 2009; Rosenbaum & Lipton, 2012). Collectively, these symptoms are often referred to as post-concussive symptoms or “PCS”. For most individuals, recovery takes place within 1-3 months following the injury, at which point they no longer report any symptoms (Levin et al., 1987). However, for approximately 30% of the MHI population (i.e., the “miserable minority”), these symptoms become chronic and may persist well beyond this time, even several years after the injury has been sustained (Konrad et al., 2011; Sigurdardottir, Andelic, Roe, Jerstad, & Schanke, 2009). Importantly, these impairments can pose a serious problem or act as barrier for reintegration into social, familial, or professional life (Konrad et al., 2011). Among somatic/physical symptoms following an MHI, the most predominant and consistent finding is that those with a history of mild head injury display a pattern of physiological underarousal, which has been replicated in all our studies (van Noordt & Good, 2011; Baker & Good, 2014). More specifically, those with a history of MHI exhibit significantly lower baseline electrodermal activity (EDA) compared to those without history of MHI (van Noordt & Good, 2011; Baker & Good, 2014). EDA reflects sympathetic nervous system activation and is often used as an index of emotional arousal (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Baker & Good, 2014; van Noordt & Good, 2011). Currently, treatment strategies for targeting these chronic post-concussive symptoms are largely understudied and have been demonstrated to be minimally efficacious (Snell, Surgenor, Hay-Smith, & Siegert, 2009).

Mindfulness is a relatively new area of research that may be useful as an alternative treatment strategy to target MHI-related symptoms. Previous studies have defined mindfulness as a way of regulating attention such that it is focused on one’s current experience, while also adopting a particular orientation (e.g., curiosity, openness, and acceptance) to those experiences (Bishop et al., 2004). Mindfulness has been conceptualized as both a state that is practiced and maintained while in mindfulness meditation and as a trait which reflects the general tendency to be mindful in daily life (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Kiken, Garland, Bluth, Paisson, & Gaylord, 2015; Lau et al., 2006). Higher levels of trait or “dispositional” mindfulness are associated with a number of beneficial or adaptive outcomes. For example, higher scores on facets of trait mindfulness are associated with less executive dysfunction,
higher self-regulation, greater positive affect, lower negative affect, and lower levels of stress (Brown & Ryan, 2003; Short, Mazmanian, Oinonen, & Mushquash, 2015). Additionally, higher trait mindfulness is associated with fewer symptoms of anxiety and depression, less impulsiveness, less hostility, greater self-esteem, greater life satisfaction, higher levels of optimism, and fewer alcohol-related consequences (Brown & Ryan, 2003; Pearson, Brown, Bravo, & Witkiewitz, 2015). Therefore, there is robust evidence to support the link between trait mindfulness and beneficial outcomes across various domains of functioning (e.g., cognitive, emotional, psychological). Although many studies have investigated the potential cognitive and emotional/psychological benefits of mindfulness practice, there is a paucity of research focusing on the physiological changes associated with mindfulness. However, the few studies that have investigated physiological effects suggest that mindfulness practice may lead to increases in physiological arousal levels. For example, when comparing the physiological effects of two different deep and slow breathing (DSB) techniques (i.e., an attentive DSB intervention vs. a relaxing DSB intervention), it was found that skin conductance levels were significantly decreased during the relaxing DSB intervention, but tended to increase during the attentive DSB intervention (Busch et al., 2012). Although the increase was not significant (possibly due to the small sample size of the study), it does suggest that when individuals are required to actively regulate their attention (i.e., similar to which occurs during mindfulness practice) physiological arousal may be increased. Despite the potential link between mindfulness practice and changes in physiological arousal, very few studies have examined this relationship, especially with respect to increasing levels of arousal. Additionally, little research has examined the utility of implementing mindfulness-based treatments to target post-concussive symptoms, as well as the potential mechanisms that may underlie improvements in symptomology.

As such, we have designed a quasi-experimental longitudinal study to examine demographic variables (e.g., age, sex, history of MHI), physiological activity (e.g., EDA), post-concussive symptoms (e.g., depression, anxiety, fatigue), level of mindfulness (both state and trait), as well as cognitive functioning (e.g., executive function) following a mindfulness-based training intervention (across 5 laboratory sessions). To determine the effectiveness of the mindfulness intervention, pre- and post-intervention scores will be assessed and compared to those of an active control group, who will undergo relaxation training. In order to obtain sufficient power to investigate these variables (based on the results from a power analysis), we intend to recruit 70 participants, who will be randomly assigned to either a mindfulness training group or to a relaxation control group. In terms of the hypotheses for this study, we expect the following results:

1. Individuals with a history of MHI will exhibit physiological underarousal compared to their non-MHI peers, as assessed by both physiological (i.e., EDA) and self-reported measures;
2. Those in the mindfulness intervention group will report higher levels of mindfulness (assessed by both state and trait measures of mindfulness) and fewer total post-concussive symptoms at post-test;
3. The MHI participants in the mindfulness intervention group will exhibit significantly greater physiological arousal, mindfulness (both state and trait), and diminished post-concussive symptoms relative to those in the control intervention group;
4. This change in arousal will mediate the relationship between increased mindfulness and fewer post-concussive symptoms as assessed at the end of the intervention sessions for MHI (in a pattern similar to that for non-MHI).

The current study has several treatment and theoretical implications. As of now, there are very few effective treatments for chronic symptoms following MHI. As well, many treatments used in this population are often taken from samples of individuals with more moderate to severe head injuries, with questionable results (Azulay et al., 2013). For example, Snell and colleagues (2009) came to the conclusion that the routine interventions provided to this population are only minimally effective and emphasized the need for research assessing alternative interventions for persisting symptoms following MHI. The results from this research study could provide preliminary evidence to support the use of mindfulness techniques in a treatment or rehabilitation setting. Specifically, it would demonstrate the efficacy and practicality of implementing mindfulness-based interventions to target chronic underarousal and persistent post-concussive symptoms. As well, this research will help to clarify the role of mindfulness in the experience of post-concussive symptoms following an MHI.

| Research Ethics Office |
10. **Methods:**

Are any of the following procedures or methods involved in this study? Check all that apply.

- [ ] Questionnaire (mail)
- [ ] Questionnaire (email/web)
- [ ] Questionnaire (in person)
- [ ] Interview(s) (telephone)
- [ ] Interview(s) (in person)
- [ ] Secondary Data
- [ ] Computer-administered tasks
- [ ] Focus Groups
- [ ] Journals/Diaries/Personal Correspondence
- [ ] Audio/video taping specify
- [ ] Observations
- [ ] Invasive physiological measurements (e.g., venipuncture, muscle biopsies)
- [ ] Non-invasive physical measurement (e.g., exercise, heart rate, blood pressure)
- [ ] Analysis of human tissue, body fluids, etc. (Request for Use of Human Tissue Sample must be completed and attached)
- [ ] Other: (specify) ______

Describe sequentially, and in detail, all of the methods involved in this study and all procedures in which the research participants will be involved (paper and pencil tasks, interviews, questionnaires, physical assessments, physiological tests, time requirements, etc.)

**Attach a copy of all questionnaire(s), interview guides or other test instruments. If reference is made to previous protocols, please provide copies of relevant documentation.**

Participants will be recruited using SONA and various posters across the University campus. Recruitment statements and advertisements (see Appendix) will inform participants that the general purpose of the study is to examine the physiological, cognitive, and psychological effects of a cognitive training intervention. Seventy subjects, aged 17 to 30 years old, from Brock University will be recruited to participate in the study. The ability to speak and write in English is a requirement. University students will be invited to participate in the study in a series of individual and group testing/training sessions (n ≤ 15) on five separate occasions (two testing sessions and three training sessions). The testing/training sessions will be on average, one week apart (depending on the availability of the participants). Participants will be invited to review the consent form prior to the first testing session via having it e-mailed to them once recruited. At this time, a discussion about the student’s potential allergies and sensitivities will take place during the review of ‘Potential Risks’. Participants will be given two copies of the written consent form to be completed (one copy is given to the participant and the other copy is for the researcher — see Appendix). Subjects will be advised that alternate arrangements can be made if they prefer ‘same sex’ researchers. All participants will be administered the same protocol and questionnaire order. These tests are well-researched and their standard administration times will be applied.

During the first session (pre-test), participants will be greeted individually for the session in a lab setting in the Jack and Nora Walker Lifespan Development Centre testing facilities at Brock University. The consent form will be read aloud to the participants by the researcher for clarification, and participants will be invited to ask any questions at that time or any time throughout the study. Participants will then undergo a 3-minute physiological recording and complete two performance-based neuropsychological measures: the Trail Making Test (TMT) to measure cognitive flexibility and the Colour-Word Interference Test to measure attention.

For the physiological measures, subjects will be introduced to the Polygraph Professional (2008) equipment which measures heart rate, electrodermal activity (EDA), respiration and blood pressure. Silver-silver chloride pads will be used to collect EDA, and will be placed on the index and fourth fingers on the participant’s non-dominant hand. Electrodermal activation (EDA) responses will be measured in terms of amplitude (i.e., the height of the electrodermal response measured in microsiemens [µS]). A pulse oximeter will be placed on the middle finger of the participant’s non-dominant hand to measure HR. Respiration will be recorded via two pneumatic chest bands - the upper will be placed around the chest and the lower, around the abdomen and over their clothing. Blood pressure will be measured via a blood pressure cuff that will be placed on the brachial artery/upper portion of the individual’s left arm. All
Participants in the relaxation training group will partake in an interactive training session, which will involve learning core mindfulness-related concepts, as well as engaging in progressively advanced mindfulness exercises (see Appendix for further details). Note: For exercises involving the consumption of food products, participants will be notified in advance (and immediately before the exercises) of the food products that will be involved in the exercise. Participants will be cautioned to take into consideration any food allergies and/or dietary restrictions they may have – precautions will be taken such that the risk of food allergies is minimized (e.g., selecting foods that are nut-free). Following the formal mindfulness sessions, participants will be instructed to complete daily “homework” exercises (for approximately 5 minutes per day), which will be accessible as handouts and audio recordings on a Brock University Sakai site. Participants will be asked to complete an online questionnaire (taking approximately one minute to complete) each day to record details regarding their daily mindfulness practice (see Appendix).

The procedure for the relaxation training sessions will be similar to the mindfulness sessions. Participants in the relaxation training group will partake in an interactive training session, which will...
involve learning about the link between stress and cognition, as well as engaging in progressively advanced relaxation techniques focused on reducing anxiety or stress prior to cognitively-demanding tasks (see Appendix for further details). Following the formal relaxation sessions, participants will be instructed to complete daily “homework” exercises (for approximately 5 minutes per day), which will be accessible as handouts and audio recordings on a Brock University Sakai site. Participants will be asked to complete an online questionnaire (taking approximately one minute to complete) each day to record details regarding their daily relaxation practice (see Appendix).

At the end of every training session (for the mindfulness group and control group), participants will be asked to complete a short self-report questionnaire, measuring state mindfulness (i.e., the Toronto Mindfulness Scale [TMS]).

During the final session (post-test), participants will be greeted individually for the session in a lab setting in the Jack and Nora Walker Lifespan Development Centre testing facilities at Brock University. The post-test session will follow the same procedure as the pre-test session (as described earlier). Participants will complete the same physiological, neuropsychological, and self-report measures as described in the pre-test session, with two exceptions: (1) a shorter version of the Everyday Living Questionnaire (and attached Post-Concussion Symptom Scale) will be used to assess changes in post-concussive symptoms since the first testing session. As well, athletic, educational, familial, and pre-test medical history information will not be reassessed. The post-test session will take approximately 1.5 hours to complete.

Upon completion of the study (at the end of the post-test session), participants will be debriefed as to the nature and purpose of the study, and thanked for their participation (see Appendix). Note: As indicated in Section 15.3(b) below, the BDI-II will be scored immediately after the student has completed testing (i.e., immediately after they leave the testing session). Overall, participation in the study will not exceed 6 hours. Included in the debriefing form is counselling contact information for Brock University Counselling Services should any negative emotions surface as a result of participation in the study. Participants will also receive contact information for the principal investigator/faculty supervisor, principal and co-student investigators. Finally, participants will be thanked for their time and participation, and will be invited to review the results of the study at its completion (by August 2017).

11. Professional Expertise/Qualifications:

Does this procedure require professional expertise/recognized qualifications (e.g., registration as a clinical psychologist, first aid certification)?

☑ Yes specify: Some of the questionnaires used in this study are protected standardized questionnaires to be used under the supervision of a Registered Clinical Psychologist. ☐ No

If YES, indicate whether you, your supervisor, or any members of your research team have the professional expertise/recognized qualifications required? ☑ Yes ☐ No

The Principal Investigator is a Registered Clinical Neuropsychologist (CPO licence #2516). The Student Investigator is not registered, however, non-registered psychologists and researchers are permitted to administer tests and questionnaires under the supervision of the Principal Investigator.

12. Participants:

Describe the number of participants and any required demographic characteristics (e.g., age, gender).

Seventy Brock University students will participate in this study (n = 70; ~47 participants with no history of head trauma, ~23 participants with a history of mild head injury). No specific demographics are
required; however, students will be fluent in English.

13. Recruitment:

Describe how and from what sources the participants will be recruited, including any relationship between the investigator(s), sponsor(s) and participant(s) (e.g., family member, instructor-student; manager-employee).

Attach a copy of any poster(s), advertisement(s) and/or letter(s) to be used for recruitment.

Seventy participants will be recruited for the study by volunteering their participation through the online Brock University Psychology Department Research website (i.e., SONA) and poster advertisements. Poster advertisements for this study will be posted on the Psychology Research Board and other various boards across campus.

14. Compensation:

a) Will participants receive compensation for participation? Yes ☒ No

b) If yes, please provide details.

Participants will have the opportunity to receive research participation hours for applicable courses at the university. The participants will be credited at the rate of one half credit per half hour of participation which is the standard rate associated with participation to a maximum of 6 hours of credit for their participation (i.e., 0.5 credits for each half-hour, or part thereof, of participation – pre- and post-test sessions will each take 1.5 hours to complete, each training session will take .5 hours to complete, and homework exercises will take approximately .5 hours to complete for each of the 3 training sessions).

Additionally, in lieu of receiving course credit (or if the maximum number of credits have been earned), participants may have their name entered into a series of draws that will be held after the testing is completed.

SECTION C – DESCRIPTION OF THE RISKS AND BENEFITS OF THE PROPOSED RESEARCH

15. Possible Risks:

1) Indicate if the participants might experience any of the following risks:

   a) Physical risks (including any bodily contact, physical stress, or administration of any substance)? Yes ☒ No

   b) Psychological risks (including feeling demeaned, embarrassed worried or upset, emotional stress)? Yes ☒ No

   c) Social risks (including possible loss of status, privacy, and/or reputation)? Yes ☒ No

   d) Are any possible risks to participants greater than those that the participants might encounter in their everyday life? Yes ☒ No

   e) Is there any deception involved? Yes ☒ No
f) Is there potential for participants to feel obligated to participate or coerced into contributing to this research (because of regular contact between participants and the researcher, relationships that involve power-dynamics, etc.)?  □ Yes □ No

2) If you answered Yes to any of 1a – 1f above, please explain the risk.

a) Participants will be connected to physiological activity recording equipment to collect physiological data (i.e., heart rate, electrodermal activity, respiration and blood pressure). To collect this data, two electrodes (placed on separate fingers of the non-dominant hand) will be used to record electrodermal activity, two respiration bands (placed around the participant’s chest and lower abdomen), a pulse oximeter (placed on the participant’s finger) to collect heart rate data, and a blood pressure cuff (placed around the participant's bicep of the left arm). Although the equipment is not invasive, the application of the electrodes, pulse oximeter, respiration bands and blood pressure cuff involves minor physical contact from the researcher to the participant. In order to minimize any discomfort participants may feel during the placement of the physiological recording equipment, participants will be clearly asked for consent and the process of applying the physiological recording equipment will be fully explained and modeled for the participants by the researcher prior to application. In addition, participants will be asked to complete/and directed as to how to make any adjustments of the equipment on his/her body to minimize physical contact between his/herself and the researcher. Participants will be asked to self-identify any dermal sensitivities (e.g., allergies) they may have as it is possible, but unlikely, that participants may have sensitivity to the electrode conductive gel. Participants will be provided with sanitary moist wipes to remove the conductive gel. Explicit instructions for all procedures will be provided to the participant (directly and through modeling in terms of the polygraph equipment) and sanitary procedures will be explained and implemented (e.g., use of gloves, cleansed and disinfected equipment, etc.). Post-recruitment, but prior to testing, subjects will be advised that alternate arrangements can be made if they prefer ‘same sex’ researchers.

The equipment will be handled by the experimenter using gloves during application, and subsequent to testing cleansed using alcohol swabs after each subject, and washed down at the end of each test day. Electrode pads are replaced. Subjects will be advised that they can administer the respiratory bands (across the chest and abdomen) overtop their clothing (there are no clothing restrictions required). Participants will be invited to complete these procedures independently; they will be advised as to how make appropriate adjustments. These steps should minimize/eliminate physical contact between his/herself and the researcher.

EDA is a measure of SNS (sympathetic nervous system) arousal via sweating. There is no risk range associated with it. Similarly, respiration rates are measures of breathing; with no risk range for this equipment to detect. Heart rate (pulse) is typically between 60 and 100, but fit individuals can have normative rates as low as 40 and higher rate of 120 are not uncommon for less fit individuals. Any detected rates for this study will not be regarded as sufficient or diagnostic. Finally, blood pressure (BP) has guidelines that suggest if BP is higher than 140/90 (systolic 140 or above; or diastolic 90 or above) this may be an indication of concern worth bringing to a medical physician’s attention. When BP is 180 or above (systolic) or 110 or above (diastolic) then medical treatment should be accessed in earnest (Bonow, Mann, Zipes, & Libby, 2012). As such, participants will be advised to review their BP with their doctor in the former case (e.g., to campus medical support, Student Health Services, [905] 688-5550 x 3243 – located in Harrison Hall next to Campus Security), and directed to medical care in the later or to an urgent/emergency centre (e.g., the St. Catharines General Hospital, 1200 Fourth Ave., St. Catharines, ON L2S 0A9, [905] 378-4647; 911 in the case of emergency) with an offer of assistance from the experimenter on site.

Additionally, participants in the mindfulness (experimental) group will be asked to consume specific food products (i.e., milk chocolate or an orange) as part of a mindfulness exercise. Participants will be asked to self-identify any food allergies or dietary restrictions during the informed consent process and immediately prior to the consumption of the food products. As well, participants will be instructed to review the list of ingredients for any food products before consuming them. Participants will be reminded that they have the option of consuming an alternative food product that is available, or they can refrain...
from consuming the food products altogether. These steps should minimize/eliminate any allergic reactions to the consumed food products.

b) Participants will be asked to complete neurocognitive tests and questionnaires of assessing their behaviours. Students may feel awkward, or cognitively inadequate, if they are unsuccessful on any of the neurocognitive tests, and they may feel uncomfortable with disclosure of information on measures of psychopathology and personal demographics. Participants often feel the psychological pressure of being evaluated when doing psychological tests (e.g., personality questionnaires, tests of reasoning) due to their association with overall competency. As a result, they may be slightly embarrassed, or disquieted, by their performance or otherwise stressed as to what their performance means in terms of capacity or ability. Participants will be reminded that the researchers are interested in group, rather than individual, responses, and that the cognitive tests are intentionally challenging in order to avoid ceiling effects, rather than it reflecting their cognitive capacity. Participants will have been previously informed during the informed consent process that the questionnaires may involve questions of a sensitive or personal nature and are at liberty to omit any answer/response should they choose.

Further, participants may experience emotional discomfort or awareness when completing the BDI-II and/or researchers may become aware of an individual’s lowered affect and/or depression as a function of his/her response to items on the BDI-II.

In order to address these concerns, they will be advised that there are no right or wrong answers for the questionnaires, and that the neurocognitive tests are designed to disallow completion (in order to avoid ceiling effects which would result in a nil measure). They will also be reminded of the confidentiality aspects of conducting research (i.e., their results will be examined in congregant and analyzed as part of a group; no one beyond the researchers will have access to their individual data, and their answer booklets and files will be alpha-numerically coded) and we will reaffirm their right to not complete any aspect of the study without prejudice.

e) While subjects will be fully informed of the tasks they will be asked to perform and the reasons associated with each of those measures, informed consent procedures and recruitment materials do not explicitly state the researchers’ interests in head injury/brain injury as a primary variable in this study. Research has shown that informing participants that head injury/brain injury as one of the study variables of interest can influence subsequent performance (Suhr & Gunstad, 2002; 2005). As well, subjects will not be informed of the researchers’ interests in mindfulness, since preconceived notions regarding mindfulness or meditation practice may produce a sampling bias, thereby decreasing the representativeness of the sample. Subjects will be fully debriefed upon study completion.

f) Given the longitudinal nature of the study (which involves regular contact between the participants and researcher), subjects may feel obligated to continue participating in the study. However, participants will be fully informed during the consent process that their participation in the study is completely voluntary and that they can withdraw from the study at any time, without penalty or prejudice. As well, participants will be reminded of their right to withdraw from the study during each of the testing/training sessions.

3) Describe how the risks will be managed and include the availability of appropriate medical or clinical expertise or qualified persons. Explain why less risky alternative approaches could not be used.

a) Subjects will be asked about any dietary restrictions, allergies, or skin sensitivities they may have and will be screened to not participate in the study as appropriate. Participants will be reminded to review food ingredients prior to consuming food products and will be reminded that they have the option to choose an alternative food product that is available or refrain from consuming the food product entirely. In the unlikely event that participants may have an unknown sensitivity to the electrode conductive gel, participants will be provided with sanitary wipes to remove the gel. Further, to ensure sanitary conditions, the researcher will provide the participant with antibacterial lotion prior to application of
During debriefing the participants will be advised of our interest in, amongst other things, head and brain injuries. They will be provided information pertaining to counseling services, should that be relevant to them. Furthermore, should the participant indicate that s/he would like assistance, the Investigator will offer to assist the participant in accessing services or support should they wish.

Counseling services at Brock University information is provided to participants in their debriefing letter as is the following advisement: If you had any negative experiences (e.g., reading/responding to sensitive questions, increased cognitive demands) as a result of participating in this research study and wish to seek with a counsellor please contact: Brock University Counselling Services, Schmon Tower 400, (905) 688-5550 extension 4750, http://www.brocku.ca/personal-counselling or the Principal Investigator, Dr. Dawn Good, Department of Psychology, B308 MC, extension 3869, dawn.good@brocku.ca.

Community-based Mental Health Programs and Services in Niagara can be accessed via: http://www.familysupportniagara.com/resources/niagara-mental-health-programs-services-directory; Canadian Mental Health Association (CMHA) Niagara branch – [905] 688-2543; Distress Centre Niagara – [905] 688-3711.

To mitigate and manage risk, participants will be advised in the informed consent letter that the study includes questionnaires that may ask sensitive questions. They will be informed that they can leave any questions blank that they do not feel comfortable answering. Furthermore, in the informed consent process participants are reminded that their participation is completely voluntary, and at any point during the testing session, they may withdraw from the study at any time. In addition, as noted above, upon debriefing, they will be provided information pertaining to counseling services, should that be relevant to them.

During debriefing the participants will be advised of our interest in, amongst other things, head and brain injuries.
injuries. For any person who has experienced a brain injury, it will be clear to them that they are in the brain injury group, and not alarmed to this fact; for persons who have experienced milder neural complications (e.g., impact to the head causing an altered state of consciousness, repeated concussions), it will be clear that they are of particular interest as well, but they may be more concerned due to the questions they may have as to 'why' they would be of interest to researchers (e.g., is there something permanently wrong with their brains?). We will explain that neural changes after concussions are mostly temporary and otherwise subtle, but can be more permanent, as has been witnessed in the popular press for some sports celebrities. We will reinforce our intention to understand the implications on function (emotional, cognitive), if any, of these possible neural changes, subtle or otherwise, and ultimately, assist/optimize functioning for any person with traumatic injuries to the head and brain. The fact of persistence versus temporary is indicated in the Debrief Form (i.e., “...a small proportion experiencing persistent symptoms after three months (the majority will have resolved fully within 3 weeks). Most effects of mild injuries to the head are temporary, and otherwise, subtle. As popularized by the press on sports injuries, some can be more permanent.” The Debrief form constitutes the script and is read aloud to the students at study completion (and they can read along in their own copy).

The researcher will also confirm with the participants their comfort and/or concerns upon testing completion and provide the participants with counseling and research ethics contact information should they feel they have any negative experience or emotion (e.g., feeling uncomfortable, etc.) as a result of participating in the study that would need to be addressed outside of the ‘study’ setting. This is information is provided in the debriefing form: It is our intention to confirm with you that your experience in this study has been a rewarding one and you are thanked for your contribution to this research endeavour. However, if you had any negative experiences (e.g., reading/responding to sensitive questions, increased cognitive demands) as a result of participating in this research study, please contact either of the Principal Investigators (listed below). Participants will also be provided with resources should they like more information/support regarding head trauma (e.g., The Ontario Brain Injury Association (OBIA): www.obia.ca; The Ontario Neurotrauma Foundation (ONF): www.onf.org); Brain Injury Association of Niagara (BIAN): www.bianiagara.org), as well as information regarding Brock Counseling Services (i.e., University Counselling Services, Schmon Tower 400, (905) 688-5550 extension 4750, http://www.brocku.ca/personal-counselling) in the event they wish to access additional supports.

e) Participants are not informed in advance about head injury/brain injury as a focus for the study because research has shown that informing participants that head injury is a study variable of interest will influence subsequent performance (referred to as ‘diagnosis threat’ - Suhr & Gunstad, 2002; 2005). Additionally, participants are not informed in advance about mindfulness as a focus for the study because this has the potential to introduce a sampling bias, which could reduce the representativeness of the sample. However, participants will be fully informed of our interest in head and brain injuries, as well as mindfulness at the completion of the study.

f) For proper facilitation of the mindfulness and relaxation interventions, regular contact between participants and researchers is necessary (e.g., in order to lead group sessions and assign homework exercises). However, participants will be fully informed during the consent process that their participation in the study is completely voluntary and that they can withdraw from the study at any time, without penalty or prejudice. As well, the subject’s freedom to withdraw from the study at the time of consent, or any other time throughout testing/training, will be reinforced.

16. Possible Benefits:

Discuss any potential direct benefits to the participants from their involvement in the project. Comment on the (potential) benefits to the scientific community/society that would justify involvement of participants in this study.

Student participants can benefit from participation in this study by gaining insight into neuropsychological and physiological research and empirical methods relevant to psychology. Additionally, by partaking in
mindfulness or relaxation training sessions, participants may experience a number of beneficial outcomes such as reduced levels of distress (e.g., symptoms of anxiety or depression) and increased positive affect, which have been shown to be potential outcomes of both mindfulness and relaxation interventions (Jain et al., 2007). Finally, this research will have implications in a clinical or rehabilitation setting, as it will provide further information regarding the efficacy of mindfulness-based interventions for use in the MHI population.

SECTION D – THE INFORMED CONSENT PROCESS

17. The Consent Process:

Describe the process that the investigator(s) will be using to obtain informed consent. Include a description of who will be obtaining the informed consent. If there will be no written consent form, explain why not. For information about the required elements in the letter of invitation and the consent form, as well as samples, please refer to: http://www.brocku.ca/researchservices/forms/index.php

If applicable, attach a copy of the Letter of Invitation, the Consent Form, the content of any telephone script, and any other material that will be utilized in the informed consent process.

The participants involved in this study will be invited to participate in the study and will be asked to register online through the Brock University Psychology Department Website (i.e., SONA) or to contact the researcher via email to arrange a convenient testing time and date. Upon arrival to the testing room, participants will be read an informed consent script by the researcher, and will be asked to sign a written informed consent form (see Appendix). All participants receive their own copy of the consent form prior to testing (note: both the participant and the experimenter maintain a signed copy). Note that individual consents will first be obtained prior to group participation and the consent will be reiterated prior to group testing.

18. Consent by an authorized party:

If the participants are minors or for other reasons are not competent to consent, describe the proposed alternative source of consent, including any permission form to be provided to the person(s) providing the alternative consent.

N/A

19. Alternatives to prior individual consent:

If obtaining individual participant consent prior to commencement of the research project is not appropriate for this research, please explain and provide details for a proposed alternative consent process.

N/A

20. Feedback to Participants:

Explain what feedback/information will be provided to the participants after participation in the project. This should include a more complete description of the purpose of the research, and access to the results of the research. Also, describe the method and timing for delivering the feedback.

At the final testing session, participants will be given a debriefing statement (see Appendix) and will also be given a verbal description of the study. The purpose of the study will be discussed and it will be explained to participants that differences in post-concussive symptom endorsement will be investigated.

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between groups (i.e., mindfulness vs. control). Participants will also be informed that the physiological data will be used to investigate the underarousal hypothesis. All participants will be informed that the data collected will be summarized, used as thesis data, presented as a publishable report and conference study. All individual data will remain confidential and anonymous. Participants will be invited to view the results of the study by date of completion (August 2017) and may contact the investigators either directly or via e-mail. Contact information will be provided to the participant on the debriefing form should the participant wish to contact the researchers at any time.

**21. Participant withdrawal:**

a) Describe how the participants will be informed of their right to withdraw from the project. Outline the procedures that will be followed to allow the participants to exercise this right.

Participation in this study is voluntary. Participants can choose to withdraw any time during the group or individualized testing/training sessions. The participants will be informed of their freedom to withdraw without penalty or prejudice both through the verbal and written informed consent processes (see Appendix). It will be explained that if the participant should choose to withdraw their participation, they will receive participation credit commensurate with their participation and their data will be destroyed and disposed of in a professional and confidential manner. Participants will be informed that he/she can verbally inform the researcher at any time during the sessions of their choice to withdraw participation. Participants will be reminded that they are welcome to omit any portion of the questionnaires and that, on occasion, testing can be completed before the session ends; participants will be excused from remaining in the test environment under these circumstances. Participants may use this reasoning to withdraw prior to test completion. Furthermore, they will be reminded of the services available that they can consult should they have any questions regarding their participation in the study (Brock University Counselling Services; Research Ethics Officer; Principal Investigator). Note that each participant is given their own Debriefing form and, should s/he choose to withdraw, will be escorted, and formally debriefed, by one of the two attending experimenters. Note that once students have left the testing area, they can contact the Principal Investigator and request that their information be withdrawn from the study.

b) Indicate what will be done with the participant’s data should the participant choose to withdraw. Describe what, if any, consequences withdrawal might have on the participant, including any effect that withdrawal may have on participant compensation.

If a participant chooses to withdraw, the researcher will provide him/her with a written debriefing form (see Appendix), and also answer any questions and any data collected from him or her will be destroyed (shredded or electronically deleted; biological measures will be appropriately disposed) and not used in data analysis. If the participant choosing to withdraw is receiving research participation credit, the length of the student’s participation will be credited for appropriate participation hours up to the maximum length of the study.

**SECTION E – CONFIDENTIALITY & ANONYMITY**

**Confidentiality:** information revealed by participants that holds the expectation of privacy. This means that all data collected will not be shared with anyone except the researchers listed on this application.

**Anonymity of data:** information revealed by participants will not have any distinctive character or recognition factor, such that information can be matched (even by the researcher) to individual participants. Any information collected using audio-taping, video recording, or interview cannot be considered anonymous. **Please note that this refers to the anonymity of the data itself and not the reporting of results.**

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22. Given the definitions above:

a) Will the data be treated as confidential?  ☒ Yes  ☐ No
b) Are the data anonymous?  ☐ Yes  ☒ No
c) Describe any personal identifiers that will be collected during the course of the research (e.g., participant names, initials, addresses, birth dates, student numbers, organizational names and titles etc.). Indicate how personal identifiers will be secured and if they will be retained once data collection is complete.

Participant names will be collected through the informed consent process, however, informed consent forms are kept entirely separate from collected data. All data collected (questionnaires, test forms, physiological measures) will be alphanumerically coded with no personal identifiers. Consent forms, data, and all files (e.g., master lists) will be maintained for 10 years post-data collection (for adults; 10 years beyond a minor’s 18th birthday) in accordance with the Regulated Health Professions Act (1991) after which they will be shredded or electronically deleted.

d) If any personal identifiers will be retained once data collection is complete, provide a comprehensive rationale explaining why it is necessary to retain this information, including the retention of master lists that link participant identifiers with unique study codes and de-identified data.

Given that we are collecting sensitive information about the well-being of our participants (e.g., symptoms of depression, anxiety, etc.), we must have a way of reaching them should any of their answers suggest that they may require clinical follow-up. Further, we are required by the College of Psychologists of Ontario, with permission from the participant, to make available any clinically-based protected measures, should one of our participant’s clinicians request this data from us. Note that the regulations require that this request be initiated by the participant, and/or his/her legal representative, and requires the participant’s explicit request or permission. The files must be maintained for 10 years (post-data collection and/or 10 years after the participant’s 18th birthday). As a result, we will require a master list of participant’s names corresponding to their respective participant alpha-numeric code which will be available only to the principle investigators. All requests are initiated by the participant (and/or his/her legal representative), none by the researcher. The requests have come through their personal medical professionals or hospital personnel. All require ‘Consent to Release’ forms (formerly, Form 14’s) to be appropriately completed.

e) State who will have access to the data.

Dr. Dawn Good (principal investigator), Bradey Alcock (principal student investigator), and research assistants associated with Dr. Good’s laboratory will have access to the data. All of these individuals have completed confidentiality agreements compliant with the FIPPA (Freedom of Information and Protection of Privacy Act, 2008), and PHIPA (Personal Health Information Protection Act, 2004). Only the principal investigators will have access to the participant identifier master list.

f) Describe the procedures to be used to ensure anonymity of participants and/or confidentiality of data both during the conduct of the research and in the release of its findings.

To ensure confidentiality, informed consent forms will be kept separate from the data collected. Also, all data will be alphanumerically coded to ensure confidentiality. No information that could potentially reveal a participant’s identity will be used in discussion, or in the reporting, of the findings. Participants will be informed that all data collected will be kept strictly confidential in a locked, safe lab to which only the principal investigator, student investigators and the research assistants will have access. To further
ensure confidentiality, researchers and research assistants have signed confidentiality agreements (see Appendix).

g) If participant anonymity and/or confidentiality is not appropriate to this research project, explain, in detail, how all participants will be advised that data will not be anonymous or confidential.

During the consent and debriefing sessions, participants will be advised that anonymity and confidentiality of their data will be preserved and that their data will be coded alphanumerically in a database, and it will never be used individually, but instead will be used only within the context of group statistical findings.

h) Explain how written records, video/audio tapes, and questionnaires will be secured, and provide details of their final disposal or storage, including how long they will be secured and the disposal method to be used.

All raw data collected will be kept in the secure and locked file in the Principal Investigator’s lab (PL 621) for a period of ten years. After the ten year period, data will be shredded and/or destroyed.

SECTION F -- SECONDARY USE OF DATA

23. a) Is it your intention to reanalyze the data **for purposes other than described in this application**?

Yes ☐ No ☐

b) Is it your intention to allow the study and data to be reanalyzed by colleagues, students, or other researchers outside of the original research purposes? If this is the case, explain how you will allow your participants the opportunity to choose to participate in a study where their data would be distributed to others (state how you will contact participants to obtain their re-consent)

N/A

c) If there are no plans to reanalyze the data for secondary purposes and, yet, you wish to keep the data indefinitely, please explain why.

N/A

SECTION G -- MONITORING ONGOING RESEARCH

It is the investigator’s responsibility to notify the REB using the “Renewal/Project Completed” form, when the project is completed or if it is cancelled.

http://www.brocku.ca/researchservices/forms/index.php

24. Annual Review and Serious Adverse Events (SAE):

a) **MINIMUM REVIEW REQUIRES THE RESEARCHER COMPLETE A “RENEWAL/PROJECT COMPLETED” FORM AT LEAST ANNUALLY.**

Indicate whether any additional monitoring or review would be appropriate for this project.

N/A

*Serious adverse events (negative consequences or results affecting participants) must be reported to the Research Ethics Officer and the REB Chair, as soon as possible and, in any event, no more than 3 days subsequent to their occurrence.*
25. **COMMENTS**

If you experience any problems or have any questions about the Ethics Review Process at Brock University, please feel free to contact the Research Ethics Office at (905) 688-5550 ext 3035, or reb@brocku.ca
Appendix C

Statistical Analyses and Tables
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Table C1

*Descriptive Statistics for Neuropsychological Measures as a Function of MHI Status*

<table>
<thead>
<tr>
<th>Neuropsychological Measure</th>
<th>MHI</th>
<th>No-MHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMT-III Total Time (seconds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>33.61</td>
<td>36.71</td>
</tr>
<tr>
<td>No-MHI</td>
<td>36.71</td>
<td>36.45</td>
</tr>
<tr>
<td>SD</td>
<td>7.6</td>
<td>11.45</td>
</tr>
<tr>
<td>Observed Range</td>
<td>21.71 - 51.30</td>
<td>15.49 - 60.72</td>
</tr>
<tr>
<td>TMT-IV Total Time (seconds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>62.73</td>
<td>71.50</td>
</tr>
<tr>
<td>No-MHI</td>
<td>71.50</td>
<td>71.50</td>
</tr>
<tr>
<td>SD</td>
<td>14.30</td>
<td>17.01</td>
</tr>
<tr>
<td>Observed Range</td>
<td>37.00 - 92.52</td>
<td>39.18 - 127.46</td>
</tr>
<tr>
<td>CWIT-I Total Time (seconds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>29.60</td>
<td>27.97</td>
</tr>
<tr>
<td>No-MHI</td>
<td>27.97</td>
<td>27.97</td>
</tr>
<tr>
<td>SD</td>
<td>4.86</td>
<td>4.24</td>
</tr>
<tr>
<td>Observed Range</td>
<td>20.63 - 39.28</td>
<td>21.00 - 40.82</td>
</tr>
<tr>
<td>CWIT-III Total Time (seconds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>49.94</td>
<td>46.01</td>
</tr>
<tr>
<td>No-MHI</td>
<td>46.01</td>
<td>46.01</td>
</tr>
<tr>
<td>SD</td>
<td>11.07</td>
<td>6.75</td>
</tr>
<tr>
<td>Observed Range</td>
<td>28.37 - 74.00</td>
<td>31.00 - 58.54</td>
</tr>
<tr>
<td>CWIT Stroop Interference †</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>20.34</td>
<td>18.04</td>
</tr>
<tr>
<td>No-MHI</td>
<td>18.04</td>
<td>18.04</td>
</tr>
<tr>
<td>SD</td>
<td>8.53</td>
<td>6.15</td>
</tr>
<tr>
<td>Observed Range</td>
<td>2.16 - 36.00</td>
<td>6.59 - 31.09</td>
</tr>
</tbody>
</table>

*Note.* TMT = Trail Making Test. CWIT = Colour-Word Interference Test. †CWIT Stroop Interference scores were derived by subtracting the CWIT-I completion times from CWIT-III completion times; these difference scores reflect the degree of cognitive interference experienced during the CWIT, such that higher scores indicate greater problems with interference.
Table C2

*Descriptive Statistics for Errors on Neuropsychological Tests as a Function of MHI Status*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-MHI (n = 32)</th>
<th>MHI (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (percentage)</td>
<td></td>
</tr>
<tr>
<td>TMT-III Errors</td>
<td>5 (15.6%)</td>
<td>1 (5.0%)</td>
</tr>
<tr>
<td>TMT-IV Errors</td>
<td>13 (40.6%)</td>
<td>11 (55.0%)</td>
</tr>
<tr>
<td>CWIT-I Errors</td>
<td>10 (31.3%)</td>
<td>10 (50.0%)</td>
</tr>
<tr>
<td>CWIT-III Errors</td>
<td>25 (78.1%)</td>
<td>17 (85.0%)</td>
</tr>
</tbody>
</table>

*Note.* Frequencies reflect the number of participants in each group (MHI and no-MHI) who committed at least one error on the task.
### Table C3

*Descriptive Statistics for Self-Reported Executive Dysfunction (BRIEF-A) Scores as a Function of MHI Status*

<table>
<thead>
<tr>
<th>Variable</th>
<th>No-MHI</th>
<th>MHI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Global Executive Composite (GEC)</td>
<td>57.16</td>
<td>11.75</td>
</tr>
<tr>
<td>Metacognition Index (MI)</td>
<td>57.39</td>
<td>11.60</td>
</tr>
<tr>
<td>Initiate</td>
<td>55.94</td>
<td>11.80</td>
</tr>
<tr>
<td>Working Memory</td>
<td>59.39</td>
<td>12.82</td>
</tr>
<tr>
<td>Plan/Organize</td>
<td>55.45</td>
<td>11.54</td>
</tr>
<tr>
<td>Task Monitor</td>
<td>58.10</td>
<td>12.73</td>
</tr>
<tr>
<td>Organization of Materials</td>
<td>53.10</td>
<td>12.41</td>
</tr>
<tr>
<td>Behavioural Regulation Index (BRI)</td>
<td>55.71</td>
<td>12.14</td>
</tr>
<tr>
<td>Inhibit</td>
<td>56.19</td>
<td>11.59</td>
</tr>
<tr>
<td>Shift</td>
<td>57.47</td>
<td>12.16</td>
</tr>
<tr>
<td>Emotional Control</td>
<td>53.84</td>
<td>12.09</td>
</tr>
<tr>
<td>Self-Monitor</td>
<td>52.52</td>
<td>11.89</td>
</tr>
</tbody>
</table>
Table C4

*Descriptive Statistics for Trait Mindfulness (FFMQ) Scores as a function of MHI Status*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Observed Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Total Score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>122.26</td>
<td>17.02</td>
<td>84 - 153</td>
</tr>
<tr>
<td>No-MHI</td>
<td>123.68</td>
<td>17.36</td>
<td>88 - 160</td>
</tr>
<tr>
<td>Observing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>26.32</td>
<td>6.16</td>
<td>14 - 40</td>
</tr>
<tr>
<td>No-MHI</td>
<td>25.97</td>
<td>5.08</td>
<td>17 - 37</td>
</tr>
<tr>
<td>Describing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>27.26</td>
<td>6.67</td>
<td>16 - 40</td>
</tr>
<tr>
<td>No-MHI</td>
<td>27.52</td>
<td>5.38</td>
<td>16 - 37</td>
</tr>
<tr>
<td>Acting with Awareness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>22.58</td>
<td>4.97</td>
<td>11 - 30</td>
</tr>
<tr>
<td>No-MHI</td>
<td>24.23</td>
<td>7.06</td>
<td>10 - 36</td>
</tr>
<tr>
<td>Non-Judgement of Inner Experiences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>25.84</td>
<td>7.77</td>
<td>8 - 38</td>
</tr>
<tr>
<td>No-MHI</td>
<td>24.52</td>
<td>8.00</td>
<td>8 - 40</td>
</tr>
<tr>
<td>Non-Reactivity to Inner Experiences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI</td>
<td>20.26</td>
<td>4.03</td>
<td>7 - 26</td>
</tr>
<tr>
<td>No-MHI</td>
<td>21.45</td>
<td>4.28</td>
<td>14 - 30</td>
</tr>
</tbody>
</table>
Table C5

Summary of Linear Regression Analysis for Total FFMQ Scores (n = 19)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury Severity</td>
<td>-2.22</td>
<td>1.02</td>
<td>-0.47</td>
<td>-2.19</td>
<td>.043*</td>
</tr>
</tbody>
</table>

Note. $R^2 = .22$. *$p < .05$.

Table C6

Summary of Linear Regression Analysis for CWIT-I Total Time (n = 50)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Non-Reactivity</td>
<td>-.34</td>
<td>.15</td>
<td>-.31</td>
<td>-2.25</td>
<td>.029*</td>
</tr>
</tbody>
</table>

Note. $R^2 = .10$. *$p < .05$.

Table C7

Summary of Linear Regression Analysis for TMT-III Total Time (n = 50)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Non-Reactivity</td>
<td>-.66</td>
<td>.34</td>
<td>-.27</td>
<td>-1.93</td>
<td>.060</td>
</tr>
</tbody>
</table>

Note. $R^2 = .07$. 
Table C8

*Summary of Linear Regression Analysis for BRIEF-A GEC T-Scores (n = 49)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Total Scores</td>
<td>-.36</td>
<td>.09</td>
<td>-.51</td>
<td>-4.10</td>
<td>.000*</td>
</tr>
</tbody>
</table>


Table C9

*Summary of Linear Regression Analysis for BRIEF-A MI T-Scores (n = 49)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Total Scores</td>
<td>-.40</td>
<td>.08</td>
<td>-.58</td>
<td>-4.89</td>
<td>.000*</td>
</tr>
</tbody>
</table>

*Note. R^2 = .34. *p < .001.

Table C10

*Summary of Linear Regression Analysis for BRIEF-A BRI T-Scores (n = 49)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Total Scores</td>
<td>-.25</td>
<td>.10</td>
<td>-.34</td>
<td>-2.50</td>
<td>.016*</td>
</tr>
</tbody>
</table>

*Note. R^2 = .12. *p < .05.
Table C11

*Summary of Multiple Linear Regression Analysis for BRIEF-A MI T-Scores (n = 49)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observing</td>
<td>.57</td>
<td>.78</td>
<td>.12</td>
<td>0.73</td>
<td>.471</td>
</tr>
<tr>
<td>Describing</td>
<td>-.11</td>
<td>.67</td>
<td>-.03</td>
<td>-0.17</td>
<td>.867</td>
</tr>
<tr>
<td>Acting with Awareness</td>
<td>-1.78</td>
<td>.58</td>
<td>-.42</td>
<td>-3.06</td>
<td>.004**</td>
</tr>
<tr>
<td>Non-Judging</td>
<td>-.83</td>
<td>.48</td>
<td>-.25</td>
<td>-1.73</td>
<td>.090</td>
</tr>
<tr>
<td>Non-Reactivity</td>
<td>-1.58</td>
<td>.83</td>
<td>-.25</td>
<td>-1.91</td>
<td>.063</td>
</tr>
</tbody>
</table>

*Note. $R^2 = .42, **p < .01.$

Table C12

*Summary of Multiple Linear Regression Analysis for BRIEF-A BRI T-Scores (n = 49)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observing</td>
<td>.40</td>
<td>.81</td>
<td>.08</td>
<td>0.49</td>
<td>.627</td>
</tr>
<tr>
<td>Describing</td>
<td>1.02</td>
<td>.69</td>
<td>.23</td>
<td>1.48</td>
<td>.146</td>
</tr>
<tr>
<td>Acting with Awareness</td>
<td>-1.31</td>
<td>.60</td>
<td>-.31</td>
<td>-2.17</td>
<td>.036*</td>
</tr>
<tr>
<td>Non-Judging</td>
<td>-.92</td>
<td>.49</td>
<td>-.27</td>
<td>-1.86</td>
<td>.069</td>
</tr>
<tr>
<td>Non-Reactivity</td>
<td>-2.60</td>
<td>.86</td>
<td>-.42</td>
<td>-3.03</td>
<td>.004**</td>
</tr>
</tbody>
</table>

*Note. $R^2 = .38, *p < .05, **p < .01.$
Table C13

Summary of Multiple Linear Regression Analysis for Predictors of TMT-III (n = 50)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Scores (centered)</td>
<td>-.08</td>
<td>.09</td>
<td>-.12</td>
<td>-0.87</td>
<td>.390</td>
</tr>
<tr>
<td></td>
<td>[-.25, .10]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>-3.35</td>
<td>3.00</td>
<td>-.16</td>
<td>-1.12</td>
<td>.270</td>
</tr>
<tr>
<td></td>
<td>[-9.39, 2.69]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFMQ Scores x MHI Status</td>
<td>.15</td>
<td>.18</td>
<td>.96</td>
<td>0.86</td>
<td>.397</td>
</tr>
<tr>
<td></td>
<td>[-.21, .52]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. $R^2 = .05$.

Table C14

Summary of Multiple Linear Regression Analysis for Predictors of TMT-IV (n = 50)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Scores (centered)</td>
<td>-.05</td>
<td>.14</td>
<td>-.05</td>
<td>-0.35</td>
<td>.727</td>
</tr>
<tr>
<td></td>
<td>[-.32, .23]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>-9.42</td>
<td>4.75</td>
<td>-.28</td>
<td>-1.98</td>
<td>.053</td>
</tr>
<tr>
<td></td>
<td>[-18.98, .13]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFMQ Scores x MHI Status</td>
<td>.02</td>
<td>.29</td>
<td>.09</td>
<td>0.08</td>
<td>.937</td>
</tr>
<tr>
<td></td>
<td>[-.55, .60]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. $R^2 = .08$. 
Table C15

**Summary of Multiple Linear Regression Analysis for Predictors of CWIT-I (n = 50)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Scores (centered)</td>
<td>-.06</td>
<td>.04</td>
<td>-.23</td>
<td>-1.62</td>
<td>.112</td>
</tr>
<tr>
<td></td>
<td>[-.14, .02]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>1.60</td>
<td>1.31</td>
<td>.17</td>
<td>1.22</td>
<td>.230</td>
</tr>
<tr>
<td></td>
<td>[-1.05, 4.24]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFMQ Scores x MHI Status</td>
<td>.03</td>
<td>.08</td>
<td>.42</td>
<td>0.38</td>
<td>.707</td>
</tr>
<tr>
<td></td>
<td>[-.13, .19]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. \( R^2 = .09 \).*

Table C16

**Summary of Multiple Linear Regression Analysis for Predictors of CWIT-III (n = 50)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Scores (centered)</td>
<td>-.04</td>
<td>.07</td>
<td>-.08</td>
<td>-0.56</td>
<td>.582</td>
</tr>
<tr>
<td></td>
<td>[-.19, .11]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>3.76</td>
<td>2.59</td>
<td>.21</td>
<td>1.45</td>
<td>.153</td>
</tr>
<tr>
<td></td>
<td>[-1.45, 8.97]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFMQ Scores x MHI Status</td>
<td>.21</td>
<td>.15</td>
<td>1.48</td>
<td>1.34</td>
<td>.186</td>
</tr>
<tr>
<td></td>
<td>[-.10, .51]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. \( R^2 = .09 \).*
### Table C17

*Summary of Multiple Linear Regression Analysis for Predictors of GEC T-Scores (n = 49)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Scores (centered)</td>
<td>-.36</td>
<td>.09</td>
<td>-.51</td>
<td>-4.05</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>[-.54, -.18]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>-.16</td>
<td>2.98</td>
<td>-.01</td>
<td>-0.05</td>
<td>.957</td>
</tr>
<tr>
<td></td>
<td>[-6.15, 5.83]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFMQ Scores x MHI Status</td>
<td>.21</td>
<td>.18</td>
<td>1.15</td>
<td>1.15</td>
<td>.255</td>
</tr>
<tr>
<td></td>
<td>[-.16, .57]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. $R^2 = .28$, *$p < .001*."

### Table C18

*Summary of Multiple Linear Regression Analysis for Predictors of MI T-Scores (n = 49)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Scores (centered)</td>
<td>-.40</td>
<td>.08</td>
<td>-.58</td>
<td>-4.83</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>[-.56, -.23]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>-.26</td>
<td>2.76</td>
<td>-.01</td>
<td>-0.09</td>
<td>.927</td>
</tr>
<tr>
<td></td>
<td>[-5.81, 5.30]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFMQ Scores x MHI Status</td>
<td>.24</td>
<td>.17</td>
<td>1.37</td>
<td>1.46</td>
<td>.150</td>
</tr>
<tr>
<td></td>
<td>[-.09, .58]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. $R^2 = .37$, *$p < .001*."


Table C19

Summary of Multiple Linear Regression Analysis for Predictors of BRI T-Scores (n = 49)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Scores (centered)</td>
<td>-.25</td>
<td>.10</td>
<td>-.34</td>
<td>-2.46</td>
<td>.018*</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>.11</td>
<td>3.35</td>
<td>.004</td>
<td>0.03</td>
<td>.974</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFMQ Scores x MHI Status</td>
<td>.11</td>
<td>.21</td>
<td>.59</td>
<td>0.54</td>
<td>.594</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Note. $R^2 = .12$, *p < .05.

Table C20

Summary of Linear Regression Analysis for baseline EDA Peak Amplitude (n = 50)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Total Scores</td>
<td>.02</td>
<td>.01</td>
<td>.34</td>
<td>2.52</td>
<td>.015*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. $R^2 = .12$, *p < .05.

Table C21

Summary of Linear Regression Analysis for Self-Reported Arousal (n = 50)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Total Scores</td>
<td>-.01</td>
<td>.01</td>
<td>-.12</td>
<td>-.81</td>
<td>.424</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. $R^2 = .01$. 
Table C22

Summary of Multiple Linear Regression Analysis for EDA Peak Amplitude (n = 50)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observing</td>
<td>.04</td>
<td>.03</td>
<td>.30</td>
<td>1.64</td>
<td>.109</td>
</tr>
<tr>
<td>Describing</td>
<td>.01</td>
<td>.02</td>
<td>.12</td>
<td>.60</td>
<td>.551</td>
</tr>
<tr>
<td>Acting with Awareness</td>
<td>.00</td>
<td>.02</td>
<td>.03</td>
<td>.17</td>
<td>.869</td>
</tr>
<tr>
<td>Non-Judging</td>
<td>.02</td>
<td>.02</td>
<td>.16</td>
<td>.96</td>
<td>.341</td>
</tr>
<tr>
<td>Non-Reactivity</td>
<td>.02</td>
<td>.03</td>
<td>.08</td>
<td>.51</td>
<td>.611</td>
</tr>
</tbody>
</table>

Note. $R^2 = .17$.

Table C23

Summary of Multiple Linear Regression Analysis for EDA Peak Amplitude (n = 50)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Scores (centered)</td>
<td>.02</td>
<td>.006</td>
<td>.33</td>
<td>2.49</td>
<td>.016*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[.003, .03]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>-.34</td>
<td>.21</td>
<td>-.22</td>
<td>-1.64</td>
<td>.108</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-.76, .08]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFMQ Scores x MHI Status</td>
<td>-.01</td>
<td>.01</td>
<td>-.82</td>
<td>-0.79</td>
<td>.436</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-.04, .02]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. $R^2 = .18$, *$p < .05$. 
Table C24

Summary of Multiple Linear Regression Analysis for Self-Reported Arousal (n = 50)

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ Scores (centered)</td>
<td>-.01</td>
<td>.02</td>
<td>-.11</td>
<td>-0.79</td>
<td>.434</td>
</tr>
<tr>
<td></td>
<td>[-.04, .02]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>.12</td>
<td>.51</td>
<td>.03</td>
<td>0.24</td>
<td>.813</td>
</tr>
<tr>
<td></td>
<td>[-.90, 1.14]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFMQ Scores x MHI Status</td>
<td>.02</td>
<td>.03</td>
<td>.64</td>
<td>0.56</td>
<td>.578</td>
</tr>
<tr>
<td></td>
<td>[-.04, .08]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. $R^2 = .02$.*

Table C25

Summary of Multiple Linear Regression Analysis for TMT-III Total Time Regressed on EDA and MHI Status (n = 51)

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDA Peak Amplitude</td>
<td>-.21</td>
<td>1.87</td>
<td>-.02</td>
<td>-0.11</td>
<td>.912</td>
</tr>
<tr>
<td>MHI Status</td>
<td>-3.41</td>
<td>3.03</td>
<td>-.16</td>
<td>-1.13</td>
<td>.266</td>
</tr>
<tr>
<td>EDA Peak Amplitude X MHI Status</td>
<td>2.40</td>
<td>5.00</td>
<td>.14</td>
<td>0.48</td>
<td>.633</td>
</tr>
</tbody>
</table>

*Note. $R^2 = .03$.*
Table C26

*Summary of Multiple Linear Regression Analysis for TMT-IV Total Time Regressed on EDA and MHI Status (n = 51)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDA Peak Amplitude</td>
<td>5.43</td>
<td>2.92</td>
<td>.25</td>
<td>1.86</td>
<td>.069</td>
</tr>
<tr>
<td>MHI Status</td>
<td>-7.06</td>
<td>4.68</td>
<td>-.21</td>
<td>-1.51</td>
<td>.138</td>
</tr>
<tr>
<td>EDA Peak Amplitude X MHI Status</td>
<td>-0.81</td>
<td>7.73</td>
<td>-.03</td>
<td>-0.11</td>
<td>.917</td>
</tr>
</tbody>
</table>

*Note. $R^2 = .11$.*

Table C27

*Summary of Multiple Linear Regression Analysis for CWIT-I Total Time Regressed on EDA and MHI Status (n = 51)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>$SE B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDA Peak Amplitude</td>
<td>0.47</td>
<td>0.83</td>
<td>.08</td>
<td>0.57</td>
<td>.571</td>
</tr>
<tr>
<td>MHI Status</td>
<td>1.95</td>
<td>1.32</td>
<td>.21</td>
<td>1.47</td>
<td>.148</td>
</tr>
<tr>
<td>EDA Peak Amplitude X MHI Status</td>
<td>-0.39</td>
<td>2.19</td>
<td>-.05</td>
<td>-0.18</td>
<td>.859</td>
</tr>
</tbody>
</table>

*Note. $R^2 = .05$.*
Table C28

*Summary of Multiple Linear Regression Analysis for CWIT-III Total Time Regressed on EDA and MHI Status (n = 51)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDA Peak Amplitude</td>
<td>2.56</td>
<td>1.57</td>
<td>.23</td>
<td>1.63</td>
<td>.109</td>
</tr>
<tr>
<td>MHI Status</td>
<td>5.30</td>
<td>2.46</td>
<td>.30</td>
<td>2.16</td>
<td>.036*</td>
</tr>
<tr>
<td>EDA Peak Amplitude X MHI Status</td>
<td>2.23</td>
<td>4.05</td>
<td>.15</td>
<td>0.55</td>
<td>.584</td>
</tr>
</tbody>
</table>

*Note. R^2 = .14, *p < .05.*

Table C29

*Summary of Multiple Linear Regression Analysis for CWIT Stroop Interference Regressed on EDA and MHI Status (n = 51)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDA Peak Amplitude</td>
<td>2.09</td>
<td>1.28</td>
<td>.23</td>
<td>1.63</td>
<td>.109</td>
</tr>
<tr>
<td>MHI Status</td>
<td>3.36</td>
<td>2.05</td>
<td>.23</td>
<td>1.64</td>
<td>.107</td>
</tr>
<tr>
<td>EDA Peak Amplitude X MHI Status</td>
<td>2.62</td>
<td>3.36</td>
<td>.21</td>
<td>0.78</td>
<td>.439</td>
</tr>
</tbody>
</table>

*Note. R^2 = .11.*
Table C30

*Summary of Multiple Linear Regression Analysis for BRIEF-A GEC Scores Regressed on EDA and MHI Status (n = 51)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDA Peak Amplitude</td>
<td>-4.35</td>
<td>4.96</td>
<td>-.13</td>
<td>-0.88</td>
<td>.385</td>
</tr>
<tr>
<td>MHI Status</td>
<td>0.45</td>
<td>8.24</td>
<td>.01</td>
<td>0.05</td>
<td>.957</td>
</tr>
<tr>
<td>EDA Peak Amplitude X MHI Status</td>
<td>17.75</td>
<td>13.10</td>
<td>.38</td>
<td>1.36</td>
<td>.182</td>
</tr>
</tbody>
</table>

*Note.* $R^2 = .05$.

Table C31

*Summary of Multiple Linear Regression Analysis for BRIEF-A MI Scores Regressed on EDA and MHI Status (n = 51)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDA Peak Amplitude</td>
<td>-6.60</td>
<td>4.75</td>
<td>-.20</td>
<td>-1.34</td>
<td>.171</td>
</tr>
<tr>
<td>MHI Status</td>
<td>0.20</td>
<td>7.88</td>
<td>.004</td>
<td>0.03</td>
<td>.979</td>
</tr>
<tr>
<td>EDA Peak Amplitude X MHI Status</td>
<td>18.40</td>
<td>12.48</td>
<td>.41</td>
<td>1.47</td>
<td>.147</td>
</tr>
</tbody>
</table>

*Note.* $R^2 = .08$. 
Table C32

Summary of Multiple Linear Regression Analysis for BRIEF-A BRI Scores Regressed on EDA and MHI Status (n = 51)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDA Peak Amplitude</td>
<td>-0.93</td>
<td>4.87</td>
<td>-0.03</td>
<td>-0.19</td>
<td>.849</td>
</tr>
<tr>
<td>MHI Status</td>
<td>1.04</td>
<td>8.08</td>
<td>0.02</td>
<td>0.13</td>
<td>.898</td>
</tr>
<tr>
<td>EDA Peak Amplitude X MHI Status</td>
<td>17.70</td>
<td>12.83</td>
<td>0.39</td>
<td>1.38</td>
<td>.175</td>
</tr>
</tbody>
</table>

*Note. R^2 = .04.*
Table C33

A 2 (MHI versus no-MHI) X 2 (High versus Low FFMQ) X 2 (High versus Low EDA) ANOVA Summary for CWIT-III Total Time

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>$\eta^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>1</td>
<td>7.64</td>
<td>.091</td>
<td>.008**</td>
</tr>
<tr>
<td>FFMQ Scores</td>
<td>1</td>
<td>6.13</td>
<td>.073</td>
<td>.017*</td>
</tr>
<tr>
<td>EDA</td>
<td>1</td>
<td>18.29</td>
<td>.218</td>
<td>.000***</td>
</tr>
<tr>
<td>MHI X FFMQ Scores</td>
<td>1</td>
<td>0.45</td>
<td>.005</td>
<td>.508</td>
</tr>
<tr>
<td>MHI X EDA</td>
<td>1</td>
<td>4.72</td>
<td>.056</td>
<td>.035*</td>
</tr>
<tr>
<td>FFMQ X EDA</td>
<td>1</td>
<td>1.67</td>
<td>.020</td>
<td>.203</td>
</tr>
<tr>
<td>MHI X FFMQ Scores X EDA</td>
<td>1</td>
<td>3.01</td>
<td>.036</td>
<td>.090</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. $R^2 = .38$, *$p < .05$, **$p < .01$, ***$p < .001$. 
Table C34

\( A^2 \) (MHI versus no-MHI) \( \times 2 \) (High versus Low FFMQ) \( \times 2 \) (High versus Low EDA) ANOVA Summary for TMT-IV Total Time

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>( \eta^2 )</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>1</td>
<td>2.30</td>
<td>.048</td>
<td>.137</td>
</tr>
<tr>
<td>FFMQ Scores</td>
<td>1</td>
<td>1.16</td>
<td>.024</td>
<td>.287</td>
</tr>
<tr>
<td>EDA</td>
<td>1</td>
<td>1.72</td>
<td>.036</td>
<td>.196</td>
</tr>
<tr>
<td>MHI X FFMQ Scores</td>
<td>1</td>
<td>0.50</td>
<td>.010</td>
<td>.483</td>
</tr>
<tr>
<td>MHI X EDA</td>
<td>1</td>
<td>0.28</td>
<td>.006</td>
<td>.603</td>
</tr>
<tr>
<td>FFMQ X EDA</td>
<td>1</td>
<td>0.20</td>
<td>.004</td>
<td>.657</td>
</tr>
<tr>
<td>MHI X FFMQ Scores X EDA</td>
<td>1</td>
<td>0.05</td>
<td>.001</td>
<td>.817</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. \( R^2 = .13 \).
### Table C35

A 2 (MHI versus no-MHI) X 2 (High versus Low FFMQ) X 2 (High versus Low EDA) ANOVA Summary for BRIEF-A GEC T Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>$\eta^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between Subjects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHI Status</td>
<td>1</td>
<td>0.01</td>
<td>0.00</td>
<td>.934</td>
</tr>
<tr>
<td>FFMQ Scores</td>
<td>1</td>
<td>6.98</td>
<td>.136</td>
<td>.012*</td>
</tr>
<tr>
<td>EDA</td>
<td>1</td>
<td>0.53</td>
<td>.010</td>
<td>.472</td>
</tr>
<tr>
<td>MHI X FFMQ Scores</td>
<td>1</td>
<td>0.02</td>
<td>.000</td>
<td>.893</td>
</tr>
<tr>
<td>MHI X EDA</td>
<td>1</td>
<td>1.36</td>
<td>.027</td>
<td>.250</td>
</tr>
<tr>
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<td>.023</td>
<td>.281</td>
</tr>
<tr>
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<td>0.35</td>
<td>.007</td>
<td>.560</td>
</tr>
<tr>
<td><strong>Error</strong></td>
<td>41</td>
<td></td>
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</tbody>
</table>

*Note. $R^2 = .23$, *p < .05.*
### Table C36

*2 (MHI versus no-MHI) X 2 (High versus Low FFMQ) X 2 (High versus Low EDA) ANOVA Summary for Stroop Interference*

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>$\eta^2$</th>
<th>p</th>
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<tr>
<td><strong>Between Subjects</strong></td>
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<td></td>
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<tr>
<td>MHI Status</td>
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<td>.052</td>
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<td>.004*</td>
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<tr>
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<tr>
<td><strong>Error</strong></td>
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</table>

*Note. $R^2 = .24$, *p < .01.*