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Recommended Citation

Whipple, Kate, "EFFICACY OF ADAPTED MINDFULNESS-BASED STRESS REDUCTION PROGRAM IN TREATING PATIENTS WITH MILD TRAUMATIC BRAIN INJURY" (2023). *Scripps Senior Theses*. 2187. https://scholarship.claremont.edu/scripps_theses/2187

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**EFFICACY OF ADAPTED MINDFULNESS-BASED STRESS REDUCTION PROGRAM
IN TREATING PATIENTS WITH MILD TRAUMATIC BRAIN INJURY**

by

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**SUBMITTED TO SCRIPPS COLLEGE IN PARTIAL FULFILLMENT OF THE
DEGREE OF BACHELOR OF ARTS**

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FRIDAY, DECEMBER 9TH, 2022

Abstract

Mindfulness-based stress reduction (MBSR) has been applied in many contexts, and has been found to be a helpful therapeutic intervention for people dealing with both mental and physical struggles. In recent years, studies exploring the effects of using MBSR in the neurorehabilitation people with traumatic brain injuries (TBIs) have emerged. However, these studies are primarily pilot studies with very few participants. This proposed study will explore whether an adapted version of the MBSR program is effective in reducing apathy and improving motivation to recover in participants with mild TBIs (mTBIs). The proposed study will have 76 participants and will use a pre-post design with a randomized control group. The experimental group will undergo a 10-week adapted MBSR program, while the control group receives treatment as usual. All participants will complete measures of apathy, motivation to recover, and post-concussive symptoms before and after the 10-week intervention. It is hypothesized that participants in the experimental group will show a greater reduction in apathy, increase in motivation to recover, and overall reduction in post-concussive symptoms than those in the control group. This would be an extremely beneficial finding, not only for the participants or people with mTBIs themselves, but also for their families, loved ones, and caregivers, as they are able to see their loved one improve and regain their pre-injury abilities.

Efficacy of adapted mindfulness-based stress reduction program in rehabilitation of mild traumatic brain injury

Is there a connection between mindfulness, apathy, and one's motivation to recover from traumatic brain injuries (TBIs)? Further, is there a connection between mindfulness and one's recovery progress in neurorehabilitation? Emerging literature has indicated that this could be so. Mindfulness has been applied in many contexts, and has been found to be a helpful therapeutic intervention many groups of people. The concept and practice of mindfulness dates back hundreds, maybe thousands of years, originating from Buddhist traditions of meditation (Chiesa, A. & Malinowski, P., 2011; Kabat-Zinn, J., 2021; Siegel, D. J., 2007; Smart, C. M., 2019). Mindfulness is a broad concept that has been observed in many religions, including but not limited to Buddhism, Christianity, Judaism, and Islam (Siegel, D. J., 2007). Simply stated, mindfulness is the practice of grounding oneself in the present moment and developing an awareness and understanding of one's thoughts, feelings, and physical sensations nonjudgmentally, whether they be positive or negative (Kabat-Zinn, J., 2021, Siegel, D. J., 2007, Smart, C. M., 2019).

The purpose of mindfulness in a religious sense has been to extract oneself from the mundane and somewhat mindless way of experiencing life, which can often lead to quick jumps and fixations on negative emotions, like anger and sadness. Instead, mindfulness practices encourage individuals to acknowledge these negative emotions, but then self-regulate them and work towards enhancing positive emotions (Siegel, D. J., 2007; Smart, C. M., 2019). These goals seem to overlap with the goals of many types of clinical rehabilitation. As a result, in recent decades researchers and clinical professionals have attempted to apply this central purpose of mindfulness practices, in a secular way, to the clinical world (Kabat-Zinn, J., 2021, Siegel, D. J.,

2007). Professor and researcher, Jon Kabat-Zinn, has devoted his work to creating a method of integrating mindfulness practices into the medical field (Kabat-Zinn, J., 2021; Smart, C. M., 2019; Siegel, D. J., 2007). Several new mindfulness-based interventions (MBIs) have recently emerged, including Kabat-Zinn's own creation, mindfulness-based stress reduction (MBSR) (Kabat-Zinn, J., 2021, Siegel, D. J., 2007).

MBSR researchers have observed mindfulness practices benefiting patients struggling with both physical and psychological ailments, including chronic pain, grueling cancer treatments, anxiety, and depression (Siegel, D. J., 2007; Hofmann & Gomez, 2017). It is important to have a good understanding of MBSR, and how it uses mindfulness meditation practices to help patients ease their physical and psychological ailments. The clinical use of MBSR is meant to teach patients to distinguish negative physical sensations, including things like chronic pain or physical symptoms of anxiety, from emotional or cognitive experiences that arise as a result of the negative physical sensations (Lutz et al., 2004, as cited in Siegel, D. J., 2007). MBSR and the mindfulness meditation it uses can be distinguished from other forms of meditation in that its core focus is self-regulation and monitoring one's thought processes. Siegel (2007) states that mindfulness meditation is really the "awareness of awareness itself".

Milner et al. (2019) explored whether a weekly mindfulness-based group intervention was useful for twenty-one participants with "chronic, complex, and co-morbid disorders" in an inpatient rehabilitation clinic. These disorders included manic and depressive disorders such as major depression, bipolar disorder, and others. Following the completion of the intervention, interviews were conducted with the participants. Additionally, self-reported stress and calm levels were collected before and after treatment. The results showed that calmness increased, and stress levels decreased following completion of the program (Milner et al., 2019). During the

interviews, participants also reported feeling “autonomy, progress, positive personal gains, and room for fine tuning” (Milner et al., 2019).

Because MBSR has been shown to help patients struggling with many different physical and psychological conditions, Lutz et al. (2004) poses an appropriate question: “does MBSR produce alterations in brain function and structure?” (Lutz et al., 2004, as cited in Siegel, D. J., 2007). This is an issue that hasn’t been explored in depth until recent years. Hatchard et al. (2017) performed a review on the existing literature on neural changes associated with MBSR. They found that, although the existing literature at the time used inconsistent methodology and had considerable limitations, there seems to be a consensus that practicing MBSR affects areas in the brain related to “attention, introspection, and emotional processing,” which is also what has been observed behaviorally in clinical settings (Hatchard et al., 2017). A few years later, Bergen-Cico et al. (2021) explored neurological changes that may be associated with the use of MBIs in women experiencing stress and trauma. The researchers used functional near-infrared spectroscopy (fNIRS) to try to measure “MBI-responsive neuro-cognitive functions” that are commonly affected by stress and trauma, specifically attentional control, emotional regulation, and working memory (Bergen-Cico et al., 2021). An experimental group of participants completed a six-week MBI program. All participants completed baseline and follow-up cognitive tasks after six weeks. The results show that the experimental group showed significant improvements in attentional control, whereas the control group showed a significant deterioration of attentional control (Bergen-Cico et al., 2021). Neurologically, Bergen-Cico et al. (2021) found that the improvements in attentional control were seen in the brain through changes in the performance and activation of the frontopolar area (FP), orbitofrontal cortex (OFC), and premotor cortex (PMC).

It has been shown that MBIs, including MBSR, can be adapted to be accessible and effective for people with traumatic brain injuries (TBIs). For example, a pilot study with 10 participants from Bédard et al. (2003) sought to explore whether it was possible to adapt mindfulness-based interventions (MBIs) for people with traumatic brain injuries, specifically whether they could be used to improve this population's quality of life. Their intervention utilized "insight meditation," which is extremely similar to the mindfulness meditation used in MBSR, as well as breathing and visualization exercises and group discussions (Bédard et al., 2003). The researchers found that the participants' cognitive affect improved, their depressive symptoms were reduced, and they reported a higher quality of life following completion the MBI program (Bédard et al., 2003). Taking inspiration from Bédard et al. (2003), researchers Azulay et al. (2013) conducted another pilot study participants exploring MBSR and its effects on people with mild TBIs (mTBIs). Azulay et al. (2013) stated that the purpose of MBSR is to bring mindfulness into clinical environments with the goal of reducing the effects of stress and anxiety on patients' health. Twenty-two participants with mild TBIs went through a 10-week MBSR program which was adapted to suit abilities that may be impacted by mTBI, such as sustained attention and executive functioning. The researchers measured perceived quality of life, perceived self-efficacy, and neurobehavioral symptoms that may be associated with their TBI. These researchers also had several secondary measures they conducted, including neuropsychological tests, a self-report problem-solving measure, and a self-report measure of mindfulness. The researchers found that the MBSR program was able to be successfully adapted for participants with mild TBIs (Azulay et al., 2013). As has been seen in studies examining the effects of MBSR on populations without TBI, Azulay et al. (2013) found that their participants with mild TBIs showed improved performance on measures associated with improved quality of

life and self-efficacy. Smaller significant effects were found on measures associated with executive function, specifically in areas like working memory and regulation of attention. There was not a significant reduction in neurobehavioral symptoms. However, the researchers suspect that this MBSR treatment used was effective at improving the participants' awareness and acceptance of their symptoms, in turn reducing the negative outlook and "catastrophic assessment" of their symptoms associated with their mTBI (Azulay et al., 2013).

Since it has been discovered that MBIs can be adapted for people with mild traumatic brain injuries (mTBIs), several studies have emerged that further elucidate the benefits of using this type of treatment in neurorehabilitation. Smart et al. (2022) conducted a literature review to explore the effects of MBIs in neurorehabilitation in a general sense. Common diagnoses in which MBIs were used as a form of treatment included age-related cognitive degeneration, ADHD, ABIs/TBIs, etc. (Smart et al., 2022). According to this literature review, certain symptoms associated with TBIs like fatigue and cognitive function are often seen to improve with the use of MBIs (Smart et al., 2022). Similarly, Hardison et al. (2016) conducted a literature review of the effectiveness of clinical MBIs in physical rehabilitation and occupational therapy. The results show a trend of MBIs leading to symptom reduction for patients with neurocognitive and neuromotor disorders (Hardison et al., 2016). Specifically for this population, several studies analyzed in this literature review found decreases in symptom distress and improvements in cognitive function, mental health, and physical health (Hardison et al., 2016).

Combs et al. (2018) explored mindfulness interventions in a residential rehabilitation center for nineteen people with TBIs in the military (some active and some veterans). Mindfulness and yoga practices group meetings were required once a week. The researchers collected participants' self-reported perceived outcomes and opinions about mindfulness before

and after the intervention. The results show that the group-based mindfulness intervention increased participants' belief in the effectiveness of mindfulness in “health, physical health, mood, focus, and self-awareness” (Combs et al., 2018). The researchers noted that this belief increased as participants attended more meetings.

Niraj et al. (2020) conducted a qualitative pilot study looking at fourteen participants with traumatic brain injuries' experiences with using MBIs. The participants completed an 8-week mindfulness group. Once this was completed, six focus-group interviews took place. The results generally showed four common themes in the participants' discussions of their experiences: "developmental learning process", "group as a supportive environment for learning", "increased awareness", and "benefits of mindfulness" (Niraj et al., 2020). The participants specifically believed that the MBI treatment provided them with coping tools to be able to better approach the negative emotional and cognitive symptoms that come with TBIs while in a group setting of individuals in similar situations (Niraj et al., 2020).

Many other similar studies have used higher-level measures and variables to evaluate participants' mental health, such as quality of life and stress levels, but apathy is particularly relevant for the population of people with traumatic brain injuries (TBIs). This is because people who have sustained traumatic brain injuries typically experience many emotional changes, including an increase in apathy. This can be a result of emotionally adjusting to the effects of the injury they have sustained, but it also can be a result of specific regions in the brain being damaged during injury. Specifically, circuits within the prefrontal cortex have been shown to be correlated with apathy (Moretti & Signori, 2016). Further, Chase (2011) found that that damage to the prefrontal cortex (PFC) and basal ganglia may be connected to the occurrence of apathy.

Although apathy is commonly observed alongside mood disorders like major depressive disorder, the two should not be mistaken as the same. Worthington and Wood (2018) make an attempt at defining apathy “in terms of what it is not, such as a lack of interest, passion, enthusiasm, involvement or initiative.” They add that “it is different from, but considered similar to, passivity, indifference, ambivalence and dispassion” (Worthington & Wood, 2018). Moretti & Signori (2016) state that apathy is known to reduce motivation, decision making abilities, empathy, and emotional involvement. Marin & Chakravorty add that apathy can also be referred to as diminished motivation, which poses a serious threat to the rehabilitation process in people with traumatic brain injuries. Researchers Gray et al. (1994) conducted a year-long longitudinal study following people with TBIs who were discharged from hospital. The participants “negative symptoms” (apathy being one) and their progress in rehabilitation, amongst other things, were assessed. The results show that participants who display more apathy often progressed slower in rehabilitation (Gray et al., 1994). Similarly, researchers Green et al. (2022) found through a meta-analysis that apathy and depression may adversely impact engagement in activities of daily living in people (ADL) with traumatic brain injuries, although they state that the potential influence of depression on ADL may occur primarily through its influence on apathy. As a result, the researchers suggest that a greater focus on apathy by clinicians in rehabilitation facilities would likely be beneficial (Green et al., 2022).

The proposed study will explore whether an adapted version of the MBSR program is effective in reducing apathy and improving motivation to recover in participants with mild TBIs. Additionally, the proposed study will explore whether improved levels of apathy and motivation to recover lead to a reduction in post-concussive symptoms, such as fatigue, irritability, difficulty concentrating, and difficulty remembering. The proposed study is amongst the first of its kind, in

that few existing studies have focused on adapting MBIs to be accessible and effective for people with mTBI. Also, similar previous studies have been pilot studies with only about 10-20 participants, whereas the proposed study will not be a pilot study, and aims to have approximately 76 participants. Additionally, existing studies addressing MBIs and mTBIs have not yet addressed apathy specifically, nor motivation to recover, both variables that the proposed study will examine.

It is hypothesized that the use of mindfulness-based interventions (MBIs) will improve the apathy of people with mild traumatic brain injuries (mTBIs). Also, that people with mild TBIs who receive MBIs will show a higher motivation to recover than people with mTBIs who are not treated with MBIs. Finally, it is hypothesized that people with mTBIs who receive MBIs will recover faster than those who do not receive MBIs, because of the improved apathy and motivation to recover that is a result of the MBIs.

Proposed Method

Participants

The participants for this study will be individuals who have sustained a mild traumatic brain injury (mTBI) with a postinjury time of at least one year. The participants will be recruited from an outpatient neurorehabilitation center, in which therapists will recommend the study to clients with mTBI who they believe may be interested in participating. These participants will all be adults, meaning above the age of 18. It is expected that the participant pool will be roughly even in gender distribution. Participants will be compensated via a reimbursement for the price of commuting to the rehab clinic over the course of the study, which will hopefully reduce a financial barrier that may prevent people of a lower socioeconomic status from participating.

Because a multiple regression with three independent variables and a medium effect size will ultimately be conducted, a power analysis indicated that the targeted sample size should be 76 participants. This minimum sample size allows the proposed study to have a power of 0.80 and a significance level of 0.5. Medium effect size was derived from the Bédard et al. (2014) finding that the relationship between the use of a similar intervention, mindfulness-based cognitive therapy (MBCT), and depression symptoms showed Cohen's $d = 0.56$. Because this is a longitudinal study involving participants with mild cognitive impairments, the aim will be to recruit 85 participants, about 10% more than the target sample size, to account for attrition.

Materials

Mindfulness-Based Stress Reduction (MBSR) Intervention

As will be further described later, there will be randomly-assigned experimental and control groups in this study. The participants assigned to the experimental group will undergo a 10-week MBSR intervention, with weekly 2-hour group sessions, which is a modification of the traditional MBSR program created and described by Kabat-Zinn (2021). Kabat-Zinn (2021)'s original 8-week MBSR program with weekly 3-hour sessions recommends healing as a means of coming to terms with one's reality through the use of mindfulness practices. However, these practices require extreme focus and attention from the participants, which is typically an impaired skill in people with mTBIs. The proposed changes are being implemented to foster a more gradual, flexible, and educational method in which this population can properly and effectively learn mindfulness practices. There will be multiple groups consisting of between ten and fifteen participants, and each session will be administered by a therapist with MBSR training. The proposed intervention will last ten weeks as opposed to eight, so that each session can be shorter. This is accommodating for difficulty in concentrating, which is a common

symptom of TBIs. The intervention will emphasize the importance of psychological well-being as an important aspect of one's overall health and general quality of life through present moment awareness and acceptance. Techniques commonly used in the traditional MBSR program Kabat Zinn (2021) describes will be used in this intervention, such as the body scan, insight meditation, breathing exercises, guided visualization, and group discussion. During the first sessions, modeling of each exercise will be used heavily so that the participants are able to understand and better follow the exercises. The intervention will specifically emphasize the enhancement of attentional skills. The participants will be encouraged by the therapist facilitating the sessions to explore their internal and external experiences throughout the process of recovery from their injury, and to take a perspective of acceptance and nonjudgmental attitude regarding those experiences. The therapists will encourage the participants to view this nonjudgmental self-exploration as a mechanism of their own transformative power, thus empowering participants to apply control over their present situation in the rehabilitation process. The first 20 minutes or so of each session will consist of breathing exercises and the body scan technique as a warm-up. That will be followed by guided insight meditation and guided visualization. Lastly, the participants will have a group discussion, in which they talk about their experience during the session, which will be led by the administrators of the MBSR portion.

Apathy

The self-report version of the Apathy Evaluation Scale (AES-S) will be used to measure the participant's levels of apathy (Glenn, 2005). The AES-S is a task completed by the participants themselves consisting of 18 items that will be rated on a fixed Likert scale from 1 ("not at all characteristic") to 4 ("a lot characteristic"). The participants will be asked to consider each item in the context of the last four weeks. Some sample items are as follows: "I am

interested in things”, “I put little effort into anything”, and “I have motivation” (Glenn, 2005). Several items, including the example item “I put little effort into anything” will be reverse-scored. After the items have been reverse-scored, the sum of all the answers will be taken. A low score indicates high amounts of apathy, whereas a high score indicates low amounts of apathy. The AES-S has shown good internal reliability, with Cronbach’s alpha ranging from 0.86 - 0.94 (Glenn, 2005). Good test-retest reliability has also been observed for this measure, with $r = 0.76$ (Glenn, 2005). Additionally, this measure appears to have good face validity.

Motivation to Recover

The Motivation for Traumatic Brain Injury Rehabilitation Questionnaire (MOT-Q) will be used to measure the participant’s motivation to recover. The MOT-Q is a Likert scale measure created to test patients with TBIs’ motivation for post-acute rehabilitation (Chervinsky, 1998). The measure consists of 31 items that are to be rated on a 5-point Likert scale ranging from strongly disagree to strongly agree. However, the responses also have numeric values assigned; the responses for each item can be either -2, -1, 0, +1, or +2. Once the questionnaire is completed, the sum of the 31 responses will be taken, and a higher score indicates a higher motivation to recover, whereas a lower score indicates a lower motivation to recover. Some sample items include: “if it was recommended, I would see a rehabilitation therapist”, “rehabilitation therapists can’t help me with my problems”, and “I’ll be the same if I get treatment or not” (Chervinsky, 1998). This measure shows good internal validity as well as good internal reliability, with Cronbach’s Alpha equaling 0.91 (Chervinsky, 1998).

Recovery Progress

The ImpACT Version 4 test will be used to measure the participants' recovery progress. The ImpACT Version 4 test is a “computerized neurocognitive test battery” designed to provide

relevant information regarding cognitive and clinical symptoms in patients who may have sustained a TBI (ImPACT Applications, Inc., 2022). This information can be used to help diagnose a concussion or other TBI and track recovery from a TBI.

This computerized test takes approximately 20 minutes to complete, although this can vary depending on the individual. Because this test will be used for post-injury evaluations in the proposed study, the test will be supervised and interpreted by a trained healthcare professional, such as those who work at the outpatient rehabilitation center from which patients will be recruited. ImPACT Version 4 must be completed on a laptop or desktop computer that has a color monitor and a mouse or a trackpad. It also requires a web browser and reliable Internet connection.

The ImPACT Version 4 assesses many things, including Sequencing/Attention, Word Memory, Visual Memory, Reaction Time, and post-concussion symptoms (ImPACT Applications, Inc., 2022). Every time the ImPACT Version 4 is taken, the same order of tasks is followed - demographics, symptom scale (of concussion or TBI), word memory, design memory, X's and O's, symbol match, color match, three letters, word memory delayed recall, and design memory delayed recall (ImPACT Applications, Inc., 2022). Upon completion of the test, participants are given composite scores in the following categories: verbal memory, visual memory, visual motor speed, impulse control, and reaction time. The participants are also given a total symptom score and a two-factor score, which consists of a speed composite and a memory composite. For the purposes of this study, only the total symptom score will be used for analysis. Future studies could replicate this study and analyze all the various subtests within the ImPACT test.

The ImpACT test and its subsections have shown high test-retest reliability, with Pearson's r for each subsection as follows: Verbal Memory = .66, Visual Memory = .43, Visual Motor Speed = .78, Reaction Time = .63, and Total Symptoms = .75 (ImpACT Applications, Inc., 2022). The ImpACT Version 4 has also shown good construct validity (ImpACT Applications, Inc., 2022). The ImpACT has also been found to minimize practice effects and is designed to be used in serial test administration.

Procedure

The proposed study uses a pre-post design with a randomized control group. The proposed study will be conducted in the outpatient rehabilitation center from which participants will be recruited. First, all participants will provide informed consent before participating. Then, all participants will complete the ImpACT Version 4, the MOT-Q, and the AES. Next, the participants will be randomly assigned to either the experimental or the control condition. The experimental group will receive the 10-week MBSR program in addition to treatment as usual, whereas the control group will just continue their treatment as usual for those 10 weeks. The participants who are randomly assigned to the control condition will be placed on a waitlist for the MBSR treatment if it is proven to be effective. At the end of the program, both the experimental and the control groups will complete the ImpACT Version 4, the MOT-Q, and the AES again. Lastly, all participants will be debriefed on the process of the study and the purpose of the study.

Ethical Considerations

The proposed study involves primarily studying a vulnerable population, that is, people with mild traumatic brain injuries who may be experiencing diminished cognitive skills following their injury. This is necessary because the central goal of this proposed study is to

explore whether MBSR treatment is useful for this specific population. When recruiting participants, we will encourage therapists to only present the study to patients who they believe would be able to participate and may benefit from participating. The therapists and patients will also be encouraged to thoroughly discuss their potential participation in the study, so that they can understand whether they would like to participate and provide informed consent. Ideally, the patient's loved ones will also be involved in the decision of whether or not to participate. Participation in this study is truly voluntary because the participants will be informed of the study by their therapists at an outpatient rehabilitation center, and they will then be able to choose whether they would like to participate. There will be no penalty for choosing not to participate.

The proposed study may involve participants providing sensitive information, specifically private health information or topics that cause them discomfort. For example, the participants will be asked questions about their cognitive functioning and mental health after sustaining their traumatic brain injury. This is necessary to determine the effectiveness of the MBSR treatment being used in the study. Because the proposed study will be conducted at a rehabilitation center and the MBSR treatment will be conducted by therapists, there will always be trained professionals nearby who can assist any participants who feel discomfort because of the study. Additionally, the participants may drop out of the study at any time if they feel that it is causing too much discomfort, or any other reason.

The proposed study poses minimal risk to participants. The risks of the study are not greater than the risks that participants would encounter in their day-to-day lives, including in their usual appointments with therapists at their rehabilitation center. The participants will be participating in mindfulness-based stress reduction (MBSR), which is similar to other types of

therapy or treatment that the participants (who are in rehabilitation for traumatic brain injuries) have likely already experienced. The participants will be asked about their mental health, including things like their motivation to recover and apathy. These types of questions are commonly asked of participants at most therapy or doctor's appointments.

The proposed study does not involve deception. Participants will be made aware of the process of the study before obtaining informed consent. The data collected from participants will be kept confidential. Because in-person therapy sessions and interviews will be used, it is not possible to have the data anonymous. However, study documents, including documentation of interviews, will be kept in a secure location, and not revealed to members outside of the study or other participants.

This study has many benefits, including on a clinical level, by expanding the scholarly knowledge base surrounding mindfulness-based interventions, and directly to participants and their families, as well as to other people in the targeted population in the future. Overall, the benefits of this proposed study outweigh the potential risks to participants. By participating in this study, the participants are receiving a type of treatment that has been shown to help individuals with many different ailments, both physical and psychological. There isn't anything to be lost by participating in this study, only potential improvements.

Anticipated Results

Data Analysis Strategy

A two independent samples t-test will be conducted to test Hypothesis 1: the use of mindfulness-based stress reduction (MBSR) will reduce apathy levels in people with mild traumatic brain injuries (mTBIs). In this case, the use of MBSR is a dichotomous predictor variable and apathy is a continuous dependent variable. The dichotomous predictor variable will

be coded as a “0”, did not receive MBSR, or a “1”, did receive MBSR. The data for the apathy variable will be calculated from the change in AES scores before and after the 10-week MBSR intervention. These changes will be compared between the experimental group and the control group.

A two independent samples t-test will be conducted to test Hypothesis 2: the use of MBSR will increase the participants’ motivation to recover. The use of MBSR is a dichotomous predictor variable and motivation to recover is a continuous dependent variable. The dichotomous predictor variable will be coded as a “0”, did not receive MBSR, or a “1”, did receive MBSR. The data for the motivation to recover variable will be calculated from the change in MOT-Q scores before and after the 10-week MBSR intervention. These changes will be compared between the experimental group and the control group.

Finally, the Baron and Kenny model of mediation will be used to test Hypothesis 3: people with mTBIs who receive the MBSR treatment will show more progress in recovery, because of the reduced apathy and increased motivation to recover that is a result of the use of MBSR. In this case, apathy and motivation to recover shift from dependent variables to mediating predictor variables. The dependent variable in this hypothesis is progress in recovery, which is a continuous variable. The data for the progress in recovery variable will be calculated from the changes in the Post-Concussion Symptoms Scale (PCSS), which is a subtest within the ImPACT test. These changes will be compared between the experimental group and the control. Because this is a mediation hypothesis, the Baron and Kenny model of mediation must be used to determine that the initial predictors, being apathy and motivation to recover, are related to the final result of the third hypothesis, being progress in recovery. To prove this, two simple correlation tests will be conducted. The first correlation test will analyze apathy and progress and

recovery, and the second will analyze motivation to recover and progress in recovery. Once correlation is established, a multiple regression will be conducted to determine whether people with mTBIs who receive the MBSR treatment will show more progress in recovery, because of the reduced apathy and increased motivation to recover that is a result of the use of MBSR.

Hypothesized Results

For Hypothesis 1, it is predicted that participants in the experimental group will show a greater reduction in apathy levels than participants in the control group. Based on the existing literature, it seems that this will be true. For example, Bédard et al. (2003) sought to explore whether it was possible to adapt MBIs for people with traumatic brain injuries, specifically whether they could be used to improve this population's quality of life. The researchers found that the participants' cognitive affect improved, their depressive symptoms were reduced, and they reported a higher quality of life following completion of the MBI program (Bédard et al., 2003). Although apathy was not an explicitly stated variable in the Bédard et al. (2003) study, depressive symptoms and quality of life often greatly overlap with apathy, as can be seen in the items described in the AES (Glenn, 2005). Similarly, researchers Green et al. (2022) found that apathy and depression together may adversely impact engagement in activities of daily living (ADL) in people with traumatic brain injuries, although they state that the potential influence of depression on ADL may occur primarily through its influence on apathy. As a result, the researchers suggest that a greater focus on apathy by clinicians in rehabilitation facilities would likely be beneficial (Green et al., 2022).

For Hypothesis 2, it is predicted that participants in the experimental group will show a greater increase in motivation to recover than participants in the control group.

Prior literature has shown that MBSR geared towards people with TBI has led to improvements in quality of life and self-efficacy, and therefore the participant's belief in themselves to recover and their motivation to recover (Azulay et al., 2013). The researchers suspect that this may be because the MBSR treatment used was directed at improving awareness and acceptance, in turn "minimizing the catastrophic assessment of symptoms associated with mTBI and chronic disability" (Azulay et al., 2013).

For Hypothesis 3, it is predicted that participants in the experimental group will show a greater reduction in post-concussion symptoms than participants in the control group, as a result of the improvements in apathy levels and motivation to recover. Essentially, it is predicted that the use of MBSR will lead to improvements in apathy levels and motivation to recover, which will then lead to a reduction in post-concussion symptoms. Prior research has shown that apathy and diminished motivation pose real threats to the rehabilitation process. For example, Gray et al. (1994) conducted a year-long longitudinal study following people with TBIs who were discharged from hospital. The participants "negative symptoms" (apathy being one) and their progress in rehabilitation, amongst other things, were assessed. The results show that participants who display more apathy often progressed slower in rehabilitation (Gray et al., 1994). Marin & Chakravorty add that apathy can also be referred to as diminished motivation, which poses a serious threat to the rehabilitation process in people with traumatic brain injuries. As mentioned, MBSR has been shown to improve apathy levels and motivation to recover for people with mTBIs. Therefore, if apathy and motivation to recover are treated by using MBSR, then the participants will feel more motivated to participate in their rehabilitation process, and will ultimately show greater improvements than those who do not receive MBSR treatment.

Scholarly Merit and Broader Impacts

If proven to be true, this study could potentially bolster the existing literature about the benefits of MBIs. Especially because of its larger sample size (most of the existing literature on this specific subject is solely pilot studies), the proposed study has the potential to further solidify findings that mindfulness. Also, the results of this study could potentially show that apathy and motivation to recover are two big factors involved in one's progress in neurorehabilitation. Lastly, the proposed study could potentially show that MBSR can improve apathy and motivation to recover, in turn improving participant's progress in their recovery. The addition of apathy and motivation to recover in connection with an adapted version of MBSR is a novel contribution to the existing literature on patients with mTBIs.

The proposed study could potentially help the community of people with mTBIs progress in their recovery journey. If successful, the participants will potentially experience a decrease in apathy and an increase in their motivation to recover, which is already a benefit on its own. Further, there is potential that the improvements in apathy and motivation to recover will reduce the participants post-concussion symptoms. This would be an extremely beneficial finding, not only for the participants or other people with mTBIs themselves, but also for their families, loved ones, and caregivers, as they are able to see their loved one improve and regain their pre-injury abilities. Many individuals with injuries such as mTBIs tend to get discouraged when their progress in recovery stalls, and it seems that an intervention like this would provide them with that motivation boost to continue their work to recover.

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