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# The Impact of the Mindfulness Attention Meditation (MAP) with a Mixed Brain injury Population to Improve Emotional Regulation Enhance Awareness

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## Abstract

**Objective:** To evaluate the effectiveness of mindfulness group intervention designed specifically for brain injury. This is an expansion from our previous pilot study of an mTBI cohort to a mixed and more severe brain injury population.

**Design:** A convenience sample of 25 participants was recruited from clinical referrals over a two -year period. Participants completed outcome measures pre and post treatment intervention.

**Setting:** Post-acute brain injury rehabilitation center within a suburban medical facility.

**Participants:** Participants included twenty-five individuals; 10 post stroke; 5 TBI (moderate-severe); 7 Autoimmune; and 3 "Other" with a post injury period greater than 10 months. Thirteen participants were male and twelve were female, ranging in age from 18 to 62 years.

**Intervention:** The intervention consisted of a 10-week group (with weekly 2-hour sessions) of a Mindful Attention Program (MAP) designed to facilitate a non-localized awareness (the ability to balance both internal and external awareness) through guided mindful meditation. The treatment involved an increased awareness of internal and external experiences through attentive meditation and cultivating acceptance and non-reactionary attitude towards those experiences.

**Main Outcome Measures:** Main outcome measures included the Difficulties in Emotion; Regulation Scale (DERS), Freiberg Mindful Inventory (FMI) and several neuropsychological; (NP) measures of attention and memory. Secondary Measures from the previous study were also repeated and included: Perceived Quality of Life Scale (PQOL), Perceived Self-Efficacy; Scale (PSE), and a self–report symptom and problem solving inventory (PSI).

**Results:** Clinically meaningful improvements were noted on measures of emotional regulation (Cohen's $d$ = 0.67) moment-to-moment awareness (Cohen's $d$ = 0.70) and on measures of central-executive aspects of working memory and regulation of attention (PASAT Cohen's $d$ =.27, CPTA Cohen's $d$ =.40). As with our previous study, improvements were also found on quality of life measures (Cohen's $d$=.43) and perceived self- efficacy (Cohen's $d$ = 0.50).

**Conclusion:** A Mindfulness Attention Program (MAP) designed for brain injury (BI) can positively impact emotional regulation with a mixed brain injury population. This study demonstrated the efficacy of a unique but simple intervention to target emotional regulation with a mixed brain-injured population. Improved performance on a measure associated with emotional regulation may be related to treatment directed at improving (nonlocal) awareness, confident self-acceptance (self efficacy), and the practice of repeatedly refocusing attention. The improvement of these three factors may be a crucial outcome of treatment post brain injury in order to facilitate a reduction in habitual physical and intellectual triggers that allow for measured responses over impulsive reactions; thereby minimizing emotional dysregulation more typically associated with brain injury and chronic disability. Additional research using a randomized control trial on the comparative effectiveness of the MAP with a larger sample base is warranted.

**Keywords:** Mindfulness; Emotional Regulation; Brain injury; Attention; Awareness; Rehabilitation; Self-efficacy; Mindfulness Attention Program (MAP)




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## Introduction

Self-regulation of emotion, cognition, and ultimately, behavior are mediated by the prefrontal cortex and commonly disrupted to some degree after brain injury. In general, self-regulation is complicated because it is mediated by a complex interaction of neurological processes that encompass ; 1) self-awareness that a response is being activated; 2) previously developed beliefs and knowledge that help to shape the response, and: 3) sufficient self-efficacy and self control to modulate the emotional triggers/reactions adequately. It also requires a metacognitive process involving a non-localized awareness (of people around you; your body; your thoughts) and cognitive choices (i.e. to attend versus distract) that culminate in anticipatory behavior or lack of behavior that is either effective or maladaptive [1-3]. Thus, its complexity makes it one of the more challenging cognitive functions to adequately ameliorate after brain injury.

The control of emotions is probably the most difficult of voluntary regulatory processes since emotions are typically intense activations of feelings that can explode and interrupt an ongoing behavior [4]; and after a brain injury, can drastically disrupt cognition and engender a host of responses that are no longer appropriate to the situation. The research literature emphasizes emotional dysregulation as one of the primary disruptive deficits of brain injury; impacting cognition, relationships and productivity. Thus, the ability to tailor emotional states after brain injury becomes crucial to functioning. "Emotion regulation" refers to the strategies used to influence, experience, and modulate emotions [4]. These strategies may include responses such as redirecting attention, withdrawal, suppression and/or cognitive re-appraisal of a stressful situation [5]. As mentioned earlier, a significant component of emotional regulation is awareness, especially a self-awareness that one is in danger of becoming emotionally disregulated. The ability to "observe the self" (self-observe) and make moment-by-moment adjustments to maintain emotional equilibrium requires a level of attentional flexibility that allows one to process the extrinsic and intrinsic experiences in a balanced and fluid way [6]. The metacognitive process of awareness at the basic level encompasses the ability to be aware of our own thoughts, recognize irrational thoughts and the impact that thoughts and emotions can have on our physiology. It includes self-awareness of metacognitive beliefs or knowledge (beliefs about our cognition) as well as self-monitoring and self-control of cognition while performing an activity. The awareness process is only successful if the attention functioning component is flexible enough to continuously reevaluate the different sensations of the individual and adjust accordingly. This working attention as a function of the central executive component of working memory, or `working attention" becomes an essential component to emotional regulation. Furthermore, accepting/adapting to the changes in ones functioning and feeling confident about managing symptoms adequately becomes an important aspect towards utilizing past experiences in shaping anticipatory strategy application [7].

Therefore, the alchemy of awareness, attention control and self -efficacy constitutes three elements necessary for emotional regulation. Unfortunately, one of the challenges after brain injury is the deficit or reduction of attentional skills including the maintenance of multiple elements in working memory such as attention to the salient situation, attending to a level of self-awareness/metacognition that there is a potential emotional reaction on the horizon and the ability to shift attention in a manner that is self-adaptive (ie step back from the situation or do nothing). Conversely, numerous studies to date have underscored the importance of emotion in directing attention to potentially relevant information in our environment [8,9]. Clearly there is a constriction of balance between the emotion/attention feedback loops. Consequently, sensitivity and awareness to slight shifts in emotional and physical homeostasis can become indicators to attend to some necessary change.

Robertson and Garavan [10] suggest ongoing activation of the right frontal-thalamic-parietal sustained attention system is required to actively, endogenously maintain higher order goal states in working memory. When the sustained attention system is compromised, habits, or environmental conditions may oppose and displace higher order goals, resulting in cue-dependent or distracted behavior that is a hallmark of patients with attentional and executive deficits. Therefore, sustained attention is viewed as crucial to supporting various processes including the regulatory process of emotion [11,12].

## Self-Regulation Interventions after Traumatic Brain Injury

The manifestations of impaired self-regulation and executive functions in individuals with BI include a variety of integrative skill sets that impact ones ability to inhibit, shift attention, integrate and self monitor towards consequent emotional self-control during activities. The few interventions that are available often require multiple-steps, substantial cognitive demands as well as considerable treatment resources. Despite the significance and scope of the problem, and given the complex interface of these executive elements, it is not surprising that the approaches are limited in their function or unwieldy in their approach. Kennedy and Coleho [2] identify obstacles to many of the interventions that preclude successful application. These include inaccurate self-feedback (lack of awareness), inability to anticipate task demands, and poor application to novel situations. With awareness being a significant aspect in the modulation of emotional regulation, an intuitive requisite for effective treatment would incorporate group treatments that allow for peer feedback and a collaborative approach to shared challenges. However, there are only a handful of group treatment studies that collectively address the relevant aspects of cognition we have identified as necessary to emotional regulation.

Rath et al [13] compared a group therapy approach that focused on emotional self-regulation and strategic thinking for problem solving with conventional cognitive rehabilitation in adults with mild to severe TBI. Important to this module was instruction on inhibiting impulsive responses that can flood the cognitive system, using a self-regulation worksheet. More importantly, participants analyzed their emotional responses by documenting their reactions and the precursors that triggered the reaction, then "reframing" by mentally rewinding the situation to observe how it could be avoided. The innovative treatment group made gains over those made by the conventional group on several measures of impairment and everyday activities associated with problem solving and self-appraisal of problem solving. The study did not measure emotional regulation per se but the outcome of improved problem solving abilities and its relationship to emotional regulation.

In a more comprehensive, randomized study using a more intensive group treatment protocol for brain injury, improvement was also found on measures of cognitive and emotional regulation [14]. The treatment combined increasing awareness of emotional triggers and the subsequent derailment of cognitive processes as well as training of strategies to improve emotional equilibrium post disruption. Improvements with quality of life and self-efficacy were noted, however, the intervention required intense coordinated manpower and resources that limited the treatment feasibility (e.g., typically at least 15 therapists, 12 hours of individual and group treatments per week over 16 weeks). Equally, Goal Management Training (GMT; [15,16,17]) is based on the theory of sustained or vigilant attention and has shown some efficacy for management of improving goal directed behaviors and the treatment encompasses some of the self-awareness training towards improved strategy usage. Although, it has been shown to be an effective intervention but it requires learning to self-monitor, which can be difficult to learn as per experienced group leaders [18].

With a relative paucity of treatment geared at addressing emotional regulation or even impacting the underlying elements that support the ability to regulate ones emotions effectively, there would seem to be a strong need to implement and assess the impact of treatments tailored specifically to the chronic BI symptom constellation, with a particular focus on improved self-awareness, central aspects of working attention, and an increased sense of self-efficacy that would support active strategy application. Potentially, controlling the focus and flexibility of attention to an improve awareness of one's self (one's impulses, habitual thoughts and physical reactions/experiences) may decrease over reacting to emotional stimuli, and create a sense of self-efficacy in responding to daily life challenges.

Mindfulness-Based-Stress Reduction (MBSR) is a group-based intervention that was developed by Jon Kabat-Zinn [19]. Initially designed for patients with chronic pain; it has now been widely implemented in a variety of medical and psychiatric populations such as those with chronic fatigue, pain, psoriasis, anxiety and cancer [20-26]. Despite earlier studies that revealed mindfulness intervention ineffective with a brain injury population [27], we discovered efficacy by significantly modifying the presentation and the emphasis of treatment focus of a mindful intervention. Our initial pilot study revealed that a modified mindfulness intervention could influence cognitive, emotional and somatic symptoms that made it very relevant to an mTBI population. In fact, our research demonstrated that improved attention, self efficacy, quality of life, and problem-solving abilities were all achieved through a very simple activity/ intervention that had few cognitive demands [28]. The success achieved with the symptoms of brain injury with a mild TBI cohort led us to consider expanding the population to a more impaired and diversified population as well as expanding our hypothesis to include changes in self-regulation of emotion, which reflected the repeated informal reports of patients participating in the intervention.

In sum, there exist a small number of interventions geared to addressing self-regulation as it relates to emotion secondary to brain injury. It is our belief that the complexity of the components essential to change has historically forced interventions to be therapeutically demanding in either resources or cognitive load. Thus, the aims of our the current study were (1) to determine whether the simplicity of our treatment, a Mindfulness Attention Program (MAP), could be efficacious with a more diversified and impaired brain injury population, and (2) to determine the effects of treatment on self-reported challenges of emotional regulation after brain injury, in addition to the earlier assessed areas of psychological and neuropsychological functioning including self-efficacy, life satisfaction, attention, memory, and problem solving. We hypothesize that a mindful attention program (MAP) delivered in a group format would result in an increase in emotional regulation, self-efficacy and perceived quality of life. We also hypothesized that there would be an improvement in social problem solving secondary to reduced emotional reactivity along with objective improvements in attention and new learning secondary to training in attentional focus.

## Methods

### Participants, recruitment and eligibility

The study was conducted in a post-acute brain injury rehabilitation center within a suburban rehabilitation hospital. A convenience sample of 25 participants was recruited from clinical referrals over the course of two years. The study was reviewed and approved by the JFK Health System Institutional Review Board. Inclusion criteria was as follows: 1) 18-62 years of age; 2) medical documentation of a brain injury both traumatic and non-traumatic in origin; 3) at least 3 months post injury; 4) being medically stable; 5) having sufficient language functioning to participate in a treatment conducted in English; 6) willingness and ability to participate in and travel to a 10-week treatment with agreement to do daily homework assignments. Specific exclusion criteria included 1) active substance abuse; and 2) psychiatric symptoms that prohibited a participant's ability to benefit from treatment.

### Design

People who sustained some form of brain injury who were participating, or had previously participated, in a post-acute brain injury rehabilitation program were referred for the study by their treating clinicians. Each potential participant was initially assessed for eligibility by one of the investigators on this study. Those who met inclusion criteria and gave their written informed consent completed neuropsychological measures of attention and new learning in addition to a number of self-report measures 1-2 weeks prior to beginning the 10-week treatment program. All measures were administered again within 2 weeks of completion of the program. Treatment dropouts were incorporated through an intent-to-treat analysis, although there were no dropouts in this particular cohort. A total of five groups were run over a two- year period with 4-6 BI individuals per group. The groups generally ran consecutively with breaks during the holiday season secondary to the need for consistent attendance.

### Outcome measurement

Difficulties in Emotion Regulation Scale (DERS) [29], is a self-report questionnaire, designed to assess multiple aspects of emotion deregulation. It consists of 36 items and six subscales including: (i) non-acceptance of emotional responses, (ii) difficulties of engaging in purposive behaviors, (iii) impulsivity, (iv) lack of emotional awareness, (v) limited access to emotion regulation strategies, and

(vi) lack of emotional clarity.

**The Freiberg mindfulness inventory:** We assessed participants' self-reported levels of mindfulness using the Freiberg Mindfulness Inventory [30] with items such as

*"When I notice an absence of mind, I gently return to the experience of the here and now,"* on a Likert scale ranging from almost always to almost never.

**Perceived Quality of Life (PQOL):** The PQOL was initially developed as a cognitive appraisal of patient's life satisfaction after intensive medical care [31]. The modified PQOL has been used with adults who have chronic neurologic disability including stroke and TBI. The PQOL measures the degree to which the individual is satisfied with his/her functioning on a 10-point scale ranging from extremely dissatisfied to extremely satisfy.

**Perceived Self-Efficacy (PSE):** Perceived self-efficacy for the management of symptoms was adopted from a measure developed for people with chronic disability [32] and modified specifically for use with TBI. Each item is preceded by the question *How confident are you that you can …* with responses on a 1to 10 point Likert scale from not at all confident to totally confident. We used the total PSE score and examined effect sizes for subscales assessing self-efficacy for the management of cognitive, emotional and social problems.

**Neurobehavioral Symptom Inventory (NSI):** The Neurobehavioral Symptom Inventory (NSI) is a self-report rating scale of 22 symptoms that are characteristic of brain injury [33]. Participants rated each symptom according to the level of resultant functional disruption how much the symptom has disturbed them in the past two weeks, using a five-point rating scale from 0 (none) to 4 (very severe). The NSI has been shown to reflect cognitive, affective and somatic/sensory clusters of symptoms [34]. In the present study we analyzed the total score and also examined effect sizes for each of the symptom clusters.

**Neuropsychological measures:** A brief neuropsychological battery was administered, to assess the central-executive aspects of attention and the ability to acquire new information. These measures were chosen based on the cognitive deficits typically associated with BI as well as the current literature regarding positive cognitive changes associated with mindfulness in a healthy population. The central-executive aspects of attention were assessed with the Continuous Performance Test of Attention (CPTA) [34] and the Paced Auditory Serial Addition Test (PASAT) [35]. The CPTA is an auditory continuous performance test with five conditions reflecting varied processing loads, and has previously been described in more detail [36]. The raw scores were based on the total number of errors, which were corrected for age and education. The PASAT is another measure of auditory processing speed and working memory. Rote verbal learning and subsequent recall were assessed with the total score from the learning trials on the California Verbal Learning Test-II, Alternate Form [37] with the assumption that improved attention functioning may lead to improved recall.

**Social Problem-Solving Inventory-Revised Short Form SPSIR: S):** A self-report measure of problem-solving [38] was administered to assess changes in problem solving orientation and problem solving skills. This measure looks at problem solving awareness and style with statements such as…"*I am too impulsive when making decisions*," that are measured from 0 (not at all like me) to 5 (extremely true of me). Raw scores from the Positive Problem Orientation and Negative Problem Orientation subscales were combined to form a single measure, with higher scores indicating more positive problem solving orientation. Problem solving skills were assessed with raw scores obtained on the SPSI-R: S.

## Intervention

The intervention consisted of a 10-week group (one, 2 hour session per week) initially modeled after Kabat-Zinn's MBSR program, but modified and progressed to what we call a mindfulness attention program (MAP); a program that focused more on continued attention training on non-local awareness and provided significant meditation guidance in the practice of moving towards physical pain, emotional pain and uncomfortable experiences to enhance adjustment to medical trauma and to more fully accommodate the needs of a brain injured population.

The meditative guidance over time evolved to a non-local awareness that is characterized by an intentional awareness of internal and external states and the ability to flexibly focus on each. Because brain injury can often have a negative and/or repeated focus (often referred to as perseveration). Our intervention stressed some of the Pantanjali Yoga Sutras that speak about using and moving to a general awareness through meditation which allows brain injured patients to move more readily through perseverations and instead observe the mind's tendency to perseverate. This self -realization of observing the injured brain's new tendencies is fostered by guidance of balancing the sensory experiences both of the internal and the external state creating a process of attention training and ultimately improved focus.

In addition, each two-hour session incrementally allotted proportionately more time to the meditative practice as patients acclimated until the majority of the session time was focused on meditation. The classes began with initially short, guided meditation sessions, starting with 15 minutes and eventually ending up with 45 minutes. These were followed by the processing of challenges to the practice, understanding the philosophy behind the practice and the context of the experiences while meditating. The patients' discussion of changes to their core functioning secondary to brain injury became an integral part that is linked to the compassionate element of the meditative experience; i.e. the acceptance, observance and method of response. This approach is a stark contrast to the normative rehabilitative practice in brain injury, which is typically focused on deficit assessment and improvement. In addition, yoga practices that are typically floor exercises were modified over the course of treatment to chair yoga positions. Systematic relaxation of the body is also practiced in a chair rather than on the floor to accommodate physical disabilities/limitations.

Each of the last 45 minutes of the two-hour sessions introduced a new meditative practice that was emphasized over a two-week period to accommodate challenges with new learning. As mentioned in our earlier study, modifications were made to specifically meet cognitive challenges such as reduced recall, disorganization, poor topic maintenance and attention dysregulation. We expanded the number of treatment sessions from 8 to 10 and reduced group sizes to an average of 6 rather than 25, to allow for the increased time patients required for us to explain concepts, repeat procedures, reinforce learning and process their experiences with the practice. We also provided heavily guided sessions (3.5-4 sessions) of more sophisticated techniques, for the exploration of emotional and physical pain, as brain injury related problems with abstract reasoning sometimes make these concepts more difficult to grasp and apply. Each client received a memory notebook system for meditation that outlined weekly homework sessions, guidance regarding the approach towards meditation, 1 week trackers for pleasant and unpleasant events and homework logs so that patients could attend to the time of day they practiced, the frequency of practice and log obstacles in the completion in order to achieve an understanding and an accurate recall of these own individual practice. Each group was run by two leaders, both of whom were neuropsychologists with training in Mindfulness based meditations among other types of meditation. This tailored treatment was then manualized to ensure treatment consistency across groups and leaders for each group; both leaders specialized in brain injury rehabilitation and have been actively practicing and teaching meditation for greater than 9 years with a brain injury population.

## Results

### Demographics

Table 1 provides the full demographics of the sample. In summary, the sample was 47% female, 64% Caucasian, with 40 % stroke survivors 20% moderate severe TBI and 28 % autoimmune disorders. More than half of the participants were married (48%), and 81% had greater than a high-school education. Religious affiliation was designated as Christian in the vast majority of the group (75%). Most participants (87%) had time post-injury of greater than 12 months and none were earlier than 7 months. Most listed their employment status as disabled at the time of treatment (68.2%). All of the participants had received some form of concurrent rehabilitation during their participation in the study, with the majority (85.8%) receiving limited (individual neuropsychology only) treatment through a neuropsychology clinic.

### Self-report and neuropsychological measures

Paired sample t-tests were used to ascertain significant changes in those variables from pre to post-test intervention. Results are presented in Table 2. To avoid the possibility of spurious findings due to Type I error, the Sìdak correction for multiple comparisons was applied to the 5 self-report measures and the 3 neuropsychological tests. To maintain alpha at 0.05 required an adjustment to p<0.01 for both the self-report measures and the neuropsychological tests. We generally used total scale scores for the outcome measures for statistical analysis of significance. In keeping with the study objectives, we also examined the effect sizes for subscales of the various outcome measures.

As was our hypothesis, the most significant changes are noted in the areas of mindfulness awareness (.70) and positive changes in their emotional regulation (.67). We believe the change in the mindfulness awareness, as compared to the last study was related to changing the measure to be more concise and straightforward which then reflected the relevant changes associated with the actual intervention. The non-acceptance of emotion and impulse control demonstrated the greatest pre and posttest differences on the DERS subscales with this population.

**Table 1:** Demographics of the sample.

| | | |
|---|---|---|
| **Mixed Brain Injury Population** | | |
| Male | 13 | 53 |
| Female | 12 | 47 |
| **Ethnicity** | | |
| African-American/Black | 4 | 16 |
| Asian-Pacific Islander | 1 | 4 |
| Caucasian | 16 | 64 |
| Hispanic/Latino | 4 | 16 |
| **Marital Status** | | |
| Never Married | 8 | 32 |
| Married | 12 | 48 |
| Divorced | 5 | 20 |
| **Level of Education** | | |
| <12 years | 2 | 4.5 |
| 12-16 years | 20 | 81.9 |
| >16 years | 3 | 13.6 |
| **Religious/Spiritual Affiliation** | | |
| Buddhist | 2 | 8.3 |
| Catholic | 13 | 54.2 |
| Jewish | 4 | 16.7 |
| Other Christian | 5 | 20.8 |
| **Etiology** | | |
| TBI | 5 | 20 |
| Stroke | 10 | 40 |
| Autoimmune | 7 | 28 |
| Other | 3 | 12 |
| **Current Employment Status** | | |
| Disabled | 15 | 68.2 |
| Full-Time | 2 | 27.3 |
| Seeking Employment | 1 | 4.5 |
| **Current Treatment Status** | | |
| *Standard Cognitive Rehabilitation | 4 | 15.2 |
| ^Neuropsychology Clinic | 21 | 85.8 |

*Receiving more than three disciplines such as ot, pt, speech and neuropsychology treatment,
^Re8ceiving less than 3 treatments such as neuropsychology and pt only.

Significant pre/post-test changes were also observed on the PSE and PQOL scales, with evidence of moderate effect sizes (Table 2).

With the neuropsychological measures, standard scores were obtained for these individuals based on relative age and education-corrected normative data. Both measures of attention CPTA ($r$ = 0.40) and PASAT (0.27) revealed significant improvements from baseline to post-intervention, and unlike the results of our last study, new learning revealed changes of a moderate effect size. Participants of this group demonstrated a small but significant effect on problems

**Table 2:** Pre/Post-Intervention Changes in Self-Report and Neuropsychological Measures (M**)**.

| Variable | *M (SD)* | *t (df)* | p | *(r)* |
|---|---|---|---|---|
| **NSI** | | | | |
| Pre | 31.0 (15.3) | | | |
| Post | 26.4 (13.5) | | | |
| Difference | 4.6 (11.3) | 2.020 (24) | 0.05 | 0.38 |
| **SES** | | | | |
| Pre | 79.8 (28.0) | | | |
| Post | 93.7 (21.1) | | | |
| Difference | 13.0 (23.9) | -2.895 (24) | 0.008 | 0.5 |
| **PQOL** | | | | |
| Pre | 58.24 (21.8) | | | |
| Post | 67.08 (16.1) | | | |
| Difference | 8.84 (14.9) | -2.957 (24) | 0.007 | 0.52 |
| **SPSI TOTAL** | | | | |
| Pre | 92.0 (15.4) | | | |
| Post | 99.2 (13.8) | | | |
| Difference | 7.8 (9.8) | -4.007 (24) | 0.001 | 0.33 |
| **DERSTOT** | | | | |
| Pre | 97.86 (25.0) | | | |
| Post | 79.7 (19.9) | | | |
| Difference | 18.1(18.89) | 4.503(21) | 0.001 | 0.67 |
| **CPT-A** | | | | |
| Pre | 13.6 (10.8) | | | |
| Post | 6.2 (4.7) | | | |
| Difference | 7.4 (10.7) | 4.186(17) | 0.001 | 0.4 |
| **PASAT** | | | | |
| Pre | 76.50 (50.68) | | | |
| Post | 103.66 (47.7) | | | |
| Difference | 27.16 (28.6) | -4.169(11) | 0.002 | 0.27 |
| **CVLT-II** | | | | |
| Pre | 51.4 (13.2) | | | |
| Post | 55.4 (14.6) | | | |
| Difference | 4.0 (7.6) | 1.952 (15) | 0.07 | 0.47 |
| **Fretotal** | | | | |
| Pre | 51.4 (13.2) | | | |
| Post | 55.4 (14.6) | | | |
| Difference | 4.0 (7.6) | -3.999 (21) | 0.002 | 0.7 |

Notes: *NSI*: Neurobehavioral Symptom Inventory; *MAAS*: Mindful Attention & Awareness Scale; *PSES*: Perceived Self-Efficacy Scale; *PQOL*: Perceived Quality of Life; *SPSI*: Social Problem-Solving Inventory-Revised, Short-Form; *CPT-A*: Continuous Performance Test of Attention; *PASAT*: Paced Auditory Serial Addition Test; *CVLT-II*: California Verbal Learning Test, Second Edition-Alternate Form, Trials 1-5.

solving abilities and new learning as compared to the mTBI data.

## Discussion

The current study represents a systematic attempt to deliver a group mindfulness meditation intervention modified to treat a broad neurologic population. While a large number of studies demonstrate the impact of mindfulness-based interventions in a variety of medical populations, comparatively fewer studies focus on implementation of mindfulness practice in a brain-injured sample, especially targeting improved self-regulation of emotion. The interesting aspect of this current study lies in the intervention being a generalized activity that has the capacity to potentially impact so many of the difficult and relevant disabilities associated with brain injury with minimal use of resources. The success of this intervention appears to lie in the simplicity of the task that requires little in the face of cognitive demands, time or resources. It appears to be applicable to a variety of neurologic impairments. Although we had been concerned about the challenge of presenting this treatment to more impaired individuals, especially those whose moment to moment recall had been severely compromised, we found that these patients made gains in their abilities despite their inability to recall the rationale behind the concept of meditation. They simply reported that they did it because "It works. I don't go around feeling angry all the time so I don't blow up as much." Thus, the current study provides encouraging results regarding the application of a mindfulness intervention with a more significantly impaired population. Even more interesting, we found that post stroke patients became more aware of their physical disabilities by the end of the treatment; potentially suggesting that the intervention appeared to allow them to become more aware and integrate their pain and physical impairments towards improved management, which may have contributed to the changes on the neurologic symptom reduction on the NSI. Anecdotally, there appeared to be a delay in the stroke cohort with the mind/body integration. More research may prove useful in teasing out how better to serve this population; whether by increasing the intervention period or supporting more activities that speed up the connection between physical experiences, thoughts and emotional reactions. As with our earlier study, when asked for post-treatment feedback, participants often spoke of the treatment as being "life changing." Likewise, many of their comments throughout the study were used to shape the final treatment product.

In light of the positive feedback we continue to get from our participants nine years later, it is important to emphasize that much of the mindfulness intervention we provide relies largely on the practice of actively moving towards both physical and emotional pain. Indeed, more than one third of the training we provide supports patients actively cultivating relationships with the more negative aspects of their experiences, thoughts, and emotions. Our combined 30 years of experience with this particular population facilitated our understanding that these participants had been exposed to a significant amount of additional emotional and physical trauma, and that symptoms of PTSD associated with their condition warranted a more aggressive focus than the typical objective observations of the more mainstream mindful intervention. Contrary to the more popular concept of distraction and neutrality, our treatment actively sought out the more painful experiences in a scaffolding progression of support with researched support into the efficacy of pain treatment [39]. A more recent study regarding pain and meditation [40] found that meditators anticipate pain less and find pain less unpleasant. It is not clear precisely how meditation changes brain function over time to produce these effects, however it affords further insight into how focusing on painful experiences/thoughts/emotions might support improved psychological health. Although we would like to credit the conceptual intervention for the changes, the newest imaging literature demonstrates that the changes we found may be primarily associated with anatomical increases of grey matter density [41] and white matter connectivity [42,43] associated with meditation interventions with normal populations. The changes we found with attention, new learning and self-regulation align well with the imaging studies of meditation interventions particular to the increases of the hippocampus, anterior cingulate gyrus and frontal attention networks of the brain that may be the actual source of our study's findings [41-44]. Consistent with these findings, our study found not only gains in cognitive functioning of attention and recall, but participants' perceived ability to regulate their emotions and feel confident in managing their symptoms had improved as well. As eloquently put by one participant in the program,

"I am no longer brought to my knees by the fear of my own pain or that my emotions will shatter me into a thousand pieces or lead me into a pit of depression. I now feel in control of being out of control."

Clinically significant improvements were noted on participants' perceived self-efficacy, particularly for the management of emotional and cognitive symptoms. Consistent with these findings, participants reported more positive problem solving orientation after the intervention.

The relationship among symptom severity, self-efficacy for symptom management and life satisfaction after mTBI requires further investigation.

This focused attention meditation modulated from a stress reduction meditation demonstrated encouraging results as a significant intervention for a mixed brain injury population. It was interesting to note the variations of recovery of traumatic versus acquired brain injury, suggests there may be different focal symptoms being targeted. While the non- neurologic populations appear to be well represented in the mindfulness, comparatively fewer studies focus on implementation of mindfulness practice in a neurologic or brain injured sample. The development of a mindfulness intervention specifically for neurologic symptoms represents the first of its kind. This study provides encouraging results regarding the application of a mindfulness intervention in a chronic BI population. This study has several limitations. All of the participants were receiving some form of additional treatment involving two to four hours per month of individual neuropsychology sessions. Thus, it is impossible to completely isolate the effects of this intervention. Future research should address the comparative effectiveness of the MAP using adequate controls, and further explore the impact of the mindfulness intervention with imaging techniques. Further elucidating the active ingredients for change using different mindfulness techniques would also be useful in understanding the active versus superfluous. The ability to detect improvements on certain measures may have been limited by the relatively small sample size. The further addition of a control group, and randomization to treatment conditions, may also enhance the strength of the design and further explain the effects of mindfulness attention program (MAP) with BI.

## Conclusion

The current study represents a systematic effort to evaluate the impact of a mindfulness intervention specifically designed to meet the needs of a chronic BI population. We theorize that emotional regulation can be effectively addressed by impacting the attention, self-efficacy and self-awareness in a mixed and more severe brain injured population. Given the challenges associated with BI and the complexity associated with the impairments, we hope this relatively simple but highly impactful intervention will stimulate further efforts to develop this and other creative interventions for a widespread problem.

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