Improving Mindfulness Outcomes and Measurements to Support Self-Regulation

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Abstract

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The field of mindfulness research is rapidly growing as mindfulness is being utilized as a tool to improve mental and cognitive health. Mindfulness is paying attention in the present moment with non-judgmental awareness. As the research body increases, weaknesses in mindfulness research have surfaced. There is a need for improved measurement tools, an increased understanding of, meditation techniques used, the dose of meditation, and the population samples being studied. Meditation and movement are both tools that can improve an individual's mindfulness. The proposed dissertation will investigate mindfulness through three studies. Study 1 was completed in a population of individual members of the International Quit and Recovery Registry and met the Diagnostic and Statistical Manual, 5th edition criteria for substance use disorder. It was found that individuals with higher mindfulness and engagement with Integrative Health Practices demonstrate success in recovery, measured by the World-Health Organization Quality of Life Scale, craving, and Days in Recovery and are more likely to have reached remission. Engagement with meditation showed more and higher correlations with success in recovery than other Integrative Health Practices measured. Study 2 investigated how mindfulness is taught. Participants were divided into two groups, comparing traditional cueing to compassion cueing. Participants received neuroscience education paired with weekly meditation techniques. There were no group differences; however, all participants expressed improvements in mindfulness, self-compassion, decreased depression symptoms, and gains in neuroscience knowledge. The impact of mindfulness curriculum development can be seen through differences in daily outcomes assessing participants' thoughts, emotions, and body on a 10-point Likert scale from settled to active. Study 3 validated a new tool to measure the multidimensional impacts of movement based on a traditional yogic framework and validated with neuroscience tools. The Multidimensional Impacts of Movement Scale (MIMS) is a valid and reliable tool showing stability over time ($r = 0.737$, $p<0.001$) and strong Cronbach's Alpha for each scale ranging from $\alpha = 0.775$ to $\alpha = 0.840$. These three studies combine as a body of work supporting continued research in the field of mindfulness by adding new knowledge about teaching mindfulness, measuring mindfulness, and how mindfulness can be applied to improve quality of recovery for individuals with substance use disorder.

General Public Abstract

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The field of mindfulness research is rapidly growing as mindfulness is being utilized as a tool to improve mental and cognitive health. Mindfulness is paying attention in the present moment with non-judgmental awareness. As the research body increases, weaknesses in mindfulness research have surfaced. There is a need for improved measurement tools, an increased understanding of, meditation techniques used, the dose of meditation, and the population samples being studied. Meditation and movement are both tools that can improve an individual's mindfulness. The proposed dissertation will investigate mindfulness through three studies. Study 1 was completed in a population of individual members of the International Quit and Recovery Registry and met the Diagnostic and Statistical Manual, 5th edition criteria for substance use disorder. It was found that individuals with higher mindfulness and engagement with Integrative Health Practices demonstrate success in recovery, measured by the World-Health Organization Quality of Life Scale, craving, and Days in Recovery and are more likely to have reached remission. Engagement with meditation showed more and higher correlations with success in recovery than other Integrative Health Practices measured. Study 2 investigated how mindfulness is taught. Participants were divided into two groups, comparing traditional cueing to compassion cueing. Participants received neuroscience education paired with weekly meditation techniques. There were no group differences; however, all participants expressed improvements in mindfulness, self-compassion, decreased depression symptoms, and gains in neuroscience knowledge. The impact of mindfulness curriculum development can be seen through differences in daily outcomes assessing participants' thoughts, emotions, and body on a 10-point Likert scale from settled to active. Study 3 validated a new tool to measure the multidimensional impacts of movement based on a traditional yogic framework and validated with neuroscience tools. The Multidimensional Impacts of Movement Scale (MIMS) is a valid and reliable tool showing stability over time ($r = 0.737$, $p<0.001$) and strong Cronbach's Alpha for each scale ranging from $\alpha = 0.775$ to $\alpha = 0.840$. These three studies combine as a body of work supporting continued research in the field of mindfulness by adding new knowledge about teaching mindfulness, measuring mindfulness, and how mindfulness can be applied to improve quality of recovery for individuals with substance use disorder.

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Chapter 1: Introduction

Mindfulness is a mental state characterized by non-judgmental awareness of the present moment and can be cultivated through practices such as meditation or movement. Mindfulness can also be applied to activities of daily living, such as mindful eating or mindful walking. Mindfulness is a concept that dates back to the first century BCE; however, in the past twenty years, mindfulness has become a popular sensation in the United States, with its most frequent use being disseminated virtually through both phone applications (apps) (Schultchen et al., 2021) and online classes (Victorson et al., 2020). Mindfulness has also recently become a significant scientific field of inquiry (Lee et al., 2021).

Mindfulness often refers to practices that result in non-judgmental awareness of the present moment. Mindfulness can be practiced as a guided experience, which includes listening to a dialog and being encouraged to pay attention to the present moment. During this experience, the individual may be engaging in traditional meditation (i.e., seated position with eyes closed), cleaning their home, walking, or doing other activities. Cues are offered to guide the experience, such as “pay attention to what you smell” or “notice your breathing”. Over time, mindfulness develops as an individual becomes more aware of each present moment, thus requiring fewer reminder cues. This moves mindfulness from a state quality to a trait quality through neuroplastic changes in the brain (Kiken et al., 2015).

Mindfulness is an umbrella term that includes all the definitions and experiences expressed above (Van Dam et al., 2018). Operationalizing the definition of mindfulness for research is necessary in increasing the comparability of mindfulness studies. John

Kabat-Zinn helped develop the scientific study of mindfulness and is a popular author of mindfulness books such as *Full Catastrophe Living* (Kabat-Zinn & Hanh, 2009). He built the Stress Reduction Clinic and developed the Mindfulness-Based Stress Reduction (MBSR) program through the University of Massachusetts Medical School. John Kabat-Zinn defines mindfulness as the awareness that arises from paying attention, on purpose, in the present moment and non-judgmentally to the unfolding of experience moment by moment (Kabat-Zinn, 2003). A similar definition found in the scientific literature is that mindfulness is the process of increasing attention, memory, present-moment thinking, and non-judgment (Van Dam et al., 2018). In the context of this dissertation, mindfulness is a measurable psychological state reflecting an individual's awareness.

On the other hand, *meditation* is the intentional mental control resulting in an altered consciousness (Matko & Sedlmeier, 2019). Meditation practice reaches back thousands of years into Buddhist and yogic traditions (Kabat-Zinn, 2003; Zambito, 1992) and has been traditionally associated with spirituality (Wang et al., 2021). Currently, investigations of the effects of meditation on mindfulness are part of the surge in new scientific research. Drawing mindfulness and meditation together, mindful meditation is a style of meditation aimed at increasing awareness, resulting in attentional control, emotional regulation, and self-awareness (Y. Y. Tang et al., 2015).

The American Mindfulness Research Association tracked peer-reviewed research on mindfulness over the past 40 years marking a significant increase in mindfulness research over the past 20 years (American Mindfulness Research Association 2022) . As mindfulness is a new and growing area of research, there are

many weaknesses in methodology, including small sample sizes; true blinding and study design; inadequate description of mindfulness; inadequate description of intervention; poor statistical analysis; and the use of limited measurement tools (Davidson & Kaszniak, 2015). Discovering better controls for clinical interventions and improving reproducibility are lingering challenges in mindfulness research (Goldberg et al., 2017).

Much of the research on mindfulness stems from John Kabat-Zinn's work. Kabat-Zinn founded the Center for Mindfulness in Medicine, Health Care and Society at the University of Massachusetts Medical Center. MBSR has a protocol including curriculum and program elements that can be replicated; therefore, it is frequently utilized in mindfulness research (Kabat-Zinn, 2011). MBSR secularized mindfulness, removing spiritual mindfulness traditions and basing MBSR in science (Kabat-Zinn, 2000). Historically, mindfulness teachers learned through intense one-on-one study and mentorship in Buddhist and Yogic practices. The current evolution away from spiritual traditions created a gap in mindfulness teacher training (Shonin & Gordon, 2014). Professionals such as psychologists, nurses, yoga teachers, physical therapists, and social workers often implement mindfulness in various populations with little or no training assuming their prior professional training is an adequate base of knowledge from which to teach (Crane et al., 2012). This means that mindfulness is being taught without standard vocabulary, sequencing, or techniques, thus creating a challenge for the reproducibility of research in mindfulness. Highly qualified mindfulness teachers should be involved in developing interventions and online programs, yet there is a gap

in both literature and practice. There are no accepted guidelines defining a highly qualified mindfulness teacher (Creswell, 2017).

Mindfulness research has potential for a broad range of populations as it can be free, is non-pharmaceutical, and can be practiced virtually. The use of apps to deliver mindfulness experiences is on the rise (van Emmerik et al., 2020) as a general public health intervention to increase quality of life (Schultchen et al., 2021) as well as a clinical tool to help improve mental health (Berg & Perich, 2021). Mindfulness, delivered through digital media, may be one of the keys to improving the quality of research on mindfulness. By using a digital delivery method, careful consideration can go into the planning and creation of an intervention. Implementation fidelity refers to how accurately a program or protocol has been executed in a population. Utilizing a digital delivery method promotes high implementation fidelity as study content is prerecorded and automated. Implementing mindfulness online enables one to create a curriculum that is executed with fidelity and teaches mindfulness skills over a period of time (Mrazek et al., 2019). Digital delivery will also enhance the ability of the study to be replicated. Additionally, online mindfulness interventions can also facilitate large and diverse sample sizes.

This dissertation harnessed the power of digital engagement to investigate mindfulness in various populations. Three different study designs, namely, 1) a cross-sectional study, 2) a single-blind randomized control trial, and 3) a tool validation, were implemented and collected digitally. These three studies each filled a unique gap in the mindfulness literature, based on the common hypothesis that heightening mindfulness

(i.e., a psychological state that results from practices such as meditation) supports self-regulation and other positive psychological outcomes.

Study 1

The first study in this dissertation focused on how mindfulness supports positive psychological outcomes in a clinical population with impairment in self-regulatory behaviors. Specifically, study 1 explored the practical application of engagement with Integrative Health Practices (IHPs) in a population with substance use disorder (SUD) and their effect on mindfulness outcomes related to the quality of recovery from SUD. Though prior literature suggests that mindfulness may promote success in recovery (Chiesa & Serretti, 2013), a gap exists regarding current engagement with various IHPs and their specific impact on recovery as a long-term process.

SUD is a recurrent and relapsing use of alcohol and/or drugs that impairs an individual's quality of life and affects 20.8 million people in the United States (US), which is 7.8% of the US population (U.S. Department of Health and Human Services (HHS) 2016). IHPs are lifestyle-based activities designed to strengthen traditional health practices and include acupuncture, chiropractic care, yoga, meditation, prayer, visualization, and relaxation. Recovery from SUD is an ongoing process of change, including self-directed action to improve overall well-being (Nugent, 2012). Mindfulness is included in this self-directed approach to improving one's quality of life (Bowen et al., 2014).

In study 1, data were collected from the International Quit and Recovery Registry, an online community for people in SUD recovery and a platform dedicated to finding new discoveries regarding the neurobehaviors that support successful recovery.

This cross-sectional data revealed that engagement with IHPs predicted success in recovery as measured by a longer time in recovery, decreased substance cravings, and improved quality of life. Further, meditation was the most effective IHP driving these results. Knowing that meditation is an effective tool to improve quality of recovery propels an investigation (Study 2) into how to optimize meditation outcomes.

Study 2

The second study of this dissertation focused on how enhancing mindfulness through mindful meditation techniques could enhance positive psychological outcomes. Specifically, study 2 investigated best practices in teaching mindful meditation to achieve optimized outcomes in a range of psychological states, including mindfulness, self-compassion, depression and anxiety. Currently, no best practices for mindful pedagogy (i.e., teaching methods) exist (Farias & Wikholm, 2016), and competencies (i.e., specific knowledge and skills to be taught) for mindful meditation have not been established (Grabovac & Burrell, 2017), and it is unknown how altering mindful meditation techniques changes mindfulness outcomes. This study filled in these gaps in the literature, examining how teacher behavior and the inclusion of neuroscience education impact psychological outcomes.

Study 2 was a single-blind randomized control trial where the researchers were aware of participant group assignments; however, participants were blind to their assignments. Both groups received the same prerecorded neuroscience content in the form of short lessons including how neurons fire, the purpose of related brain regions, and how the Vagus nerve (i.e., the 10th cranial nerve) aids in the regulation of sympathetic/parasympathetic balance. The control group received lightly guided

meditations with functional cueing (e.g., “If you are distracted, return to the mantra”), and the experimental group received lightly guided meditations with functional cueing plus added compassion cueing (e.g., “When you are distracted, remember it’s okay. Do your best to return to the mantra.”). Participants engaged in 10-minute sessions, 5 days a week for 4 weeks, with a new meditation technique presented each week. Each daily session included three before and after meditation questions on a 10-point Likert scale from active to settled, asking about their body, emotions, and thoughts. At the beginning of the week, more time was spent on education, and by the end of the week, the entire ten minutes were spent in meditation.

Study 2 found that the 20-day neuroscience education infused meditation program promoted improvement in mindfulness, decreased depression symptoms, increased self-compassion, and individuals gained neuroscience knowledge. Study results also connect daily acute outcomes to intervention improvements using four meditation techniques. As mindfulness pedagogy and competencies for mindful meditation are being established, these outcomes will help guide future research and practice protocols about how to best focus the brain during meditation. Our findings indicate that the actual practice of meditation may be more important than the specific cues being offered by the teacher and that different types of meditation may lead to different outcomes regarding thoughts, emotions, and physical sensations. The findings also highlight the idea that the acute or immediate impacts of meditation impact the long-term beneficial effects of meditation. Accordingly, this study will help contributed to the standardization of future research protocols. As part of the need for standardization of methods, more measurement tools are also needed to strengthen mindfulness

research further. To have more accurate tools for measuring mindfulness, study 3 validated a new tool measuring the multidimensional impacts of mindful movement.

Study 3

The third study of this dissertation focused on designing a tool to examine the multidimensional positive psychology outcomes of mind-body-movement techniques. To measure the effects of mindfulness interventions, validated tools must exist to measure these outcomes. Currently, self-report tools exist to measure mindfulness as dispositional (Brown & Ryan, 2003) and as trait (R. A. Baer et al., 2008) characteristics; however, no tool explicitly measures the impacts of mindful movement in an acute setting. Direct brain measures provide specific information about brain function related to mindfulness; however, direct measures are expensive, challenging, and often impossible to acquire when a participant is in motion. Mindfulness research is beginning to include phenomenological reporting; however, phenomenology is time-consuming and subjective in nature (Lundh, 2020). Self-report tools are between the specificity of direct brain measurements and the subjective nature of phenomenological reporting. Self-report questionnaires are accessible to researchers and participants, making them desirable for research purposes (R. Baer, 2019). Therefore, the final study created and validated a new self-report tool to aid in measuring mindful outcomes related to movement practices. This new tool fills a gap in the literature by measuring the multidimensional impacts of movement on various mindfulness outcomes.

Yoga is a mindful movement practice with both historical roots and modern practice, including movement, breathwork, sensory awareness, and meditation (Rakel, 2012). The Koshas is a traditional yogic framework that establishes individuals as

multidimensional beings with various bodies, energy, minds, intuition, and contentment (Eswaran, 2007).

In study 3, the Multidimensional Impacts of Movement Scale (MIMS) was designed by overlapping the yogic Kosha framework with neuroscience measures, blending yogic tradition and western science. The Multidimensional Impacts of Movement Scale (MIMS) is valid and reliable. Cronbach's alpha is between 0.775 and 0.840 for each of the factors and confirmatory factor analysis validated each factor as a unique concept. MIMS is stable over time demonstrating test-retest reliability of $r = 0.737$, $p < 0.001$. MIMS was measured within three known movement groups: yoga (i.e., a mindful movement practice that focuses on balance and flexibility), running (i.e., cardiovascular movement), and weightlifting (i.e., anaerobic movement) with significant differences among the groups.

Specific Aims and Hypothesis
Study 1

Primary Aim

To explore the use of Integrative Health Practices (IHPs) among individuals with substance use disorder (SUD) and the impact of IHPs on the quality of recovery for these individuals.

Hypothesis

Within a population of individuals with a lifetime diagnosis of a SUD, engagement in IHPs, decreased impulsivity, and increased mindfulness will significantly predict success in recovery as measured by the following outcomes.

1) days in recovery

2) quality of life

3) craving level

4) remission status

Secondary Aim

To determine if there are differences between specific IHPs and the quality of recovery for individuals with SUD.

Hypothesis

Within a population of individuals with a lifetime diagnosis of SUD, engagement with meditation will show the greatest associations with quality of recovery measures compared to other IHPs examined (i.e., Yoga, Tai Chi, Qi Gong, Relaxation, Visualization, Prayer, and Traditional Healing Ceremonies).

Study 2

Primary Aim

To determine if adjusting mindfulness teacher behavior by adding self-compassion cueing to functional cueing during a month-long education meditation intervention enhances the study outcomes of mental health, compassion, and mindfulness when compared to functional cueing alone.

Hypothesis

Outcomes for individuals receiving enhanced compassion cueing will have greater gains in mental health, compassion, and mindfulness than those receiving functional cueing alone.

Secondary Aim 1

To explore the relationships between neuroscience knowledge acquisition and mental health, compassion, and mindfulness outcomes.

Hypothesis

Individuals with greater gains in neuroscience knowledge will have greater gains in mental health, compassion, and mindfulness.

Secondary Aim 2

To determine if the technique of meditation (i.e., mantra, movie of the mind, hand turning, and breath watching) impacts participants' perception of their body, emotions, and thoughts based on self-report before and after daily education-meditation sessions.

Hypothesis

1) During Mantra meditation, participants will show greater change in their thoughts compared to emotions and body.

2) During Movie of the Mind meditation, participants will show greater change in their emotions compared to thoughts and body.

3) During Hand Turning Meditation, participants will show greater changes in their body compared to thoughts and emotions.

4) During Breath Watching meditation, participants will show significant improvement in their overall scores over the prior three-week periods.

Study 3

Primary Aim

To determine the validity and reliability of the newly created, Multidimensional Impacts of Movement Scale (MIMS) to measure the *a priori* five factors of the body, energy, mind, intuition, and contentment outcomes of movement among yogis, runners, and weightlifters.

Hypothesis

1) The Multidimensional Impacts of Movement will have acceptable validity and reliability.
    a) (Validity) Confirmatory Factor Analysis with a good model fit for all five factors assessing Chi Square, Comparative Fit Index, and the Root Mean Square Error of Approximation.
    b) (Internal Consistency/Reliability) Cronbach's Alpha $\geq$ 0.70.

Secondary Aim

To discern differences and similarities among responses to the Multidimensional Impacts of Movement Scale in three different population samples: Yogis, Runners, and Weightlifters.

Hypothesis

Yogis will have higher outcomes in each of the five domains compared to runners and weightlifters, with similar outcomes between runners and weightlifters.

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Chapter 2: Review of Literature

Overview

This dissertation will fill in gaps in mindfulness literature with three studies based on the common hypothesis that heightening mindfulness (i.e., a psychological state that results from practices such as meditation) supports various positive psychological outcomes. These three different studies (i.e., cross-sectional, single-blind randomized control, and tool validation) endeavor to improve mindfulness outcomes and measurements for individuals. This chapter will examine the historical roots of mindfulness, the neuroscience basis of mindfulness, and the factors that influence the outcomes of mindfulness and how we measure mindfulness.

Historical context: Mindfulness and meditation have a rich historical evidence-base, originating in Asia as part of Buddhist and Yogic traditions. Mindfulness is introduced in the Yoga Sutras of Patanjali (Zambito, 1992) through awareness of self. In Contemporary Buddhism (2011), Bhikkhu Bodhi takes the history of mindfulness back to the Pali Canon (written in the 1st century BCE), a canonical text foundational to Buddhist traditions. A modern interpretation of the Pali Canon describes mindfulness to be “lucid awareness.” Bodhi establishes that a secular use of mindfulness to alleviate suffering is warranted; however, he cautions against reductionist action to understand mindfulness. John Kabat-Zinn, the founder of the Center for Mindfulness at the University of Massachusetts Memorial Medical Center in the 1970s, defines mindfulness as “…the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment.”

(Kabat-Zinn, 2003) As you can see, this modern definition of mindfulness is free from spirituality.

In the fourth chapter of the Yoga Sutras of Patanjali (Zambito, 1992), sanyama is discussed. Sanyama links together three procedural steps beginning with conscious effort in the form of concentration (Dharana). Concentration intentionally focuses your mind on a thought, topic, or sensation. Focus then alters into a state of meditation (dhyana), resulting in freedom (samadhi). According to the ancient texts, Samadhi is about being free from mental afflictions and feeling deeply interconnected with all humanity and a divine presence (Gard et al., 2014). However, in a more modern language, samadhi may refer to the state of being free from mental affliction or illness. The practice of concentration is mindfulness, and it is the gateway to an altered state of consciousness with predictable neural changes, balancing top-down and bottom-up brain activity (Raffone et al., 2019). Deshmukh (2006) describes mediation as the “Art of efficient and adaptive management of neurobehavioral energy.”

Recent research indicates that mindfulness is associated with benefits to overall health (Roberts & Danoff-Burg, 2010), stress reduction (Chiesa & Serretti, 2009; Grossman et al., 2004), mental health (Bohlmeijer et al., 2010), and well-being (Birtwell et al., 2018; Brown & Ryan, 2003). Additionally, mindfulness is being utilized as a tool to enhance health behavior change in a range of situations (Schuman-Olivier et al., 2020) including after hospitalization (Gawande et al., 2019), eating with Type II Diabetes (Miller, 2017), and addiction (Brewer et al., 2013; Zgierska & Marcus, 2010). Importantly, mindful meditation demonstrates three consistent improved neurological outcomes: 1) attentional control; 2) emotional regulation; and 3) self-awareness,

resulting in improved self-regulation (Tang et al., 2015) (See figure 2.1, adapted from Tang et al. 2015). Self-regulation is the ability to monitor and adapt attention, emotions, and cognitive function to internal and environmental feedback (Baumeister & Heatherton, 1996; Schuman-Olivier et al., 2020).

The use of modeling is helpful to understand how a particular intervention might act at both the behavioral and brain levels (Hölzel et al., 2011), and several similar theoretical models have been proposed to explain how meditation works on the brain. First, a simple model from Tang et al. (2015) shows that mindfulness meditation offers individuals the three brain-based improvements of attentional control, emotional regulation, and self-awareness. These three outcomes of mindfulness meditation allow individuals to improve their self-regulation, moving brain changes from mindful meditation to behavioral outcomes. (see Figure 2.1)

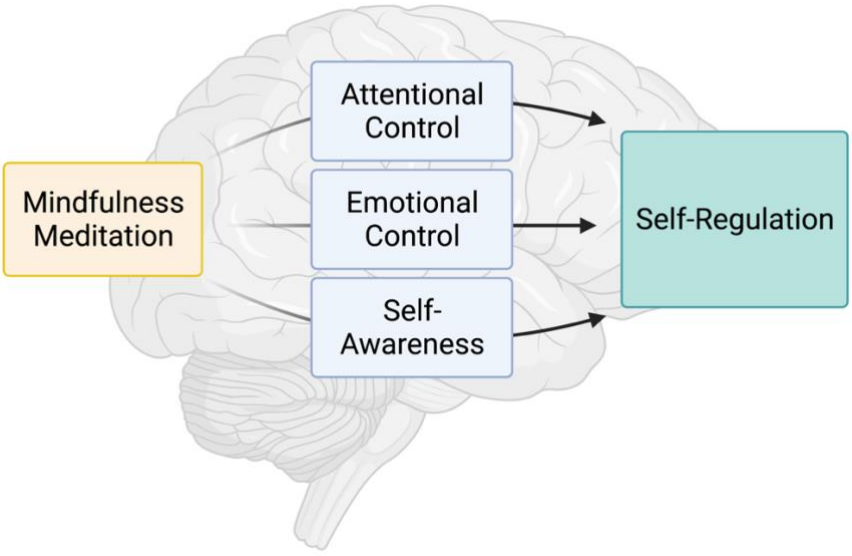

Figure 2.1 - Components of Mindful Meditation

Peter Malinowski (2013) created the Liverpool Mindfulness Model that includes motivational factors, mind training, core processes, mental stance, and outcomes of

mindfulness meditation. This model demonstrates how the intention of an individual to practice mindfulness is a critical component in the development of mindfulness. When an intentional action or practice is undertaken, predictable outcomes will emerge. This supports Kabat-Zinn's definition, "the awareness that arises from paying attention, on purpose, in the present moment and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003). Tang's earlier description of mindfulness components (i.e., attentional control, emotional regulation, and self-awareness resulting in self-regulation) is also well aligned with this more elaborate model by Malinowski. See figure 2.2 for a blended version of these models. Malinowski's model and Kabat-Zinn's definition include the idea of non-judging awareness as an element that leads to behavior change, aligning with Tang's self-regulation. Decoding the mechanisms of action of meditation and its impact on consciousness will allow for more precise application of meditation and examination of its clinical outcomes (Singer & Engert, 2019).

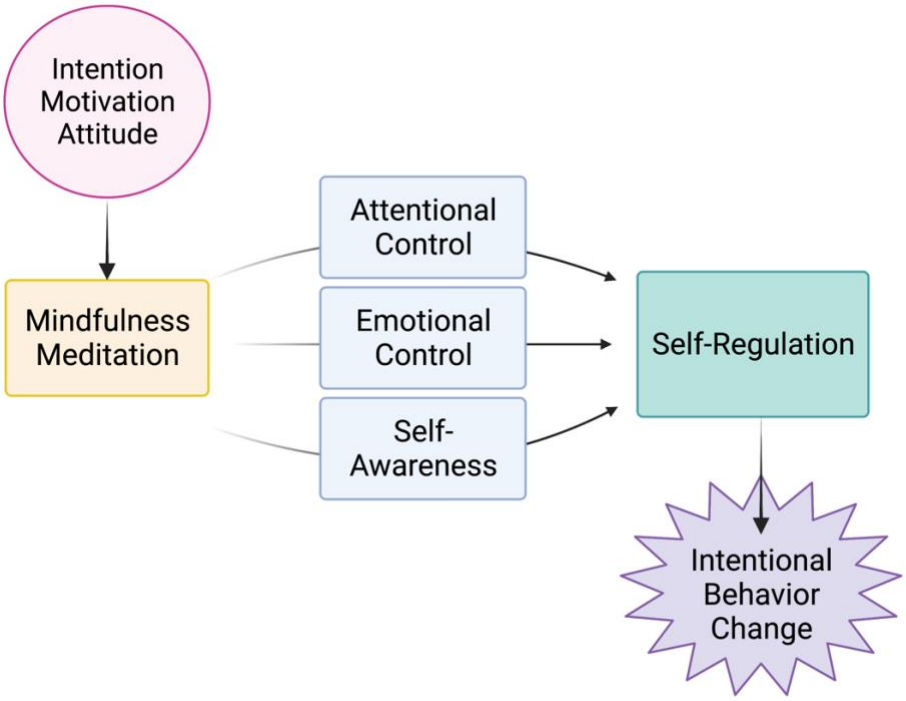

Figure 2.2 – Basic model of mindfulness meditation including motivations and outcomes

The Tang and Malinowski models show how mindful meditation impacts a healthy brain. When an individual shows behavioral dysregulation, there is often an explanation through altered brain function (Nielsen et al., 2018). The competing neurobehavioral decision system shows how underactivity in brain regions associated with executive function (i.e., prefrontal cortex and anterior cingulate cortex) and overactivity in the limbic region (i.e., amygdala) often results in impulsive behaviors (Bickel et al., 2018). The practice of mindful meditation activates the prefrontal cortex and anterior cingulate cortex, strengthening executive function and offering emotional regulation through decreased amygdala activity (See figure 2.3) (Deshmukh, 2006; Tang et al., 2015). We hypothesize that mindful meditation may be an effective treatment targeting brain regions associated with imbalances in activity and behavior.

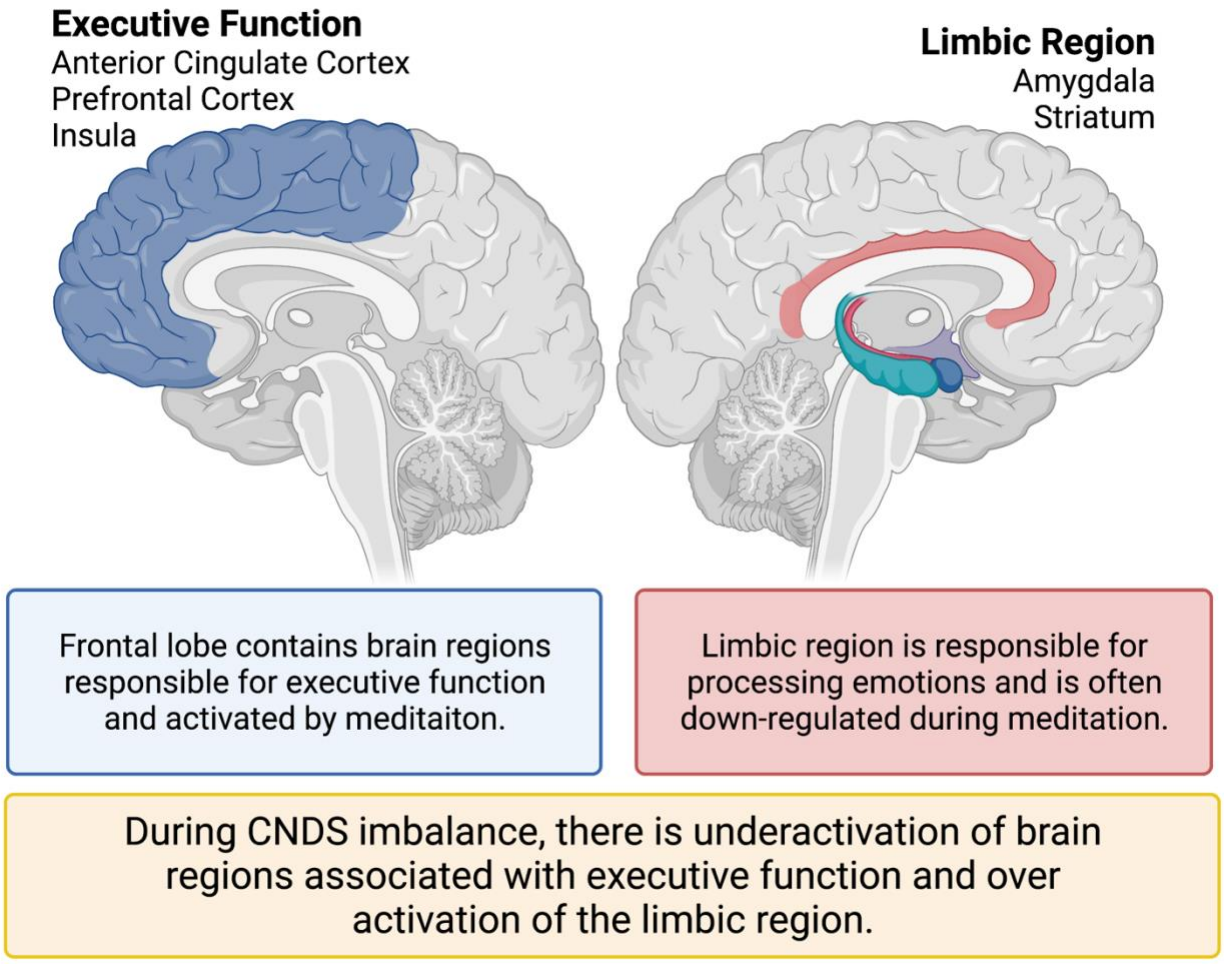

Figure 2.3 – Two brains displaying areas of interest in executive function (on the left) and the limbic region (on the right)

Attentional Control and Focused Attention Meditation

Definition: Attentional control is part of executive function that allows individuals to self-direct and sustain their focus even when distractions arise (A. Lutz, Slagter, et al., 2008). Attentional control can be voluntary and is measured through direct brain measures as well as behavioral measures. Attention includes alerting, orienting, and conflict resolution through three separate but interrelated brain networks (Jha et al., 2007). Specifically, the anterior cingulate cortex and prefrontal cortex are involved in

attentional control during mindful meditation (Manna et al., 2010; Tang et al., 2007; Zeidan et al., 2010).

Behavioral effects: Attentional control is improved with mindful meditation (Tang et al., 2015). Previous work has shown that varied doses (i.e., times) of mindful meditation and different techniques of mindful meditation can be effective at improving attention. Norris et al. (2018) studied the effect of a 10-minute focused attention meditation versus control activity on attentional control. They measured attention using the Flanker Task and Attention Network Test (ANT) using Event Related Potentials (ERPs) (i.e., the measured brain response at the exact time of a behavioral action) gathered through encephalography (EEG). Participants randomly assigned to the meditation group showed greater attentional control with more accuracy on incongruent trials of the Flanker task without compromising time on this task. ERP results focused on two trials of the Flanker task. Those receiving meditation demonstrated that larger N2s were associated with larger P3b's. N2s are distinct wavelengths seen as individuals detect inconsistencies, such as an incongruent Flanker trail. P3b's are wavelengths showing enhanced attentional allocation. The meditation group shows greater attentional control through this association of N2s and P3b than the control group.

Basso et al. (2019) found that a brief 13-minute daily meditation changed attentional measures after 8 weeks. Attention, measured by the Stroop Task, improved along with mood, emotional regulation, and recognition memory. Specifically, the meditation group significantly improved on congruent trials over the podcast listening control group. Another study with a different dose of meditation (i.e., 20 minutes per day for 5 days) found improved scores on ANT through faster response times for correct

trials (Tang et al., 2007). Yet another study measuring mindfulness and attention using ANT compared the effects of focused attention and open monitoring mediation to a relaxation control (Ainsworth et al., 2013). The focused attention and open monitoring groups showed improvements in attention; however, the relaxation control group did not. The mediation intervention for this study was 3, 1-hour meditation training sessions over 8 days, which is a longer daily meditation with more days of practice than most acute interventions. One immersive meditation study found that after a one-month retreat (10-12 hours of meditation a day), the retreat participants showed improved attentional scores on the alerting subscale of the ANT (Jha et al., 2007). All of the participants had prior meditation experience, and their months of experience positively correlated to their improvement in alerting. The literature consistently shows that mindfulness improves attention regardless of the dose of meditation considered in the amount of daily meditation and the length measured in days of the intervention.

Despite these findings, there is conflicting evidence presented in a recent meta-analysis by Im et al. (2021) about mindfulness's effectiveness in improving attention. These researchers found little evidence that mindfulness interventions improve attention. Im et al. report that the meditation technique and dose was not always reported in the literature included in their study. When reported, the type of meditation moderated outcomes in the meta-regression analysis—supporting the idea that meditation techniques matter. Importantly, a systematic review by Chisea et al. (2011) asserts that specific subgrouping of mindfulness, utilizing the category of focused attention, significantly improve attentional outcomes, especially among participants new to meditation.

Brain effects: Attentional control changes are seen early and often in novice meditators. The effortful doing of meditation for novices usually involves conscious attentional control. Early-stage meditators place effort on noticing when they are focused and when they are distracted. Middle-stage meditators often experience mind wandering, an effect of the default mode network (DMN) activation (Mason et al., 2007). The DMN includes functionally networked brain regions such as the posterior cingulate cortex, precuneus, ventromedial prefrontal cortex, and dorsomedial prefrontal cortex. Together, they spontaneously give rise to thoughts such as daydreaming and analysis of past events (Yeshurun et al., 2021). Advanced stage meditators experience "effortless being" during meditation and are not experiencing the attentional struggles of early and middle stage meditators. The progression of attentional control demonstrates the neuroplastic changes occurring in the brain over time and how they impact the mindful meditation experience (Norris et al., 2018; Tang et al., 2015). Attention may be a key component in meditation, as it is required to sustain awareness in developing emotional control, cognitive flexibility, and self-awareness. Attentional control may be a first step in developing mindfulness (Malinowski, 2013).

Suggested Technique for Attentional Control: A meditation technique that targets attentional control is focused attention meditation. A specific technique for focused attention is using a mantra, a repeated word or phrase. Mantra work can be utilized to enter meditation or at any point, even outside of a meditation experience (Easwaran, 2008). Mantras can be but are not required to be spiritual. They can be generated individually for a personal experience or taken from other texts and/or traditions (Easwaran, 2008). In a population sample of 146 veterans with PTSD, mantras were

used in a randomized control trial, with two groups: treatment as usual (TAU) or TAU plus a mantra program (Bormann et al., 2012). Twenty-four percent of veterans assigned to TAU plus mantra meditation showed clinically significant improvement in PTSD symptoms compared to 12% in the TAU group.

Emotional Regulation and Open Monitoring Meditation

Definition: Emotional regulation resulting from mindfulness meditation does not diminish emotions; instead, it creates acceptance of emotions as a present moment experience (D. G. Taylor & Mireault, 2008). Gross (2014) explains emotional regulation as an individual's ability to regulate the range of emotional responses, including positive and negative responses and the duration of these responses. Emotional regulation utilizes the prefrontal cortex to down-regulate limbic regions, including the amygdala (J. Lutz et al., 2013; V. Taylor et al., 2011).

Behavioral effects: Mindfulness can help moderate emotional control. Trait mindfulness is more stable than state mindfulness. These two measures vary among individuals and over time (Mesmer-Magnus et al., 2017). Trait mindfulness is based on the trained experience of an individual's internal observation, reducing automaticity and thus reducing emotional reactivity (Glomb et al., 2011). This decreased emotional reactivity creates greater time and space to experience the present moment, increasing emotional regulation. Scores on the Five Facet Mindfulness Questionnaire (FFMQ) and the Mindful Attention Awareness Scale (MAAS) determine aspects of both trait and state mindfulness. Lin et al. (2016) concluded that mindfulness skills could be practiced and acquired to improve emotional regulation.

Using the Mindful Attention Awareness Scale (MAAS) to measure dispositional mindfulness, Erisman and Roemer (2010) divided participants at baseline, stratifying for levels of mindfulness in each group. Participants received either guided meditation or an educational control and viewed movie clips that evoked emotion. Both groups then completed the Positive and Negative Affect Schedule (PANAS). The meditation group experienced less difficulty regulating after distressing film clips and greater positive responses to positive movie clips. This study concluded that meditation could help individuals regulate emotional responses.

Mindfulness studies measuring emotional regulation often use meditation as a practice to increase mindful states. Emotional regulation can be measured using the Trier Social Stress Test (TSST), a mock interview simulating social stress. Basso et al. (2019) measured the effects of a brief meditation on psychosocial stress. The meditation group demonstrated greater emotional regulation on the TSST than the podcast listening control group. Another study, with a mindful meditation intervention of 15 minutes a day for 7 days in a row, found that this brief mindful meditation improved emotional processing as measured through emotional intensity, emotional memory, and emotional attention bias (Wu et al., 2019).

Systematic and Meta-Analytic reviews consistently report difficulty compiling data on mindfulness-related emotional regulation as study design and measurement indications are not consistent or standardized (Hoge et al., 2021; Mesmer-Magnus et al., 2017). In the literature reported here, methodological differences abound in measurement tools, dose of meditation, and meditation technique. Future research is

needed to investigate the specific effects of dose, technique, and measurement on the effects of mindful meditation on emotional control.

Brain Effects: In an EEG investigation, Lin et al. (2016) analyzed the late positive potential (LPP), a specific ERP indicating emotional regulation. After meditation or control activity, LLPs indicated exposure to emotion-evoking images as measured at the CPz electrode scalp placement over the central parietal lobe. Individuals with higher trait mindfulness had greater modulation of LPPs than those with higher state mindfulness. This impressive result showed reduced emotional reactivity from merely a single 20-minute open monitoring (OM) guided meditation.

Evidence supports that mindfulness training has lasting effects on brain function and emotional regulation (Desbordes et al., 2012). In a longitudinal study using functional magnetic resonance imaging (fMRI), participants undergoing mediation training showed decreased amygdala activation in response to positive and negative images. The experience level of a meditator offers varied neural responses to emotional stimuli, further supporting the idea that emotional regulation resulting from mindful meditation takes time and can have an enduring effect on an individual (V. Taylor et al., 2011). Experienced meditators displayed down-regulation of the DMN and little amygdala activation to all images, positive and negative. The novice meditators showed downregulation of the amygdala in response to negative images. The investigators concluded that the difference in response was related to experienced meditators altering their brain networks and activations over time.

Suggested Technique for Emotional Regulation: Open monitoring meditation is often suggested to improve emotional regulation. Open monitoring meditation

encourages participants to observe their thoughts during meditation without reacting to them (Tomasino et al., 2013). Open monitoring meditation allows individuals time to experience the unfolding of thoughts and events in real-time, reducing reactivity and increasing emotional regulation (A. Lutz, Brefczynski-Lewis, et al., 2008).

Self-Awareness and Interoceptive Awareness Meditation

Definition: Self-awareness is the conscious knowledge of one's emotions, body, and thoughts (Tang et al., 2015). As a result of mindfulness, self-awareness reduces biases related to decision-making and self-processing (Gu et al., 2015). Psychologically speaking, this unbiased sense of self creates a healthy mind, freeing one's thoughts away from unhealthy or self-centered views of one's existence (Vago & Silbersweig, 2012). Brain networks such as regions of the prefrontal cortex and DMN (e.g., posterior cingulate cortex, insula) are involved in self-awareness (Tang et al., 2015). The DMN is active when daydreaming, recalling memories, and self-referential processing. Meditation decreases DMN activation as novice meditators gain skill in attentional control (Garrison et al., 2015). As meditation experience increases, more connectivity with the DMN shows increased self-referential processing; therefore, greater self-awareness. (Tang et al., 2015, Brewer et al., 2011). Additionally, increases in activity in somatosensory regions such as the insula are related to self-awareness and activated during meditation (J. Lutz et al., 2016).

Behavioral effects: Vago and Silbersweig (2012) present a mindfulness process model including executive Monitoring (i.e., meta-awareness) in in the center. Said another way, executive monitoring is self-awareness and is needed for the process of mindfulness. Figure 2.4 builds on previously presented models (figures 2.1 and 2.2),

including the influence of Vago and Silbergsweig (2012) to show how elements of mindful meditation are used in the process of improving mindfulness. Individuals must be aware that they are distracted, recognize any emotional response, choose to modulate the response, and then intentionally return to the mental stabilization of attentional control. This process uses and in turn, improves self-regulation.

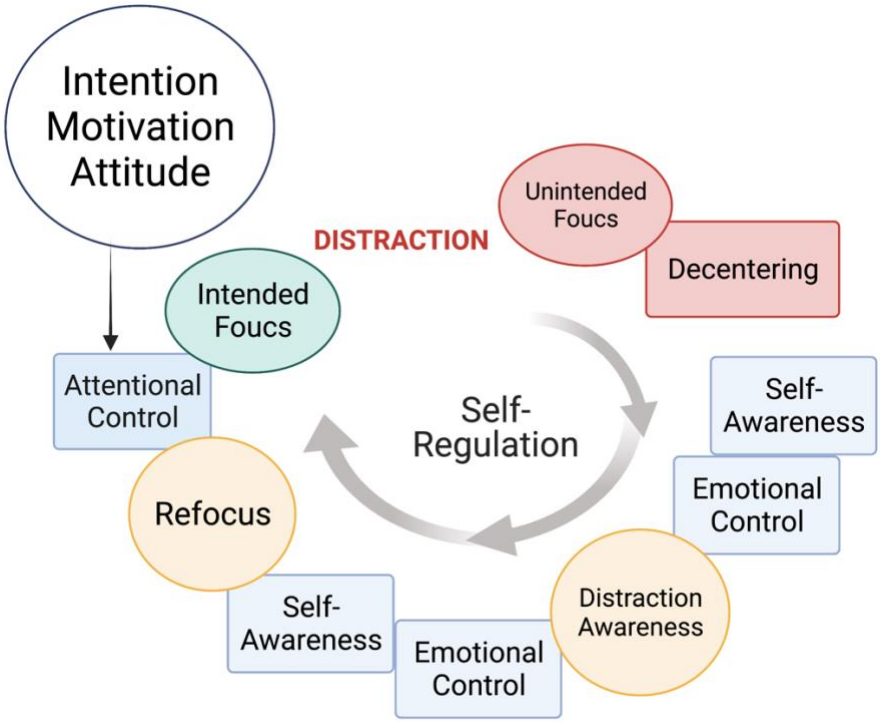

Figure 2.4 - The process of mindfulness uses and strengthens Self-Regulation

At the beginning of the process, the attentional network is engaged (left of the figure in yellow). When an individual becomes distracted, an emotional response occurs (right of the figure in turquoise). The interaction of emotion and attention networks share neural correlates, especially in the prefrontal cortex and anterior cingulate cortex (Dolcos et al., 2020). The center of the Mindfulness Process Model demonstrates the importance of self-awareness in green. Self-awareness allows the individuals to

regulate by returning to focus, controlling emotions, and/or disengaging from the distraction.(Vago & Silbersweig, 2012)

A lack of self-awareness may be linked to mental and physical habits and patterns (Vago, 2014). While these habits may save time in certain circumstances, they can also keep us in negative feedback loops through processes of automaticity. Self-awareness may be the key to unlocking these loops (Vago, 2014). Vago asserts that open monitoring meditation allows individuals to build new episodic memories or enhance their prosocial concerns and positive affective reappraisal. Through this process of self-awareness, an individual may be able to extinguish negative habits or negative feedback loops. This change in thought pattern and potentially behavior change may explain positive mental health outcomes from meditation.

Brain Effects: The neural correlates of self-awareness include both activations and deactivations in various brain regions and altered states of network connectivity. Neural correlates of meditation are present in meditators and non-meditators; however, the degree of change is greater in those who meditate than in those who do not (J. Lutz et al., 2016). Self-awareness is marked by decreased cortical midline and amygdala activation and increased somatosensory activity. Lutz et al. (2016) used fMRI to measure neural activity related to self-awareness in two groups, meditation naïve and meditation practitioners with 1-3 years of experience. The researchers showed images to participants. Then the researchers provided prompts “How do you feel?’ and “What do you think about how you feel?” All participants reacted to the question prompts however those who meditated showed a greater response to the prompt, “What do you think about how you feel?” than the non-meditators. This shows those who meditate

have greater meta-awareness, or knowledge of their thoughts and emotions than those who do not meditate.

Suggested Technique for self-awareness: Meditation techniques that encourage interoceptive awareness, such as hand turning, may increase self-awareness. Connecting mind and body in motion effectively increases self-awareness (Raffone et al., 2019). Mindfulness practices that incorporate movement, such as yoga, profoundly impact self-awareness and its neural correlates of the insula and regions of somatosensory processing (van Aalst et al., 2020).

Self-regulation and Breathing Meditation

Definition: Self-regulation is an outcome of the three elements of mindfulness: attentional control, emotional control, and self-awareness (Tang et al., 2015). Self-regulation results from neural and behavioral changes associated with attentional control, emotional regulation, and self-awareness. As such, there is not a unique brain network dedicated to self-regulation. A combination of the brain's executive network (i.e., prefrontal cortex, anterior cingulate cortex), DMN (prefrontal cortex, posterior cingulate cortex), salient network (insula), and limbic network (i.e., amygdala) activations and deactivations work together to optimize mindful states (Hölzel et al., 2011; Tang et al., 2012). Self-regulation allows individuals to be intentional and non-judgmental in their present moment experience.

Behavioral Effects: Self-regulation, as a result of improved self-awareness, also includes body awareness (Hölzel et al., 2011). Interoceptive awareness, or the knowledge and felt sensation of what's happening inside your own body, is a tool utilized during breath-focused meditations (Weng et al., 2021). Interoceptive awareness

is associated with activation of the insula and decreased engagement of the DMN. Freeing oneself from DMN activation allows for greater self-referential processing (Yeshurun et al., 2021). Mindfulness practices focused on the breath can create this new balanced system improving sympathetic regulation and decreasing the risk of hypertension and cardiovascular disease (Weng et al., 2021).

Self-regulation can improve many health behaviors and is a process that can be augmented by mindfulness meditation (Schuman-Olivier et al., 2020). Schuman-Oliver et al. (2020) propose a theory that self-regulation through mindfulness can help individuals make positive health behavior changes. They state that focusing on emotional feedback makes time and space to evaluate thought patterns and execute the extinction of negative thoughts. With the extinction of negative thought patterns, positive feelings emerge during meditation practice. As positive reinforcement develops from healthy behaviors, dopamine responses reinforce health behavior change supported by meditation through reward-based learning. Schuman-Oliver et al. (2020) present this as an explanation for self-regulation resulting from mindful meditation.

In conclusion, brain and behavior research support mindful meditation as a tool for self-regulated behavior change. Attentional control, emotion regulation, and self-awareness work together to promote these changes. Various techniques of meditation and movement enable changes to mindful states. The above research supports the common hypothesis that mindfulness supports such positive psychological outcomes, and the following discussion will investigate how mindfulness can best be implemented to optimize mindful states.

Mindful Meditation and Substance Use Disorder

Substance use disorder (SUD) is a recurrent and relapsing use of alcohol and/or drugs in a way that impairs an individual's quality of life (Bowen et al., 2014). SUD is defined by the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as meeting one or more of eleven criteria, (i.e., Substance is taken in larger amounts or over longer periods than intended. Important social, occupational or recreational activities are given up or reduced due to substance use.) (American Psychiatric Association., 2013). 20.8 million people in the United States have SUD (U.S. Department of Health and Human Services (HHS) 2016) and 24.1% of those who report clinical levels of substance misuse never receive treatment (Hasin et al., 2007). Treatment may move individuals from active use toward remission, experiencing none of the initial eleven criteria used for DSM-5 diagnosis (excluding cravings) in the previous three months. Recovery from SUD is an ongoing change process, including self-directed action to improve overall well-being (Nugent, 2012). Mindfulness is included in this self-directed approach to enhancing well-being (Witkiewitz et al., 2006).

The Experimental Medicine Approach from the National Institute of Health Science of Behavior Change Program (Nielsen et al., 2018) seeks to understand the mechanism of action creating change in an individual. Mechanisms of action supporting mindful meditation have been well documented (Brefczynski-Lewis et al., 2007; Dolcos et al., 2020; J. Lutz et al., 2016) as are the neural patterns specific to individuals with SUD. Mindful meditation and combined SUD research show mindful meditation improves quality of recovery when added to treatment as usual (Bowen et al., 2014; Chiesa & Serretti, 2014; Garland & Howard, 2018). The NIH Science of Behavior

Change Program supports the combination of brain-based and behavioral research on mindful meditation and SUD in order to work for improvements to the underlying cause of SUD rather than just treating its symptoms.

Reinforcer pathology theory has two primary components. Individuals with SUD display an excessive preference for immediate rewards, they also prefer drugs/alcohol over other reinforcers. The combination of these preferences reinforces the attraction to use drugs and alcohol. (Bickel et al., 2020). The reinforcer pathology theory is a behavioral theory that can be applied to help understand the choices made by individuals with SUD. When looking at the neural mechanism of action that may promote various reinforcing behaviors, the Competing Neurobehavioral Decision System (CNDS) theory emerged. In this theory, the limbic system (i.e., amygdala) which is active during impulsive actions is in competition with the executive systems (i.e., prefrontal cortex, insula, and anterior cingulate cortex) which are thoughtful and guide decisions. (Bickel et al., 2007). When the brain experiences homeostasis, individuals make thoughtful decisions; however, individuals with SUD often experience overactive limbic activity and under active executive function, resulting in more impulsive behavior.

The neuroscience of mindful meditation shows promise in rebalancing these imbalanced systems (i.e., increased executive and decreased impulsive). In figure 2.3, you can see that the brain on the left shows areas of enhanced activation during mindful meditation (i.e. Prefrontal Cortex, Anterior Cingulate Cortex, Insula), and the brain on the right shows the CNDS with areas of hyper-activation (i.e., amygdala, striatum) . The overlap here shows that mindful meditation may reduce impulsivity and increase

executive function in individuals with SUD. Increases in attentional control, emotional regulation, and self-regulation may underlie mindfulness-induced improvements in the quality of SUD recovery (Garland & Howard, 2018).

Study 1 (Chapter 3), investigated the use of Integrative Health Practices and Future Valuation on the Quality of Recovery from Substance Use Disorder. Integrative Health Practices (IHPs) are lifestyle-based activities designed to strengthen traditional health practices. IHPs range from receiving acupuncture and/or chiropractic care to yoga, meditation, prayer, visualization, and relaxation practices (Quandt et al., 2009). This study filled in a gap in the literature showing that heightened mindful states promote success in recovery from SUD. Further, this study supports meditation as the primary IHP driving mindfulness changes related to success in recovery.

Aligning Content, Participants, and Technique

Meditation is an effective tool to augment mindfulness outcomes; however, little is known about mindfulness interventions' best practices. There is no professional or regulatory body to support teaching or implementing mindfulness interventions (Farias & Wikholm, 2016). This leaves a gap in both practice and literature of mindfulness interventions. New research must address the content and methodologies of mindful meditation interventions. Meditation techniques utilized should be chosen with care and consideration for participant characteristics and then carefully analyzed.

The content of a mindfulness program changes study outcomes through various phenomenological reports, neuroplasticity, mental, cognitive, and social outcomes according to findings from the ReSource Project (Singer & Engert, 2019), which was a 9-month longitudinal mental training study designed to examine differences in research

designs. The ReSource Project cautions that lumping all mindfulness techniques under one umbrella category will diminish study findings and participant benefits. As in the example of mindfulness and SUD, consider the importance of targeting a mindfulness program to cultivate the most positive experience possible for participants.

Understanding the mechanism of action that promotes positive mindfulness outcomes can help researchers and practitioners build programs that best target desired outcomes. Roca et al.(2021) compared Mindfulness-Based Stress Reduction (MBSR) to a compassion program. They were looking to find MBSR's mechanism of action and what shifts the mind into present-moment awareness. The compassion program demonstrated changes in prosocial and emotional mechanisms; however, both studies showed similar outcomes for distress and overall well-being, indicating that different meditation techniques and associated brain activity can bear similar psychological results.

An ALE meta-analysis study found four clustered brain regions of interest and sorted them as activations, deactivations, mantra, and meditation experience (Tomasino et al., 2012). Neural networks that are activated during meditation include the left superior medial gyrus, left paracentral lobule, right supplementary motor area, left superior and inferior parietal lobe, left insula, and right supramarginal gyrus. Clusters of brain regions deactivated during meditation included the precuneus, superior medial gyrus, angular gyrus, fusiform gyrus, and a right-lateralized network in the middle temporal gyrus. As a sub-analysis, mantra meditations generally focused awareness, showed changes in the networks of the medial gyrus, left superior parietal lobe, left insula, and the right supramarginal gyrus. A final sub-analysis looked at the differences

in participants with short- versus long-term experience with meditation. The superior parietal lobe had equal activation in both groups; however, short versus long-term meditators showed distinctly different activations during meditation. Novice meditators show more prefrontal activations than experienced meditators who could sustain focus with less effort. This meta-analysis shows different responses to meditation. The brain responds with both activations and deactivations of various brain regions to meditation, and the brain shows differences between short- and long-term meditators. This study also indicates the specificity of mantra meditation having distinct effects on the brain. This analysis demonstrates the importance of the meditation technique and the individual characteristics of participants when designing mindfulness interventions.

Individual personality traits were found to predict preference for meditation technique (R. Tang & Braver, 2020). Tang and Braver conducted a study comparing focused attention, open monitoring, loving-kindness, and body scan meditation hypothesizing that participant characteristics could predict preference for different styles of meditation. Females prefer loving-kindness meditation over males and those reporting higher levels of empathy and kindness also prefer loving-kindness meditation. Open monitoring was preferred by those reporting higher levels of non-judgment and nonreactivity. Therefore, tailoring interventions to individual preferences may improve adherence to intervention protocols (R. Tang & Braver, 2020).

Mantra, mindfulness, and spiritual meditation prevalence data were collected from the 2012 National Health Interview Survey (n=34,525) and compared to various health behavior data collected from the same survey (Burke et al., 2017). In this study, approximately 1.6% of individuals reported utilizing mantras, 1.9% reported using

mindfulness meditation, and 3.1% reported using spiritual meditation. Former users of alcohol were most likely to use spiritual meditation. This distinction of use, combined with the previously mentioned secularization of meditation, and various neural pathways activated during meditation, called for specific meditation techniques and expected outcomes of interventions to be intentionally paired with interventions (Burke et al., 2017).

Compassion and Self-Compassion

Targeting and testing a specific outcome of meditation will help fill in the gap of what content belongs in mindful meditation interventions. Compassion is a prosocial emotion linked to personal feelings such as empathy and sympathy (see figure 2.6) (Stevens & Woodruff, 2018). Sympathy is an emotion where one person feels badly for another person struggling, while empathy allows an individual to imagine feeling what another is feeling. Compassion takes empathy one step further and adds an element of caretaking. Someone with compassion wants to help others in need. Self-compassion is the desire to help oneself when in need. Compassion and self-compassion are often reported as improved outcomes of meditation interventions (Condon et al., 2013; Engström & Söderfeldt, 2010; A. Lutz, Brefczynski-Lewis, et al., 2008; Tirch, 2010). Compassion is a distinct emotion connected to caregiving and the facilitation of cooperation to protect those who are weak or suffer (Goetz et al., 2010). Lineages of traditional Buddhist meditation teach compassion for those who suffer as one of the primary outcomes of meditation (Tirch, 2010).

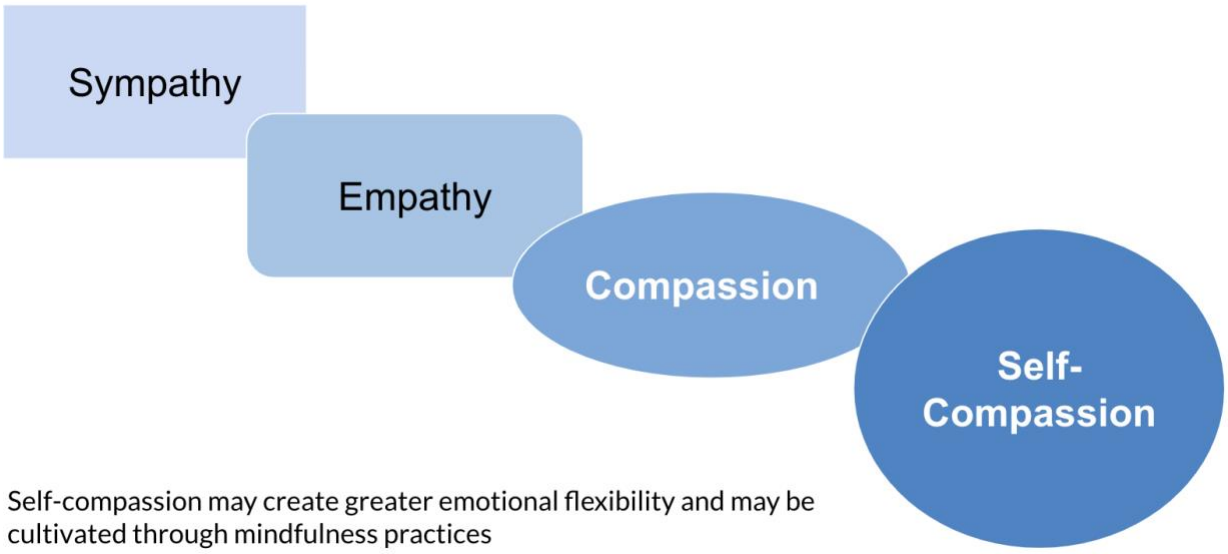

Figure 2.5 – Sliding scale toward Self-Compassion

Compassion has been researched in connection with meditation. Meditators were nearly five times as likely to offer their chair to someone in need than nonmeditators after an eight-week meditation intervention; however, there was no difference in compassionate action between those who practiced mindful meditation vs. compassionate meditation (Condon et al., 2013). Condon et al.'s study demonstrates that the process of meditation may be more important than the modality, challenging prior works citing the importance of meditation technique.

Compassion meditation, also called metta meditation, or loving-kindness meditation, is a foundational element in Buddhist meditation utilized to help eliminate the suffering of others (Tirch, 2010). Metta meditations are a form of focused attention in which the meditator focuses their thoughts on positive statements directed towards others. "I wish happiness and good health for all beings" would be an example of metta meditation (Kim et al., 2020). In a case study focused on an experienced Tibetan Buddhist meditator, activation of the left medial prefrontal cortex and the anterior

cingulate gyrus along with the right caudate body, the right insula, and the left midbrain close to the hypothalamus became active during compassion meditation (Engström & Söderfeldt, 2010). The Tibetan Buddhist meditator's brain activity aligns with regions known for feelings of empathy and happiness. A meta-analysis of 16 studies investigating the neural correlates of compassion identified seven regions of common activation, including frontal, salience, and midbrain regions (Kim et al., 2020). The authors concluded that the range of involved pathways resulted from varying study designs, including loving-kindness meditation to develop compassion, which may better align with empathy than compassion.

Using fMRI to visualize brain activity, Lutz et al.(2008) played sounds that were meant to elucidate various emotions (e.g., a baby crying, laughter, etc.), including compassion, and then compared experienced Buddhist meditators (n=16) to non-meditators (n=16). Non-emotion-producing sounds were also tested, and all participants responded to sounds, even if they did not evoke emotion. Robust differences existed in these groups, with those skilled at developing positive emotion (Buddhist meditators) demonstrating greater compassionate responses.

Self-compassion is adaptive and allows an individual to be caring, kind, and non-judgmental towards oneself during challenging times (NEFF, 2003). Neff further outlines three components of self-compassion as self-kindness (accepting one's pain and difficulty without criticism), common humanity (perceiving your struggles as part of everyday human existence), and mindfulness (holding negative thoughts and emotions at a balanced distance to happier emotions) (Neff & Dahm, 2015). Neff reported on two studies that both identified self-compassion as not simply the lack of negative emotion

and affect but rather a distinct indicator of adaptive psychological function (Neff et al., 2007). The first study used the Self Compassion Scale (SCS) (Neff, 2003) and measures of affect, anxiety, self-esteem, and text analysis during a mock job interview. Neff found a relationship between self-compassion and self-evaluative anxiety when controlled for self-esteem. As self-compassion increased, self-evaluative anxiety decreased. Soysa and Wilcomb (2013) also report self-compassion as distinctly different from a lack of negative affect but rather a multidimensional construct. McKay and Walker (2021) used a population sample of 190 participants with meditation experience, confirming that self-compassion is related to mindfulness, well-being, and happiness in a flourishing model.

Programs and apps are beginning to target compassion and self-compassion as desired outcomes. A pilot program of the “Mindful Self-Compassion Program” showed its ability to improve self-compassion, mindfulness, and well-being outcomes (Neff & Germer, 2013). This pilot program included meditation practice within the 2 to 2.5-hour sessions, once a week, with homework over 8 weeks. Participants showed significant gains in self-compassion and mindfulness from pre- to post-tests. According to a meta-analytic review, smartphone apps targeting acceptance, mindfulness, and self-compassion demonstrate a small but significant improvement in self-compassion; however, methodologies and reporting are inconsistent in many of the included studies (Linardon, 2020). According to Arch et al. Field (2016), not all individuals respond the same way to self-compassion training. Those with higher baseline anxiety or attachment benefitted less than individuals with moderate scores on the same scales.

Condon's research shows that meditation in any form may produce compassion outcomes (Condon et al., 2013). Kim's case study of an experienced Buddhist meditator used metta meditation, referred to as a compassion meditation; however, this technique may align better with empathy than compassion (Kim et al., 2020). While many programs are being developed to target compassion and self-compassion, not all participants respond the same way to compassion training (Arch et al., 2016). There is a gap in the literature about how mindfulness instructors and interventions can best target compassion outcomes.

Study 2 (Chapter 4), investigated the impact of teacher behavior through cueing in a neuroscience-infused meditation intervention. The control group received traditional cueing and the experimental group received enhanced compassion cues while all participants received the same neuroscience content. There was no significant difference between the groups although participants did enhance their self-compassion over time from pre- to post- intervention assessment.

Evaluation and Fidelity

Mindfulness is often taught as a program, and there is a gap in the literature looking at program evaluation for mindfulness interventions. Program evaluation would need to include program implementation fidelity, participant fidelity, and instructor competence. Study 2 of this proposal is a longitudinal education-meditation study targeting the effects of teacher behavior on outcomes of mindful meditation. It contains a curriculum including education on the neuroscience of mindful meditation for four different meditation techniques. Pre- and post-tests will evaluate the effects of neuroscience education and mindful meditation. There are fidelity checks through built-

in timers, participant check-ins, and implementation, which will be designed through a digital execution. A gap in the literature shows no established tool for mindful meditation program evaluation, leaving this program to be designed with considerations for high fidelity and accurate implementation.

One tool was recently developed to evaluate Mindfulness-Based Stress Reduction (MBSR) program instructors. This tool will help ensure program implementation. The Mindfulness-Based Interventions: Teaching Assessment Criteria (MBI:TAC) has been through several variations and versions (Crane & Kuyken, 2019). MBI:TAC was created to evaluate instructors of MBSR programs specifically. The working form is reliable, with Cronbach's alpha at 0.94 with all six domains; content and face validity were confirmed by a group of experts over 18 months (Crane et al., 2013). Nonetheless, the authors suggest that further validation testing needs to be completed. The MBI:TAC prioritizes addressing the teacher process in a way that does not show a preference for one teaching style over another. However, it is unknown if teacher scores on the MBI:TAC relate to student outcomes. The National Institute of Health (NIH) also developed a tool for reporting fidelity in Mindfulness-Based Interventions based on their Behavior Change Consortium Guidelines. This guide promotes a system for reporting fidelity in the literature, which includes addressing the training received by mindfulness instructors; however, it isn't a guide or assessment for improving fidelity or instructor competence (Kechter et al., 2018). The Mindfulness-Based Relapse Prevention Adherence and Competence Scale also exists as a participant fidelity checking (Chawla et al., 2010).

Fidelity of implementation can be high when delivering mindfulness interventions on digital devices; however, participant fidelity to digital interventions isn't extensively studied. A systematic review by Fish et al. (Fish et al., 2016) concludes that digital mindfulness interventions can effectively decrease anxiety and depression; however, more research is needed in content and formatting. Fish et al. (2016) urge that emphasis be placed on evaluating current popular, for-profit platforms and investigating novel combinations utilizing new technology and expert meditators. An updated meta-analysis (Victorson et al., 2020) published in 2020 showed similar findings, that digital mindfulness interventions can reduce negative affect in participants. Victorson et al. suggest exploring new ways to include human support (i.e., occasional in-person instruction, therapist) and rigorous controls for future research. Specific to phone apps, another systematic review suggests that the variety and quantity of available apps make it difficult for users to pick wisely. Without detailed, evidence-based research to support or refute apps, mindfulness app consumers are left without guidance (Schultchen et al., 2021). Overall, there is great potential for low-cost, accessible, non-pharmaceutical use of digital mindfulness programs to support clinical and non-clinical populations if careful consideration is given to the creator's technology and mindfulness field expertise (Fish et al., 2016). There is a gap in the literature addressing mindfulness meditation program evaluation. There is no literature guiding best practices in implementation fidelity, participant fidelity, or teacher competence, or program elements. Therefore, future research is needed to determine program elements required for high-quality mindfulness interventions and best practices in teacher behavior as it directly changes/impacts program implementation.

Study 2 (Chapter 4), investigated this gap in the literature through neuroscience-infused meditation intervention. The program curriculum was based on YY Tang's (2015) outline of mindful meditation including attentional control, emotional control, and self-awareness resulting in enhanced self-regulation. Each of these elements were paired with an appropriate meditation technique and assessed through acute, daily reporting before and after each education-meditation session. Participant fidelity was tracked through time spent on the meditation and the use of these check-in questions. Acute responses indicate a connection to the overall study outcomes as well as demonstrating differentiation among the meditation techniques. This study begins to tease out the programmatic impact of how mindfulness meditation is taught.

Measuring Mindfulness in Motion

The gap in mindfulness research widens when you add the lack of tools to measure mindfulness outcomes to the lack of program evaluation measurements. Additionally, mindfulness in motion is underrepresented in the mindfulness literature, and no measurement tool exists to measure the multidimensional impacts of movement practices on mindfulness. The Yoga Sutras of Patanjali were written in the second century BC and are a collection of statements about what yoga is and is not, emphasizing lifestyle and ethical considerations of yoga (Zambito, 1992). Crossing between chapters two and three, the sutras outline the "Eight Fold Path of Patanjali," an instruction manual with eight steps to practicing yoga. The third step describes the physical qualities of yoga that lead to breathwork. Many of the supporting texts of yoga, such as the Yoga Sutras of Patanjali (Zambito, 1992), the Bhagavad Gita (Easwaran, 2007), and the Upanishads (Eswaran, 2007), focus on mindfulness, meditation, and

contemplative practices (Khalsa et al., 2016). As it is currently practiced in the United States, yoga is mindfulness in motion with the potential to promote physical, mental, well-being, cardiovascular, and immune improvements through self-regulation (Gard et al., 2014). However, yoga is not the only movement practice that promotes well-being. Weightlifting is another place to insert the discipline of mindfulness as an embodied practice, according to Vernon (2018). Runners are adding mindfulness training to their running work-outs. A systematic review of long-distance runners demonstrated decreased competitive anxiety, moderated immune responses to high-intensity running, and improved state-mindfulness with the addition of mindfulness training to their running workouts (Corbally et al., 2020). Mindful Sport Performance Enhancement training also showed benefits to long-distance runners through decreased sports-related anxiety and perfectionism (De Petrillo et al., 2009). This literature demonstrates that added mindfulness training can impact running outcomes and that weightlifting can be perceived as mindful embodiment; however, it is unknown if running or weightlifting has an impact on mindfulness.

A systematic review of mindfulness measurement tools acknowledges that the ten tools examined have distinct features; however, they are not cited equally in the literature. Five Facet Mindfulness Questionnaire (FFMQ) (Carpenter et al., 2019) and Mindfulness Attention Awareness Scale (MAAS) (Brown & Ryan, 2003) are the most frequently utilized and rated as having easy scoring systems. While the FFMQ and MAAS are frequently used as measures of mindfulness, they are not specific to mindfulness in motion. Park et al, (2013) acknowledge that the weak point of most mindfulness measurement tools is their construct validity and further state that more

qualitative evaluation and tools external to mindfulness studies are needed to confirm the validity of future mindfulness measurement tools. Additionally, Davidson and Kaszniak (2015) have pointed out numerous weaknesses in research on mindfulness and meditation, including robust statistical analyses. A systematic review completed in 2017 shows only slow positive progress in improving mindfulness research methods (Goldberg et al., 2017).

Questionnaires, scales, and surveys are frequently utilized in health research; however, they may be overused due to their accessibility, adaptability, and ease of creation (Gillham, 2008). Questionnaires gather information about how people think, feel, and act. The arduous task of tool validation makes questionnaire usage a valuable method in health research. Before creating a new tool, it is essential to do an exhaustive search of existing tools to see if any match your needs (Meadows KA, 2003). This saves the researcher time by either not needing to create a new tool or finding similar tools that can be used later for validity testing. Validation of an instrument includes assurances that the tool is both reliable and valid (Boynton & Greenhalgh, 2004). Reliability verifies that the tool tests and retests as expected in various groups. On the other hand, validity demonstrates that the created tool tests the targeted concept/s.

In Chapter 5, careful attention was taken to follow best research practices with a rigorous process that validated a new tool to measure the multidimensional impacts of movement. The body of literature supporting tool validation is strong and served as a guide during the validation process. There are multiple ways to assess the reliability and validity of a new tool. Using more than one method to confirm validity will reassure researchers that the tool is valid. The gold standard is to use Cronbach's alpha to

measure Inter-observer consistency to measure the tool's reliability. Cronbach's Alpha (Tavakol & Dennick, 2011) is between 0 and 1, measures the similarity of items in a group or scale, and should be above .60; however, a score above .80 is preferred. Higher alpha means less measurement error. Item correlations can also measure the tool's reliability when stronger correlations (closer to 1) among items are present (Ferketich, 1991). Item correlations are helpful when tools are shorter. Test-retest procedures also use correlations. Scores closer to 1 indicate that test-retest answers are similar and that the tool is likely reliable and free from systematic error (Yen & Lo, 2002).

Validity, differing from reliability, may involve qualitative data collection. Content validity can be determined by qualitative data collection from an expert in the field and focus groups, confirming that the new tool targets the desired phenomenon (Rattray & Jones, 2007). Convergent and divergent validity can be established through correlations with existing similar and dissimilar tools. Confirmatory factor analysis aims to confirm that a theoretical model is accurate. Chi-square analysis can confirm a model; however, chi-square analysis is sensitive to the sample size (Alavi et al., 2020). When validating a tool with an a priori factor structure, chi-square analysis may help support the scale's validity. Predictive validity can also be assessed by looking at how subscale scores predict the hypothesis for that subscale in the overall tool (Kumar, 2015).

When tool validation data has been analyzed, sometimes modifications need to be made to question wording or order. Once revisions have been made, the validation process needs to be repeated, gleaning new data from participants, and rerunning

statistical testing. Many tools do initial testing but fail to revise for improvement (Keszei et al., 2010).

Study 3 (Chapter 5), outlines the process of tool creation and validation for the Multidimensional Impacts of Movement Scale (MIMS). MIMS is a valid and reliable tool showing stability over time ($r = 0.737$, $p<0.001$) and strong Cronbach's Alpha for each scale ranging from $\alpha = 0.775$ to $\alpha = 0.840$. Validity was confirmed through a panel of experts, focus groups, gold standard convergent and divergent testing, as well as confirmatory factor analysis. Statistically significant differences were seen among runners, weightlifters, and yogis. MIMS can be used for future movement research, by individuals, and the fitness industry seeking a greater understanding of the multidimensional impacts of movement.

Conclusion

"Mindfulness is the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment "(Kabat-Zinn, 2003). The prefrontal cortex and anterior cingulate cortex are often activated during and after meditation, while amygdala and default mode network activation decreases. This combination of brain activity cultivates attentional control, emotional regulation, and self-awareness to enhance self-regulation. Using neuroscience as the backbone of this dissertation, three significant gaps in mindfulness literature were addressed.

1) To explore the use of Integrative Health Practices (IHP) to improve mindfulness among individuals with substance use disorder and explore the impact of IHPs on the quality of recovery for these individuals.

2) Determine if teacher behavior can influence mindfulness outcomes through guiding words and the program curriculum.

3) Validate a new tool to measure the impact of movement on mindfulness.

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Chapter 3

Future Valuation, Mindfulness, and Active Engagement with Integrative Health Practices Support Recovery from Substance Use Disorders

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ABSTRACT

Objectives: Substance Use Disorders (SUDs) are a global public health concern, causing both financial and health burdens for up to 20% of the world population, which require long-term treatment. Quality of SUD recovery is multifaceted, including aspects of physical, mental, and social health. However, the behavioral determinants underling success in recovery are unknown. We hypothesized that cultivating intentional states of mind through engagement in Integrative Health Practices (IHPs) may be integral in promoting successful recovery. *Methods*: Participants were recruited from the International Quit and Recovery Registry (IQRR), an online platform supporting individuals who self-report substance misuse. Individuals reporting DSM-5 criteria of a lifetime SUD were included (N=242). Engagement in IHPs was assessed using the International Complementary and Alternative Medicine Questionnaire (I-CAM-Q). State of mind was captured using the Five Facet Mindfulness Questionnaire (FFMQ), Mindful Attention Awareness Scale (MAAS), and the Minute Delay Discounting Task. Quality of recovery was assessed using days in recovery, quality of life, craving, and remission status. We utilized linear and logistic regression modeling to assess whether mindfulness, future valuation, and engagement in IHPs predicted our recovery outcomes. *Results*: Our predictors statistically significantly predicted days in recovery, quality of life, and craving along with remission status. Individuals in remission reported greater engagement with IHPs, demonstrated enhanced future valuation, increased mindfulness, decreased craving, and improved quality of life. *Conclusions*: Our results suggest that engaging in IHPs such as meditation, yoga, or tai chi may cultivate states of mind (i.e., mindfulness; future valuation) that promote success in recovery.

Keywords: Mindfulness; quality of life; substance use disorder; recovery; meditation

INTRODUCTION

Substance Use Disorder (SUD) is the recurrent and relapsing use of alcohol and/or drugs that impairs mental health, physical health, and overall quality of life. SUDs are defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as meeting at least two of the eleven criteria listed (see Box 3.1) within the previous twelve months (American Psychiatric Association 2013). These diagnostic criteria demonstrate the multidimensional nature of SUDs, which affect a range of elements, including behavior, physiology, and lifestyle (Witkiewitz et al. 2020). In 2016, 20.8 million people in the United States (US), which is 7.8% of the US population, met these criteria (U.S. Department of Health and Human Services (HHS) 2016) at an estimated cost of 740 billion dollars a year in healthcare, crime, and lost productivity (National Institute on Drug Abuse n.d.).

Recovery from SUD is defined as meeting no SUD criteria in the previous three months, excluding cravings that tend to persist (American Psychiatric Association 2013). Modern definitions of recovery seek to include the heterogeneous nature of SUDs. For example, the Substance Abuse and Mental Health Services Administration defines recovery as “a process of change through which individuals improve their health and wellness, live a self-directed life, and strive to reach their full potential” (Nugent 2012). Similarly, the Recovery Science Research Collaborative defines recovery as, “an individualized, intentional, dynamic, and relational process involving sustained efforts to improve wellness” (Ashford et al. 2019). While abstinence from a substance may be necessary to achieve outcomes, a greater emphasis is being placed on the dynamic qualities of recovery (Dennis and Scott 2007; McLellan et al. 2000). However, to date,

little has been done to date to investigate the multidimensional aspects that support success in recovery.

1. Taking the substance in larger amounts or for longer than you meant to.
2. Wanting to cut down or stop using the substance but not managing to.
3. Spending a lot of time getting, using, or recovering from use of the substance.
4. Cravings and urges to use the substance.
5. Not managing to do what you should at work, home, or school because of substance use.
6. Continuing to use, even when it causes problems in relationships.
7. Giving up important social, occupational, or recreational activities because of substance use.
8. Using substances again and again, even when it puts you in danger.
9. Continuing To use, even when you know you have a physical or psychological problem that could have been caused or made worse by the substance.
10. Needing more of the substance to get the effect you want (tolerance).
11. Development of withdrawal symptoms, which can be relieved by taking more of the substance.

Box 3.1 DSM-5 Diagnostic Criteria for Substance Use Disorders. An individual must meet at least 2 of the 11 criteria to be diagnosed with an SUD.

The Competing Neurobehavioral Decisions Systems (CNDS) Theory posits that decision-making processes are regulated by two overarching neural systems (Bickel et al. 2018). The impulsive system consists of limbic brain regions (e.g., nucleus accumbens, amygdala) and governs reward-driven behaviors that are acted upon immediately. The executive system consists of prefrontal brain regions (e.g., dorsolateral prefrontal cortex) and governs future-driven behaviors that are goal-oriented. Individuals with SUDs have a hyperactive impulsive system and a hypoactive executive system, which causes them to compulsively engage in drug-use behaviors. Psychologically speaking, individuals with SUDs demonstrate a heightened level of impulsivity (de Wit 2009; Kozak et al. 2019; Verdejo-García et al. 2008). Impulsivity is a multidimensional construct that encompasses several behaviors including acting with automaticity, difficulty in suppressing behavior (e.g., inhibitory control), and sub-optimal decision making

processes (Adinoff et al. 2007). That is, the behavior of individuals with SUDs is characterized by automatically responding to internal (e.g., drug craving) or external (e.g., drug-related cues) stimuli through the unconscious and compulsive use of drugs or alcohol. One measure of impulsivity is the behavioral economic task of delay discounting (DD), and we and others have previously shown that individuals with SUDs show significantly steeper discounting rates than healthy controls (Amlung et al. 2017; Yi et al. 2010). Heightened DD rates in individuals with SUDs indicate that decision-making processes are mainly focused on the immediate present, without intentional consideration for long-term future consequences.

In contrast to impulsivity is mindfulness. Mindfulness is an inclusive term that refers to the intentional consideration of thoughts, emotions, and sense perceptions (Tang et al. 2015). Mindfulness is a conscious state that can be cultivated over time, especially through Integrative Health Practices (IHPs) such as meditation, yoga, Tai Chi, or Qi gong. As such, mindfulness has been proposed as an adjunct treatment for individuals in recovery from SUDs, and several mindfulness-based interventions (MBIs) have recently been established such as Mindfulness-Oriented Recovery Enhancement (MORE) and Mindfulness-Based Relapse Prevention (MBRP) (Bowen et al. 2011, 2014; Garland et al. 2019). The idea behind such MBIs is to enhance meta-cognition or the ability to be aware of what you notice without attachment or judgment, to pay attention to what is happening in the moment without perseverating on past or future thoughts, an issue that is common in individuals with SUDs. Through these practices, the individual is able to observe intero- and exteroceptive sensation and accept potential distressing physical or emotional experiences while remaining nonreactive. For example, an individual practicing

mindfulness would be able to acknowledge when a drug craving arose, be able to sit with the experience, and choose not to act on the sensation through the use of drugs.

Mindfulness may be a particularly helpful strategy for individuals with SUDs as mindfulness practices can be seen as cognitive behavioral strategies that target engagement of prefrontal cortical networks (Tang et al. 2015). That is, mindfulness may help to enhance prefrontal cognitive inhibitory control of subcortical structures that are hyperactive in individuals with SUDs, thus enhancing these individuals' ability to regulate impulsive behaviors. Indeed, mindfulness practices such as meditation have been shown to enhance functional activation and connectivity of prefrontal executive control networks (Dodich et al. 2019; Jang et al. 2018; Kwak, Kim, et al. 2019; Kwak, Lee, et al. 2019; Zeidan et al. 2019). Though IHPs are recommended as adjunct treatments for individuals in SUD recovery, little research has been conducted to examine whether and how these practices support success in recovery.

Therefore, the present study examined the hypothesis that among individuals with a lifetime diagnosis of SUD, engagement in IHPs, decreased impulsivity, and increased mindfulness, would significantly predict success in recovery as measured by 1) days in recovery; 2) quality of life; 3) craving; and 4) remission status. We utilized the International Quit and Recovery Registry (IQRR; www.quitandrecovery.org), an online platform dedicated to understanding behaviors that support success in recovery, to gather data from individuals in recovery from SUDs. Our findings support the notion that mindfulness, future valuation and IHPs enhance the outcomes of recovery in individuals with a lifetime history of SUDs. We offer suggestions for clinical practice to support individuals recovering from SUDs to enhance successful recovery outcomes.

METHODS

Participants

Participants were recruited for this study from the International Quit and Recovery Registry (IQRR; https://quitandrecovery.org). IQRR is a voluntary online community of adults in self-reported recovery from substance misuse. IQRR provides resources to learn more about scientific research in the field of addiction and recovery as well as being an online community of support from one participant to another. Participation is voluntary; individuals can join, participate, and exit the community at any time. IQRR offers regular opportunities for participants to engage in survey-based research with compensation of $1.00 per 100 points they receive. Each survey has a reward of up to 1000 points and those points are redeemable at any time.

Inclusion criteria for this study dictates that participants are 18 years or older and meet the DSM-5 criteria for SUD. This was to ensure that participants have a lifetime diagnosis of an SUD. While 758 individuals completed the study and self-reported substance misuse, 413 individuals were excluded as they did not meet the DSM-5 criteria, and 103 individuals were excluded because of incomplete data (i.e., missing delay discounting (n=65); missing days in recovery (n=37); or missing demographics (n=1)). The remaining participants (n=242) were included in data analysis (Figure 3.1). The Institutional Review Board of Virginia Polytechnic Institute and State University approved this study.

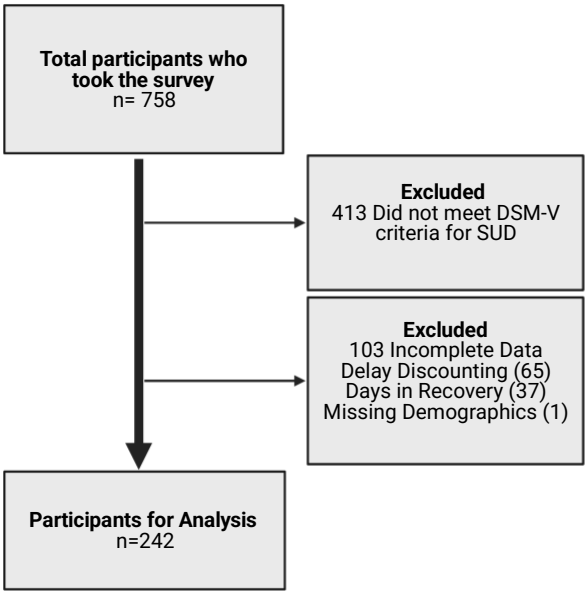

Figure 3.1 CONSORT diagram of participant inclusion for analysis

Study Measures

Demographics: Demographic data were collected in the IQRR initial assessment and included sex, race, ethnicity, employment status, year of birth, level of education, and household income (Table 3.1). Age was calculated by subtracting the year of birth from the year in which the current assessment was completed. Race was described as White/Caucasian, Black/African American, Asian or other (includes those who answered American Indian/Alaska Native, Pacific Islander or other). Employment status was described as not working (includes those who answered not working, laid off, or homemaker), working part-time, working full-time or other. Household income was categorized as low (<$40,000 per year), medium ($40,000 to $119,999 per year), and high (>$120,000 per year). Demographics, DSM-5 status, remission status, along with quality of life measures, were collected through the initial survey at registration with the IQRR.

DSM-5 Diagnostic Criteria for SUD and Remission Status: The DSM-5 (American Psychiatric Association 2013) was utilized to determine which subset of our sample met the criteria for SUD. The DSM-5 provides eleven criteria (see Box 3.1), requiring individuals to report "yes" to at least two items in their lifetime, with more items corresponding to greater severity of the SUD. The DSM-5 also establishes criteria for remission from SUDs. To be considered in remission, individuals must report no SUD criteria (excluding cravings) in the previous three months.

Days in Recovery: In the IQRR initial survey, an intake survey that is completed as participants join the IQRR, participants indicated the first time they tried in earnest to quit each substance they self-reported misusing. The earliest reported quit date for a substance meeting the DSM-5 criteria for SUD was subtracted from the date that the current survey was completed, resulting in the number of days a participant has been in recovery.

World Health Organization Quality of Life Scale (WHOQOL-BREF): The World Health Organization developed the Quality of Life Scale (1998) to address quality of life over a variety of domains. A brief version (WHOQOL-BREF) was later created, based on, and validated against the WHOQOL-100. Individuals are asked to reflect on 26 quality of life statements, over the past two weeks, based on a 5-point Likert scale. The scale includes four domains related to quality of life including physical health, psychological, environmental, and social relationships. For scoring, indicated items are reversed, domains are summed, and raw scores transformed based on the WHOQOL-BREF protocol. The WHOQOL-BREF internal consistency was high, with Cronbach's alpha ranging from 0.66 to 0.84 on each of the four domains.

Brief Substance Craving Scale: The Brief Substance Craving Scale (Somoza et al. 1999) is a self-report questionnaire used in clinical settings to assess substance craving in the past 24 hours. Participants were asked to rate the intensity and frequency of their craving for their primary substance in the past 24 hours utilizing 8 questions. The intensity and frequency scores were summed for a holistic craving score which was used in all analyses.

Delay Discounting: The five-trial adjusting delay discounting task is a measure of future valuation (Koffarnus and Bickel 2014)**.** Participants were asked "Would you rather have $1000 in three weeks or $500 now?" Based on their response, the time delay in the subsequent trial increased or decreased. The time delays continued to adjust based on participant responses in this manner for a total of five trials. The indifference point is the delay at which the reward loses 50% of its value compared to the immediate reward (ED_{50}). The discount rate (k) is calculated as the inverse of the ED_{50}. The natural log transformed discount rate (ln(k)) is utilized in all analyses.

International Complementary and Alternative Medicine Questionnaire (I-CAM-Q): The International Complementary and Alternative Medicine Questionnaire (Quandt et al. 2009) is a tool that demonstrates the epidemiological use of complementary and integrative health practices. The ICAM-Q was developed through an international workshop sponsored by the National Research Center in Complementary and Alternative Medicine (NAFKAM) of the University of Tromsø, Norway, as a standard CAM questionnaire to be used across cultures and countries. Since its publication in 2009 the survey has been translated into various languages and used in studies from many countries, including Iran, Japan, Taiwan, Mexico, Korea, Cambodia, Australia, Saudi

Arabia, Norway, Vietnam, Thailand, Argentina, Germany, and France (Kebede et al. 2021). The I-CAM-Q assesses the frequency of use of practitioners (physicians, acupuncturists, etc.), complementary and integrative treatments (manipulations, needles, etc.), supplements (vitamins, minerals, herbs, etc.), and self-care practices (yoga, meditation, prayer, etc). The frequency of use of all items were summed and reported as Integrated Health Practices.

Five Facet Mindfulness Questionnaire (FFMQ): The Five Facet Mindfulness Questionnaire (Baer et al. 2008) is a valid and reliable (α=0.72-0.92) 39 item self-report measure of trait mindfulness. Items are scored on a 5-point Likert scale and summed for a total score and five subscale scores including observing (e.g., "I notice the smells and aromas of things."), describing (e.g., "I am good at finding words to describe my feelings."), acting with awareness (e.g., "I find myself doing things without paying attention." - reverse scored), non-reacting (e.g., "I perceive my feelings and emotions without having to react to them."), and non-judging (e.g., "I think some of my emotions are bad or inappropriate and I should not feel them." - reverse scored).

Mindful Attention Awareness Scale (MAAS): The Mindful Attention Awareness Scale (Brown and Ryan 2003) measures unique qualities of mindfulness through the lens of self-awareness. MAAS is a 15-item survey that uses a six point Likert scale (almost always to almost never). This survey was tested in various geographic locations, with Cronbach's alpha ranging from 0.80 to 0.87 and an internal consistency of 0.82.

Statistical Analysis

All statistical analyses were conducted using IBM SPSS Statistical Software, version 26. Independent samples Chi-square tests and Fisher's exact tests were performed to compare the distributions of sex, race, household income, education,

ethnicity and employment status between individuals in remission and not in remission. An independent samples t-test was conducted to compare age between groups. We used Pearson correlations, with a Bonferroni correction, to understand the relationships among quality of life, craving, days in recovery, delay discounting, MAAS, FFMQ total and subscale scores, and Integrative Health Practices. Three independent multiple linear regression analyses were used to assess the ability of MAAS, FFMQ, IHPs, delay discounting, and demographic variables to statistically predict the following metrics of success in recovery: 1.) quality of life; 2.) craving; and 3.) days in recovery. A binomial logistic regression was performed to determine the predictive ability of MAAS, FFMQ, IHPs, delay discounting, and demographics on the likelihood that participants would achieve remission status. To determine if there were differences between Remission and non-Remission groups for each of our outcomes of interest (i.e., quality of life, craving, DD, MAAS, FFMQ, Integrative Health Practices), analysis of covariance (ANCOVA) was used, controlling for demographics. To determine significance, an alpha value of 0.05 was used for all regression analyses; an alpha value of p=0.0045 was used for all correlational analyses where a Bonferonni correction was applied.

RESULTS

Participants

242 participants are included in this analysis (79 in remission, 163 not in remission). Participant characteristics are shown in Table 3.1. Age ($p<0.001$), marital status ($p<0.001$), race ($p<0.001$), household income ($p<0.001$), sex ($p<0.001$), ethnicity ($p<0.05$), employment status ($p<0.05$), and education ($p<0.001$) were significantly different between groups. Therefore, we controlled for these variables in subsequent analysis.

	Non Remission	*Remission*	*X2/t*	*p*
Mean age	36.28 (11.57)	45.04 (17.61)	-4.619	0.001
Marital Status			16.04	0.001
% Divorced	8	20.3		
% Married	19	25.3		
% Widow	12.9	1.3		
% Other	60.1	53.2		
Race [1]			20.064	0.001
% White/Caucasian	72.4	91.1		
% Black/African American	20.2	3.8		
% Asian	5.5	0		
% Other	1.8	5.1		
Gender			39.909	0.000
% Female	81	40.5		
% Male	19	59.5		
Ethnicity			7.452	0.006
% Hispanic	16	3.8		
% Non-hispanic	84	96.2		
Employment Status [1]			9.751	0.021
% Not working	45.4	25.3		
% Working part time	15.4	19		
% Working full time	35	51.9		
% Other	4.3	3.8		
Education			47.938	0.000
% Not finished High school	54.6	24.1		
% High school	23.3	16.5		
% Some college	12.9	12.7		
% Bachelor's degree	2.5	17.7		
% Advanced degree	6.7	29.1		
Household income			72.781	0.000
% Low income	83.4	58.3		
% Middle income	14.1	35.5		
% High income	2.4	6.3		

[1] Fisher's exact test

Other race includes those who answered American Indian/Alaska Native, Pacific Islander, or Other

Not working includes those who answered not working, laid off, or homemaker

Table 3.1 Demographics

Quality of Life

Using a linear regression model, the overall model predicting quality of life was significant ($F(11, 230)= 26.468$ $p<0.001$), with our independent variables predicting 53.8% of the variance. Significant elements within the model were MAAS ($p=0.008$, $\beta=0.143$), FFMQ ($p<0.001$, $\beta=0.346$), ethnicity ($p=0.03$, $\beta=0.099$), income ($p<0.001$, $\beta=0.284$), and sex ($p=0.04$, $\beta=0.103$) (Figure 2A). Pearson correlations further show moderate to strong associations between various aspects of mindfulness and quality of life at a significance level of $p<0.0045$ with Bonferroni correction (Figure 2B).

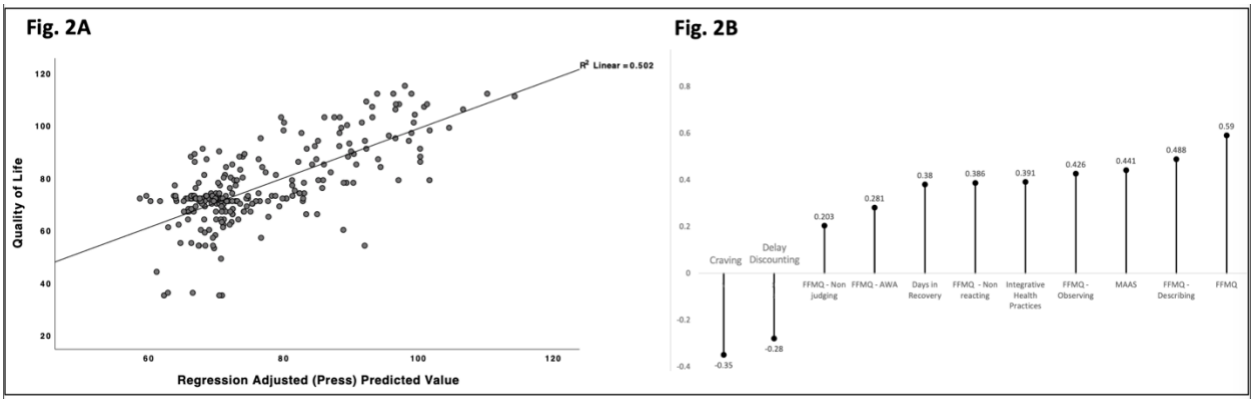

Figure 3.2A Scatter plot showing the positive relationship between Quality of Life and our outcomes of interest
Figure 3.2B Lollipop Chart displays statistically significant correlations among Quality of Life and other study measures

Days in Recovery

The overall model predicting days in recovery was significant ($F(11, 230)=22.638$, $p<0.001$) with our independent variables predicting 53.9% of the variance. Within the days in recovery regression model, MAAS ($p=0.021$, $\beta=0.123$), FFMQ ($p=0.004$, $\beta=0.170$), DD ($p=0.001$, $\beta=-0.172$), and marital status ($p=0.021$, $\beta=0.116$) were significant predictors (Figure 3.3a). Pearson's correlations further show moderate associations between various aspects of mindfulness and days in recovery at a significance level of $p<0.0045$, with Bonferroni correction (Figure 3.3b).

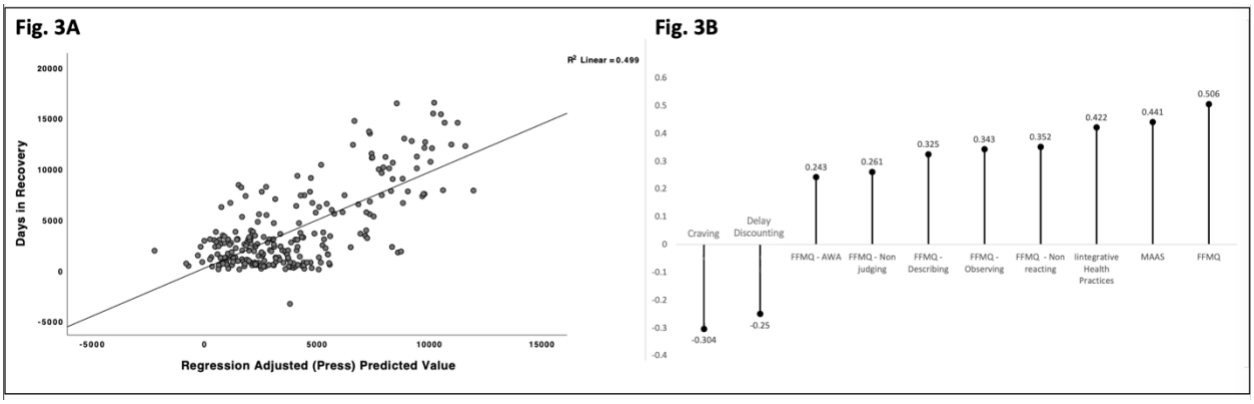

Figure 3.3A Scatter plot showing the positive relationship between Days in Recovery and our outcomes of interest

Figure 3.3B Lollipop Chart displays statistically significant correlations among Days in Recovery and other study measures

Craving

The overall linear regression model predicting craving was significant ($F(11, 230)=8.192$, $p<0.001$) with the independent variables predicting 24.7% of the variance. Within this model, IHPs ($p=0.003$, $\beta=0.220$), and age ($p=0.011$, $\beta=-0.195$) are significant predictors (Figure 4a). Pearson correlations further show negative associations between various aspects of mindfulness and craving at a significance level of $p<0.0045$ with Bonferroni correction, indicating that individuals with increased mindfulness experience less craving (Figure 4b).

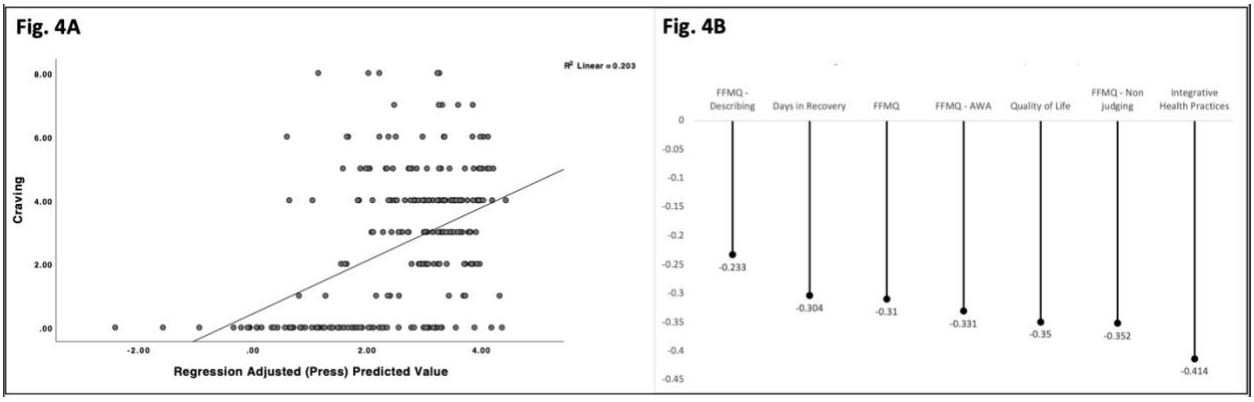

Figure 3.4A Scatter plot showing the positive relationship between Craving and our outcomes of interest
Figure 3.4B Lollipop Chart displays statistically significant correlations among Cravings and other study measures

Remission

A Logistic Regression model predicts remission, in a statistically significant model, ($x^2(11)=77.206$, $p<0.001$), with 58.2% sensitivity and 88.3% specificity. In this model, IHPs, delay discounting, and sex were statistically significant. Between-groups comparisons revealed that individuals in remission reported significantly decreased

craving (F(1,233)=16.885 p<0.001) and significantly shallower delay discounting (F(1,233)=4.964, p=0.019) compared to individuals not in remission. Interestingly, people in remission showed enhanced quality of life (F(1, 233)=6.357, p=0.008), mindfulness (F(1, 233)=4.546, p=0.039), and greater engagement in IHPs (F(1, 233)=9.632, p=0.002) compared to the group not in remission.

The Effect of Specific IHPs on Quality of Recovery

Individual IHPs are associated with an improved quality of recovery. Specifically, meditation shows the greatest correlations to all aspects of recovery measured in this study. The number of times an individual meditated in the previous 3 months was significantly associated with MAAS (r=0.33), FFMQ (r=0.49), delay discounting (r=0.15), quality of life (r=0.36), days in recovery (r=0.40), and craving (r=-0.30) are all significant (p<0.001; delay discounting significant at p=0.02) (Figure 3.5).

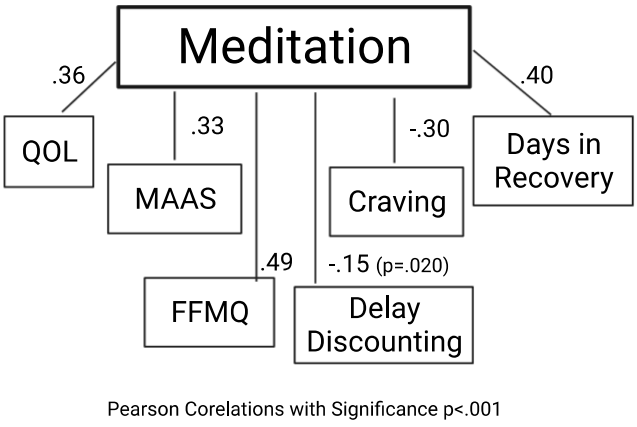

Figure 3.5 Correlations showing the relationships among meditation and our outcomes of interest

DISCUSSION

IHPs, such as yoga, meditation, and prayer, bring an individual into the present moment and have been linked to physical and mental wellbeing in healthy populations.

However, how IHPs support recovery in individuals with SUDs is is unknown. Therefore, the present study examined whether engagement in IHPs and resulting psychological states (i.e., future valuation as measured by DD and mindfulness) predict success in SUD recovery. First, we found that both shallower DD and enhanced mindfulness predicted success in recovery as measured by 1) QOL; 2) craving; and 3) days in recovery. Additionally, individuals in remission, compared to those not in remission, reported greater engagement with IHPs, shallower DD, enhanced mindfulness, decreased craving, and enhanced QOL. Further, more frequent engagement with IHPs was associated with enhanced mindfulness, and engagement with meditation, compared to other IHPs (e.g., yoga, prayer, relaxation), demonstrated the strongest relationship to positive recovery outcomes. Finally, our two metrics of psychological state, mindfulness and future valuation, were significantly associated with each other, indicating that these two states may be cultivated in tandem to optimize success in recovery.

Future Valuation is associated with success in recovery

Our results indicate that DD is a significant predictor of days in recovery and remission status, with lower rates of discounting (i.e., increased future valuation) reported among those who indicated being in remission and have been in recovery for a longer period of time. Further, our results indicate that those with lower rates of discounting have enhanced quality of life, another important indicator of recovery. Our findings are in line with a large body of literature from our lab and others, which have demonstrated that DD is an important contributor to successful recovery outcomes (Amlung et al. 2017; Athamneh et al. 2020; Bickel et al. 2018, 2019; Tomlinson et al. 2020; Turner et al. 2021). Specifically, Athamneh et al. (2020) reported that shallower discounting is related to

improved quality of life as well as the remission status amongst individuals in recovery from alcohol use disorders (AUDs). Moreover, Turner et al. reported a significant association between lower rates of discounting and lower perceived risk of relapse in individuals in recovery from SUDs. Shallower discounting is also related to decreased perceived stress and enhanced locus of control in individuals recovering from SUDs (Tomlinson et al. 2020).

Mindfulness and engagement with IHPs are associated with success in recovery

We additionally found that greater levels of mindfulness predicted improved QOL, decreased craving, and increased days in recovery. Additionally, the individuals who achieved remission status demonstrated higher levels of mindfulness than the non-remission group. Importantly, our data indicated that engagement in IHPs improved recovery outcomes for individuals in recovery from SUDs. Specifically, the practices of meditation, yoga, relaxation techniques, visualization, and praying for one's own health showed significant positive correlations with mindfulness and QOL scores. Meditation practice demonstrated the strongest correlations to mindfulness and future valuation outcomes, along with the indices of success in recovery including, QOL, craving, and days in recovery.

Mindfulness practices have been utilized and studied as treatments for SUDs, and the literature shows positive effects to adding mindfulness to treatment as usual (TAU); however, how long the effects of these mindfulness-based practices persist is unclear (Sancho et al. 2018). The systematic review by Sancho et al. (2018) included 54 papers, with the most commonly cited mindfulness practices being Mindfulness Based Relapse Prevention, Mindfulness Training for Smokers, and Mindfulness-Oriented Recovery

Enhancement, which were all integrated with TAU. Another systematic review of 24 studies found that mindfulness added to TAU can enhance recovery outcomes and decrease consumption of alcohol and many drugs of abuse (Chiesa and Serretti 2014). Our findings along with this body of work suggest that integration of IHPs into the recovery process may support wellbeing, with mindfulness being an integral component of recovery and meditation being an ideal potential treatment intervention for SUD recovery.

We speculate that actively engaging in one's own wellbeing is a part of successful recovery (Ashford et al. 2019; Nugent 2012). One of the reasons why engagement with IHPs may be helpful for success in recovery is because the individual gains a sense of locus of control for their own self care. Self care, as defined by the World Health Organization is the ability of individuals, families and communities to promote, maintain health, and prevent disease (World Health Organization. Regional Office for South-East Asia 2014). The use of these IHPs as self care modalities demonstrates the positive contribution individuals in recovery can make to their own recovery outcomes at little to no cost, on their own schedule, and without the need for medical intervention.

Integration of Mindfulness and Future Valuation

The relationship between future valuation and mindfulness is a newer area of research, with seemingly conflicting goals of getting an individual to consider their future (i.e., future valuation) while staying in the present moment (i.e., mindfulness) (Murphy and Mackillop 2012). Here, we newly show that delay discounting is significantly associated with the conscious state of mindfulness. Limited research to date has addressed the use of both future valuation and mindfulness together as integrated tools to support individuals in recovery from SUDs. One study, however, in young adults found

that delay discounting (as measured by the Monetary Choice Questionnaire) and impulsivity (as measured by the UPPS-P Impulsivity Scale) was positively associated with alcohol involvement whereas mindfulness was negatively associated with alcohol involvement (Murphy and Mackillop 2012). Further, they found that various aspects of impulsivity including negative urgency, lack of perseverance, lack of premeditation, sensation seeking, and positive urgency, was negatively associated with mindfulness. (Murphy and Mackillop 2012) found no association between delay discounting and mindfulness; however, the population used was a group of undergraduate students without SUDs.

To integrate the concepts of mindfulness and future valuation and their impact on recovery into behavioral theories underlying SUDs may be useful. SUDs function, in part, as a valuation disorder in which an individual's decision making processes become pathological, leading them to value smaller, immediate rewards over larger, later rewards - resulting in the outcome of substance misuse (Bickel et al. 2012). In fact, Reinforcer Pathology Theory suggests that SUDs result from the synergistic interactions of both excessive valuation of a substance and excessive preference for immediate rewards, which is evidenced as steep temporal discounting (Bickel et al. 2011, 2014). In tandem with Reinforcer Pathology Theory, CNDS Theory, a neurobiological theory of economic decision (Bickel et al. 2007), demonstrates that SUDs are linked to dysregulation in both the impulsive and executive systems of the brain, with hyperfunctioning in the impulsive areas (e.g., nucleus accumbens, amygdala) and hypofunctioning in executive areas (e.g., prefrontal cortex, hippocampus) (Bickel et al. 2019).

Though future valuation is relatively steady over time, it can be altered with interventions (Landes et al. 2012). In fact, Reinforcer Pathology Theory predicts that alteration of the temporal window will shift the valuation of the reinforcer and that by increasing an individuals' temporal window, you can decrease the preference for immediate reinforcers. That is, the neurobiological imbalance can be targeted to find balance in the CNDS regions, decreased substance misuse, and enhanced recovery processes (Bechara and Damasio 2005). Interestingly, mindful meditation acts directly on the same brain regions involved in the CNDS, specifically promoting decreased reactivity of the impulsive system and heightened functioning of the executive system. Behaviorally speaking, mindful meditation helps to increase self-regulation through attentional control, emotional control, and self-awareness (Tang et al. 2015). These changes may be key factors in mindful meditation's influence on quality of recovery (Garland and Howard 2018). Mindfulness may increase awareness of triggers, behaviors, and alternatives, creating a pause to think, decreasing impulsivity, and making more space for informed decision making (Ludwig et al. 2020). Additionally, behavior change, such as a reduction or elimination of substance use, may also be supported by mindfulness practices through awareness of prediction error (Schuman-Olivier et al. 2020). The pause to step away and look at thoughts, feelings, and senses, may allow an individual to see how their impulse to use a substance may not meet their long-term abstinence goals. Therefore, the individual has time to correct the prediction error before acting upon the impulse and consuming the substance. Schuman-Olivier et al. (2020) continue to postulate that metacognitive monitoring and meta-awareness of mindfulness states may be instrumental in the neuroplastic changes needed for long-term recovery. We hypothesize

that as executive function enhancement is a result of increased mindfulness (Schuman-Olivier et al. 2020; Tang et al. 2015), mindfulness interventions including future valuation measures should be studied with regard to quality and success in recovery.

LIMITATIONS AND FUTURE DIRECTIONS

We acknowledge several limitations of the current study. First, the study population comes from an online community, IQRR, which is dedicated to education, support and research on recovery. This self-selection to join and participate potentially poses a bias from the start. IQRR is an online community, requiring participants to share their email address and have access to the internet. Additionally, the nature of cross-sectional data only provides us with associations, limiting the directional conclusions that can be drawn from this data. Further, the majority of the measures are self-report rather than objective, and could add additional bias to the study.

The strong findings from this work suggest potential for future longitudinal studies. Specifically, randomized controlled trials should be conducted to determine which IHPs have the greatest impact on SUD recovery. Considering that meditation was the strongest IHP predictor of success in recovery, different types of meditation such as focused attention meditation or open monitoring meditation may be compared to investigate their influence on recovery. Also, developing targeted interventions for SUD recovery using a variety or combination of IHPs is suggested. Based on the current findings, we also suggest using mindful meditation in combination with episodic future thinking (EFT), an intervention that directly targets delay discounting. EFT is the process of generating vivid, positive future events and actively engaging with them on a daily basis. EFT in combination with meditation may prove especially effective in the treatment of SUDs.

Finally, future research will need to focus on the necessary frequency and duration of IHPs to induce a positive outcome on recovery.

Conclusions

Using a large, international cohort of individuals in recovery from SUDs, we found that both DD and mindfulness were significantly associated with success in recovery as evidenced by QOL, craving, days in recovery, and remission. Further, we found that mindful states could be cultivated by engagement in IHPs, especially the practice of meditation. Importantly, DD and mindfulness were significantly associated with one another, suggesting that interventions such as meditation and episodic future thinking, which target those psychological states, respectively, could be combined for optimal recovery outcomes. These findings have important clinical outcomes. Specifically, developing a high quality of recovery from SUDs includes individuals taking intentional steps in the process of improving their wellbeing. Engaging in self care practices, including mindful meditation, may target the same neurobiological underpinnings that can adjust the temporal window, decrease the rate of discounting, and balance the CNDS. Future interventional studies are needed to investigate the use of mindfulness-based practices in combination with EFT on SUD recovery outcomes. We hypothesize that a combinatorial approach will help to enhance self-regulatory processes in individuals in SUD recovery, enhancing the multiple domains of recovery beyond abstinence and towards an improved overall quality of life.

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Chapter 4

Effects of a neuroscience-based mindfulness program on psychological health

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ABSTRACT

Introduction

Mindfulness and meditation have a rich historical tradition and a growing scientific base of evidence to support its use in creating positive psychological and neuroplastic change for practitioners. It is critical that the instruction of mindfulness be evidence-based as meditation is being used in clinical settings. This study investigated the use of teacher cueing and the integration of neuroscience education into a meditation program, hypothesizing that participants receiving compassion cueing will have enhanced outcomes over participates receiving functional cueing. Further, it is hypothesized that the integration of neuroscience education will enhance study outcomes.

Methods

Participants (n=89) were recruited via social media, university listservs, and local businesses of interest. Those with English proficiency and access to a digital device for study implementation were included and those with recent trauma or diagnosed and untreated mental illness were excluded. Participants were randomized into two groups, those receiving functional cues and those receiving compassion cues, engaged with 5 daily, 10-minute meditations a week for the duration 4 weeks. They completed before and after check-in questions surrounding the daily intervention. Participants engaged in pre- and post-intervention questionnaires.

Results

No significant between group changes were found; however, participants demonstrated benefits over the duration of the intervention with increases in mindfulness and self-compassion, decreased depression symptomology, and gains in neuroscience content.

Gains in neuroscience knowledge were not correlated to other study outcomes. Daily scores also showed a significant movement from active towards settled both daily and across the intervention. The change in daily scores about thoughts, body, and the total change are correlated to the change in mindfulness. The daily change in emotions is correlated to change in self-compassion, pointing to a relationship between the acute and longitudinal outcomes of meditation.

Conclusion

This study supports the behavioral importance of practicing meditation in order to improve psychological well-being.

INTRODUCTION

Mindfulness and meditation have a rich historical evidence base, originating in Asia as part of Buddhist and Yogic traditions. The Yoga Sutras of Patanjali (Zambito, 1992) introduce mindfulness through the awareness of self. Bhikkhu Bodhi, in Contemporary Buddhism (Bodhi, 2011), traces the history of mindfulness back to the Pali Canon (written in the 1st century BCE), a canonical text foundational to Buddhist traditions. A modern interpretation of the Pali Canon describes mindfulness to be “lucid awareness”. Bodhi establishes that a secular use of mindfulness to alleviate suffering is warranted; however, he cautions against simplification of the concepts in order to understand and study mindfulness. John Kabat-Zinn, the founder of the Center for Mindfulness at the University of Massachusetts Memorial Medical Center in the 1970s, defines mindfulness as “…the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment.” (Kabat-Zinn, 2003). This modern definition is free from spirituality and establishes a baseline set of characteristics to assess the psychological state of mindfulness (Deshmukh, 2006).

Meditation is a non-pharmaceutical, low-cost practice that can be integrated into a healthy lifestyle and promotes the psychological outcome of mindfulness (Tang et al., 2015). A systematic review and meta-analysis show that meditation significantly decreases symptoms of anxiety (Chen et al., 2012), while others have shown that meditation lessens symptoms of depression (Schreiner & Malcolm, 2008). Meditation is also beneficial for improving levels of attention, an executive function dependent on the prefrontal cortex (Rubia, 2009). Self-compassion is yet another outcome promoted by the practice of meditation (Germer & Neff, 2013). Though meditation is often studied in

healthy populations, the benefits of meditation are also being studied in specific clinical populations such as those with psychiatric illness and substance use disorder (Dakwar & Levin, 2009). The scientific literature supporting the benefits of mediation are increasing, and it is now time to look at best practices to teach and augment the benefits of meditation.

The use of mindful meditation is not standardized (Grabovac & Burrell, 2017). Specifically, no professional or regulatory body exists to support teaching or implementing mindfulness interventions in a scientific or clinical setting (Farias & Wikholm, 2016). In a review by Farias and Wikholm, they highlight the many promised outcomes of mindfulness related to mental and physical health (R. A. Baer, 2003; Grossman et al., 2004) but note that in order to optimize outcomes, physical and mental health practitioners will require specific training and certification in mindfulness techniques (Farias & Wikholm, 2016). It is recommended that instructors of mindful meditation have embodied experience with the practice (Woods, 2009). Translating personal experiences into clinical interventions of mindfulness, however, requires careful consideration. Lessons learned from a clinical experience in the United Kingdom (Crane et al., 2010) outline six domains of teacher competence: 1) coverage and pacing of session curriculum; 2) relational skills; 3) guiding mindfulness practices; 4) conveying course themes through interactive teaching; 5) embodiment of mindfulness, and 6) management of group process. In their handbook, *Resources for Teaching Mindfulness,* McCown et al. (2016), suggest that scientific literacy is also a foundational competency for teachers of mindful meditation. However, it is unknown if scientific literacy about mindful meditation changes participant outcomes.

The significant effects of mindfulness on neuroplasticity and the use of mindfulness in clinical settings creates an imperative to address how mindful meditation is taught (i.e., the content of the intervention, including key facts and techniques) and how instructor behavior affects participant outcomes (Crane et al., 2010). This study begins to fill this gap in the literature by looking at the following questions: 1) How does teacher behavior impact participant outcomes?; 2) Should content about the neuroscience of mindfulness meditation be included as a standard element (i.e., competency) of mindfulness interventions?; and 3) What impacts do dose and technique of mindful meditation have on study outcomes?

Here, we explore how teachers of mindfulness use their words and curriculum to guide and instruct meditation to optimize outcomes, including compassion and self-compassion. Improved compassion and self-compassion are common outcomes of meditation interventions (Condon et al., 2013; Engström & Söderfeldt, 2010; Lutz et al., 2008; Tirch, 2010). Compassion is a prosocial emotion connected to caregiving and the facilitation of cooperation to protect those who are weak or suffer (Goetz et al., 2010). Lineages of traditional Buddhist meditation teach compassion for those who suffer as one of the primary outcomes of meditation (Tirch, 2010). Self-compassion is a distinct indicator of adaptive psychological function associated with mindfulness practices (McKay & Walker, 2021; K. Neff, 2003; K. D. Neff, 2011). Ferrari et al. (2019) conducted a meta-analysis to examine interventions that improve self-compassion, indicating that mindfulness is a mechanism to improve this psychological state. Further studies confirm the relationship between mindfulness and self-compassion (Duarte & Pinto-Gouveia, 2017; Nedeljkovic et al., 2012), with self-compassion becoming an essential component

of modern mindfulness training programs (R. A. Baer et al., 2012; Birnie et al., 2010; Kuyken et al., 2010).

Through a single-blind randomized control trial, two groups provided a comparison of two different styles of teacher behavior through varied cueing. The control group received lightly guided meditations with functional cueing (i.e., “If you are distracted, return to the mantra”), and the experimental group received lightly guided meditations with functional cueing plus added compassion cueing (i.e., “When you are distracted, remember it’s okay. Do your best to return to the mantra.”). We hypothesized that compassion cueing would enhance our outcomes of interest, including improvements in mindfulness, compassion/self-compassion, and mental health. Additionally, this study evaluated the impact of adding neuroscience education to mindful meditation. We hypothesized that gains in neuroscience knowledge would significantly correlate to our outcomes of interest. Before and after meditation, daily check-ins provided information about the acute effects of meditation on thoughts, emotions, and bodily sensations. We hypothesized that larger acute gains would correlate to larger long-term gains from meditation. Understanding the impact of the curricular implementation of meditation will help fill in the gap of best practices and competencies for inclusion in future mindfulness interventions.

METHODS

Participants

To be eligible for the study, participants were required to be 18 years old and have English as their primary language. Exclusionary criteria included active trauma or diagnosed and untreated psychiatric illness which were all self-report through an initial

screening questionnaire developed by investigators. Virginia Tech's Institutional Review Board (IRB) reviewed and approved this study (IRB-20-799), and all participants completed informed consent. Recruitment was conducted using social media platforms as well as other online forums through Virginia Tech. Virginia Tech faculty who were teaching related content (i.e., mindfulness and meditation) announced the study to their classes as well. Participants were compensated up to $25 for their participation, with proration occurring at $2.50 for pre-test, $1 for each day of meditation, and $2.50 for post-test.

Study Design

This study was a four-week randomized control trial (RCT), with participants randomized (using a random number generator) to receive either meditation with functional cues (control group) or meditation with self-compassion cues (experimental group). This RCT was partially blinded as the investigators knew participant group assignment; however, participants were unaware of their group assignment. The study included 10-minute sessions, five days a week. Each day, participants were instructed to watch a 10-minute prerecorded education-meditation video. The control group received standard, functional meditation directions (i.e., "If you are distracted, return to the mantra."), while the experimental group received functional meditation directions and additional self-compassion cueing (i.e., "When you are distracted, remember that's okay. Try to return to the mantra."). Both groups received identical neuroscience education portions of this study. Participants engaged in neuropsychological assessments before and after the four-week intervention. Additionally, participants

completed momentary assessments before and after the presentation of the daily education-meditation video.

Pre-Test	Acute Assessment – Before and after each meditation	Post-Test
Five Face Mindfulness Questionnaire (FFMQ)	How are your thoughts? How are your emotions? How is your body? 10-point Likert Scale from Settled to Active	Five Face Mindfulness Questionnaire (FFMQ)
Mindful Attention Awareness Scale (MAAS)		Mindful Attention Awareness Scale (MAAS)
Compassion Scale (CS)		Compassion Scale (CS)
Self-Compassion Scale (SCS)		Self-Compassion Scale (SCS)
Beck Anxiety Scale		Beck Anxiety Scale
Beck Depression Scale		Beck Depression Scale
Neuroscience Knowledge Check (NKC)		Neuroscience Knowledge Check (NKC)

Table 4.1 Assessments by timepoint

The weekly schedule was the same for each of the four weeks. Day one included seven minutes of neuroscience education and 3 minutes of meditation. Days two, three, and four included 5 minutes of neuroscience education and 5 minutes of meditation. The final day of the week was a 10-minute meditation practice (see Table 4.2).

Minutes	1	2	3	4	5	6	7	8	9	10
Day 1	Neuroscience Education							Meditation		
Day 2	Neuroscience Education					Meditation				
Day 3	Neuroscience Education					Meditation				
Day 4	Neuroscience Education					Meditation				
Day 5	Meditation									

Table 4.2. Weekly schedule for the division of time spent in the intervention. This was repeated 4 times, with a new meditation technique provided weekly.

The education-meditation curriculum was designed by a Ph.D. neuroscientist and an experienced meditation teacher with over 10,000 hours of teaching (see supplemental document 4.1). The curriculum scaffolds from week to week to offer participants a comprehensive mindful meditation learning experience (Table 4.2). The first week of the curriculum focused on attentional control and utilized a focused attention meditation. Focused attention meditation used the mantra or repeated phrase, “I am alive. I am at ease.” The second week of the curriculum focused on emotional control and utilized an open monitoring meditation. This technique called “The movie of your mind” instructed participants to watch their thoughts without engaging with or trying to change them. The third week of the curriculum focused on self-awareness and utilized the practice of embodiment or connecting mind and body through intentional movement with awareness. Hand turning paired with the breath facilitated mindful embodiment as participants were guided to feel and respond to bodily sensations. The fourth week of the curriculum focused on self-regulation and utilized the practice of breath control. Participants were instructed to observe their breath without interrupting it.

	Week 1	Week 2	Week 3	Week 4
Neuroscience	Attentional Control	Emotional Regulation	Self-Awareness	Self-Regulation
Meditation Style	Focused Attention	Open Monitoring	Embodiment	Breath Control
Meditation Technique	Mantra	Movie of your Mind	Hand Turning	Observing the Breath
All groups received the same neuroscience curriculum. During meditation, the control group received functional cues and the experimental group received functional cues plus compassion cues.				

Table 4.3. This table displays how neuroscience concepts, meditation style, and meditation techniques are related and utilized in this study design.

In terms of the weekly flow of the experiment, participants received an email (on Sunday) with a link to begin their education meditation on the following day. The provided link took the participants to a Qualtrics survey with three daily questions. The questions were on a 10-point Likert Scale ranging from Settled (1) to Active (10). The questions included: 1) “How are your thoughts?”; 2) “How are your feelings?”; and 3) “How is your body?”. These questions were followed by a pre-recorded video with neuroscience education content and lightly guided meditation (see Supplementary Document 4.1), followed by a repeat of the daily questions. Once the second set of daily questions was complete, automation in Qualtrics sent the next day’s link twelve hours later. This system allowed participants flexibility to fit their meditations into the most convenient and reliable time during their days. If participants missed a session, reminder emails nudged participants to complete the sessions over the weekend, accomplishing five sessions every seven days.

Time spent on the 10-minute video was monitored in Qualtrics with a clock feature on the embedded video page. Less than 10 minutes assured they did not complete the session, and much more than 10 minutes suggested that they may have been distracted with other tasks or fallen asleep. Participants displaying inconsistent times more than once were removed from the study (n=3).

Study Measures

Beck Anxiety Inventory (BAI)

The Beck Anxiety Inventory (BAI) (Borden et al., 1991) is a self-report measure of anxiety symptoms. Questions about somatic and psychological experiences related to anxiety are included. BAI includes 21 items for reflection on a 4-point Likert scale with 0 paired with “Not at all” and 3 paired with “It bothered me a lot.” The total score is calculated by summing responses for each question. Results range from 0-21 = low anxiety; 22-35 = moderate anxiety; and 36 and above = potentially concerning anxiety levels. BAI demonstrates high internal consistency with a Cronbach’s alpha = 0.91 with median item correlations at r = 0.56. Principal Components Analysis (PCA) with eigenvalues greater than 1.0 with a varimax rotation converged in 19 iterations, resulting in five factors, which accounted for 60% of the variance.

Beck Depression Inventory (BDI)

The Beck Depression Inventory (BDI) (Beck et al. 1988) is a self-report measure of depression symptoms, with over twenty-five years of validity testing. BDI has 21 items, organized like multiple-choice questions, instructing the participant to select the phrase that best reflects their response to the prompt (e.g., “I do not feel sad”, “I feel sad, I am sad all the time, and I can’t snap out of it”, or “I am so sad and unhappy that I can’t stand it”). Each possible response has an assigned value from 0 to 3, summed for a total score. The sums are then rated as: 1-10 = These ups and downs are considered normal; 11-16 = mild mood disturbance; 17- 20 = borderline clinical depression; 21-30 = moderate depression; 31-40 = severe depression; and over 40 = extreme depression. BDI’s reliability was tested in clinical, Cronbach’s alpha = 0.86 , and non-clinical, Cronbach’s alpha = 0.8, populations. The test-retest reliability showed $r > 0.60$. Concurrent validity with the Hamilton Psychiatric Rating Scale for Depression (HRSD)

(Miller et al., 1985) showed r = 0.72 to 0.73 for clinical populations and r = 0.60 to 0.74 in nonclinical populations.

Five Facet Mindfulness Questionnaire (FFMQ)

The Five Facet Mindfulness Questionnaire (FFMQ) (R. A. Baer et al., 2006) is a self-report measure of trait mindfulness behaviors and mindful thought patterns. It is valid and reliable, demonstrating a Cronbach's alpha ranging from 0.72 to 0.92. Confirmatory factor analysis with a principal axis factoring with oblique rotation along with scree plots suggests a five-factor structure. The FFMQ has 39 items and utilizes a 5-point Likert Scale with 1 representing "Never or very rarely true" and 5 representing "Very often or always true". The five subscales include observing, describing, acting with awareness, non-reacting, and non-judging. Scoring uses the total sum and sums of subscales, with specific questions scored in reverse.

Mindful Attention Awareness Scale (MAAS)

The Mindful Attention Awareness Scale (MAAS) (Brown & Ryan, 2003) measures unique qualities of mindfulness and consciousness. MAAS includes 15 items without subscales. Items are scored by individuals on a 6-point Likert scale with 1 representing "Almost always" and 6 representing "Almost never". MAAS was tested in various populations with Cronbach's alpha ranging from 0.80 to 0.87, and after final modifications, the internal consistency of 15 items was alpha = 0.82. In a general adult population, Cronbach's alpha was 0.87. Known group validity showed sensitivity to Zen meditators, clinical populations, and the general adult population.

Self-Compassion Scale (SCS)

Kristen Neff created the Self-Compassion Scale (SCS) (K. D. Neff, 2003) as a self-report measure of kindness and understanding towards oneself during times of struggle. SCS is a 26-item scale measured on a 5-point Likert Scale, with 1 representing “Almost never” and 5 representing “Almost always”. SCS has 6 subscales: self-kindness, self-judgement (reverse scored), common humanity, isolation (reverse scored), mindfulness, and over-identification (reverse scored). Scoring is completed by calculating the means of each subscale, reversing where indicated, and then taking a sum of the subscale means. Cronbach’s alpha (0.92) shows high internal consistency. The Cronbach’s alpha ranged from 0.75 to 0.81 on each of the six subscales. Test-retest ($r = 0.93$) overall and subscales range from $r = 0.80$ to 0.88. Exploratory structural equation modeling found a good fit with six factors, and 95% of the variance was attributed to the general factor.

Compassion Scale (CS)

The Compassion Scale (CS) (Pommier et al., 2020) is a self-report measure of one’s kindness and desire to lessen the suffering of others. CS includes 16 items divided among 4 subscales: kindness, common humanity, mindfulness, and indifference (reverse scored). The overall score is a total mean. Subscales are also represented as means. A variety of studies show the CS to be reliable, with Cronbach’s alpha ranging from 0.77 to 0.90. Test-retest reliability demonstrated $r = 0.81$. Known group validity showed marked differences, as expected in meditators versus non-meditators. Structural equation modeling found a good fit with three positive subscales and one negative subscale.

Neuroscience Knowledge Check (NKC)

To assess neuroscience knowledge, we created a Neuroscience Knowledge Check to partner with content presented in the education portion of this study (see supplemental document 4.2). This knowledge check helped determine if neuroscience knowledge acquisition influences mental health, compassion, and mindfulness outcomes. There were 50 items with 4 subscales paired with one of each of the four meditation techniques. Each question was multiple choice with two incorrect answers, one correct answer, and a selection for “I don’t know”. The inclusion of “I don’t know” as an answer offered participants an honest way to report what they actually know rather than having participants guess at the correct answer. The total score is a sum of the number of correct answers.

Power and Statistical Analysis

An a priori power analysis was run using G*Power 3.1 to determine the appropriate number of participants to power this study. We utilized an F test, ANOVA: repeated measures, within-between interaction using an effect size of 0.25, an alpha error probability of 0.0001 to correct for multiple testing, a power level of 0.08, 2 groups (functional versus compassion cueing), 2 measurements (pre- versus post-testing), correlation among repeated measures of 0.5, and a non-sphericity correction epsilon of 1 to determine a sample size of n=98.

Repeated Measures Analysis of Variance (ANOVAs) with within-between interactions (within: time; between-group) were conducted to examine the hypothesis that teacher behavior, including compassion cues, will significantly enhance mindfulness (i.e., FFMQ, MAAS), compassion (i.e., CS, SCS), and mental health (i.e., BAI, BDI) outcomes compared to the control group. We further hypothesized that a

greater gain in neuroscience knowledge (i.e., NKC) would be significantly associated with greater changes in mindfulness, compassion, and mental health outcomes as shown using Pearson's product-moment correlations. Additionally, paired-samples t-tests were used to assess the acute effects of meditation through before and after questions (i.e., How are your thoughts/emotions/body?) during each day of the intervention, and repeated Measures ANOVAs were used to determine differences between the types of acute changes (i.e., thoughts, emotions, body) across the 20 days of the intervention. Post-hoc analyses were used to determine specific changes where main effects were seen. An alpha value of $p<0.05$ was utilized to determine statistical significance. To correct for multiple testing in a family of analyses, Bonferroni corrections were used as appropriate. SPSS Version 27 was utilized for all statistical analyses (*IBM SPSS Statistics for Macintosh*, 2020). Due to a randomization, neuropsychological assessments were conducted on different numbers of participants, as reported in the results.

RESULTS

Participants

Demographics

N = 89	Frequency (Percentage)		Frequency (Percentage)
Sex		**Marital Status**	
Female	65(73)	Divorced	8(9)
Male	23(25.8)	Living with significant other	10(11.2)
Other	1(1.1)	Married	44(49.4)
Race		Single (Never Married)	26(29.2)
Asian	13(14.6)	Widow/Widower	1(1.1)
Black/African American	5(5.6)	**Annual Income**	
Other	4(4.5)	Under $15,000	3(3.4)
White/Caucasian	67(75.3)	$15,000 to $24,999	11(12.4)
Ethnicity		$25,000 to $34,999	7(7.9)
Hispanic	2(2.2)	$35,000 to $49,999	14(15.7)
Non-Hispanic	87(97.8)	$50,000 to $74,999	6(6.7)
Education		$75,000 to $99,999	14(15.7)
Advanced degree	65(73)	$100,000 to $149,999	14(15.7)
Bachelor's degree	19(21.3)	$150,000 to $199,999	8(9)
Some college	4(4.5)	$200,000 and over	11(12.4)
Finished high school	1(1.1)	**Employment**	
		Homemaker	4(4.5)
		Not working	7(7.9)
		Retired	13(14.6)
		Working full time	46(51.7)
		Working part time	19(21.3)

Table 4.4 Participants included in data analysis

Measurements assessed before and after the intervention

No significant interaction (time*group) effect was found between the groups for any study outcomes. However, a significant time effect was found for mindfulness (Figure 4.1A; FFMQ: $F(1,75) = 26.595$, $p<0.001$, partial $Eta^2 = 0.262$), with mindfulness

scores significantly increasing from pre- to post-test. This effect was driven by the FFMQ subscales of observing ($F(1,75)=12.680$, $p<0.001$, partial $Eta^2 = 0.145$), describing ($F(1,75)=10.566$, $p=0.002$, partial $Eta^2 = 0.123$), acting with awareness ($F(1,75)=5.706$, $p=0.019$, partial $Eta^2 = 0.071$), nonjudging ($F(1,75)=8.108$, $p=0.006$, partial $Eta^2 = 0.098$), and nonreactivity ($F(1,75)=24.622$, $p<0.001$, partial $Eta^2 = 0.247$) (Supplementary Document 4.3).

Additionally, a significant time effect was found for self-compassion (Figure 4.1B; SCS: $F(1,70) = 26.406$, $p<0.001$, partial $Eta^2 = 0.274$), with self-compassion scores significantly increasing from pre- to pos-test; however, no significant interaction (time*group) was found. This effect was driven by the SCS subscales of self-kindness ($F(1,70)=15.942$, $p<0.001$, partial $Eta^2 = 0.185$), self-judgment ($F(1,70)=5.149$, $p=0.026$, partial $Eta^2 = 0.069$), isolation ($F(1,70)=14.091$, $p<0.001$, partial $Eta^2 = 0.168$), mindfulness ($F(1,70)=16.070$, $p<0.001$, partial $Eta^2 = 0.187$), and overidentification ($F(1,70)=169.324$, $p<0.001$, partial $Eta^2 = 0.708$) (Supplementary Document 4.3).

A significant time effect was also found for depression (Figure 4.1C; BDI: $F(1,78) = 32.852$, $p<0.001$, partial $Eta^2 = 0.296$), with depression scores significantly decreasing from pre- to post-test; however, no significant interaction (time*group) was found.

Finally, a significant time effect was found for neuroscience knowledge (Figure 4.1D; NKC: $F(1,87) = 126.387$, $p<0.001$, partial $Eta^2 = 0.592$), with scores increasing from pre- to post-test; however, no significant interaction (time*group) was found (Supplementary Document 4.3).

No significant time nor time*group effects were found for anxiety (BAI), compassion (CS), or dispositional mindfulness (MAAS) (Supplementary Document 4.3; $p>0.05$).

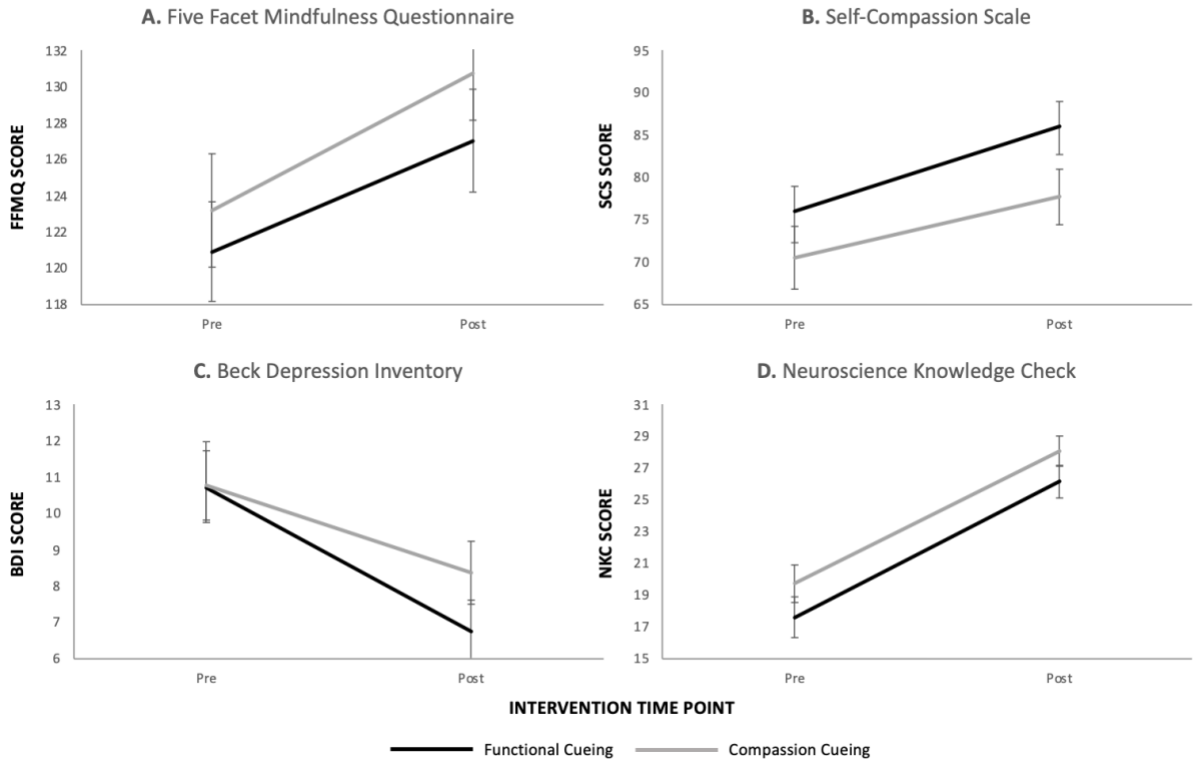

Figure 4.1 Pre- and post-test measurements between groups receiving either functional cueing or compassion cueing, n=89 for all tests. A) Five Facet Mindfulness Questionnaire, B) Self-Compassion Scale, C) Beck Depression Inventory, and D) Neuroscience Knowledge Check. All time effects are significant at $p<0.001$.

Measurements assessed before and after the daily education-meditation practice

Because no significant time*group differences were established for measurements assessed before and after the intervention, the following data were analyzed across groups. Daily scores were significantly lower after the meditation than daily scores before the meditation on all days ($p<0.001$), demonstrating a significant

acute effect of the daily education-meditation practice from a state of active toward settled (Figure 4.2; Supplementary Document 4.4).

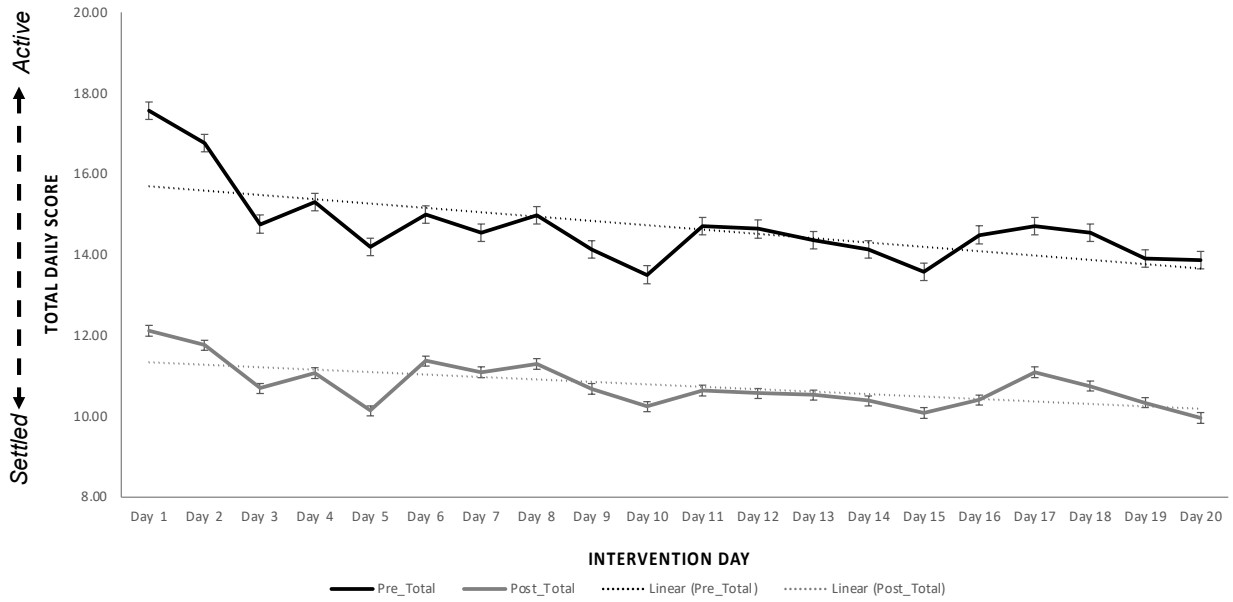

Figure 4.2 Mean(±SEM) of the total daily score, combining thoughts, emotions, and body from settled to active both before (black line) and after (gray line) the daily education-meditation video. All values are significant to $p<0.001$.

Change scores from before to after the daily education-meditation practice demonstrated a statistically significant effect over the 20 days of the intervention (Figure 4.3; $F(15.044, 4005.997)=5.140$, $p<0.001$, partial $Eta^2=0.019$); however, no time*type (i.e., thoughts, emotions, body) differences were found ($F(30.007,4005.997)=0.573$, $p=0.970$, partial $Eta^2=0.004$).

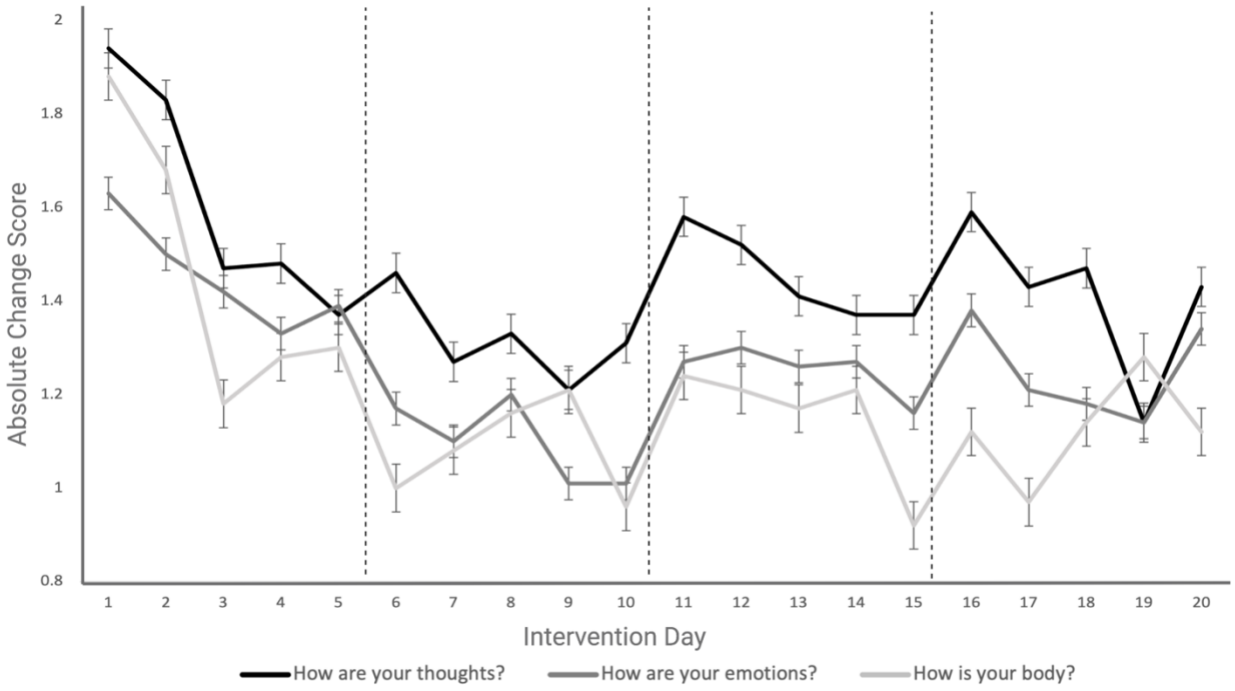

Figure 4.3 Change scores, represented as mean(±SEM), for aspects of thoughts, emotions, and body from before to after the education-meditation practice. More negative values represent larger shifts in the direction of active to settled.

Because the intervention provided a unique meditation each week, we additionally visualized and analyzed the data on a per week basis (Figure 4.4). When each week was analyzed independently, no between group effects were found for week 1 ($F(2,267)=2.272$, $p=0.105$), week 2 ($F(2,267)=1.520$, $p=0.221$), week 3 ($F(2,267)=2.026$, $p=0.134$), nor week 4 ($F(2,267)=1.910$, $p=0.150$). However, when data were analyzed across weeks, both time ($F(2.678, 715.034)=3.389$, $p=0.022$, partial $Eta^2=0.013$) and time*type effects ($F(5.356, 715.034)=5.606$, $p<0.001$, partial $Eta^2=0.040$) were found. Post hoc analyses revealed that though the acute effects on thoughts ($F(3,356)=1.409$, $p=0.240$) and emotions ($F(3,356)=1.850$, $p=0.138$) did not differ per week, the effect on body differed per week ($F(3,356)=2.780$, $p=0.041$) with the

strongest effect on body occurring during week 1 (comparison to week 2: -1.911, 95% CI -3.362 to -0.456, p=0.010; comparison to week 3: -1.578, 95% CI -3.033 to -0.123, p=0.034: comparison to week 4: -1.678, 95% CI -3.133 to -0.223, p=0.024)

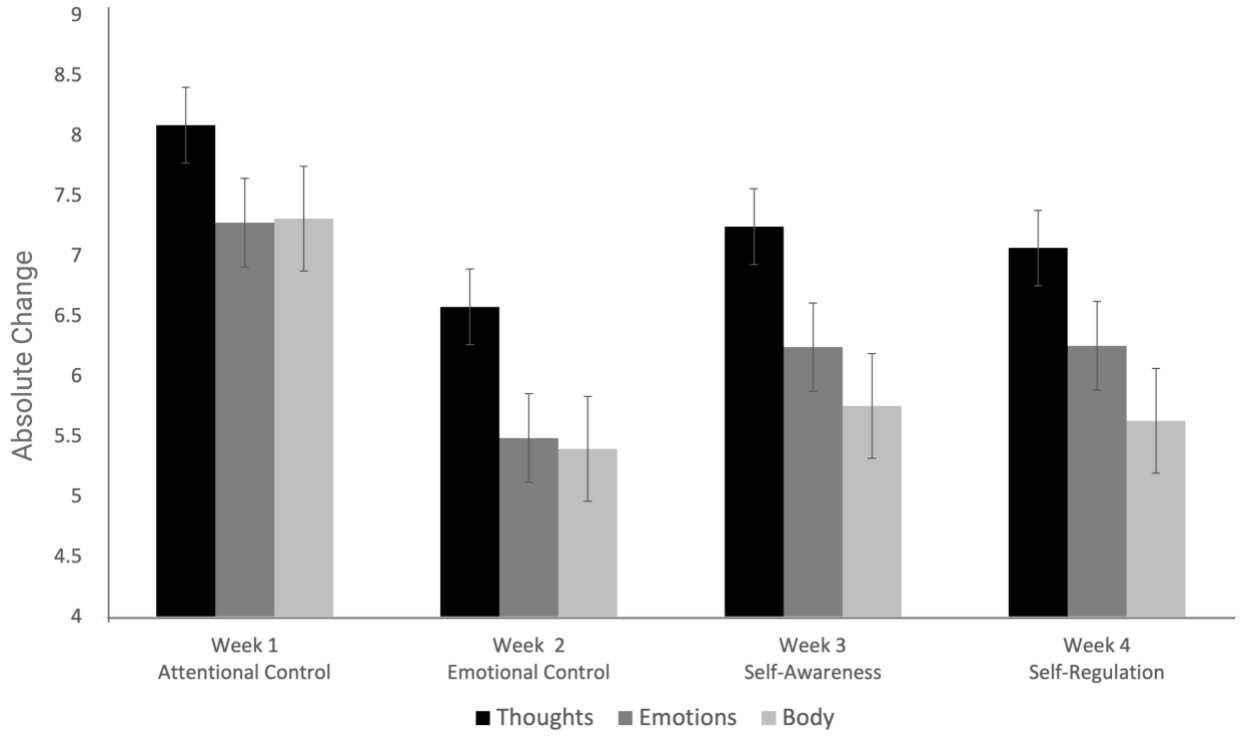

Figure 4.4 Absolute change from before to after the education-meditation for thoughts, emotions, and body during each week of the intervention.

Relationships between meditation outcomes

Statistically significant relationships were found between the change in FFMQ and the change in CS (r=0.326, p=0.009), SCS (r=0.424, p<0.001), BAI (r=-0.266, p=0.031), and BDI (r=-0.271, p=0.026) (Figure 4.5). Additionally, statistically significant relationships were found between the change in MAAS and the change in SCS self-judgement (r=0.333, p=0.008), BAI (r=-0.528, p<0.001), and BDI (r=-0.314, p=0.008) (Supplementary Document 4.5). The change in neuroscience knowledge revealed only one significant correlation with SCS common humanity (r=0.287, p=0.015). All other

correlations regarding meditation outcomes are provided in Supplementary Document 4.5.

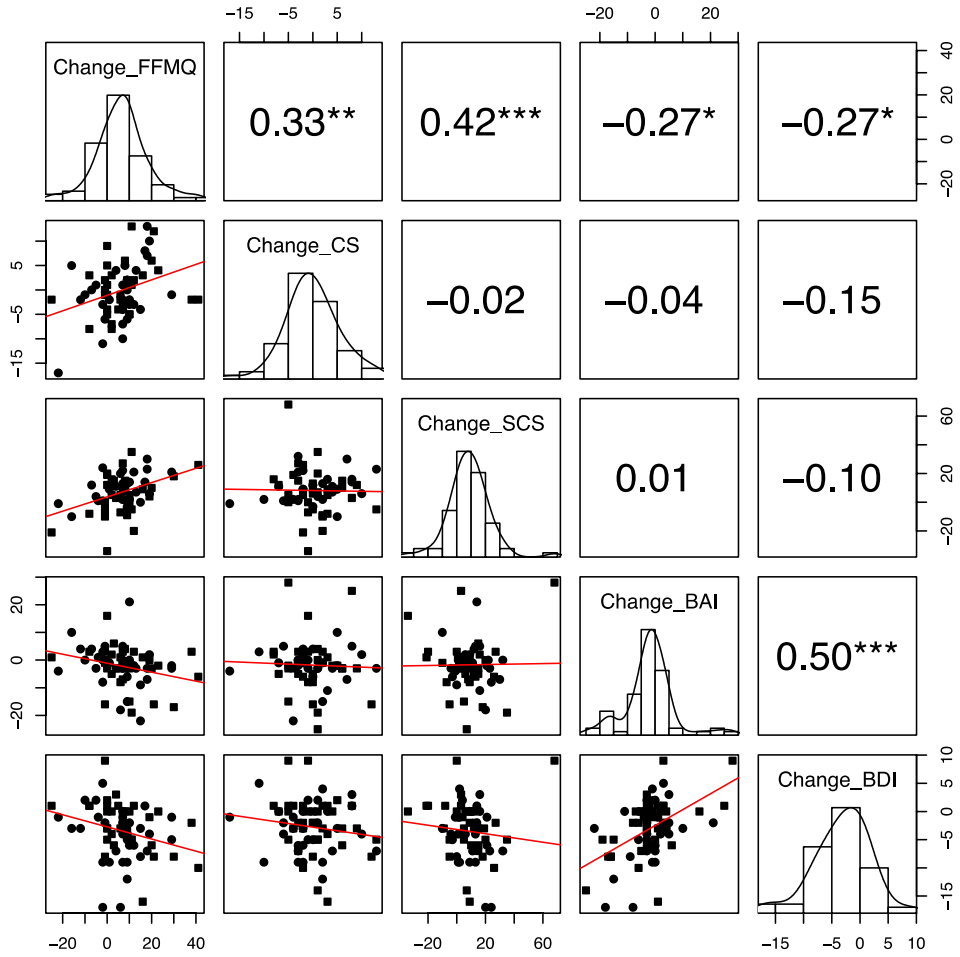

Figure 4.5 Pearson product moment correlation coefficients (top right), histograms (diagonal), and correlation scatterplots (bottom left) demonstrating the relationships among the change in scores from pre- to post- intervention. Outer edge scales represent the range of total response for each individual scale.
*p < 0.05, **p < 0.01, ***p < 0.001.

Further, total daily change scores (after meditation minus before meditation) demonstrated significant correlations with the change in FFMQ (r=-0.251, p=0.030), FFMQ acting with awareness (r=-0.235, p=0.043), FFMQ nonreactivity (r=-0.239, p=0.039), MAAS (r=-0.352, p=0.002), and SCS mindfulness (r=-0.269, p=0.025).

Additionally, total daily change score for emotions was significantly related to the change in SCS (r=-0.258, p=0.033). All other correlations regarding specific aspects of total daily change scores related to thoughts, emotions, and body are provided in Supplementary Document 4.5.

Discussion

The present study examined the effect of adding compassion cueing to a neuroscience-based mindfulness meditation practice on various neuropsychological outcomes. We found that compassion cueing did not enhance our outcomes of interest, but that the practice of meditation increased mindfulness, enhanced self-compassion, and decreased levels of depression. Importantly, we found that those individuals who gained the most in terms of mindfulness showed the largest gains in compassion, self-compassion, and mental health. Additionally, we found that though our intervention improved neuroscience knowledge, this new knowledge was not correlated with our neuropsychological outcomes of interest. Finally, we found that the acute effects of meditation were related to the long-term effects of meditation, those who gained the most acutely benefited the most in the long-term. Though our neuropsychological findings are consistent with existing literature (Bohlmeijer et al., 2010; Chiesa & Serretti, 2009; Grossman et al., 2004; Khoury et al., 2013), we newly show the impact of daily acute outcomes connect to and predict longitudinal outcomes of meditation which were promoted by the influence of neuroscience on the teaching of mindful meditation.

The effects of meditation on the mind

Our results are in line with existing literature showing that meditation is a powerful tool to improve neuropsychological function, with the most significant positive impacts seen in self-regulatory behaviors (Tang et al., 2015, Basso et al., 2019). Specifically, we

found that this novel education-meditation intervention promoted increases in mindfulness, decreases in depression, and gains in self-compassion. Together, these psychological outcomes are evidence that this 4-week mindfulness program promotes self-regulation (Schultz & Ryan, 2015, Deci & Ryan, 2012), which include aspects of enhanced self-awareness (i.e., increased mindfulness) and emotional regulation (i.e., decreased depression). Importantly, the outcome of self-compassion reflects internal flexibility allowing an individual to be caring, kind, and non-judgmental towards oneself, particularly during times of distress (Neff, 2003). This finding in particular indicates that this practice may be especially beneficial for populations with deficits in self-compassion such as those with neuropsychiatric disorders (Athanasakou et al., 2020). Others have put forth the idea that self-compassion is an important indicator of adaptive psychological function associated with mindfulness practices (McKay & Walker, 2021; K. Neff, 2003; K. D. Neff, 2011). In fact, it is suggested that as an outcome of mindful meditation (Tang et al., 2015), self-regulation allows for greater self-compassion through meditation's mechanisms of action (i.e., changes at the level of the brain) (Short et al., 2016).

Similar to our work, previous work indicates that individuals with increased mindfulness leads to improved well-being (Birtwell et al., 2018; Brown & Ryan, 2003), decreased depression symptomology (Fish et al., 2016), and stress reduction (Chiesa & Serretti, 2009; Grossman et al., 2004). Well-being and stress reduction are part of preventative health measures that require active intentionality to cultivate (Nyklíček & Kuijpers, 2008). We and others hypothesize that the intentional practice of meditation may be one key way to improve well-being, with this effect being driven by the impact of

meditation on self-regulatory brain processes. Research has demonstrated that enhanced self-regulation can be characterized by neuroplastic changes to the anterior cingulate cortex, insula, temporo-parietal junction, fronto-limbic network, and default mode network structures (Hölzel et al., 2011). Therefore, future mindful meditation studies should utilize neuroimaging techniques to examine how these brain areas are impacted and how changes in these brain structures relate to meditation-induced changes in self-regulation.

The effect of teacher cueing on meditation outcomes

Our novel intervention focused on the teacher's cueing behavior (i.e., functional versus compassion cueing) during meditation and how cueing impacted outcomes related to mindfulness, compassion, and mental health. Interestingly, we found that cueing behavior did not have a significant impact on our outcomes of interest. Rather, we found that it is the practice of meditation itself rather than teacher behavior that impacts outcomes. Condon et al. (2013) presented mindful meditation to one group and compassion mediation to another over an 8-week period. Participants were 5 times (odds ratio = 5.33) more likely after the intervention to offer compassion to others, despite what type of meditation they were assigned.

This particular outcome of our study is consistent with mindful self-regulation theory (Schuman-Olivier et al., 2020), suggesting that mindfulness, no matter how it is practiced, has distinct and predictable outcomes that may improve health behaviors (Kuyken et al., 2010). Baer et al. (1987) reinforce the importance of the behavior itself, examining what precedes it and the results of change through the scientific field of applied behavioral analysis. In this case, we highlight the importance of the actual

practice of meditation; no matter how meditation is taught or presented, the act of engaging meditation results in improved psychological health.

Knowing about the brain is not necessary for functional improvements of the brain

This intervention included a neuroscience education curriculum, teaching the neuroscience of four unique meditation techniques that focused on attention, emotional regulation, self-awareness, and self-regulation, respectively (Table 4.4). Our research demonstrates that participants increased their knowledge of the neuroscience that supports these meditation techniques; however, neuroscience knowledge acquisition was not related to improvements in our outcomes of interest (i.e., mindfulness, self-compassion, depression). This lack of correlation further supports the idea that practicing mindfulness meditation has a powerful effect on outcomes without the need to fully understand the process.

Though mindfulness has been examined from the perspective of neuroscience, (Tang 2015, Tang & Leve 2016) this is the first meditation intervention designed within the context of a neuroscience curriculum. Specifically, the curriculum used in this intervention intentionally scaffolded neuroscience content and meditation skills. The curriculum built skills considering the prerequisites needed to move onto the following week; attentional control (i.e., mantra) was presented first, followed by emotional control (i.e., movie of the mind), then self-awareness (i.e., hand turning), and finally self-regulation (i.e., watching the breath) (Table 4.3). Future randomized control studies will need to evaluate this meditation intervention with and without the inclusion of the neuroscience curriculum.

The acute effects of meditation correspond to the longitudinal outcomes of meditation

The daily scores provided insight into how meditation acutely impacted thoughts, emotions, and bodily sensations. First, we found that the most prominent acute effects occurred during the first week of the intervention, with thoughts, emotions and body moving from active to settled from before to after the daily intervention. Subsequently, the total change scores decreased over the 20 days of the intervention; however, this change was related to the long-term beneficial effects of the intervention. That is, as the intervention progressed, participants started their daily intervention in a more settled state, with less room for improvement. This is similar to other work showing that the effects of meditation changes as novice meditator gains experience (Basso et al., Fox et al., 2012, Hölzel et al., 2007, Rodriguez-Larios et al., 2021).

Each week showed significant acute changes at the level of thoughts, emotions, and body. Regarding the impact of each unique meditation, attentional control demonstrated the most significant acute effects, with this effect being driven by changes in bodily sensations. This may be due to the fact that it was the first week of meditation. Alternatively, attentional control meditation may have had the most significant impact on acute changes at the level of the body. Though this curriculum was intentionally scaffolded, future studies may choose to alter the presentation of attentional control, emotional control, self-awareness, and self-regulation meditations.

Importantly, we found that the acute effects of meditation significantly related to our outcomes of interest. Specifically, those individuals who showed the largest acute benefits (from states of active to settled) showed the largest gains in various aspects of mindfulness, including acting with awareness, nonreactivity, dispositional mindfulness,

and self-compassion mindfulness. Additionally, those that demonstrated the largest shifts in emotion from active to settled, demonstrated the largest gains in self-compassion. This is the first study that has combined momentary assessment with long-term outcomes to shown that the acute effects of meditation are related to the chronic effects.

Considerations regarding the curriculum development of this and future education-meditation interventions

Considering that self-regulation is the outcome of improved attentional control, emotional control, and self-awareness (Tang et. al, 2015), we designed the present curriculum in alignment with this framework. In the Liverpool Mindfulness Model, Malinowski (2013) places attentional control at the center of the model as the primary or prerequisite skill of mindful meditation. Vago and Silbersweig (2012) present a Mindfulness Process model that begins and returns to attention control, moving on to emotional awareness, and finally adds a component of self-awareness that results in self-regulation and response inhibition. The curriculum design of this intervention followed these models. We hypothesize that this intentional scaffolded approach is important to the curricular implementation of mediation, but future studies are needed to investigate whether altering the presentation of meditations alters the outcomes.

We and others assert that teaching mindfulness meditation should be systematic and thoughtful. McCown et al. (2016) discuss the importance of scientific literacy for mindfulness meditation teachers, whereas Woods (2009) notes the importance of mindfulness meditation teachers having an embodied meditation experience. Crane et al. (2010) adds the pedagogical importance of how a teacher interacts with students

and the curriculum. While a practitioner does not need to understand how the brain works through neuroscience education, a meditation teacher does need to know and implement the neuroscience of mindfulness meditation into curriculums and interventions of mindful meditation.

LIMITATIONS AND FUTURE DIRECTIONS

While the results of this study are well supported by existing literature, and add to existing knowledge, limitations exist. Through randomization during data collection, not all post-test data were collected from every participant, creating unequal sample sizes for some measurements. Also, this is a convenience sample that could be more diverse. Many of the predictable neuroplastic changes associated with mindful meditation may take longer to manifest than the 20 days spanning over 4 weeks, offered by this intervention. A future iteration of this study should be completed with each of the four techniques spanning 2 weeks, for a total intervention of 8 weeks.

Meditation studies often struggle to have a solid study design and implementation methodology. Among these challenges is finding a suitable control for mindful meditation. In the future, we foresee that separating the neuroscience education piece from the meditation practice will create an excellent mindful meditation education control. Additionally, as the intervention did not display any significant differences between the control and experimental group, future studies should include a comparison of basic cueing vs no cueing.

Finally, this study design included 5 days of meditation spread over a 7-day week. This allowed for the most flexibility from participants. If a day was missed during a traditional weekday, they could make it up on the weekend. The effect of the meditation

may have been lessened by this break in meditation. Also, creating a daily routine with less flexibility may have been easier for participants. A future study design could benefit from 20 days in a row, or a longer intervention being 40 mindful meditation sessions over 8 weeks to investigate the effect of time dosage on meditation.

CONCLUSION

This study supports the behavioral importance of engaging with mindfulness meditation to optimize individual well-being through improved mindfulness, self-compassion, and depression symptomology, suggesting enhanced self-regulation. This study additionally reinforces the idea that the benefits of meditation are independent of teacher cueing behavior. These neuropsychological changes are likely supported by neuroplastic changes associated with mindfulness meditation. Finally, this study provides initial evidence that how mindfulness meditation is taught can improve outcomes of meditation through the teacher's embodiment and scientific knowledge of mindfulness meditation. Future studies will need to systematically investigate the inclusive use of the neuroscience curriculum as well as test other types of teacher cueing.

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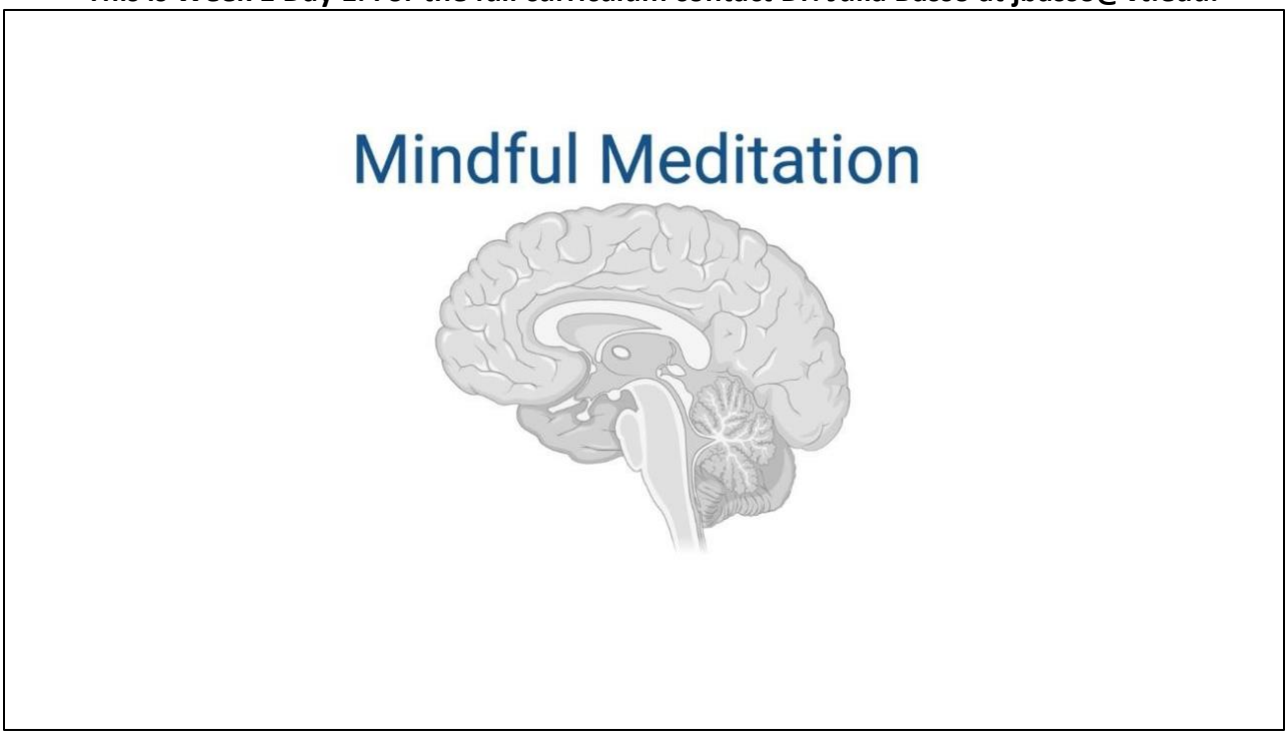
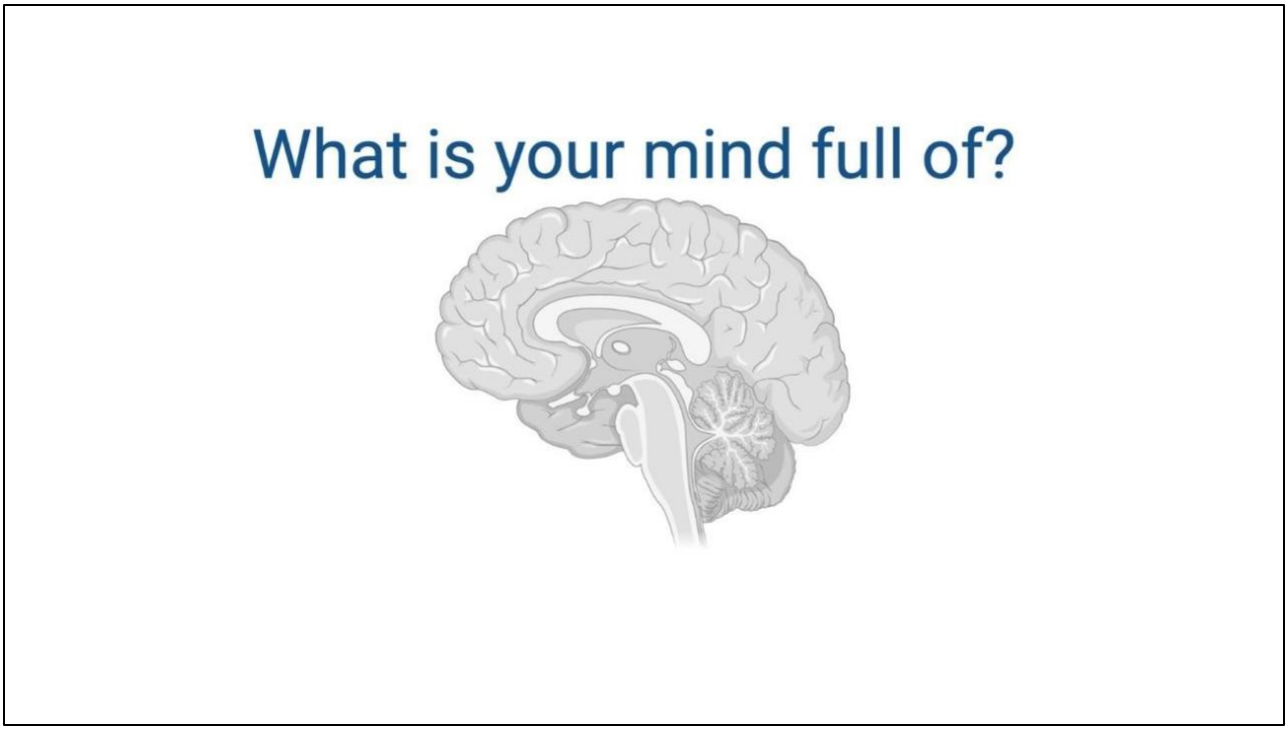
SUPPLEMENTAL MATERIAL

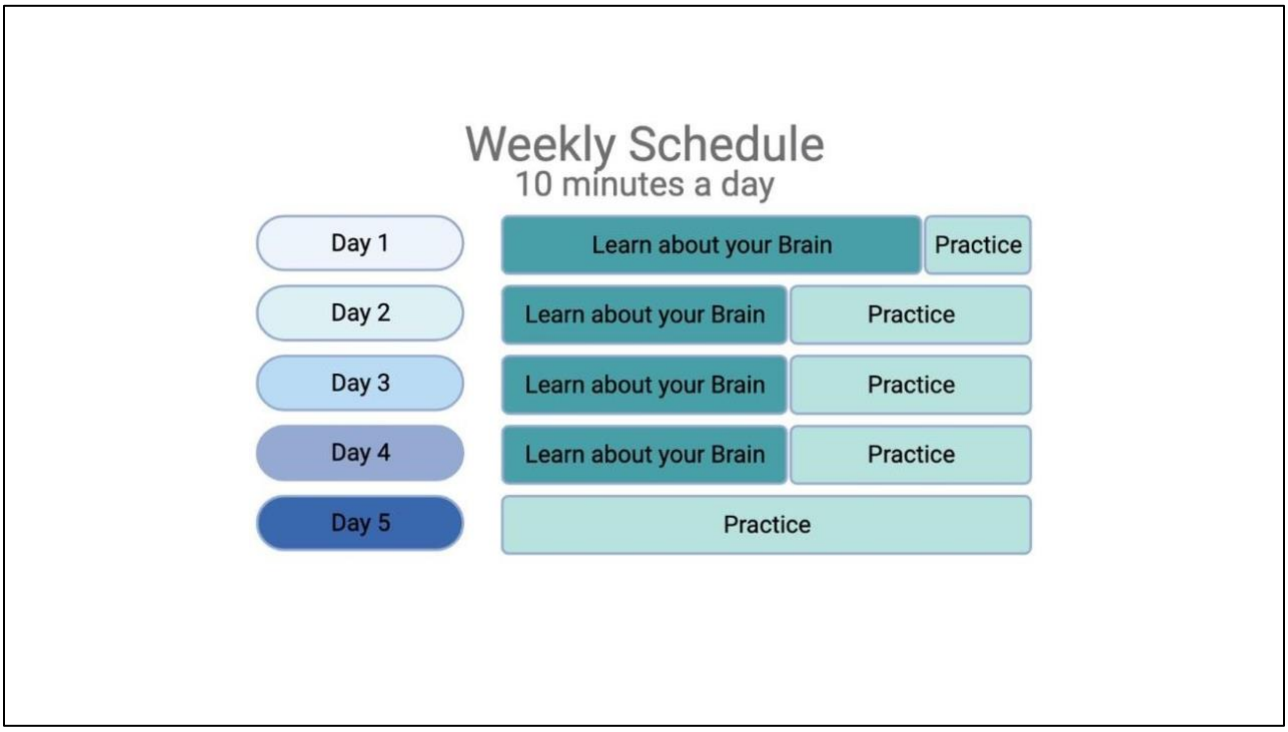
Supplemental Document 4.1
This is Week 1 Day 1. For the full curriculum contact Dr. Julia Basso at jbasso@vt.edu.



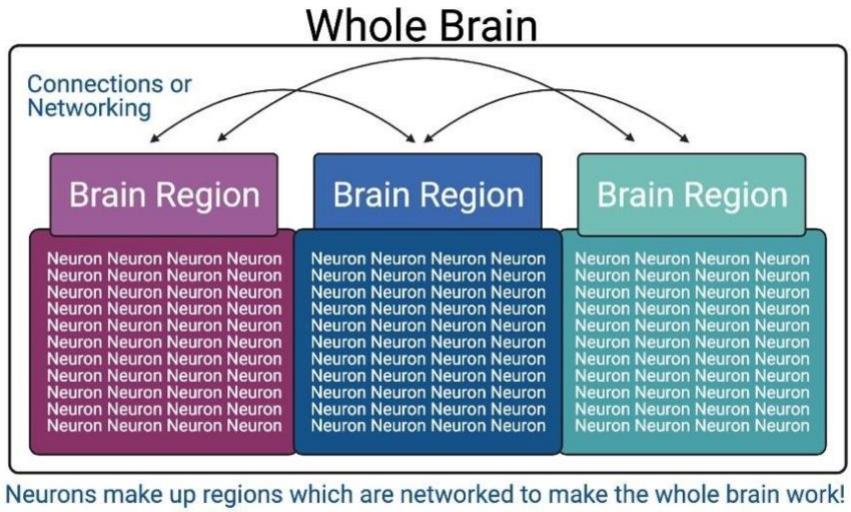
Welcome! This project will introduce you to concepts in neuroscience that relate to mindful meditation and then give you the opportunity to practice mindful meditation. For some of you, the neuroscience information may be a bit overwhelming and for others of you, I may be talking about familiar concepts. Either way, absorb as much information as you can and allow yourself to think about the way you think.



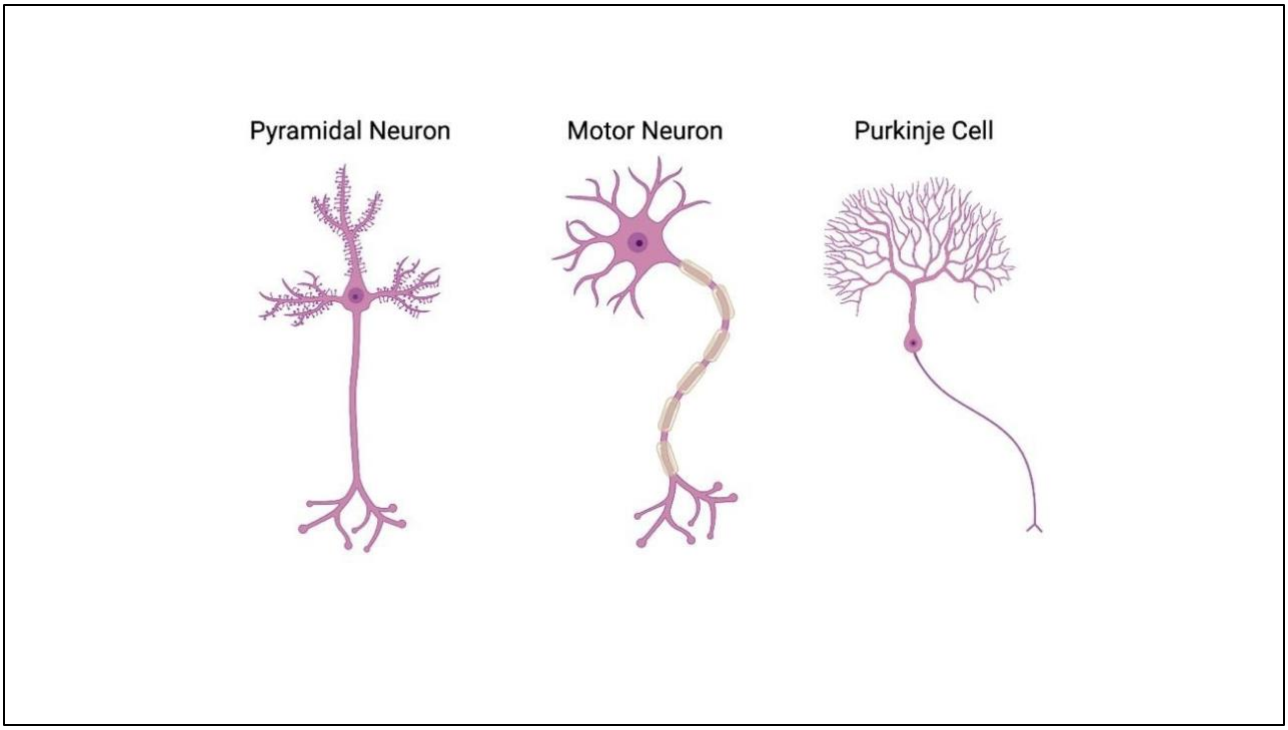
Mindful meditation. What IS your mind full of? Think of your mind as your thoughts and emotions, and your brain as the container. It is possible to study how a brain functions, however there is no way to study the mind without you telling someone what you are thinking and feeling. Hopefully, as we continue, this will make more sense to you!



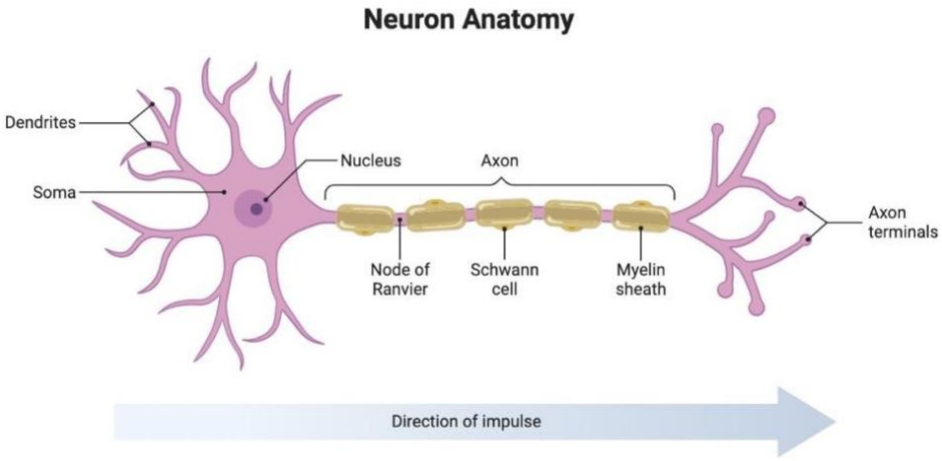
Each week our schedule will follow the same pattern. Each day we will have some time learning about neuroscience and practicing mindful meditation. As each week progresses, we will have more mindful meditation and less neuroscience, until Friday, when the entire time will be spent in meditation. Let's start talking about the brain!



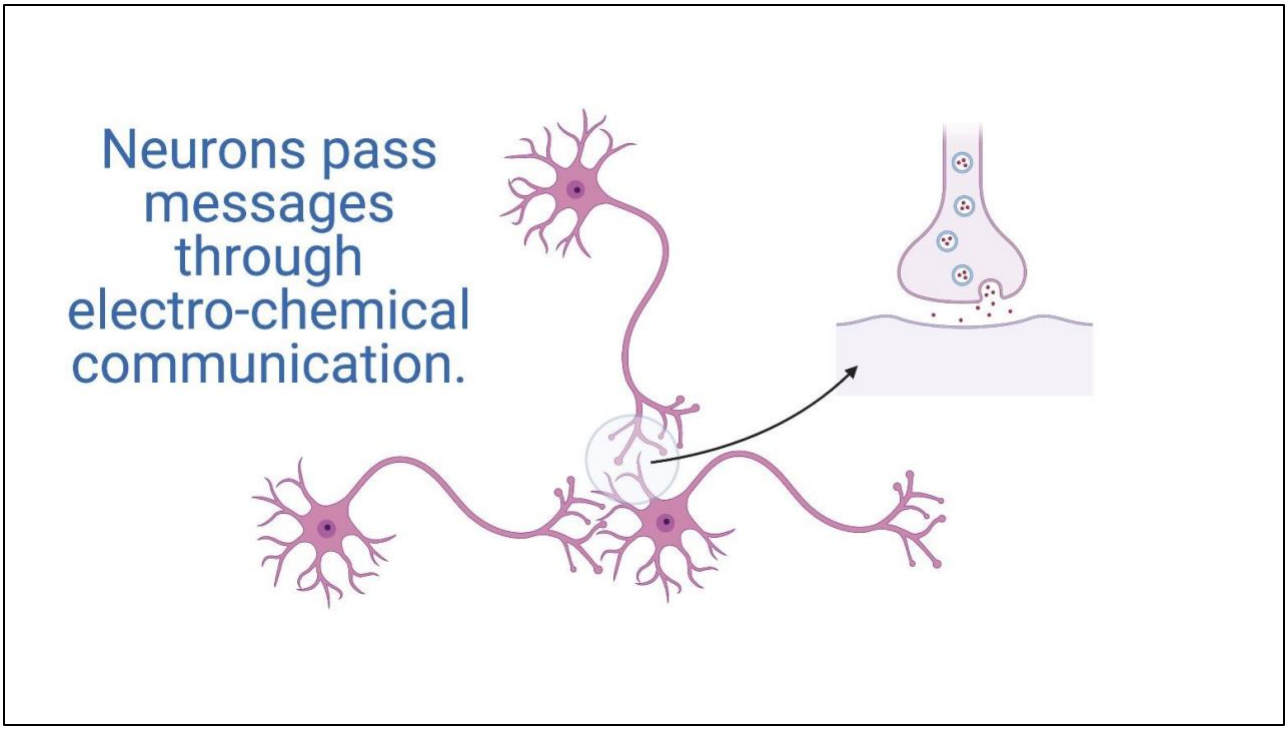
In order to make the neuroscience content more accessible, we've simplified many of the concepts you will be learning about.
Like many things, the brain is made up of parts which are made up of parts! The brain has 86 BILLION neurons in it. Synapses are the spot where neurons connect to each other. The neurons are organized into brain regions. Then the different brain regions, together, make up the brain. The regions have distinct purposes and are networked together to produce our entire conscious experience. The brain also contains glial cells which are like workers, maintaining the health of the neurons.



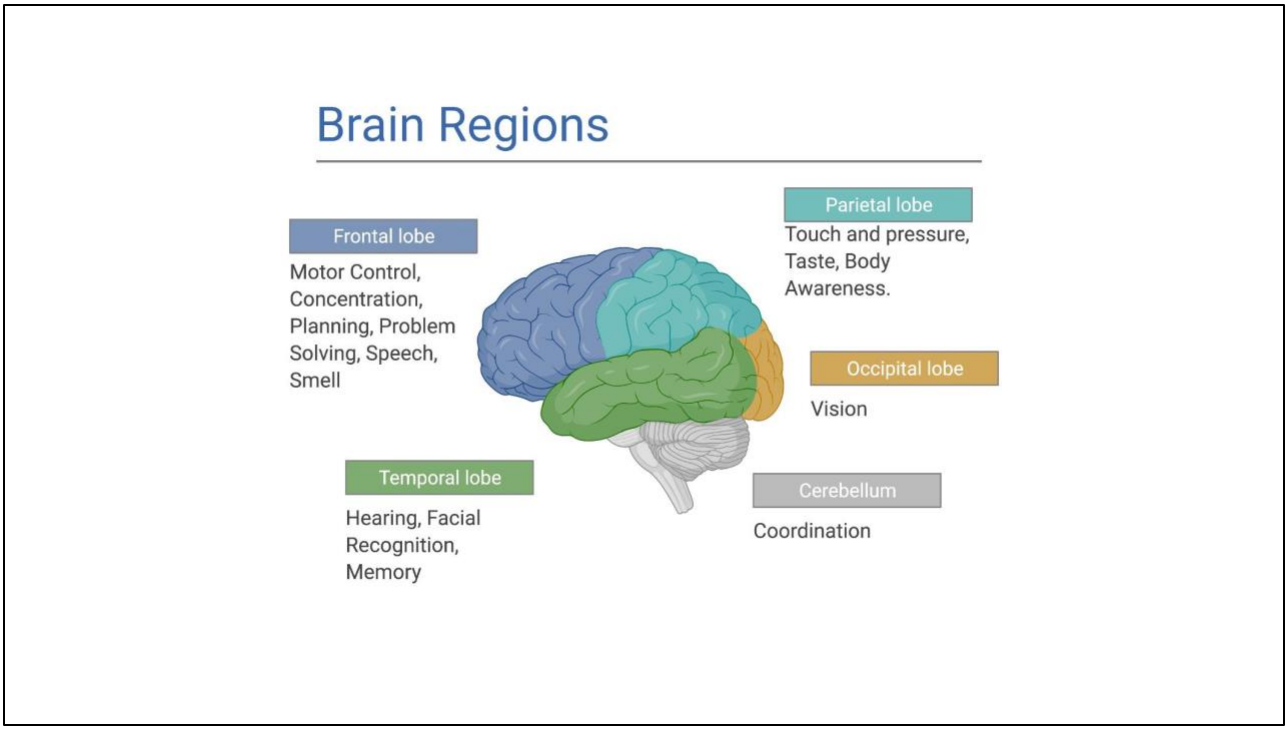
There are different types of neurons, although they all have the same basic structure. When you look at these different neurons, what do you notice that is the same and what do you notice that is different?



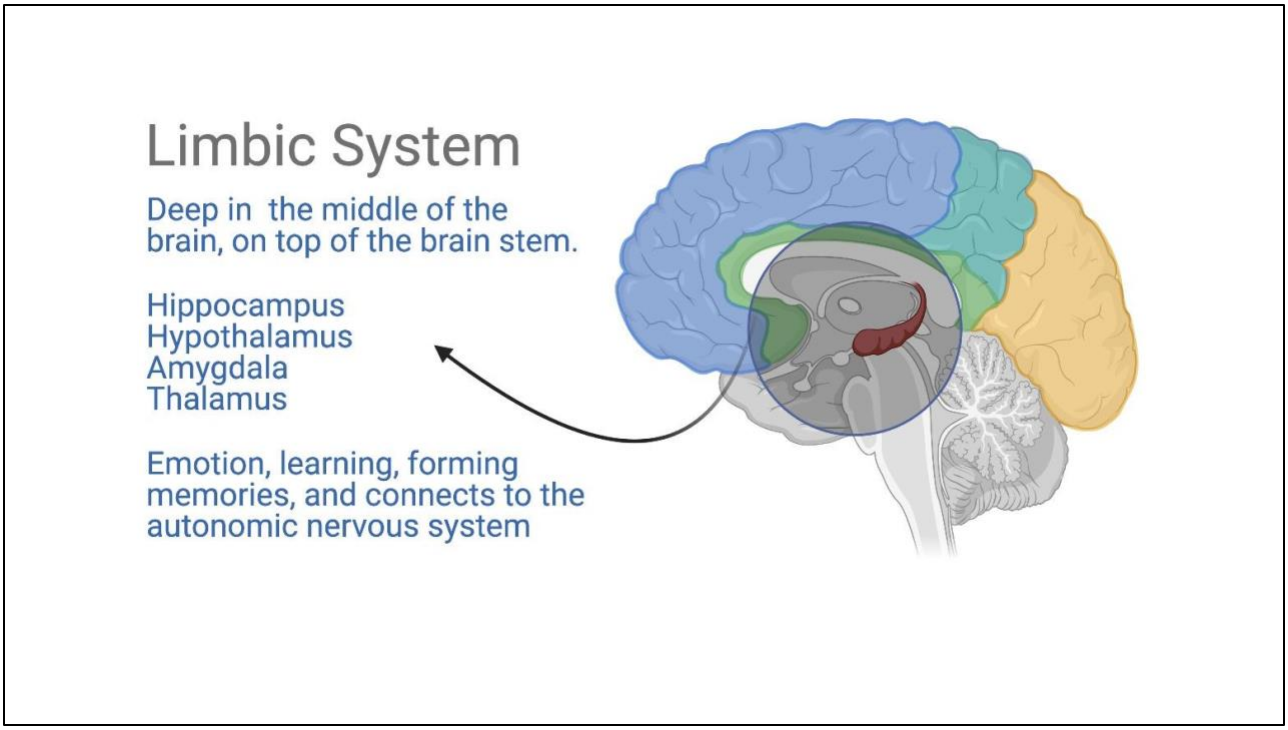
Neurons are single cells with many parts. The soma is the cell body, containing the nucleus. The soma is surrounded by dendrites, which receive information from other neurons. Some neurons have more or less dendrites than other neurons. Messages move from the dendrites, past the soma and down the long axon, coated in myelin for insulation and speed, and to the axon terminals. The axon terminals are just that. Terminal.The end. When an axon sends a message to the next set of dendrites, this message, which is known as an action potential, leaves the cell. Notice the consistency of the anatomy. From dendrite through the soma to the axon.



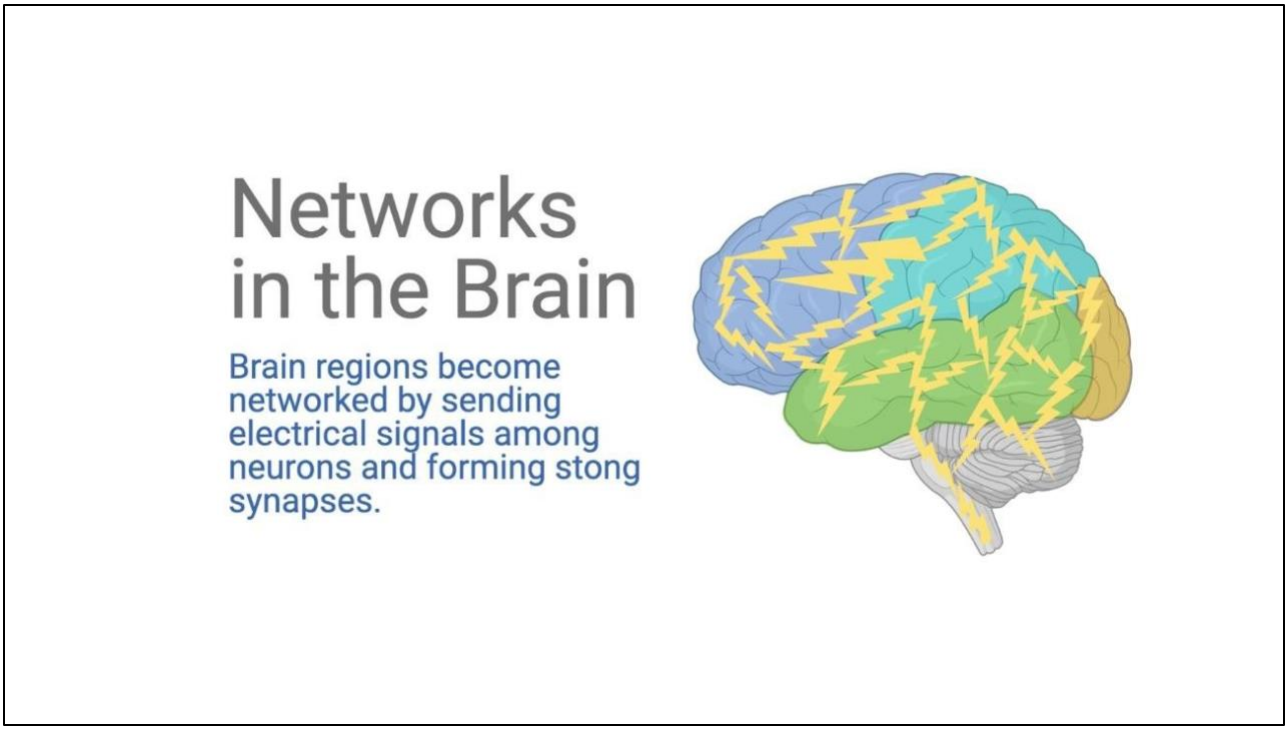
Neurons communicate through electrochemical communication. The space between neurons, where dendrites come close to other axons, is called a synapse. The synapse isn't just a gap, it's a space where electro-chemical changes happen! To pass a message from the axon of one neuron to the dendrites of another, chemicals called neurotransmitters are released from one neuron that cause the opening of channels like doors, for electrical charges or ions to pass through. Depending on the type of neurotransmitter released from the neuron, the message will either continue on or stop the transfer of the message, at that neuron. This is called excitatory or inhibitory messaging, respectively.



Brain regions represent local, specific brain function however, few brain regions work in isolation. It is amazing how many brain regions work together to accomplish a single task! For example, if you want to take a drink of water from your water bottle, first you notice you are thirsty (hypothalamus). You choose to reach for your water bottle. The occipital lobe helps you see the water bottle, the motor cortex in the frontal lobe help to control your arm, and the cerebellum helps you stay coordinated and balanced while you reach for the bottle. The specific regions of the brain all provide different functions and can provide “directions” for how the body acts and responds.

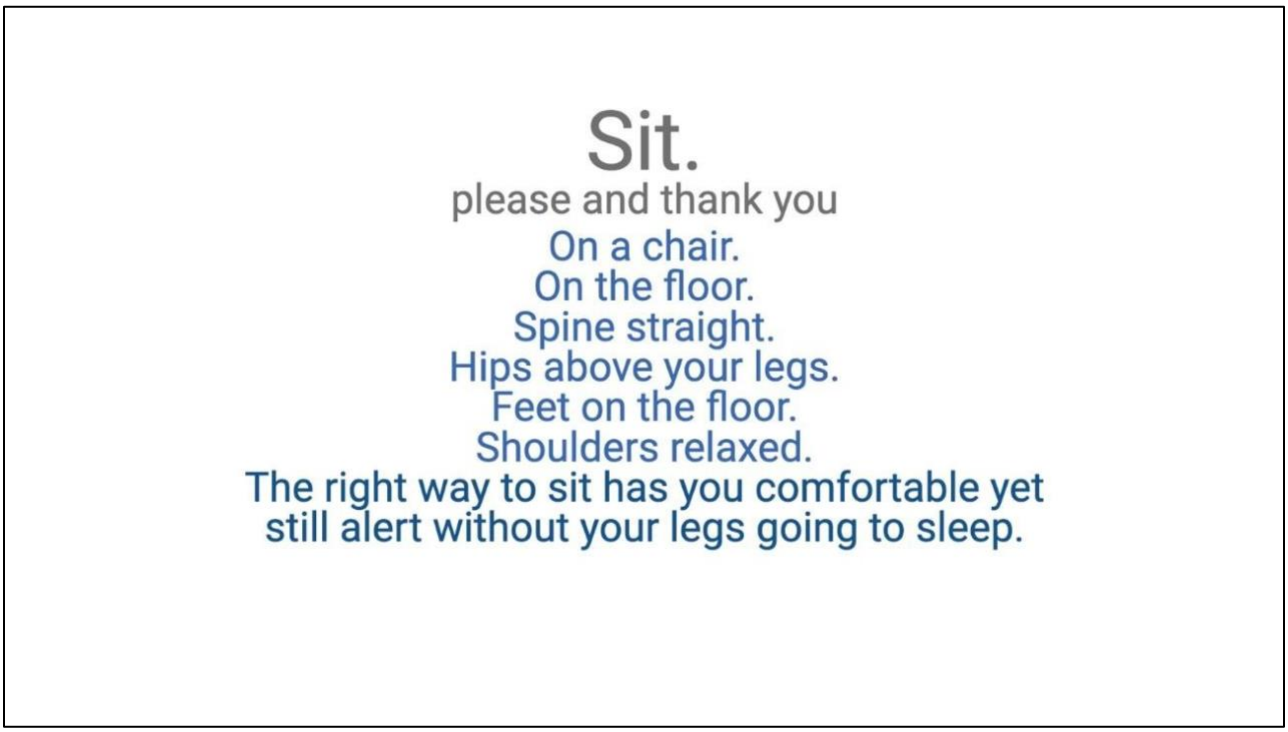


The limbic system is deep inside the the center of your brain and is responsible for forming memories and having emotions. The limbic system processes much of what is going on in the world around you, and then sends these perceptions to other parts of the brain for storage. When you experience something exciting for the first time, your limbic system processes the location, color, sounds and smells of the experience. These experiences are then transferred, overnight, to the other areas of your brain so that you can later remember the exciting experience.



While brain regions are distinct, they are not isolated. Like the highway system that allows you to travel all over the country, in and out of different states, the brain is networked! Instead of roads, the brain is using the network of neurons. Some networks are local with in brain regions enhancing communication within a structure. Other networks are global, enhancing communication between structures. Communication within and between these networks allows us to make new connections (synapses) and remember existing ones. There's more than one way to get from point A to point B using roads, just as there's often more than one way to connect various brain regions.

Mindfulness practice is largely about choosing your thoughts. Notice what you are thinking, and stick with it, or make a decision to refocus your thoughts. Remember you can always blink a few times, come out of the mediation and then return to it, or also give it a break for the day at any point you choose.



In order to meditate, you can sit on the floor but I actually suggest a chair. Sit with your spine pretty straight. Your hips above your legs. Ground your feet on the floor. Now relax your shoulders. There's not one right way to sit, but a wrong way will cause your feet to go to sleep and maybe your back/neck or shoulders to be sore. Relax your hands on your thighs, palms up or down. If you feel comfortable with it, close your eyes for meditation.

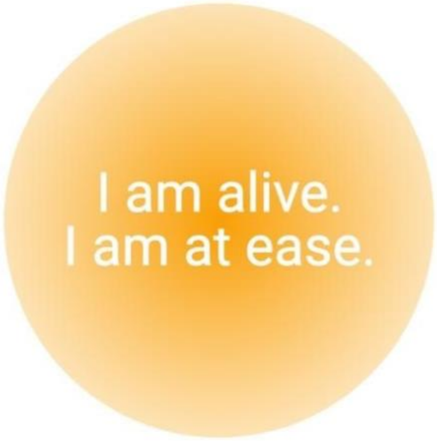
This week, your mindful meditation technique will be to use a mantra, “I am alive. I am at ease.” A mantra is a repeated word or phrase. Repeat the mantra silently in your head. Notice how simple the mantra is. It’s not designed to be something you have to memorize like a poem, rather a simple affirmation. A mantra may naturally pair with your breathing but that connection does not have to be forced. If it feels natural in your body, inhale and you hear yourself think “I am alive.” As you exhale, hear yourself think “I am at ease.” During the meditation, there will be reminders on the video, but it’s meant to reassure you, if your eyes pop open. The video is not meant to be watched the entire time, but rather reassure you time is passing, if you look up.

Be curious about this process.
It’s okay to be distracted. When you get distracted, see if you can grant yourself compassion, move on, and try to return to your mantra.

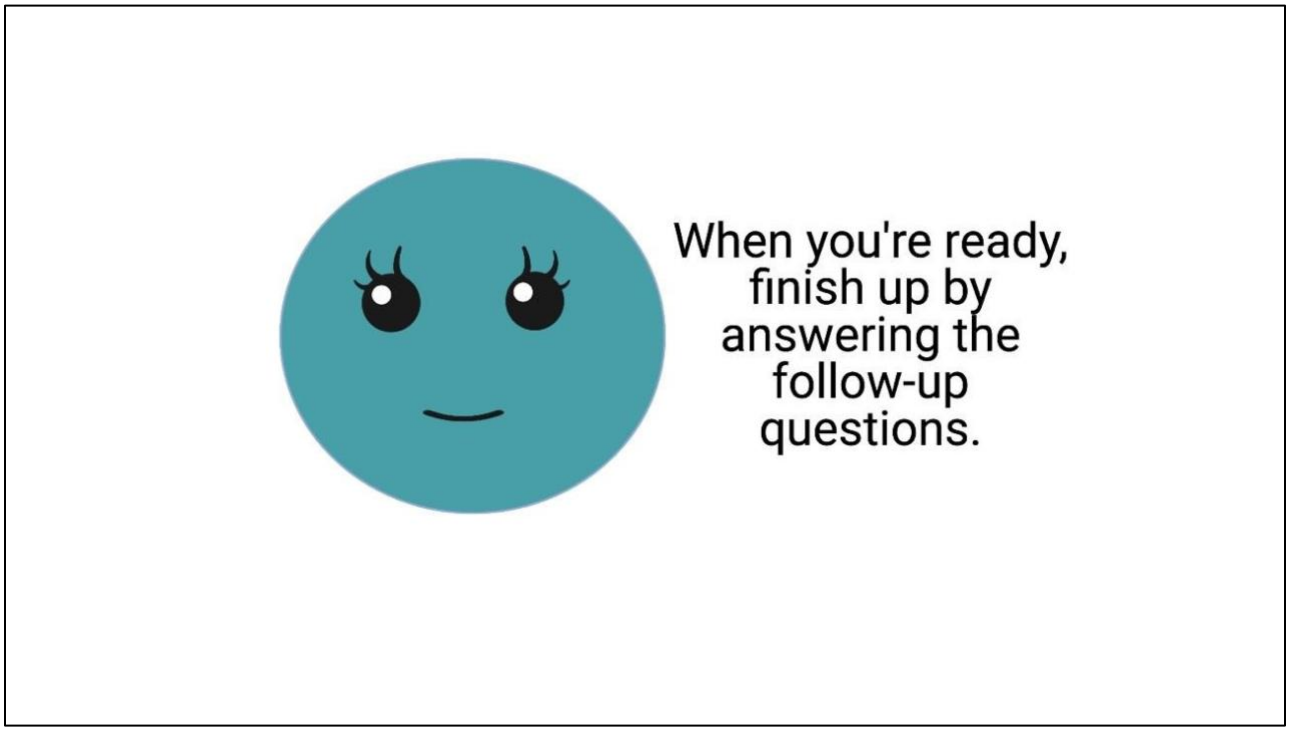

I am alive.
I am at ease.


I am alive.
I am at ease.


I am alive.
I am at ease.


I am alive.
I am at ease.


I am alive.
I am at ease.



9:45
Begin to take bigger, fuller breaths. Inhale until your lungs and ribs are full and completely exhale. Wiggle. Squeeze. And open your eyes. When you are ready, finish up by answering the follow-up questions.

Supplemental Document 4.2
Neuroscience Knowledge Check

- ➔ Choose the best answer to each of the following questions.
- ➔ You may only select one option per question.
- ➔ Do not look up the answers, rather tell us what you know.
- ➔ Choose "I don't know" instead of guessing, if you do not know the answer to the question.

Neurons are

a. Groupings of cells, working together for optimal brain function
b. Single cells with many parts
c. The unit in the brain responsible for cleaning and maintaining the brain
d. I don't know

The synapse is

a. Where neurons join together
b. Marked with clear boundaries
c. The space between neurons
d. I don't know

Brain regions

a. Differentiate brain function
b. Usually work in isolation
c. Control every single function of the body
d. I don't know

The network of neurons in the brain

a. Creates the ability to perform complicated tasks in the body
b. Is limited to brain regions that touch each other
c. Requires neurons to actually touch each other
d. I don't know

Attention in the brain, is controlled by

a. The amygdala and hypothalamus
b. The will of an individual
c. The Prefrontal Cortex, Anterior Cingulate Cortex, and Striatum
d. I don't know

Attention requires you to

a. Resist distractions and sustain focus
b. Only resist distractions
c. Release decisions over to automatic function
d. I don't know

Mental Conflicts arise when

a. You want something you know you don't need
b. Your brain receives conflicting messages from various brain regions
c. Your brain has more than one region active at the same time
d. I don't know

The Anterior Cingulate Cortex

a. Works on executive functions, decision making and goal setting
b. Works on decision making, coordinating thoughts, voluntary movement
c. Works on self-regulation, empathy, and impulse control
d. I don't know

The Prefrontal Cortex

a. Works on executive functions, decision making and goal setting
b. Works on decision making, coordinating thoughts, voluntary movement
c. Works on self-regulation, empathy, and impulse control
e. I don't know

The Striatum

a. Works on executive functions, decision making and goal setting
b. Works on decision making, coordinating thoughts, voluntary movement
c. Works on self-regulation, empathy, and impulse control
d. I don't know

The Amygdala is part of the

a. Cortex
b. Brainstem
c. limbic system
d. I don't know

The amygdala primarily processes

a. Emotions of joy and happiness
b. Emotions of fear and stress
c. All emotions equally
d. I don't know

What are feelings?

a. Emotions
b. Physical Sensations
c. Both emotions and physical sensations
d. I don't' know

The Limbic System of the brain includes the

a. Prefrontal cortex, Anterior Cingulate Cortex and Striatum
b. Prefrontal cortex, Anterior Cingulate Cortex, Amygdala and Insula
c. Hippocampus, Hypothalamus, Amygdala and Insula
d. I don't know

Electro-Chemical Communication specifically happens

a. Only among neurons in the same brain region
b. Only across brain regions
c. In the synapse between neurons
d. I don't know

Emotional Regulation

a. Includes observing a reaction, then choosing to engage and alter a response
b. Is not possible
c. Requires extreme determination
d. I don't know

The enteric immune system

a. Is isolated in the digestive system
b. Links the digestive system and the brain
c. Is the brain's protective immune system
d. I don't know

Networking among brain regions

a. Happens in glial cells
b. Is faster when brain regions are closer together
c. Requires brain regions to touch each other
d. I don't know

An individual's emotional responses are determined by

a. That individual's previous experiences
b. The amount of neurotransmitters are in the brain at the time of stimulation
c. That individual's intelligence
d. I don't know

The limbic system helps regulate

a. The balance among thinking, feeling, and reacting to a situation
b. All your emotions about a situation
c. The intensity of your reaction to a situation
d. I don't know

Proprioception connects mind and body

a. By the mind telling the body what to do
b. As the mind knows where the body is in space
c. As the mind is aware of what's happening inside the body
d. I don't know

Interoception connects mind and body

a. As the mind knows where the body is in space
b. As the mind is aware of what's happening inside the body
c. By the mind telling the body what to do
d. I don't know

The connection among brain, spinal cord, and muscles are

a. Perkinji Cells
b. Pyramidal Neurons
c. Motor Neurons
d. I don't know

How are neurons grouped in your body?

a. Evenly through the entire body
b. More neurons closer to your brain
c. In areas where you need them most
d. I don't know

Top Down neuroscience emphasizes

a. How the brain and automatic responses tell the body what to do
b. How the brain and body communicate with each other
c. How the body and sensory input informs the brain
d. I don't know

Bottom Up

a. How the brain and automatic responses tell the body what to do
b. How the brain and body communicate with each other
c. How the body and sensory input informs the brain
d. I don't know

Balancing bottom up and top down brain activity support

a. The mind-body connection
b. The body to be strong
c. The mind to be in control
d. I don't know

Feelings are identified best by

a. Top down neuroscience
b. Bottom up neuroscience
c. Integration of top down and bottom up
d. I don't know

The Homunculus Man is a visual representation of

a. Where neurons need to be located
b. Where we have large numbers of neurons
c. How neuroscientists think
d. I don't know

The Striatum processes information

a. About voluntary movement
b. Using purkinje cells
c. Involved in involuntary movements
d. I don't know

When you see a threat, three common responses are

a. Fight, flight, or fantasize
b. Fight, flight or freeze
c. Freeze, flight, or fix
d. I don't know

The sympathetic nervous system

a. Regulates responses to life threatening situations
b. Helps the body to rest, repair and digest
c. Works in isolation from all other body systems
d. I don't know

The parasympathetic nervous system

a. Regulates life threatening responses
b. Helps the body to rest, repair and digest
c. Works in isolation from all other body systems
d. I don't know

The Vagus Nerve

a. Controls both conscious and unconscious actions in the body
b. Only controls body organs
c. Is named for its direct path through the body
d. I don't know

The Vagus Nerve

a. Turns off the digestive system
b. Amplifies action of the HPA Axis
c. Connects the diaphragm to conscious and unconscious actions
d. I don't know

Intentional slow breathing

a. Only makes you think you are slowing your body systems down
b. Happens when the diaphragm moves the ribs, expanding and contracting the lungs
c. Speeds up your heart rate
d. I don't know

The HPA Axis responds to stress,

a. Changing the way your body processes glucose through changed liver function
b. By slowing heart rate and respiration
c. When you sleep, aiding in rest and repair
d. I don't know

Balance of the vagus nerve and the HPA Axis

a. Requires more time spent with the HPA axis dominant
b. Allows people to react to and recover from stress
c. Means people always feel neutral
d. I don't know

When the diaphragm contracts

a. And upper chest muscles relax, it creates space in the ribs for expanding lungs
b. So does the heart, signalling the HPA Axis
c. Your abdominal muscles should also contract to maximize the size of a breath
d. I don't know

Resiliency

a. Can be cultivated through conscious engagement of the diaphragm and vagus nerve
b. Cannot be cultivated through conscious engagement of the the diaphragm
c. Is all about emotional regulation
d. I don't know

Supplemental Document 4.3

F = Functional Cues C = Compassion Cues T = Time T*G = Time by Group Pre and Post = mean (SEM)	Group	Pre	Post	N		F	Sig	Partial ETA squared
BAI	F	12.24(1.492)	10.5(1.185)	38	T	32.852	0	0.046
	C	14.92(1.690)	12.83(1.504)	40	T*G	1.988	0.163	0
BDI	F	10.71(1.251)	6.74(0.863)	38	T	32.852	0	0.296
	C	10.76(0.873)	8.36(0.873)	42	T*G	1.988	0.163	0.025
MAAS	F	51.88(1.753)	54.1(1.765)	40	T	2.15	0.147	0.027
	C	54.85(2.393)	56.33(2.121)	39	T*G	0.085	0.772	0.001
FFMQ	F	120.9(2.735)	127(2.834)	39	T	26.595	0	0.262
	C	123.18(3.136)	130.74(2.611)	38	T*G	0.3	0.586	0.004
FFMQ_Observing	F	26.33(0.810)	27.33(0.770)	39	T	12.68	0.001	0.145
	C	26(0.881)	27.5(0.007)	38	T*G	0.507	0.479	0.007
FFMQ_Describing	F	26.03(1.032)	27(1.040)	39	T	10.566	0.002	0.123
	C	26.26(1.026)	27.76(0.942)	38	T*G	0.477	0.492	0.006
FFMQ_Acting_with_awareness	F	23.59(0.909)	25.23(1.004)	39	T	5.706	0.019	0.071
	C	24.82(0.966)	25.89(0.942)	38	T*G	0.244	0.623	0.003
FFMQ_Nonjudging	F	26.38(1.010)	27.44(0.974)	39	T	8.108	0.006	0.098
	C	25.76(1.047)	27.97(0.957)	38	T*G	1.024	0.315	0.013
FFMQ_Nonreactivity	F	19.69(0.697)	21.38(0.772)	39	T	24.622	0	0.247
	C	20.82(0.778)	22.87(0.690)	38	T*G	0.228	0.634	0.003
CS	F	65.83(1.089)	65.44(1.165)	36	T	0.001	0.975	0
	C	66.05(1.125)	66.4(1.179)	40	T*G	0.345	0.559	0.005
CS_kindness	F	4.27(0.093)	17.17(0.358)	36	T	2313.212	0	0.969
	C	4.56(0.256)	16.95(0.349)	40	T*G	0.912	0.343	0.012
CS_Common_Humanity	F	4.15(0.074)	16.44(0.074)	36	T	1610.217	0	0.956
	C	4.34(0.297)	16.23(0.441)	40	T*G	0.48	0.491	0.006
CS_Mindfulness	F	4.08(0.096)	15.72(0.373)	36	T	2235.011	0	0.968
	C	4.46(0.285)	16.93(0.305)	40	T*G	2.565	0.114	0.033
CS_Indifference	F	3.97(0.105)	16.11(0.431)	36	T	1377.779	0	0.949
	C	4.24(0.266)	16.3(0.418)	40	T*G	0.016	0.899	0

Continued

SCS	F	76(2.896)	86(2.922)	35	T	26.406	0	0.274
	C	70.49(3.710)	77.68(3.266)	37	T*G	0.706	0.404	0.01
SCS_SelfKindness	F	3.02(0.131)	3.41(0.147)	35	T	15.942	0	0.185
	C	2.79(0.160)	3.02(0.125)	37	T*G	1.098	0.298	0.015
SCS_SelfJudgment	F	2.9(0.140)	3.07(0.149)	35	T	5.149	0.026	0.069
	C	2.63(0.164)	2.85(0.139)	37	T*G	0.1	0.752	0.001
SCS_Common_Humanity	F	4.01(0.142)	4.1(0.117)	35	T	0.689	0.409	0.01
	C	3.92(0.181)	3.99(0.114)	37	T*G	0.01	0.922	0
SCS_Isolation_Items	F	2.94(0.163)	3.26(0.165)	35	T	14.091	0	0.168
	C	2.61(0.183)	2.93(0.182)	37	T*G	0.004	0.949	0
SCS_Mindfulness_Items	F	3.2(0.139)	3.56(0.117)	35	T	16.07	0	0.187
	C	3.01(0.149)	3.28(0.115)	37	T*G	0.256	0.614	0.004
SCS_Overidentified	F	2.26(0.110)	3.18(0.099)	35	T	169.324	0	0.708
	C	2.12(0.124)	2.86(0.117)	37	T*G	1.803	0.184	0.025
NKC	F	17.59(1.286)	26.14(1.033)	44	T	126.387	0	0.592
	C	19.71(1.199)	28.04(0.943)	45	T*G	0.02	0.888	0

F = Functional Cues
C = Compassion Cues
T = Time
T*G = Time by Group
Pre and Post = mean (SEM)

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Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	1_Pre-Total - 1_Post-Total	5.456	5.685	0.599	4.265	6.646	9.104	89	0.000
Pair 2	2_Pre-Total - 2_Post-Total	5.011	4.684	0.494	4.030	5.992	10.148	89	0.000
Pair 3	3_Pre-Total - 3_Post-Total	4.067	4.173	0.440	3.193	4.941	9.246	89	0.000
Pair 4	4_Pre-Total - 4_Post-Total	4.233	4.014	0.423	3.393	5.074	10.005	89	0.000
Pair 5	5_Pre-Total - 5_Post-Total	4.056	4.012	0.423	3.215	4.896	9.589	89	0.000
Pair 6	6_Pre-Total - 6_Post-Total	3.622	3.770	0.397	2.833	4.412	9.114	89	0.000
Pair 7	7_Pre-Total - 7_Post-Total	3.444	3.860	0.407	2.636	4.253	8.465	89	0.000
Pair 8	8_Pre-Total - 8_Post-Total	3.689	3.324	0.350	2.993	4.385	10.529	89	0.000
Pair 9	9_Pre-Total - 9_Post-Total	3.456	3.184	0.336	2.789	4.122	10.296	89	0.000
Pair 10	10_Pre-Total - 10_Post-Total	3.267	3.765	0.397	2.478	4.055	8.231	89	0.000
Pair 11	11_Pre-Total - 11_Post-Total	4.067	4.086	0.431	3.211	4.922	9.443	89	0.000
Pair 12	12_Pre-Total - 12_Post-Total	4.067	3.859	0.407	3.258	4.875	9.997	89	0.000
Pair 13	13_Pre-Total - 13_Post-Total	3.833	3.312	0.349	3.140	4.527	10.979	89	0.000
Pair 14	14_Pre-Total - 14_Post-Total	3.744	3.568	0.376	2.997	4.492	9.956	89	0.000
Pair 15	15_Pre-Total - 15_Post-Total	3.489	3.458	0.365	2.765	4.213	9.570	89	0.000
Pair 16	16_Pre-Total - 16_Post-Total	4.089	3.833	0.404	3.286	4.892	10.121	89	0.000
Pair 17	17_Pre-Total - 17_Post-Total	3.611	3.463	0.365	2.886	4.336	9.892	89	0.000
Pair 18	18_Pre-Total - 18_Post-Total	3.789	3.146	0.332	3.130	4.448	11.425	89	0.000
Pair 19	19_Pre-Total - 19_Post-Total	3.567	3.130	0.330	2.911	4.222	10.809	89	0.000
Pair 20	20_Pre-Total - 20_Post-Total	3.900	3.687	0.389	3.128	4.672	10.034	89	0.000

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9 Pages of a large correlations chart.

1,2,3 follow all rows down the chart while A,B,C follow columns across the chart

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Correlations of Change Scores

		TOTAL_change	TOTAL_thoughts_change	TOTAL_emotions_change	TOTAL_body_change	Change_BDI	Change_BAI	Change_CS	Change_CS_Kindness	Change_CS_Common_Humanity
TOTAL_change	Pearson Correlation	1	.961**	.957**	.941**	0.137	0.149	0.032	-0.045	0.116
	Sig. (2-tailed)		0	0	0	0.236	0.199	0.791	0.704	0.33
	N	86	86	86	84	77	76	73	73	73
TOTAL_thoughts_change	Pearson Correlation	.961**	1	.894**	.843**	0.114	0.174	0.006	-0.061	0.09
	Sig. (2-tailed)	0		0	0	0.326	0.134	0.959	0.611	0.448
	N	86	86	86	84	77	76	73	73	73
TOTAL_emotions_change	Pearson Correlation	.957**	.894**	1	.855**	0.158	0.149	0.09	-0.035	0.123
	Sig. (2-tailed)	0	0		0	0.17	0.199	0.447	0.77	0.298
	N	86	86	86	84	77	76	73	73	73
TOTAL_body_change	Pearson Correlation	.941**	.843**	.855**	1	0.116	0.095	-0.025	-0.035	0.109
	Sig. (2-tailed)	0	0	0		0.323	0.419	0.839	0.769	0.363
	N	84	84	84	84	75	75	71	71	71
Change_BDI	Pearson Correlation	0.137	0.114	0.158	0.116	1	.502**	-0.153	-0.155	-0.164
	Sig. (2-tailed)	0.236	0.326	0.17	0.323		0	0.216	0.209	0.186
	N	77	77	77	75	80	69	67	67	67
Change_BAI	Pearson Correlation	0.149	0.174	0.149	0.095	.502**	1	-0.045	-0.16	-0.111
	Sig. (2-tailed)	0.199	0.134	0.199	0.419	0		0.723	0.202	0.381
	N	76	76	76	75	69	78	65	65	65
Change_CS	Pearson Correlation	0.032	0.006	0.09	-0.025	-0.153	-0.045	1	.386**	.385**
	Sig. (2-tailed)	0.791	0.959	0.447	0.839	0.216	0.723		0.001	0.001
	N	73	73	73	71	67	65	76	76	76
Change_CS_Kindness	Pearson Correlation	-0.045	-0.061	-0.035	-0.035	-0.155	-0.16	.386**	1	.566**
	Sig. (2-tailed)	0.704	0.611	0.77	0.769	0.209	0.202	0.001		0
	N	73	73	73	71	67	65	76	76	76
Change_CS_Common_Humanity	Pearson Correlation	0.116	0.09	0.123	0.109	-0.164	-0.111	.385**	.566**	1

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	Sig. (2-tailed)	0.33	0.448	0.298	0.363	0.186	0.381	0.001	0	
	N	73	73	73	71	67	65	76	76	76
Change_CS_Mindfulness	Pearson Correlation	0.039	-0.028	0.027	0.126	-0.099	-0.093	.323**	.776**	.543**
	Sig. (2-tailed)	0.741	0.817	0.819	0.296	0.424	0.461	0.004	0	0
	N	73	73	73	71	67	65	76	76	76
Change_CS_Indifference	Pearson Correlation	0.094	0.076	0.096	0.078	-0.182	-0.074	.385**	.566**	.565**
	Sig. (2-tailed)	0.428	0.521	0.421	0.517	0.14	0.56	0.001	0	0
	N	73	73	73	71	67	65	76	76	76
Change_SCS	Pearson Correlation	-0.195	-0.142	-.258*	-0.178	-0.105	0.013	-0.02	0.225	-0.041
	Sig. (2-tailed)	0.109	0.243	0.033	0.147	0.413	0.919	0.883	0.086	0.758
	N	69	69	69	68	63	61	59	59	59
Change_SCS_SelfKindness	Pearson Correlation	-0.167	-0.119	-0.197	-0.169	0.006	0.098	-0.173	0.018	-0.098
	Sig. (2-tailed)	0.17	0.329	0.104	0.168	0.964	0.451	0.19	0.89	0.461
	N	69	69	69	68	63	61	59	59	59
Change_SCS_SelJudgement	Pearson Correlation	-0.083	-0.057	-0.088	-0.107	-0.156	0.065	0.07	0.16	0.067
	Sig. (2-tailed)	0.499	0.642	0.472	0.387	0.221	0.62	0.598	0.226	0.613
	N	69	69	69	68	63	61	59	59	59
Change_SCS_CommonHumanity	Pearson Correlation	-0.209	-0.211	-.247*	-0.156	0.202	0.099	-0.093	-0.108	-0.038
	Sig. (2-tailed)	0.085	0.082	0.041	0.203	0.112	0.45	0.485	0.416	0.775
	N	69	69	69	68	63	61	59	59	59
Change_SCS_Isolation	Pearson Correlation	-0.069	0.014	-0.164	-0.079	-0.13	0.065	0.138	.370**	0.122
	Sig. (2-tailed)	0.571	0.906	0.177	0.523	0.31	0.62	0.296	0.004	0.358
	N	69	69	69	68	63	61	59	59	59
Change_SCS_Mindfulness	Pearson Correlation	-.269*	-.239*	-.308**	-0.231	-0.087	0.061	-0.12	-0.008	-0.225
	Sig. (2-tailed)	0.025	0.048	0.01	0.058	0.497	0.642	0.365	0.953	0.086
	N	69	69	69	68	63	61	59	59	59
Change_SCS_Overidentified	Pearson Correlation	-0.212	-0.17	-.284*	-0.165	-0.142	0.152	0.028	.293*	-0.072
	Sig. (2-tailed)	0.08	0.162	0.018	0.18	0.267	0.241	0.831	0.024	0.589
	N	69	69	69	68	63	61	59	59	59
Change_FFMQ	Pearson Correlation	-.251*	-.249*	-0.196	-.298*	-.271*	-.266*	.326**	0.198	0.092
	Sig. (2-tailed)	0.03	0.031	0.092	0.01	0.026	0.031	0.009	0.117	0.472
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_O	Pearson Correlation	-0.139	-0.142	-0.06	-0.22	-0.089	-0.114	0.178	0.056	-0.056

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		TOTAL_change	TOTAL_thoughts_change	TOTAL_emotions_change	TOTAL_body_change	Change_BDI	Change_BAI	Change_CS	Change_CS_Kindness	Change_CS_Common_Humanity
	Sig. (2-tailed)	0.234	0.226	0.611	0.062	0.473	0.362	0.159	0.66	0.662
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_D	Pearson Correlation	-0.086	-0.103	-0.043	-0.116	-.290*	-0.215	0.132	0.096	0.018
	Sig. (2-tailed)	0.461	0.378	0.717	0.329	0.016	0.082	0.297	0.451	0.887
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_AWA	Pearson Correlation	-.235*	-0.203	-0.178	-.301**	-.344**	-.274*	.378**	.252*	0.14
	Sig. (2-tailed)	0.043	0.081	0.126	0.01	0.004	0.026	0.002	0.044	0.27
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_NJ	Pearson Correlation	-0.044	-0.073	-0.013	-0.052	0.081	-0.17	.271*	0.2	0.165
	Sig. (2-tailed)	0.708	0.536	0.915	0.66	0.513	0.171	0.03	0.113	0.194
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_NR	Pearson Correlation	-.239*	-0.225	-.265*	-0.221	-.245*	-0.154	0.096	0.008	0.017
	Sig. (2-tailed)	0.039	0.052	0.022	0.06	0.044	0.216	0.449	0.951	0.896
	N	75	75	75	73	68	66	64	64	64
Change_MAAS	Pearson Correlation	-.352**	-.307**	-.327**	-.378**	-.314**	-.528**	0.229	0.174	0.091
	Sig. (2-tailed)	0.002	0.007	0.004	0.001	0.008	0	0.065	0.162	0.466
	N	76	76	76	74	70	68	66	66	66
Change_NKC	Pearson Correlation	-0.184	-0.204	-0.149	-0.163	0.056	0.063	-0.067	-0.075	-0.016
	Sig. (2-tailed)	0.089	0.059	0.17	0.139	0.619	0.584	0.563	0.521	0.893
	N	86	86	86	84	80	78	76	76	76

**** Correlation is significant at the 0.01 level (2-tailed).**

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Change_CS_Mindfulness	Change_CS_Indifference	Change_SCS	Change_SCS_SelfKindness	Change_SCS_SelJudgement	Change_SCS_CommonHumanity	Change_SCS_Isolation	Change_SCS_Mindfulness	Change_SCS_Overidentified	Change_FFMQ	Change_FFMQ_O	Change_FFMQ_D	Change_FFMQ_AWA	Change_FFMQ_NJ
0.039	0.094	-0.195	-0.167	-0.083	-0.209	-0.069	-.269*	-0.212	-.251*	-0.139	-0.086	-.235*	-0.044
0.741	0.428	0.109	0.17	0.499	0.085	0.571	0.025	0.08	0.03	0.234	0.461	0.043	0.708
73	73	69	69	69	69	69	69	69	75	75	75	75	75
-0.028	0.076	-0.142	-0.119	-0.057	-0.211	0.014	-.239*	-0.17	-.249*	-0.142	-0.103	-0.203	-0.073
0.817	0.521	0.243	0.329	0.642	0.082	0.906	0.048	0.162	0.031	0.226	0.378	0.081	0.536
73	73	69	69	69	69	69	69	69	75	75	75	75	75
0.027	0.096	-.258*	-0.197	-0.088	-.247*	-0.164	-.308**	-.284*	-0.196	-0.06	-0.043	-0.178	-0.013
0.819	0.421	0.033	0.104	0.472	0.041	0.177	0.01	0.018	0.092	0.611	0.717	0.126	0.915
73	73	69	69	69	69	69	69	69	75	75	75	75	75
0.126	0.078	-0.178	-0.169	-0.107	-0.156	-0.079	-0.231	-0.165	-.298*	-0.22	-0.116	-.301**	-0.052
0.296	0.517	0.147	0.168	0.387	0.203	0.523	0.058	0.18	0.01	0.062	0.329	0.01	0.66
71	71	68	68	68	68	68	68	68	73	73	73	73	73
-0.099	-0.182	-0.105	0.006	-0.156	0.202	-0.13	-0.087	-0.142	-.271*	-0.089	-.290*	-.344**	0.081
0.424	0.14	0.413	0.964	0.221	0.112	0.31	0.497	0.267	0.026	0.473	0.016	0.004	0.513
67	67	63	63	63	63	63	63	63	68	68	68	68	68
-0.093	-0.074	0.013	0.098	0.065	0.099	0.065	0.061	0.152	-.266*	-0.114	-0.215	-.274*	-0.17
0.461	0.56	0.919	0.451	0.62	0.45	0.62	0.642	0.241	0.031	0.362	0.082	0.026	0.171
65	65	61	61	61	61	61	61	61	66	66	66	66	66
.323**	.385**	-0.02	-0.173	0.07	-0.093	0.138	-0.12	0.028	.326**	0.178	0.132	.378**	.271*
0.004	0.001	0.883	0.19	0.598	0.485	0.296	0.365	0.831	0.009	0.159	0.297	0.002	0.03
76	76	59	59	59	59	59	59	59	64	64	64	64	64
.776**	.566**	0.225	0.018	0.16	-0.108	.370**	-0.008	.293*	0.198	0.056	0.096	.252*	0.2
0	0	0.086	0.89	0.226	0.416	0.004	0.953	0.024	0.117	0.66	0.451	0.044	0.113
76	76	59	59	59	59	59	59	59	64	64	64	64	64
.543**	.565**	-0.041	-0.098	0.067	-0.038	0.122	-0.225	-0.072	0.092	-0.056	0.018	0.14	0.165

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0	0	0.758	0.461	0.613	0.775	0.358	0.086	0.589	0.472	0.662	0.887	0.27	0.194
76	76	59	59	59	59	59	59	59	64	64	64	64	64
1	.523**	-0.001	-0.135	0.175	-0.119	0.146	-0.224	-0.026	0.05	-0.087	-0.034	0.09	0.168
	0	0.992	0.308	0.186	0.371	0.271	0.087	0.848	0.694	0.495	0.792	0.478	0.185
76	76	59	59	59	59	59	59	59	64	64	64	64	64
.523**	1	-0.041	-0.203	0.088	-0.04	0.153	-0.097	-0.008	0.157	0.026	0.041	0.2	.256*
0		0.759	0.123	0.506	0.763	0.249	0.467	0.952	0.214	0.839	0.751	0.114	0.041
76	76	59	59	59	59	59	59	59	64	64	64	64	64
-0.001	-0.041	1	.840**	.721**	.542**	.675**	.731**	.668**	.424**	0.108	.394**	.376**	0.1
0.992	0.759		0	0	0	0	0	0	0.001	0.409	0.002	0.003	0.448
59	59	72	72	72	72	72	72	72	60	60	60	60	60
-0.135	-0.203	.840**	1	.598**	.530**	.448**	.690**	.542**	.358**	0.058	.410**	.305*	0.078
0.308	0.123	0		0	0	0	0	0	0.005	0.662	0.001	0.018	0.552
59	59	72	72	72	72	72	72	72	60	60	60	60	60
0.175	0.088	.721**	.598**	1	.332**	.466**	.384**	.420**	.433**	0.197	.374**	.369**	0.121
0.186	0.506	0	0		0.004	0	0.001	0	0.001	0.132	0.003	0.004	0.356
59	59	72	72	72	72	72	72	72	60	60	60	60	60
-0.119	-0.04	.542**	.530**	.332**	1	0.149	.614**	0.146	0.016	-0.124	-0.086	-0.005	0.104
0.371	0.763	0	0	0.004		0.211	0	0.22	0.906	0.347	0.513	0.972	0.429
59	59	72	72	72	72	72	72	72	60	60	60	60	60
0.146	0.153	.675**	.448**	.466**	0.149	1	.361**	.511**	.319*	0.024	0.24	.258*	0.14
0.271	0.249	0	0	0	0.211		0.002	0	0.013	0.854	0.065	0.046	0.285
59	59	72	72	72	72	72	72	72	60	60	60	60	60
-0.224	-0.097	.731**	.690**	.384**	.614**	.361**	1	.530**	.271*	0.074	.339**	0.23	-0.062
0.087	0.467	0	0	0.001	0	0.002		0	0.036	0.575	0.008	0.077	0.639
59	59	72	72	72	72	72	72	72	60	60	60	60	60
-0.026	-0.008	.668**	.542**	.420**	0.146	.511**	.530**	1	.358**	0.09	.473**	.272*	0.052
0.848	0.952	0	0	0	0.22	0	0		0.005	0.494	0	0.035	0.692
59	59	72	72	72	72	72	72	72	60	60	60	60	60
0.05	0.157	.424**	.358**	.433**	0.016	.319*	.271*	.358**	1	.550**	.616**	.756**	.626**
0.694	0.214	0.001	0.005	0.001	0.906	0.013	0.036	0.005		0	0	0	0
64	64	60	60	60	60	60	60	60	77	77	77	77	77
-0.087	0.026	0.108	0.058	0.197	-0.124	0.024	0.074	0.09	.550**	1	.294**	0.175	0.143

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Change_CS_Mindfulness	Change_CS_Indifference	Change_SCS	Change_SCS_SelfKindness	Change_SCS_SelJudgement	Change_SCS_CommonHumanity	Change_SCS_Isolation	Change_SCS_Mindfulness	Change_SCS_Overidentified	Change_FFMQ	Change_FFMQ_O	Change_FFMQ_D	Change_FFMQ_AWA	Change_FFMQ_NJ
0.495	0.839	0.409	0.662	0.132	0.347	0.854	0.575	0.494	0		0.009	0.128	0.213
64	64	60	60	60	60	60	60	60	77	77	77	77	77
-0.034	0.041	.394**	.410**	.374**	-0.086	0.24	.339**	.473**	.616**	.294**	1	.316**	.238*
0.792	0.751	0.002	0.001	0.003	0.513	0.065	0.008	0	0	0.009		0.005	0.037
64	64	60	60	60	60	60	60	60	77	77	77	77	77
0.09	0.2	.376**	.305*	.369**	-0.005	.258*	0.23	.272*	.756**	0.175	.316**	1	.408**
0.478	0.114	0.003	0.018	0.004	0.972	0.046	0.077	0.035	0	0.128	0.005		0
64	64	60	60	60	60	60	60	60	77	77	77	77	77
0.168	.256*	0.1	0.078	0.121	0.104	0.14	-0.062	0.052	.626**	0.143	.238*	.408**	1
0.185	0.041	0.448	0.552	0.356	0.429	0.285	0.639	0.692	0	0.213	0.037	0	
64	64	60	60	60	60	60	60	60	77	77	77	77	77
0.022	-0.042	.307*	.257*	.314*	0.045	.315*	0.171	0.173	.593**	.275*	0.224	.348**	0.123
0.865	0.745	0.017	0.048	0.015	0.735	0.014	0.192	0.187	0	0.015	0.051	0.002	0.285
64	64	60	60	60	60	60	60	60	77	77	77	77	77
0.113	0.072	0.238	0.206	.333**	-0.061	0.132	0.127	0.149	.628**	0.226	.460**	.631**	.253*
0.365	0.565	0.062	0.108	0.008	0.635	0.307	0.323	0.248	0	0.066	0	0	0.039
66	66	62	62	62	62	62	62	62	67	67	67	67	67
-0.041	-0.059	0.171	0.103	0.13	.287*	0.024	0.228	0.002	0.083	0.085	-0.029	0.058	0.02
0.723	0.61	0.152	0.387	0.277	0.015	0.842	0.054	0.986	0.472	0.465	0.8	0.619	0.864
76	76	72	72	72	72	72	72	72	77	77	77	77	77

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Change_FFMQ_NR	Change_MAAS	Change_NKC		
-.239*	-.352**	-0.184	Pearson Correlation	**TOTAL_change**
0.039	0.002	0.089	Sig. (2-tailed)	
75	76	86	N	
-0.225	-.307**	-0.204	Pearson Correlation	**TOTAL_thoughts_change**
0.052	0.007	0.059	Sig. (2-tailed)	
75	76	86	N	
-.265*	-.327**	-0.149	Pearson Correlation	**TOTAL_emotions_change**
0.022	0.004	0.17	Sig. (2-tailed)	
75	76	86	N	
-0.221	-.378**	-0.163	Pearson Correlation	**TOTAL_body_change**
0.06	0.001	0.139	Sig. (2-tailed)	
73	74	84	N	
-.245*	-.314**	0.056	Pearson Correlation	**Change_BDI**
0.044	0.008	0.619	Sig. (2-tailed)	
68	70	80	N	
-0.154	-.528**	0.063	Pearson Correlation	**Change_BAI**
0.216	0	0.584	Sig. (2-tailed)	
66	68	78	N	
0.096	0.229	-0.067	Pearson Correlation	**Change_CS**
0.449	0.065	0.563	Sig. (2-tailed)	
64	66	76	N	
0.008	0.174	-0.075	Pearson Correlation	**Change_CS_Kindness**
0.951	0.162	0.521	Sig. (2-tailed)	
64	66	76	N	
0.017	0.091	-0.016	Pearson Correlation	**Change_CS_Common_Humanity**

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0.896	0.466	0.893	Sig. (2-tailed)	
64	66	76	N	
0.022	0.113	-0.041	Pearson Correlation	**Change_CS_Mindfulness**
0.865	0.365	0.723	Sig. (2-tailed)	
64	66	76	N	
-0.042	0.072	-0.059	Pearson Correlation	**Change_CS_Indifference**
0.745	0.565	0.61	Sig. (2-tailed)	
64	66	76	N	
.307*	0.238	0.171	Pearson Correlation	**Change_SCS**
0.017	0.062	0.152	Sig. (2-tailed)	
60	62	72	N	
.257*	0.206	0.103	Pearson Correlation	**Change_SCS_SelfKindness**
0.048	0.108	0.387	Sig. (2-tailed)	
60	62	72	N	
.314*	.333**	0.13	Pearson Correlation	**Change_SCS_SelJudgement**
0.015	0.008	0.277	Sig. (2-tailed)	
60	62	72	N	
0.045	-0.061	.287*	Pearson Correlation	**Change_SCS_CommonHumanity**
0.735	0.635	0.015	Sig. (2-tailed)	
60	62	72	N	
.315*	0.132	0.024	Pearson Correlation	**Change_SCS_Isolation**
0.014	0.307	0.842	Sig. (2-tailed)	
60	62	72	N	
0.171	0.127	0.228	Pearson Correlation	**Change_SCS_Mindfulness**
0.192	0.323	0.054	Sig. (2-tailed)	
60	62	72	N	
0.173	0.149	0.002	Pearson Correlation	**Change_SCS_Overidentified**
0.187	0.248	0.986	Sig. (2-tailed)	
60	62	72	N	
.593**	.628**	0.083	Pearson Correlation	**Change_FFMQ**
0	0	0.472	Sig. (2-tailed)	
77	67	77	N	
.275*	0.226	0.085	Pearson Correlation	**Change_FFMQ_O**

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0.015	0.066	0.465	Sig. (2-tailed)	
77	67	77	N	
0.224	.460**	-0.029	Pearson Correlation	**Change_FFMQ_D**
0.051	0	0.8	Sig. (2-tailed)	
77	67	77	N	
.348**	.631**	0.058	Pearson Correlation	**Change_FFMQ_AWA**
0.002	0	0.619	Sig. (2-tailed)	
77	67	77	N	
0.123	.253*	0.02	Pearson Correlation	**Change_FFMQ_NJ**
0.285	0.039	0.864	Sig. (2-tailed)	
77	67	77	N	
1	.498**	0.135	Pearson Correlation	**Change_FFMQ_NR**
	0	0.243	Sig. (2-tailed)	
77	67	77	N	
.498**	1	0.005	Pearson Correlation	**Change_MAAS**
0		0.962	Sig. (2-tailed)	
67	79	79	N	
0.135	0.005	1	Pearson Correlation	**Change_NKC**
0.243	0.962		Sig. (2-tailed)	
77	79	89	N	

Change_FFMQ_NR

Change_MAAS

Change_NKC

Chapter 5

Development, Validity, and Reliability of the Multidimensional Impacts of Movement Scale (MIMS)

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ABSTRACT

Introduction

Movement is an essential element in maintaining overall wellbeing with both physical and mental health benefits. Yoga is a mindful movement practice, with traditional yogic texts providing a framework, called the “Koshas”, that delineates how an intentional movement practice may impact multidimensional aspects of an individual. To date, no self-report measure examines the multifaceted ways that movement affects the individual at a physical and psychological level. Therefore, we developed the Multidimensional Impacts of Movement Scale (MIMS) by aligning ancient yogic traditions with current neuroscience concepts.

Methods

MIMS was developed with X categories with X questions. Participants (n=103) self-identified as having yoga, running, or weightlifting as their primary movement practice, engaging in this practice at least 30 minutes per session, once a week, for the past 3 months. Participants engaged in their usual movement practice and then (within 2 hours of their workout session) completed the MIMS along with a series of previously validated questionnaires. After a period of 2 weeks, participants completed their normal movement practice once again and took the MIMS a second time to assess test-retest reliability and Cronbach’s Alpha. Validity testing included convergent and divergent validity testing through Pearson product moment correlations and Confirmatory Factor Analysis.

Results

One-hundred and three participants completed all study measures. Test-retest reliability demonstrates stability over time ($r = 0.737$, $p < 0.001$). Cronbach's alpha is between 0.775 and 0.840 for each of the factors, $p < 0.001$. MIMS is sensitive to confirmatory and discriminatory validity testing. Validity is also demonstrated through confirmatory factor analysis (i.e., Chi Square, Comparative Fit Index, Root Mean Square Error of Approximation).

Conclusion

MIMS is a valid and reliable tool to measure the multidimensional impacts of movement. The tool provides information about the effects of movement on a range of physical and psychological elements including subscales representing the body, energy, mind, intuition, and contentment. Physical activities that include aspects of mindfulness may demonstrate the most robust effects on the MIMS.

INTRODUCTION

Yoga is a mindfulness practice that incorporates movement, breathwork, concentration, and meditation (Rakel, 2012). A 2012 National Health Interview Survey (NHIS) found that approximately 31 million (13.2%) US adults have tried yoga in their lifetime and about 21 million (8.9%) US adults practice yoga regularly (Cramer et al., 2016). The NHIS found that yoga practitioners were motivated to practice yoga due to wellness and disease prevention, increased energy, enhanced immune function, and reduced stress.

The Yoga Sutras of Patanjali (Zambito, 1992), a primary yogic text, explains a process of achieving freedom through yoga, including ethical considerations (*yamas* and *niyamas*), movement (*asana*), breathwork (*pranayama*), sensory control (*pratyahara*), concentration (*dharana*), meditation (*dhyana*), and the resulting freedom (*samadhi*). In addition, the Taittiriya Upanishads (200 CE), a book on the nature of life, death, love, and divine presence, explains a system of multidimensionality among layers of every individual called the Koshas (Eswaran, 2007). The five layers of the Koshas are the body, energy, mental function, wisdom, and contentment. The Koshas are often spoken of as containers such that the physical body contains the energetic body, which contains the thoughts, emotions, and sense perceptions, which holds the wisdom, which holds contentment (Figure 5.1).

In yoga, movement is the object of focused attention, and participants are encouraged to notice internal physical sensations and body placement in space. From a neuroscientific perspective, these are the processes of interoception and proprioception, respectively (Tsur et al., 2016). In fact, when the historical yogic texts are examined in

the context of neuroscience, excellent alignment can be found between yogic and neuroscientific concepts (Table 5.1). Here, we utilize these established yogic frameworks to develop a validated tool to examine the multidimensional impacts of movement practices from a neuroscience-based perspective.

Overlapping Yogic and Neuroscience Concepts		
8 Fold Path of Patanjali - The steps to doing yoga	Koshas - Multidimensional Aspects of being	Neuroscience/Psychology
1. *Yamas* 2. *Niyamas* Ethical restraint and development	No Kosha equivalent	Not assessed in present study
3. *Asana* Physical poses	*Anamaya Kosha* Physical body [BODY]	Proprioception, balance, embodiment
4. *Pranayama* Breathing practices	*Pranayama Kosha* Breath, force, energy [ENERGY]	Vitality, fatigue
5. *Pratyahara* Control of the senses	*Manomaya Kosha* Thoughts, emotions and sense perception [MIND]	Aspects of mental health (anxiety, depression, affect)
6. *Dharana* Concentration 7. Dhyana Meditation	*Vjnanamaya Kosha* Wisdom [INTUITION]	Confidence, trust, compassion, interoception
8. *Samadhi* Freedom from constraint	*Anandamaya Kosha* Bliss and contentment [CONTENTMENT]	Satisfaction, awe, gratitude

Table 5.1 Overlapping yogic and neuroscientific concepts regarding the multidimensional aspects of being

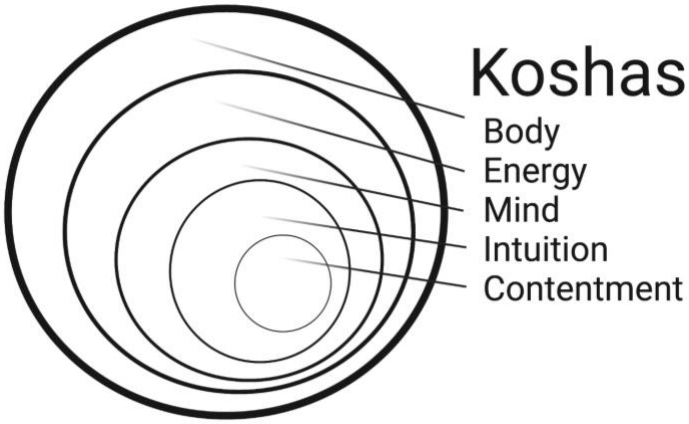

Figure 5.1 Diagram demonstrating the concentric nature of the koshas

Physical activity, defined as “any bodily movement produced by skeletal muscle contraction that increases energy expenditure above a basal level” (U.S. Department of Health and Human Services, 2018), is beneficial for a range of physical and mental health issues, including obesity, type II diabetes (Sampath Kumar et al., 2019), cancer (McTiernan et al., 2019), and mood and anxiety disorder (Chan et al., 2019). Additionally, engaging in physical activity throughout life can increase one’s life span (Anderson & Durstine, 2019). Yoga, a form of mindful physical activity, includes physical elements as well as elements of breath and meditation (Govindaraj et al., 2016). In a comparison review of the health benefits of yoga and exercise (Ross A. & Thomas S., 2010)**,** yoga was found to be as effective as exercise at reducing stress through biomarkers (e.g., salivary cortisol, C-reactive protein), improving diabetic outcomes, and enhancing mood. Despite these known benefits at both the levels of the body and brain, there are no self-report scales to measure the multidimensional outcomes of movement. Additionally, there are no known scales addressing the complex system of outcomes of mindful movement practices such as yoga.

Currently, two validated tools exist to assess yoga. First, the Beliefs about Yoga Scale (Sohl SJ et al., 2011) was developed to help researchers find participants likely to complete longitudinal yoga studies. The information gathered from the Beliefs about Yoga Scale illuminates positive and negative beliefs about yoga's potential outcomes and its connection to spiritual traditions. However, the Beliefs about Yoga Scale is not based on a yogic framework. Second, the Yoga Self Efficacy Scale (Sohl SJ et al., 2011) was developed to determine how people feel during the practice of yoga. Questions on this scale target body, breath, mind, and confidence in knowing how and what to do during a yoga class. This scale was developed to help researchers understand how likely participants are to feel comfortable in their practice. The Yoga Self Efficacy Scale mirrors yoga sutras 1.21 and 1.22 (Zambito, 1992). Sutra 1.21 explains how individuals who pursue their practice with intensity and conviction will achieve results more quickly than those who take a path of lesser intensity. Sutra 1.22 emphasizes that the rate of progress for an individual can vary depending upon how quickly they can apply what has been learned, despite the level of intensity to which they try. Considering the Yoga Self Efficacy Scale and Beliefs About Yoga Scale assess yoga beliefs as a process, we sought to develop a scale that measured its outcomes.

Therefore, we developed and subsequently validated a tool based on aligned yogic and neuroscientific frameworks that assessed the multifaceted impacts of movement (i.e., body, mind, energy, intuition, contentment; Table 5.1). We utilized 3 different movement practices (i.e., yoga (balance/flexibility/mindfulness); running (aerobic); and weightlifting (anaerobic)) to test the hypothesis that the Multidimensional

Impacts of Movement Scale (MIMS) is valid and reliable using rigorous statistical analytic techniques.

METHODS

Procedure

The Virginia Tech Institutional Review Board (IRB) approved this study (IRB-21-074). MIMS was created in four phases: 1) item generation; 2) review by a panel of experts; 3) focus groups, and 4) testing. The study authors are experts in behavioral neuroscience and yoga and completed the initial item generation through conversations that surrounded mapping the Koshas onto modern neuroscientific concepts. We utilized a panel of experts to review the first iteration of MIMS, including a neuroscientist, a yoga instructor, and two experts in tool validation. Several iterative revisions were made considering changes from this panel. Feedback from two focus groups, including both undergraduate and graduate students at Virginia Tech, helped to further refine the individual items and study format.

Recruitment occurred through social media posts, online posts hosted through the university, and flyers hung around campus. Direct emails were also sent to related places of business (e.g., gyms and yoga studios). After passing a screening questionnaire, participants were randomized into Group A (receives MIMS + surveys for validation at test, and MIMS + demographics at retest) or Group B (receives MIMS + demographics at test, and MIMS + surveys for validation at retest) (Figure 5.2). The random division into two groups minimized any effect the surveys may have on responses to MIMS. Participants completed their usual movement practice, and within 2 hours completed their initial test/survey. We chose this 2-hour period as the acute effects of exercise are most potent up to 2 hours after exercise cessation (Basso et al.,

2015). After a two-week wash-out period, participants were instructed to complete their typical workout again and then complete their retest within two hours. Participants were instructed that this 2nd workout should be as close to the initial as possible in terms of type of activity, length and intensity of workout, and time of day completed. Participants were compensated $20 for completing the entire study with no partial payments.

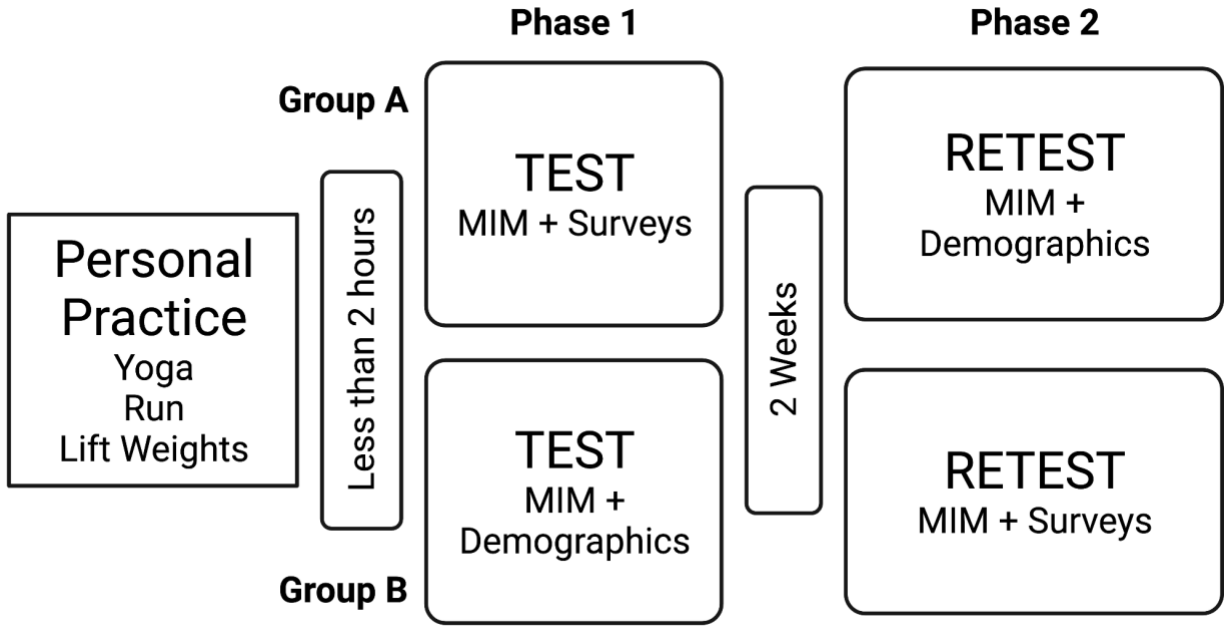

Figure 5.2 Study design, including study elements and timeline

Participants

A total of n=146 participants volunteered and completed screening. Participants were included if they were 18 years or older, had English as their primary language, and self-identified as having yoga, running, or weightlifting as their primary form of physical activity. Participants were excluded if they did not pass the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) (Warburton, Jamnik, et al., 2011) or reported that their regular movement sessions lasted less than 30 minutes. Of the 146 participants

who took the screening tool, 24 did not meet the eligibility criteria. Of the 122 participants who started the study, 19 did not complete all necessary components of the research and were removed, leaving n=103 participants for analysis.

Study Measures

Assessing Physical Activity Readiness

The Physical Activity Readiness Questionnaire (PAR-Q+) (Warburton, Bredin, et al., 2011) is a self-report tool created to help individuals make connections between their health and physical activity. The PAR-Q+ was used as a screening tool to assure participants were safe to engage in their regular movement practice. The PAR-Q+ underwent a revision in which some of the questions were revised for clarity. In this study, we use the short form of the PAR-Q+, which has seven questions that can be answered with a “yes” or “no” response. Three questions have space to add greater detail with free writing. From the old to the new version of PAR-Q, there was a strong correlation (r=0.80); the test-retest reliability of the PAR-Q+ is (r=0.99), and it shows a much greater specificity over the PAR-Q.

Confirming Validity for the A Priori Factor, Body

The Activities Specific Balance Confidence Scale (ABCS) (Peretz et al., 2006) is a self-report scale providing information about an individual’s fear of falling and confidence in moving through the world. It is a single factor scale with 16 questions, with the overall score reported as an average. Answers to the questions are reported in increments of 10 as confidence percentages that one will not fall given a specific activity. The ABCS validation testing reports a Cronbach’s alpha = 0.96 and a test-retest correlation ($r = 0.92$, $p<.001$). Convergent Validity was tested against the Physical Self-

Efficacy Scale (PSES) (Ryckman et al., 1982), while divergent validity was tested with the Positive and Negative Affect Scale (Crawford & Henry, 2004).

The Scale of Body Connection (SBC) (Price et al., 2017) is a self-report measure of bodily awareness and dissociation. There are 20 questions divided into 2 subscales: body awareness and body dissociation. The SBC is measured on a 5-Point Likert Scale, with 0 representing “Not at all” and 4 representing “All of the time”. The SBC is best scored using two subscales, with higher scores corresponding to higher levels of body awareness and body dissociation, respectively. An overall score is calculated by reversing the body dissociation score and taking an average of the two subscale scores. The SBC proves reliability with Cronbach’s alpha = 0.83. Construct validity using Structural Equation Modeling found a goodness-of-fit model that demonstrated two independent factors.

Confirming Validity for the A Priori Factor, Energy

The Brief Resilience Scale (BRS) (Smith et al., 2008) is a self-report measure of an individual’s perception of resilience. There are six questions and no subscales, with overall score reported as a mean. Questions are answered on a 5-point Likert scale, with 1 representing “Strongly Disagree” and 5 representing “Strongly Agree”. The BRS displays strong internal consistency with a Cronbach’s alpha ranging from 0.80 to 0.91 for each of the four groups used for testing. Principal Component Analysis from all four samples shows only one factor, accounting for 55-67% of the variance. Factor loadings ranged from 0.68 to 0.91.

The Fatigue Severity Scale (FSS) (Learmonth et al., 2013) is a self-report measure bringing together emotional and physical symptoms of fatigue on one scale.

The FSS has 9 questions and no subscales, with the overall score reported as an average. It is measured on a 7-point Likert scale with 1 representing “Strongly Disagree” and 7 representing “Strongly Agree.” The FSS was validated using the Intraclass Correlation Coefficient (ICC) with 95% confidence intervals and a test-retest score of 0.751. Convergent validity of the FSS and the Modified Fatigue Impact Scale (MFIS) (Larson, 2013) show r >0.5 Spearman Correlation.

The Subjective Vitality Measure (SVM) (Ryan & Frederick, 1997) is a self-report measure of an individual’s perception of their vitality or sense of energy and livelihood. Seven questions on this measure are scored on a 7-point Likert Scale with 1 representing “Not at all” and 7 representing “Very True”. Certain items are reverse scored, and the overall score is reported as an average. The SVM earned a Cronbach’s alpha ranging from 0.84 to 0.86 in three samples. The test-retest in both clinical and non-clinical samples was >0.70. Factor analysis revealed eigenvalues = 6.77.

Confirming Validity for the A Priori Factor, Mind

The Beck Anxiety Inventory (BAI) (Borden et al., 1991) is a self-report measure of anxiety symptoms, including questions about somatic and psychological experiences related to anxiety. It has 21 questions, with various factor-analytic studies reporting between two to six factors. Questions are asked on a 4-point Likert scale, with 0 representing “Not at all” and 3 representing “Severely – it bothered me a lot”. The total score is calculated by summing responses for each question. Results can be described as 0-21 = low anxiety; 22-35 = moderate anxiety; and 36 and above = potentially concerning anxiety levels. BAI demonstrates high internal consistency with a Cronbach’s alpha = 0.91 with median item correlations at r = 0.56. Principal

Components Analysis (PCA) with eigenvalues greater than 1.0 with a varimax rotation converged in 19 iterations, resulting in five factors, which accounted for 60% of the variance.

The Beck Depression Inventory (BDI) (Beck et al., 1988) is a self-report measure of depression symptoms. BDI has 21 questions, and factor analysis over twenty-five years of re-testing shows between three and seven factors. BDI includes multiple-choice questions, instructing the participant to select the phrase that best describes them (e.g., “I do not feel sad”, “I feel sad”, “I am sad all the time and I can’t snap out of it”, or “I am so sad and unhappy that I can’t stand it”). The responses are rated from 0 to 3, and it is scored as a sum of all responses. These sums are then rated as: 1-10 = these ups and downs are considered normal; 11-16 = mild mood disturbance; 17- 20 = borderline clinical depression; 21-30 = moderate depression; 31-40 = severe depression; and over 40 = extreme depression. BDI’s reliability shows a Cronbach’s alpha = 0.86 in the clinical population and 0.81 in non-clinical populations. The test-retest reliability showed $r>0.60$. Concurrent Validity with Hamilton Psychiatric Rating Scale for Depression (HRSD) (Miller et al., 1985) showed $r =0.72$ to 0.73 for clinical populations and $r =0.60$ to 0.74 in nonclinical populations.

The Positive and Negative Affect Scale (PANAS) (Crawford & Henry, 2004) is a self-report measure of positive and negative affect. PANAS has 20 questions with 2 subscales: positive affect and negative affect. It is scored on a 5-Point Likert Scale, with 1 representing “Very slightly or not at all” and 5 representing “Extremely”. Both positive and negative affect scores range from 10 to 50, with higher scores representing higher levels of that particular affective state. PANAS has a Cronbach’s alpha = 0.89 for

Positive Affect and 0.85 for Negative Affect. Confirmatory Factor Analysis showed both models of good and poor fit.

Confirming Validity for the A Priori Factor, Intuition

The Compassion Scale (CS) (Pommier et al., 2020) is a self-report measure of one's kindness and desire to lessen the suffering of others. CS includes 16 items divided among 4 subscales: kindness, common humanity, mindfulness, and indifference (reverse scored), with the overall score and subscales reported as averages. A variety of studies show CS to be reliable, with Cronbach's alpha ranging from 0.77 to 0.90. Test-retest reliability demonstrated r = 0.81. Known group validity showed marked differences, as expected in meditators vs. non-meditators, and Structural Equation Modeling found a good fit with three positive subscales and one negative subscale.

The Metacognition Questionnaire - 30 (MCQ-30) (Wells & Cartwright-Hatton, 2004) is a 30 question self-report measure of cognitive confidence. The MCQ-30 has 5 subscales: confidence, positive beliefs about worry, cognitive self-consciousness, negative beliefs about uncontrollability and danger, and need to control thoughts. A 4-Point Likert scale is used in the MCQ-30, with 1 representing "Do not agree" and 4 representing "Agree very much". Summation scores range from 30 to 120, with higher scores representing higher levels of unhelpful metacognitions. Cronbach's alpha for MCQ-30 ranges from 0.70 to 0.93 for each of the five subscales.

The Multidimensional Assessment of Interoceptive Awareness (MAIA) (Mehling et al., 2012) is a self-report measure of an individual's awareness of their internal sensations. It has 32 questions with 8 subscales: noticing, not-distracting, not-worrying, attention regulation, emotional awareness, self-regulation, body listening, and trusting.

MAIA uses a 6-Point Likert Scale with 0 = Never to 5 = Always. Scores are calculated as the average of each domain with selected items reversed. Internal Consistency ranged from 0.66 to 0.82 for individual subscales of MAIA. Correlations among subscales ranged from 0.09 to 0.60. The validity of MAIA was tested with convergent and divergent scales.

Assessing Validity for the A Priori Factor, Contentment

The Dispositional Positive Emotions Scale (DPES) (Shiota et al., 2006) contains a subscale measuring Awe. This subscale has been validated individually to measure an individual's curiosity and wonder about the world (Gottlieb et al., 2018). The Awe Subscale is made up of 6 questions on a 7-point Likert scale, with 1 representing "Strongly Disagree" and 7 representing "Strongly Agree", and the overall score reported as an average. The validation study utilized Amazon Mechanical Turk, with participants having >95% approval ratings. Cronbach's alpha = 0.82 among all 6 items of the Awe Subscale. The Awe Subscale was validated against other scales considering spirituality and science and was found to have significant and measurable scientific quality.

The Satisfaction with Life Scale (SLS) (Pavot W et al., 1991) is a self-report measure of subjective well-being. It has 5 questions and no subscales, scored on a 7-Point Likert Scale with 1 representing "Strongly disagree" and 7 representing "Strongly Agree". Scores are reported as one total sum, divided into designations of extremely satisfied (31-35), satisfied (26-30), slightly satisfied (21-25), neutral (20), slightly dissatisfied (15-19), dissatisfied (10-14), and extremely dissatisfied (5-9). The SLS proves reliable with a Cronbach's alpha = 0.85 and test-retest reliability of 0.84. Factor

Analysis and Factor Loading were stronger for individual questions than composite scores, ranging from 0.55 to 0.93.

Power and Statistical Analysis

An a priori power analysis was run using G*Power 3.1 to determine the appropriate number of participants to sufficiently power this study (Faul et al., 2009). We utilized an F test, ANOVA: Repeated measures, within-between interaction using an effect size of 0.25, an alpha error probability of 0.0005 to correct for multiple testing, power level of 0.8, 3 groups (yoga, running, weightlifting), 2 measurements (test versus retest), correlation among representative measures of 0.5, and nonsphericity correction of 1 to determine a sample size of n=96.

Statistical analysis was completed for validation and reliability of the Multidimensional Impacts of Movement Scale. Cronbach's alpha and correlations were conducted using SPSS, Version 27.0.1.0, 64-bit edition (*IBM SPSS Statistics for Macintosh*, 2020). Internal consistency was calculated as Cronbach's alpha. Pearson's product-moment correlations were calculated to determine test-retest reliability demonstrating the tool's stability over time. Convergent and divergent validity were determined with Pearson's product-moment correlations using previously validated tools alongside the initial test of MIMS. One-Way Analysis of Variance (ANOVAs) was performed to determine statistically significant differences in MIMS outcomes between yogis, runners, and weightlifters; Tukey-Kramer post-hoc analyses were conducted as appropriate. Data are presented as mean (standard error of the mean), and statistical significance was determined using $p<0.05$.

RESULTS

Participants

Basic Characteristic	*n*	%	Basic Characteristic	*n*	%
N = 103					
Sex			**Ethnicity**		
Female	82	79.6	Hispanic	7	6.8
Male	21	20.4	Non-Hispanic	95	92.2
Race			Prefers not to answer	1	1
Asian	7	6.8	**Education**		
Black	4	3.9	High School	7	6.8
Indigenous	0	0	Some college or vocational training	28	27.2
White	90	87.4	Associates Degree	7	6.8
Prefers not to answer	1	1	Bachelor's Degree	29	28.2
Income			Graduate Degree	32	31.1
Low < $40,000	19	18.4			
Middle $40,000-$120,000	36	35		**Mean**	**±SD**
High > $120,000	35	34	**Age**	30.39	12.63
Prefers not to answer	13	12.6			

Table 5.2: Demographic data for all 103 participants in the study

The initial scale that was developed included 50 total questions, with 10 questions in each of the 5 a priori factors. Through Confirmatory Factor Analysis, we eliminated 1 question from each of the a priori factors, leaving a total of 45 total

questions (9 per factor). Therefore, the following results are based on these 45 final questions.

Reliability

MIMS demonstrated test-retest reliability of $r = 0.737$ with significance of $p<0.001$. All subscales showed significant stability over time, with $r > 0.670$, $p<0.001$ or higher for each subscale. Internal consistency was confirmed with Cronbach's alpha for each factor and individual question. There were 9 questions in each of the 5 *a* priori factors, which were all examined individually. All questions remained, showing that a removal of any question would not result in a change in Cronbach's alpha below 0.700. Cronbach's alpha is between 0.775 and 0.840 for each of the factors (body $\alpha=0.781$, energy $\alpha=0.840$, mind $\alpha=0.815$, intuition $\alpha=0.775$, and contentment $\alpha=0.830$).

Validity

The body factor was positively associated with the SBC awareness ($r = 0.509$, $p<0.001$) and dissociation ($r = -0.296$, $p=.002$) subscales. No association was found with the ABCS.

The energy factor was positively associated with the FSS ($r = -0.226$, $p=0.022$) and SVM ($r = 0.602$, $p<0.001$). No association was found with the BRS.

The mind factor was positively associated with the BAI ($r = -0.218$, $p < 0.027$), BDI ($r = -0.392$, $p<0.001$), PANAS positive affect ($r = 0.428$, $p<0.001$), and PANAS negative affect ($r = -0.339$, $p < 0.001$).

The intuition factor was positively associated with the CS ($r = 0.377$, $p<0.001$) and MAIA ($r = 0.580$, $p<0.001$). No significant correlation was found with the MCQ-30.

The contentment factor was positively correlated with the DPES awe subscale ($r = 0.515$, $p<0.001$) and the SLS ($r = 0.461$, $p<0.001$).

Confirmatory Factor Analysis

Confirmatory Factor Analysis supported 5 distinct factors. Scale purification was completed based on initial data. After reviewing correlations, factor loading, and to improve parsimony, items 14 (contentment), 31 (body), 32 (energy), 27 (mind), and 45 (intuition) were removed from MIMS. The revised scale has 45 items, 9 in each factor. The data are represented in Table 5.5 and Figures 5.3 A-E.

Models	Chi Square	Df	CFI	RMSEA
(N=103)				
Factor 1 Body	40,835	27	0.971	0.071
Factor 2 Energy	30.352	27	0.995	0.035
Factor 3 Mind	73.096	27	0.934	0.129
Factor 4 Intuition	41.539	27	0.962	0.073
Factor 5 Contentment	98.015	27	0.917	0.161

Table 5.3 Confirmatory Factor Analysis

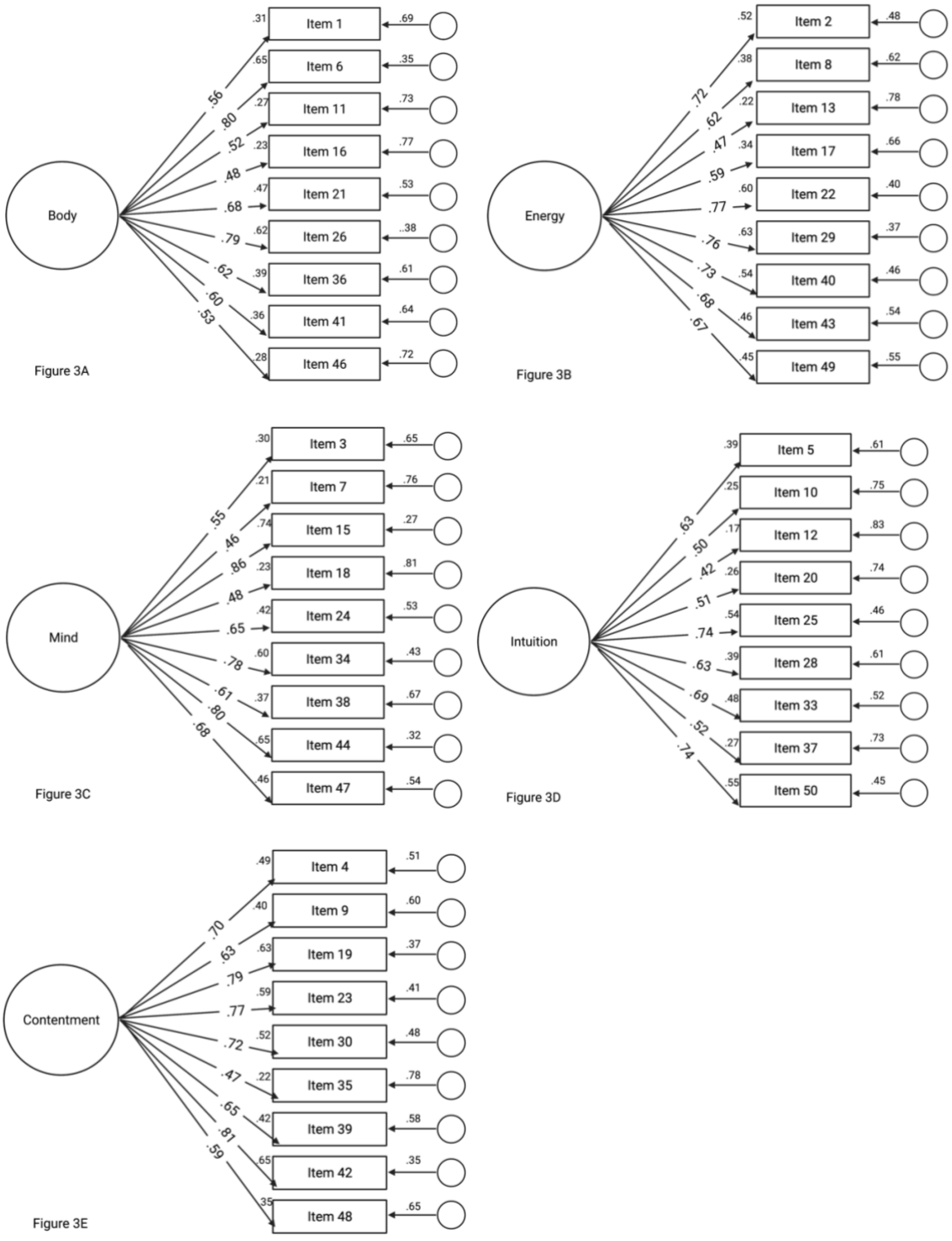

Figure 5.3 A-E: Confirmatory Factor Analysis (CFA) Model for five factors of MIMS

Differences Among Movement Groups

Regarding the overall MIMS score, statistically significant differences were found between the three movement groups (F(2,100)=4.095, p=0.020), with this effect being driven by body (F(2,100)=5.618, p=0.005) and intuition (F(2,100)=4.083, p=0.020). Regarding the MIMS total score, the yoga group reported the highest score while the running group reporting the lowest score (Table 5.4 Figure 5.4). Post-hoc analyses revealed that the yoga group scored significantly higher than the running group on the total MIMS score (16.991, 95% CI (2.29 to 31.69), p=0.19), as well as the body (3.791, 95% CI (0.92 to 6.67), p=0.006) and intuition (3.546, 95% CI (0.38 to 6.71), p=0.024) subscales. Additionally, the weightlifting group scored significantly higher on the physical (3.370, 95% CI (0.50 to 6.24), p=0.017) and intuition (3.177, CI (0.02 to 6.34), p=0.049) subscales than the running group.

	Yoga Mean(SEM)	Running Mean(SEM)	Weightlift Mean(SEM)	F	p-value
N=103					
Body	38.42(0.437)	34.63(0.475)	38.00(0.505)	5.618	0.005
Energy	36.24(0.514)	33.37(0.514)	35.50(0.629)	2.149	0.122
Mind	36.32(0.520)	33.07(0.493)	35.13(0.612)	2.678	0.075
Intuition	35.84(0.510)	32.30(0.479)	35.47(0.557)	4.083	0.020
Contentment	36.32(0.507)	33.81(0.590)	35.29(0.632)	1.438	0.242
Total	182.66(2.273)	165.67(2.262)	179.58(2.656)	4.095	0.020

Table 5.4 Between Group Differences in Yoga, Running, and Weightlifting

Figure 5.4: Violin plot of Total MIMS scores by movement group. Data reported as mean(SEM).

DISCUSSION

In this study, we delineated the process for validating the Multidimensional Impacts of Movement Scale (MIMS), which included item generation, examination of the items/scale through a panel of experts and focus groups, data testing, and validity and reliability analyses. MIMS was built by aligning modern neuroscientific concepts with the traditional yogic framework of the Koshas, which supports the idea that humans are complex beings, with intricate, simultaneous aspects of the self (Eswaran, 2007). Our results demonstrate that the MIMS is valid and reliable with five distinct subscales:

body, energy, mind, intuition, and contentment. MIMS is stable over time as represented by strong test-retest scores and demonstrates strong internal consistency with a high Cronbach's alpha for each of the five distinct subscales, ranging from α = 0.775 to 0.840. The tool is valid, showing convergent validity with significant correlations between known, previously validated tools, clearly defining the psychological constructs that MIMS measures.

The overall MIMS score indicates the general impact of movement on an individual, while the subscales themselves provide a more nuanced examination of the multidimensional outcomes of movement. The body subscale measures an individual's awareness and control over their body. A high score on the body subscale indicates high levels of physical awareness and low levels of bodily dissociation. The energy subscale measures vitality and an individual's ability to turn energy into action. A high score on the energy subscale indicates increased levels of vitality and decreased levels of fatigue. The mind subscale measures the integration of thoughts, emotions, and senses. A high score on the mind subscale indicates high levels of positive affect and low levels of negative affect (e.g., depression, anxiety). The intuition subscale measures how much an individual trusts their thoughts and emotions to guide decision-making. A high score on the intuition subscale indicates high levels of interoceptive awareness and compassion. Finally, contentment measures the ease and satisfaction an individual feels within oneself and the world around them. A high score on the contentment subscale indicates high levels of awe and satisfaction with life.

We recommend that MIMS can be used in movement research, both for scientific and clinical purposes. Importantly, the tool will reduce participant burden by having one

scale with various outcomes. The self-report element of this tool makes it easy to implement, taking only a few minutes to complete. This tool will allow consistency of measurement across different movement modalities and may even be implemented in other mind-body-movement techniques such as meditation. MIM can also be applied within the movement industry as a tool to assess outcomes of group and individual exercise, helping individuals or businesses to visualize the results of their movement practice/offerings.

As the Physical Activity Guidelines for Americans (U.S. Department of Health and Human Services, 2018) encourage participation in cardiorespiratory, strength training, and flexibility/balance activities weekly, the tool was intentionally validated across these three movement categories (i.e., running, weightlifting, and yoga). Our data indicate that different forms of movement may produce different outcomes at the physical and psychological levels. Therefore, encouraging multiple movement forms across the week may create the most balanced results across the full range of MIMS outcomes. Specifically, yoga practitioners scored highest on the MIMS, indicating that yoga may impact more elements measured by this scale than weightlifting or running. We hypothesize that this may be because yoga is a mindfulness-based technique that incorporates aspects of the physical body (*asana*) as well as breathwork (*pranayama*) and meditation (*dhyana*). These types of physical activities that incorporate multiple aspects of physical and mental wellbeing may be optimal to enhance overall wellness.

LIMITATIONS AND FUTURE DIRECTIONS

While the study shows strong reliability and validity, there are some limitations to this research. First, we utilized a convenience sample and therefore outcomes would

benefit from sampling a more diverse population. Second, participants engaged in diverse workout experiences. Controlling for the same time of day, duration, and intensity of workouts may further refine outcomes. Third, this research was conducted during the COVID-19 pandemic. We did not control for pandemic-based variables such as wearing a mask during workouts, previous or current COVID-19 status, or other aspects of the pandemic. Closer consideration to pandemic variables may be warranted in future studies.

Future research with the MIMS is needed to investigate the influence of a range of movement practices including dance, tai chi, qi gong, swimming, or cross-training. Additionally, researchers may be interested in utilizing MIMS for team sports such as soccer, football, basketball, baseball, lacrosse, or rugby. Future research may also seek to investigate the relationship between the MIMS outcomes and brain-based effects using tools such as electroencephalography or magnetic resonance imaging. Researchers may also consider investigating the influences of exercise duration, exercise habits, age, and COVID-19 considerations on MIMS outcomes. Finally, cultural considerations should be made through culturally-sensitive translations into other major languages, allowing the tool to be used more broadly.

MIMS should be used as a standard tool when investigating the outcomes of movement practices, particularly when investigating mind-body impacts. As the original framework of this scale is rooted in yogic texts designed to explore and explain the multidimensional aspects of any individual, MIMS may help explain varied outcomes of movement among individuals. MIMS can also help individuals find their desired results and motivations for movement as the scale may help identify unexpected positive

effects of movement. Professionals may use MIMS to help guide individuals to their most needed movement practice.

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SUPPLEMENTAL MATERIAL

Multidimensional Impacts of Movement Scale (MIMS)

Respond to these statements with one mark per row.

Consider how your movement practice influences how you feel now, in this moment. While you may cross-train some, think about the movement practice that you most identify with as your primary movement practice.

	No Answer 0	Disagree 1	2	3	4	Agree 5
1. I am in control of my physical balance.						
2. I am thriving.						
3. I am able to learn new things.						
4. I am at ease.						
5. I am able to pay attention to the way my mind works.						
6. I am coordinated.						
7. I have an easy time remembering things.						
8. I am able to focus on the task at hand.						
9. I am comfortable with the unexpected.						
10. I make choices based on increasing the greater good.						
11. I am physically strong.						
12. I am not obligated to act as others expect.						
13. I am open.						
14. I am able to integrate my thoughts, emotions and senses.						
15. I am flexible.						
16. I am quick to recover.						
17. I can feel emotions in my body.						
18. I am whole.						
19. I am confident of my memories.						
20. I am able to release tension in my body.						
21. I am alert.						
22. I see beauty all around me.						
23. I am able to let go of fears.						
24. I fully understand who I am.						

Multidimensional Impacts of Movement Scale (MIMS)

Respond to these statements with one mark per row.

Consider how your movement practice influences how you feel now, in this moment. While you may cross train some, think about the movement practice that you most identify with as your primary movement practice.

	No Answer 0	Disagree 1	2	3	4	Agree 5
25. I am able to control my breath.						
26. I am able to observe my life without judgement.						
27. I am breathing easily.						
28. I am healthy in my body.						
29. I notice what I notice.						
30. I am comfortable expressing my feelings.						
31. I want to help others in need.						
32. I am physically able to do the things I want to do.						
33. I am open to the wisdom of the Universe.						
34. I have a full range of emotions.						
35. I am connected to the energy of the Universe.						
36. I am able to replenish my energy.						
37.I am at home in my body.						
38. I am filled with joy.						
39. I feel free of fatigue.						
40. I am aware of my bodily sensations.						
41. I am able to experience the physical sensations of emotions.						
42. I am comfortable with my own mistakes.						
43. My conscience is clear.						
44. I naturally know what to do next.						
45. I trust my intuitions.						

Scoring MIMS

- To figure s***ubscales*** of this tool, add the numbers indicated for each subscale below.
- For a ***total*** tool score, add all responses
Higher scores indicate a greater influence of exercise

	Score
Body 1, 6, 11, 15, 20, 25, 32, 37, 41	
Energy 2, 8, 13, 16, 21, 27, 36, 39, 44	
Mind 3, 7, 14, 17, 23, 30, 34, 40, 42	
Intuition 5, 10, 12, 19, 24, 26, 29, 33, 45	
Contentment 4, 9, 18, 22, 28, 31, 35, 38, 43	
Total Maximum 225	

Body

Awareness of and control over one's body

1. I am in control of my physical balance.
6. I am coordinated.
11. I am physically strong.
15. I am flexible.
20. I am able to release tension in my body.
25. I am able to control my breath.
32. I am physically able to do the things I want to do.
37.I am at home in my body.

Energy

Vitality and ability to turn energy into action

2. I am thriving.
8. I am able to focus on the task at hand.
13. I am open.
16. I am quick to recover.
21. I am alert.
27. I am breathing easily.
36. I am able to replenish my energy.
39. I feel free of fatigue.
44. I naturally know what to do next.

Mind

Integration of thoughts, emotions, and senses

3. I am able to learn new things.
7. I have an easy time remembering things.
14. I am able to integrate my thoughts, emotions, and senses.
17. I can feel emotions in my body.
23. I am able to let go of fears.
30. I am comfortable expressing my feelings.
34. I have a full range of emotions.
40. I am aware of my bodily sensations.
42. I am comfortable with my own mistakes.

Intuition

Trust in how thoughts and emotions guide decision-making.

5. I am able to pay attention to the way my mind works.
10. I make choices based on increasing the greater good.
12. I am not obligated to act as others expect.
19. I am confident of my memories.
24. I fully understand who I am.
26. I am able to observe my life without judgement.
29. I notice what I notice.
33. I am open to the wisdom of the Universe.
45. I trust my intuitions.

Contentment

Ease and contentment with oneself and the world around them

4. I am at ease.
9. I am comfortable with the unexpected.
18. I am whole.
22. I see beauty all around me.
28. I am healthy in my body.
31. I want to help others in need.
35. I am connected to the energy of the Universe.
38. I am filled with joy.
43. My conscience is clear.

Chapter 6: Conclusion

Mindfulness is an ancient practice; however, the scientific inquiry of mindful practice is in its infancy. This dissertation was inspired by the challenges of investigating a new field of science, evidenced by the careful attention paid to increasing the quality of mindfulness research through well-powered studies, detailed study design, quality controls, and rigorous statistical analysis. Increasing research rigor will support the evidence-based use of mindfulness as an integrative health treatment for physical and mental health challenges. In addition, using high-quality evidence and measurement tools will augment the understanding of the impact of mindfulness on specific populations. Finally, combining neuroscience knowledge with mindfulness traditions will inform how best to adjust mindfulness teaching and practices to improve related outcomes.

Study 1 - Integrative Health Practices improve Quality of Recovery from SUD.

Participants with substance use disorder (SUD) showed improvement in their quality of recovery when engaging with Integrative Health Practices. Specifically, individuals who reported higher engagement with mediation showed improved mindfulness, greater future valuation, more days in recovery, decreased cravings, and enhanced quality of life. One of the hallmarks of SUD is impaired function of the Competing Neurobehavioral Decision Systems (CNDS), as demonstrated by heightened emotions and diminished executive function. Mindfulness supports the development of executive function and emotional regulation, positioning mindfulness as a targeted tool to repair this dysregulation in individuals with SUD.

Future Research: Design and implement a 12-week study using meditation to target CNDS by teaching focused awareness meditation and then open monitoring. MRI imaging pre- and post-intervention will document neuroplastic changes in executive function and limbic system regions.

Study 2 – Individual and Programmatic Outcomes of Mindful Meditation

A new mindful mediation program combined with neuroscience education enhanced mindfulness, self-compassion, neuroscience knowledge, and decreased depression from pre- to post-intervention. Three questions, paired before and after each meditation, showed how participants' thoughts, emotions, and bodies settled over time, at the start of meditation, with further progress after the meditation. The analysis of these programmatic trends may explain the positive changes reported by participants. The education curriculum stacked meditation skills in a cohesive program, building focused attention, emotional control, and finally followed by self-awareness to optimize self-regulation. This study shows distinct responses to the skills taught and a pattern toward self-regulation. Participants demonstrated an increase in personal neuroscience knowledge; however, this increase in knowledge was not correlated with other study outcomes. Interestingly, the influence of neuroscience on curriculum development, teaching and assessing 4 meditation techniques, was impactful on program outcomes. Mindfulness instructors need to understand the science of mindfulness and apply this knowledge to program development and education to optimize the outcomes of mindful meditation. This study shows it may be far more important to engage in an evidence-based mindfulness practice than to understand the process.

Future Research: This study provided a baseline of knowledge from which to continue exploring the effects of mindful education on meditation outcomes through study iterations. The next study should be a randomized control trial comparing a group that receives neuroscience education and one that does not while all participants receive the same meditation. Another study should extend the study duration to a minimum of 8-weeks, with time divided equally among each technique of meditation. Another trial could test the use of cueing to help refocus against the effect of silent meditation. Finally, it will be useful to explore curriculum development with groups each receiving only one meditation technique, comparing differences pre to post-intervention with behavioral self-report and direct brain measures.

Study 3 – Tool Validation – Multidimensional Impacts of Movement (MIMS)

Practices to improve mindfulness include both meditation and intentional movement. There are many tools available to measure mindfulness in general; however, there are no tools available to measure the mindfulness-related outcomes of movement. The Multidimensional Impacts of Movement Scale (MIMS) connects the ancient, mindful practice of yoga to modern neuroscience tools. Multiple statistical analyses confirmed the reliability and validity of MIMS. Future researchers can use MIMS in their continued efforts to understand the effects of movement on mindfulness. Movement instructors, coaches, and health care professionals can use MIMS to direct individuals toward movement practices that will meet their multidimensional human needs.

Future Research: MIMS is an element that can be used in future research designs studying mindful movement, including specific movement types such as aerobic, anaerobic, and mind-body. However, future validation studies will be needed in cases where American English is not the primary language and for movement groups not previously tested (i.e., cross-training, swimming, dancing).

Final Thoughts

The body of research represented in this dissertation demonstrates the potential for mindfulness to improve the quality of life for all individuals through integrative health practices such as meditation, movement, or both. Evidence-based neuroplastic brain changes resulting from mindfulness practices must inform the development of future practices and interventions. Studies combining direct brain measures and behavioral self-report will continue to strengthen the rigor of mindfulness research and its supporting body of literature. This approach establishes a path to begin testing specific mindfulness techniques to optimize outcomes for individuals.

APPENDIX A

Appendix A

Division of Scholarly Integrity and Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-3732
irb@vt.edu
http://www.research.vt.edu/sirc/hrpp

MEMORANDUM

DATE: March 28, 2022

TO: Warren K Bickel, Anya Hariharan, Michele Jeremie King, Michelle Hui Zheng, Julia C Basso, Will Craft III, Candice Laurel Dwyer, Allison Tegge, Jesse Macklin, Anita Sherry Kablinger, et. al.

FROM: Virginia Tech Institutional Review Board (FWA00000572)

PROTOCOL TITLE: International Quit & Recovery Registry

IRB NUMBER: **11-716**

Effective March 27, 2022, the Virginia Tech Institution Review Board (IRB) approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

https://secure.research.vt.edu/external/irb/responsibilities.htm

(Please review responsibilities before beginning your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 7**
Protocol Approval Date:	**September 8, 2021**
Protocol Expiration Date:	**September 7, 2022**
Continuing Review Due Date*:	**August 17, 2022**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.

APPENDIX B

Division of Scholarly Integrity and Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-3732
irb@vt.edu
http://www.research.vt.edu/sirc/hrpp

MEMORANDUM

DATE: June 4, 2021

TO: Julia C Basso, Sarah Lynn, Medha Kumari Satyal, Lia Dopp

FROM: Virginia Tech Institutional Review Board (FWA00000572)

PROTOCOL TITLE: Examining the Effects of Mindfulness Education on Brain Function

IRB NUMBER: **20-799**

Effective June 4, 2021, the Virginia Tech Institution Review Board (IRB) approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

https://secure.research.vt.edu/external/irb/responsibilities.htm

(Please review responsibilities before beginning your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 7**
Protocol Approval Date:	**June 4, 2021**
Progress Review Date:	**June 4, 2022**

ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.

APPENDIX C

Division of Scholarly Integrity and Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
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irb@vt.edu
http://www.research.vt.edu/sirc/hrpp

MEMORANDUM

DATE: July 23, 2021

TO: Julia C Basso, Sarah Lynn, Medha Kumari Satyal, Lia Dopp

FROM: Virginia Tech Institutional Review Board (FWA00000572)

PROTOCOL TITLE: The Multidimensional Impacts of Movement (MIM)

IRB NUMBER: **21-074**

Effective July 23, 2021, the Virginia Tech Human Research Protection Program (HRPP) determined that this protocol meets the criteria for exemption from IRB review under 45 CFR 46.104(d) category (ies) 2(ii).

Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit an amendment to the HRPP for a determination.

This exempt determination does not apply to any collaborating institution(s). The Virginia Tech HRPP and IRB cannot provide an exemption that overrides the jurisdiction of a local IRB or other institutional mechanism for determining exemptions.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

https://secure.research.vt.edu/external/irb/responsibilities.htm

(Please review responsibilities before beginning your research.)

PROTOCOL INFORMATION:

Determined As:	**Exempt, under 45 CFR 46.104(d) category(ies) 2(ii)**
Protocol Determination Date:	**July 23, 2021**

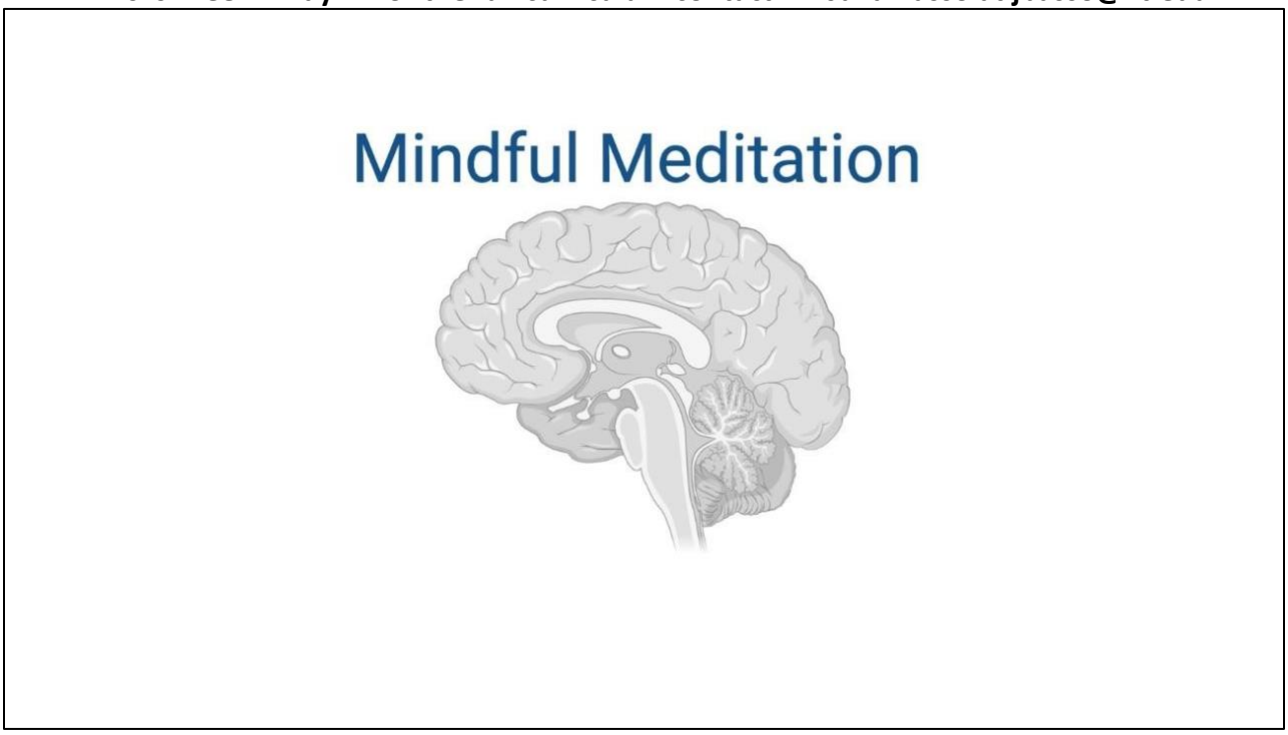
ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.

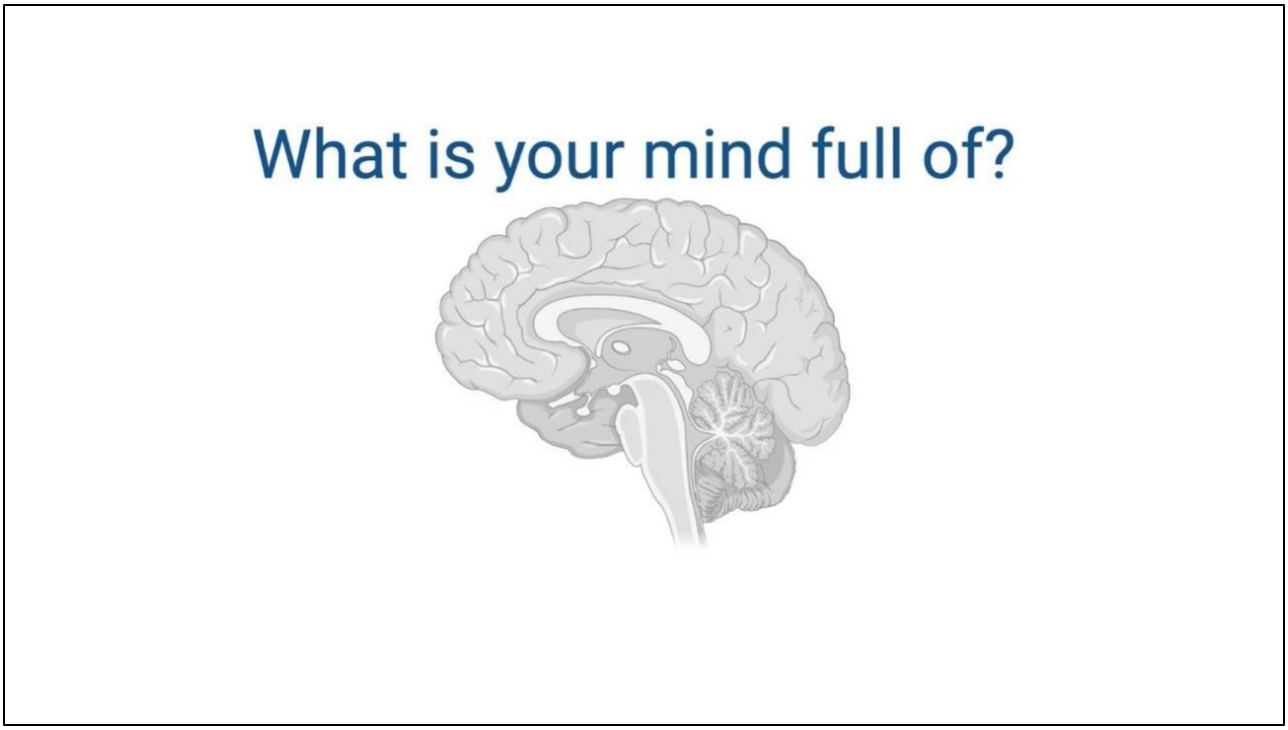
APPENDIX D

Supplemental Document 4.1 – Curriculum

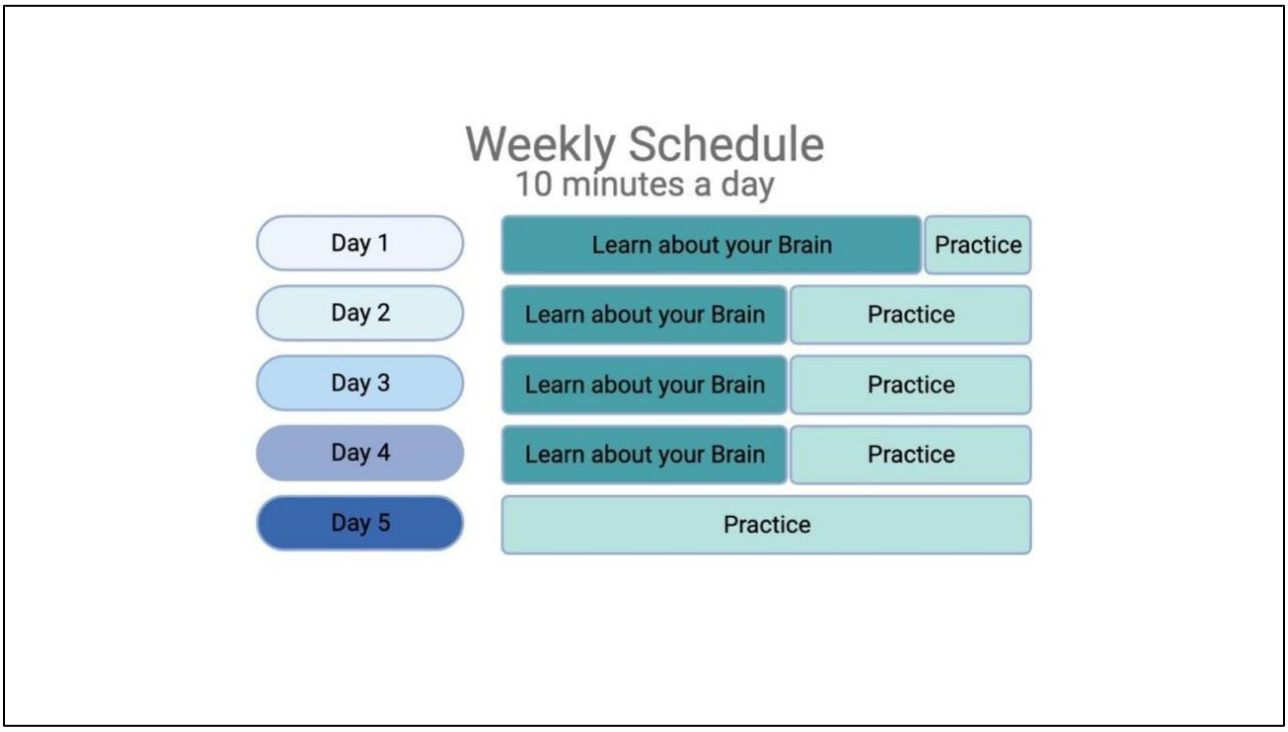
This is Week 1 Day 1. For the full curriculum contact Dr. Julia Basso at jbasso@vt.edu.



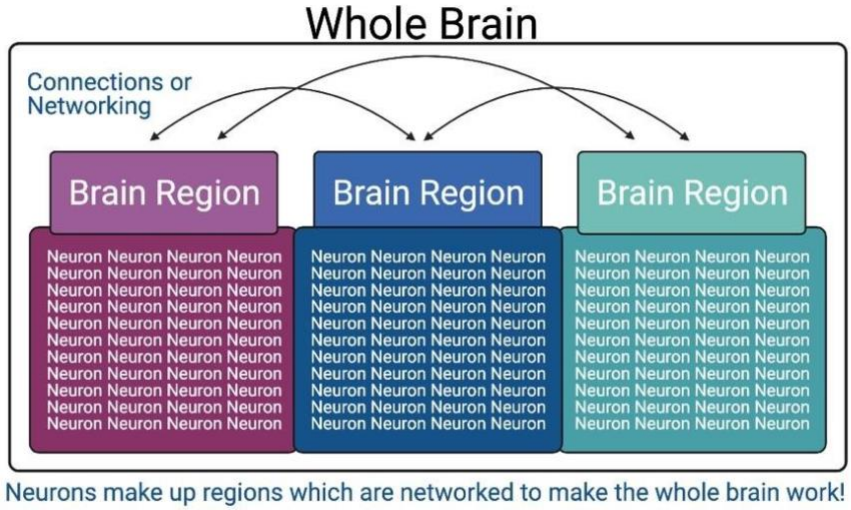
Welcome! This project will introduce you to concepts in neuroscience that relate to mindful meditation and then give you the opportunity to practice mindful meditation. For some of you, the neuroscience information may be a bit overwhelming and for others of you, I may be talking about familiar concepts. Either way, absorb as much information as you can and allow yourself to think about the way you think.



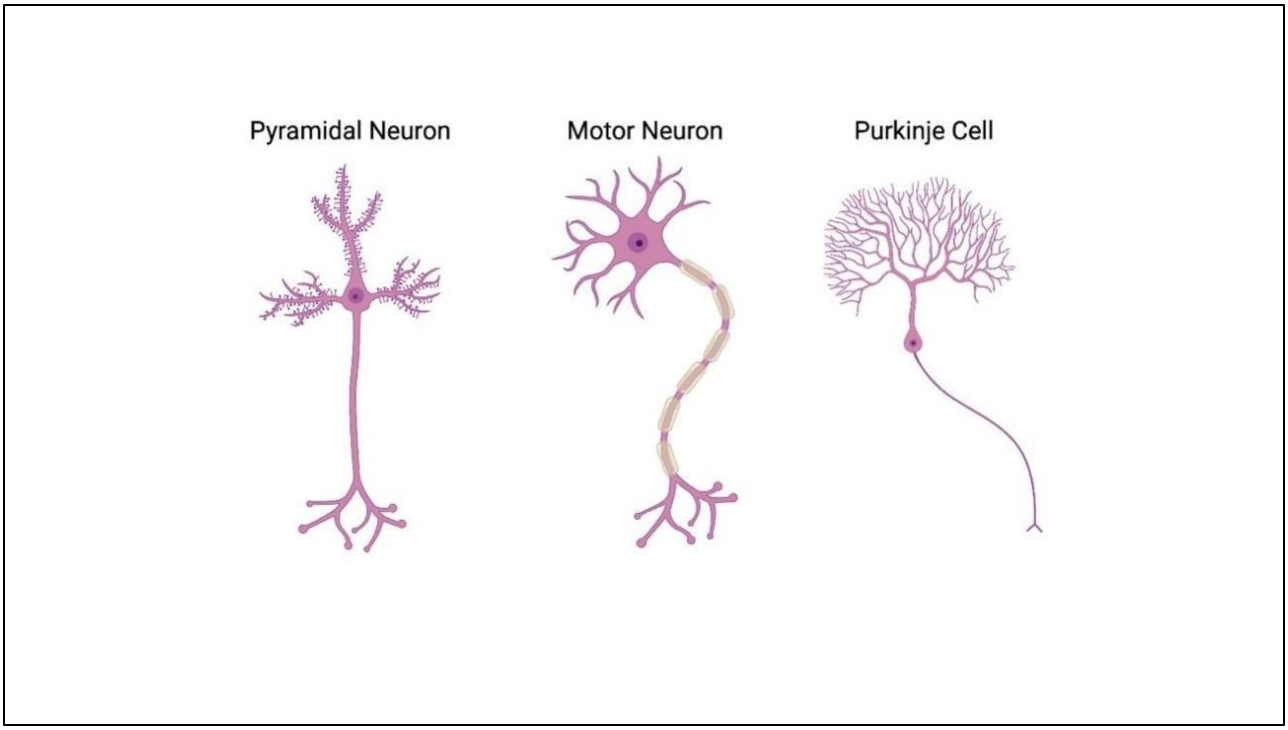
Mindful meditation. What IS your mind full of? Think of your mind as your thoughts and emotions, and your brain as the container. It is possible to study how a brain functions, however there is no way to study the mind without you telling someone what you are thinking and feeling. Hopefully, as we continue, this will make more sense to you!



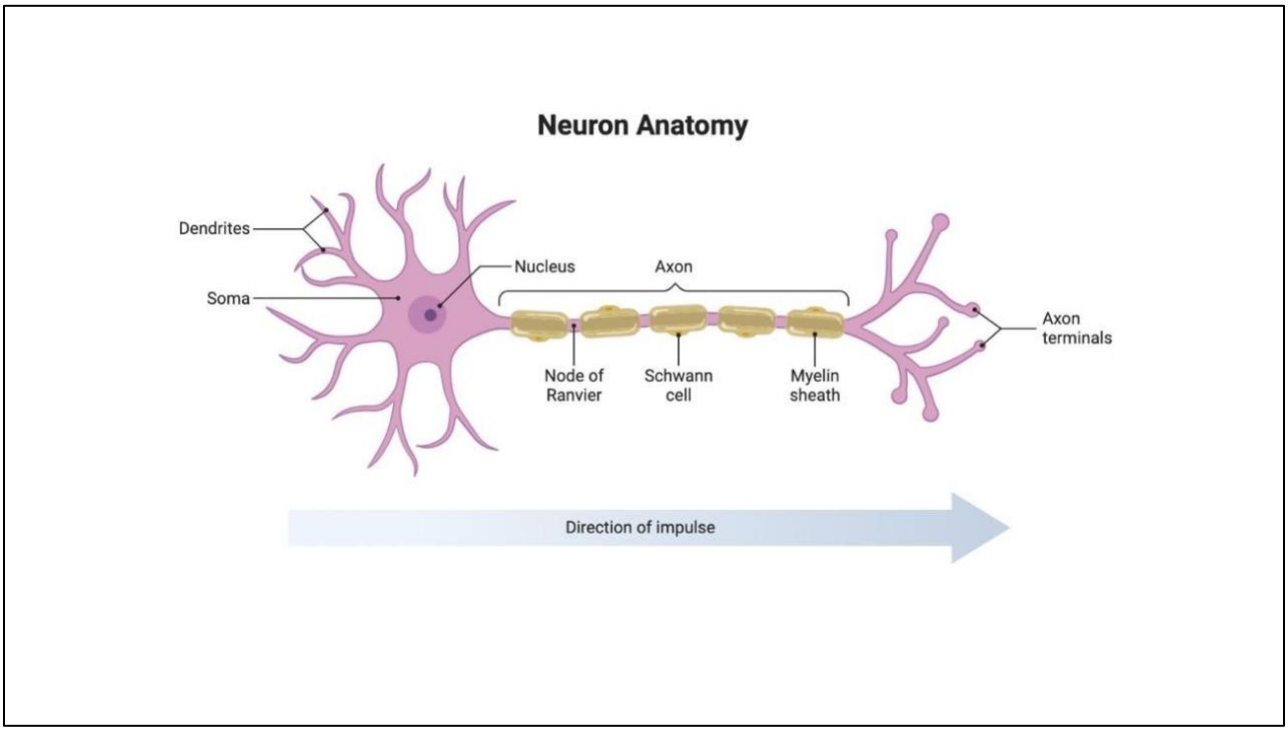
Each week our schedule will follow the same pattern. Each day we will have some time learning about neuroscience and practicing mindful meditation. As each week progresses, we will have more mindful meditation and less neuroscience, until Friday, when the entire time will be spent in meditation. Let's start talking about the brain!



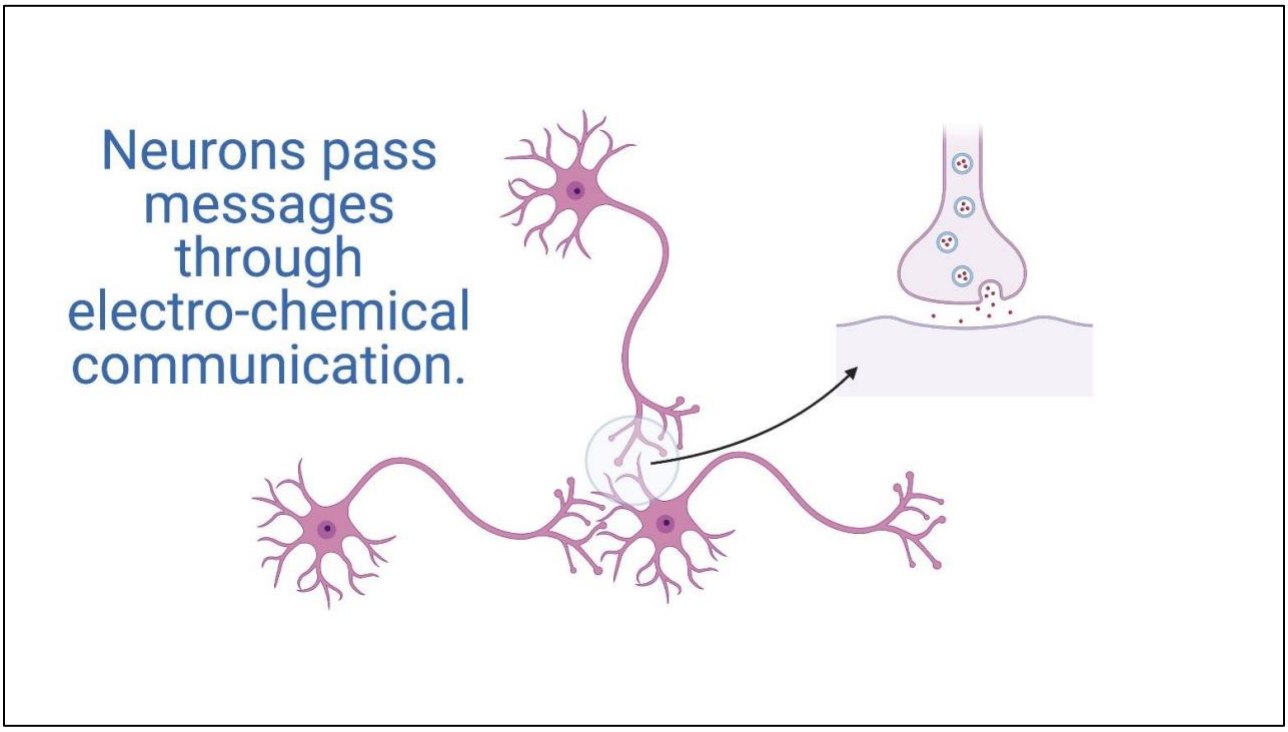
In order to make the neuroscience content more accessible, we've simplified many of the concepts you will be learning about.
Like many things, the brain is made up of parts which are made up of parts! The brain has 86 BILLION neurons in it. Synapses are the spot where neurons connect to each other. The neurons are organized into brain regions. Then the different brain regions, together, make up the brain. The regions have distinct purposes and are networked together to produce our entire conscious experience. The brain also contains glial cells which are like workers, maintaining the health of the neurons.



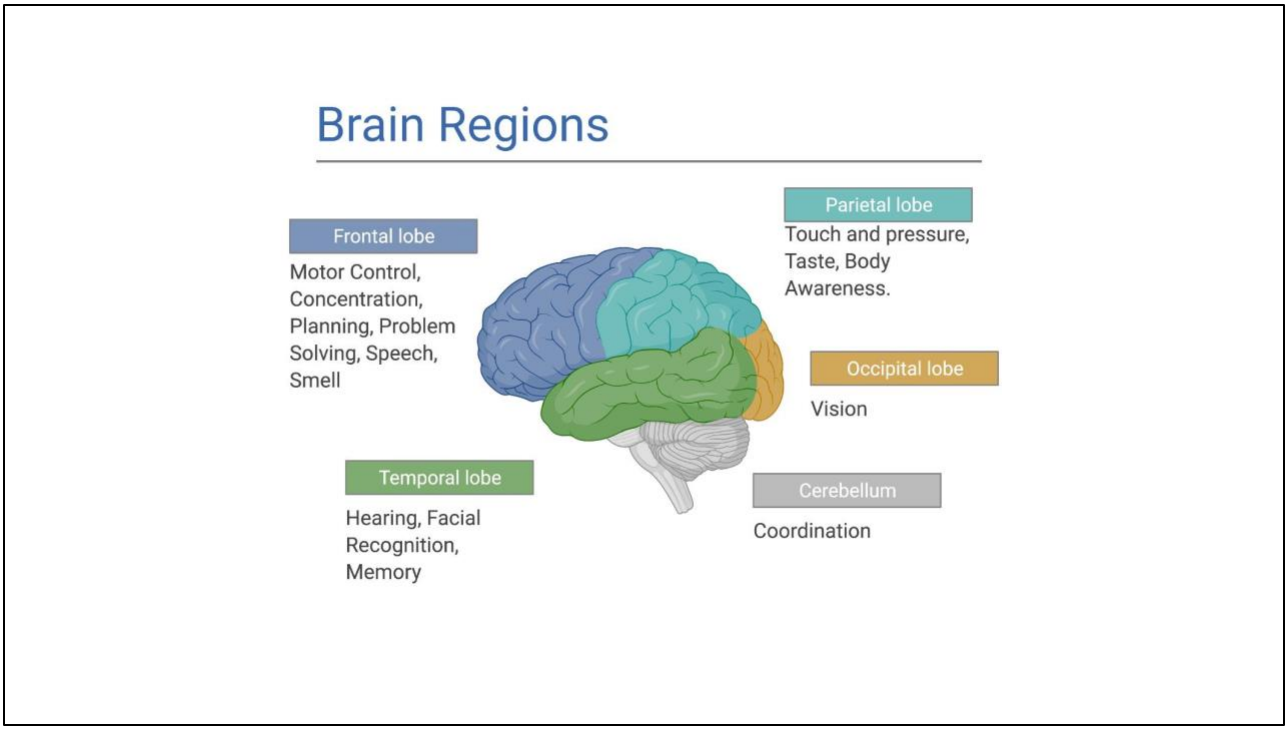
There are different types of neurons, although they all have the same basic structure. When you look at these different neurons, what do you notice that is the same and what do you notice that is different?



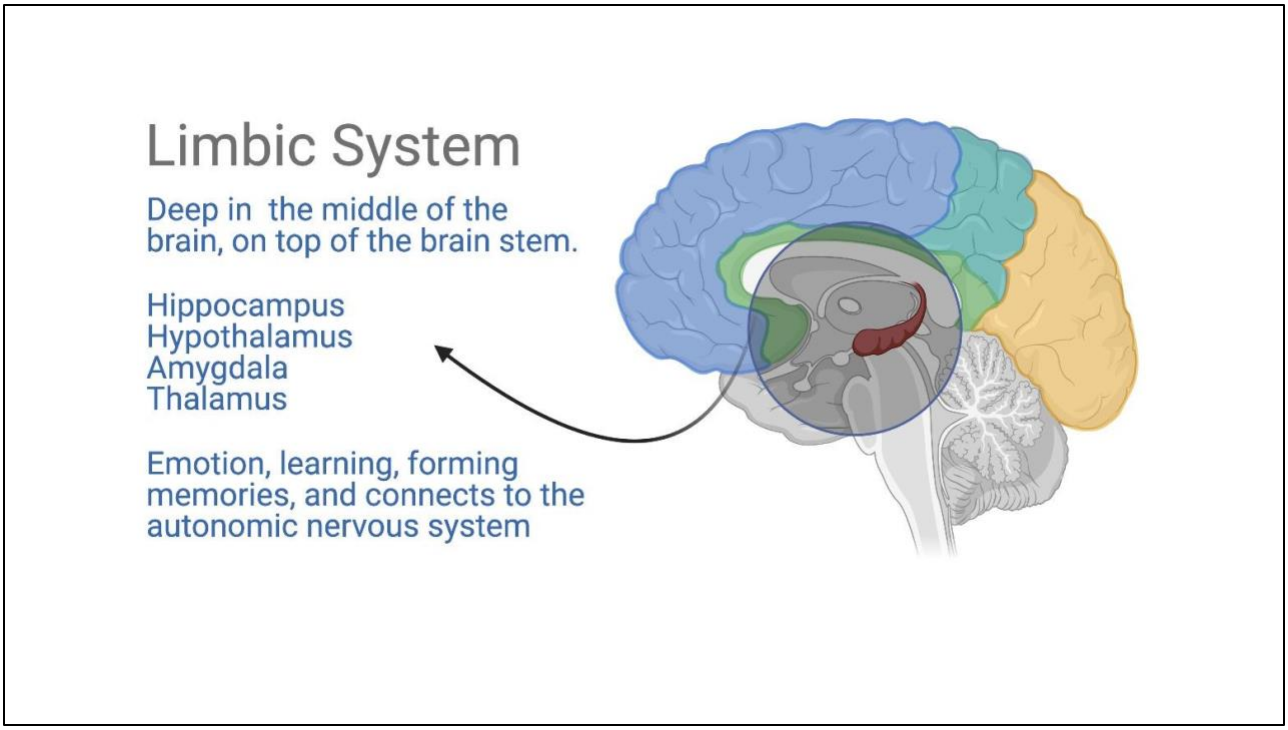
Neurons are single cells with many parts. The soma is the cell body, containing the nucleus. The soma is surrounded by dendrites, which receive information from other neurons. Some neurons have more or less dendrites than other neurons. Messages move from the dendrites, past the soma and down the long axon, coated in myelin for insulation and speed, and to the axon terminals. The axon terminals are just that. Terminal.The end. When an axon sends a message to the next set of dendrites, this message, which is known as an action potential, leaves the cell. Notice the consistency of the anatomy. From dendrite through the soma to the axon.



Neurons communicate through electrochemical communication. The space between neurons, where dendrites come close to other axons, is called a synapse. The synapse isn't just a gap, it's a space where electro-chemical changes happen! To pass a message from the axon of one neuron to the dendrites of another, chemicals called neurotransmitters are released from one neuron that cause the opening of channels like doors, for electrical charges or ions to pass through. Depending on the type of neurotransmitter released from the neuron, the message will either continue on or stop the transfer of the message, at that neuron. This is called excitatory or inhibitory messaging, respectively.



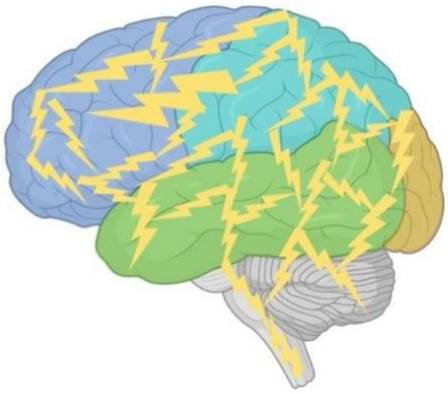
Brain regions represent local, specific brain function however, few brain regions work in isolation. It is amazing how many brain regions work together to accomplish a single task! For example, if you want to take a drink of water from your water bottle, first you notice you are thirsty (hypothalamus). You choose to reach for your water bottle. The occipital lobe helps you see the water bottle, the motor cortex in the frontal lobe help to control your arm, and the cerebellum helps you stay coordinated and balanced while you reach for the bottle. The specific regions of the brain all provide different functions and can provide “directions” for how the body acts and responds.



The limbic system is deep inside the the center of your brain and is responsible for forming memories and having emotions. The limbic system processes much of what is going on in the world around you, and then sends these perceptions to other parts of the brain for storage. When you experience something exciting for the first time, your limbic system processes the location, color, sounds and smells of the experience. These experiences are then transferred, overnight, to the other areas of your brain so that you can later remember the exciting experience.

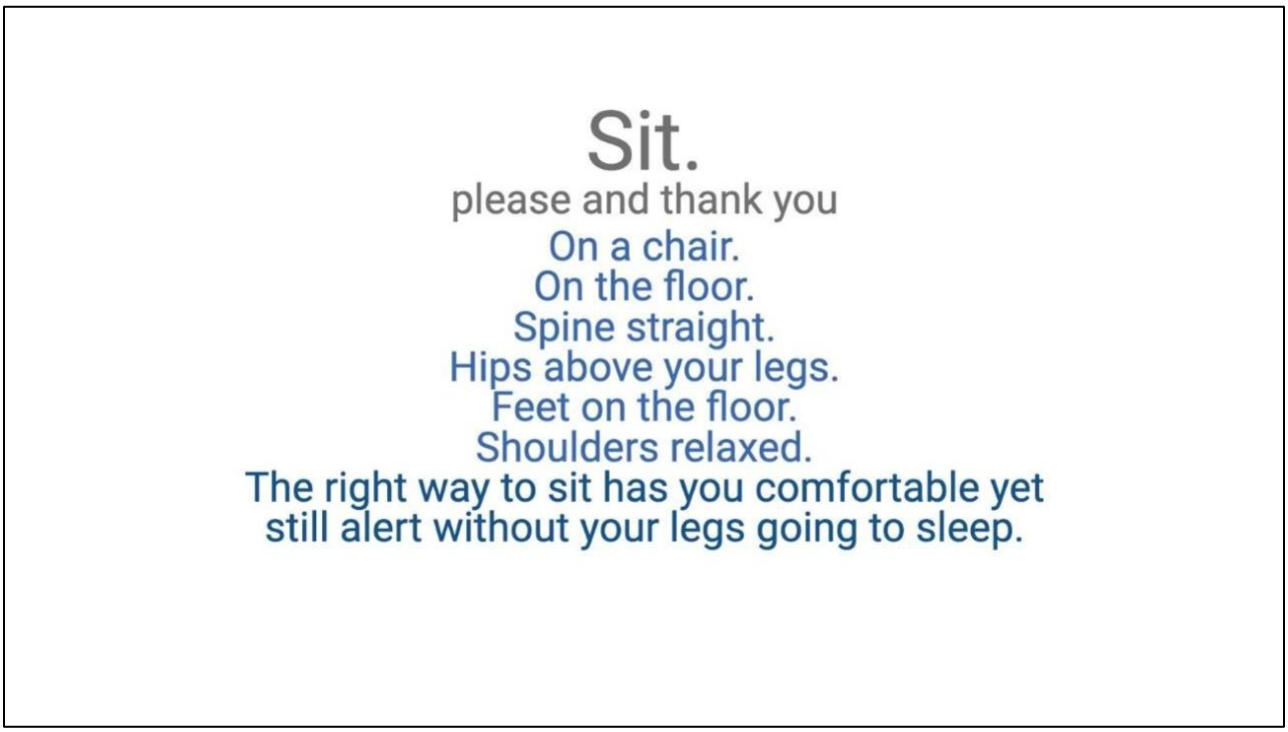
Networks in the Brain

Brain regions become networked by sending electrical signals among neurons and forming stong synapses.



While brain regions are distinct, they are not isolated. Like the highway system that allows you to travel all over the country, in and out of different states, the brain is networked! Instead of roads, the brain is using the network of neurons. Some networks are local with in brain regions enhancing communication within a structure. Other networks are global, enhancing communication between structures. Communication within and between these networks allows us to make new connections (synapses) and remember existing ones. There's more than one way to get from point A to point B using roads, just as there's often more than one way to connect various brain regions.

Mindfulness practice is largely about choosing your thoughts. Notice what you are thinking, and stick with it, or make a decision to refocus your thoughts. Remember you can always blink a few times, come out of the mediation and then return to it, or also give it a break for the day at any point you choose.



In order to meditate, you can sit on the floor but I actually suggest a chair. Sit with your spine pretty straight. Your hips above your legs. Ground your feet on the floor. Now relax your shoulders. There’s not one right way to sit, but a wrong way will cause your feet to go to sleep and maybe your back/neck or shoulders to be sore. Relax your hands on your thighs, palms up or down. If you feel comfortable with it, close your eyes for meditation.

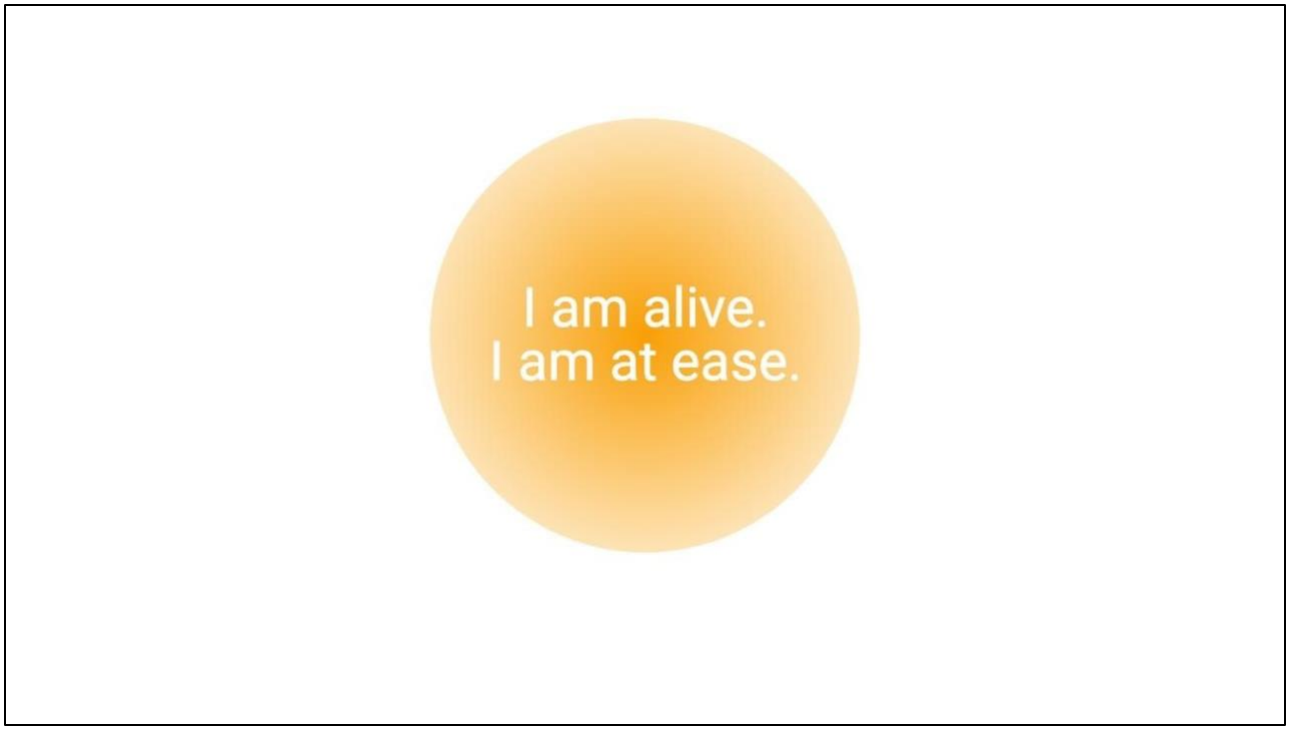
This week, your mindful meditation technique will be to use a mantra, “I am alive. I am at ease.” A mantra is a repeated word or phrase. Repeat the mantra silently in your head. Notice how simple the mantra is. It’s not designed to be something you have to memorize like a poem, rather a simple affirmation. A mantra may naturally pair with your breathing but that connection does not have to be forced. If it feels natural in your body, inhale and you hear yourself think “I am alive.” As you exhale, hear yourself think “I am at ease.” During the meditation, there will be reminders on the video, but it’s meant to reassure you, if your eyes pop open. The video is not meant to be watched the entire time, but rather reassure you time is passing, if you look up.

Be curious about this process.
It’s okay to be distracted. When you get distracted, see if you can grant yourself compassion, move on, and try to return to your mantra.

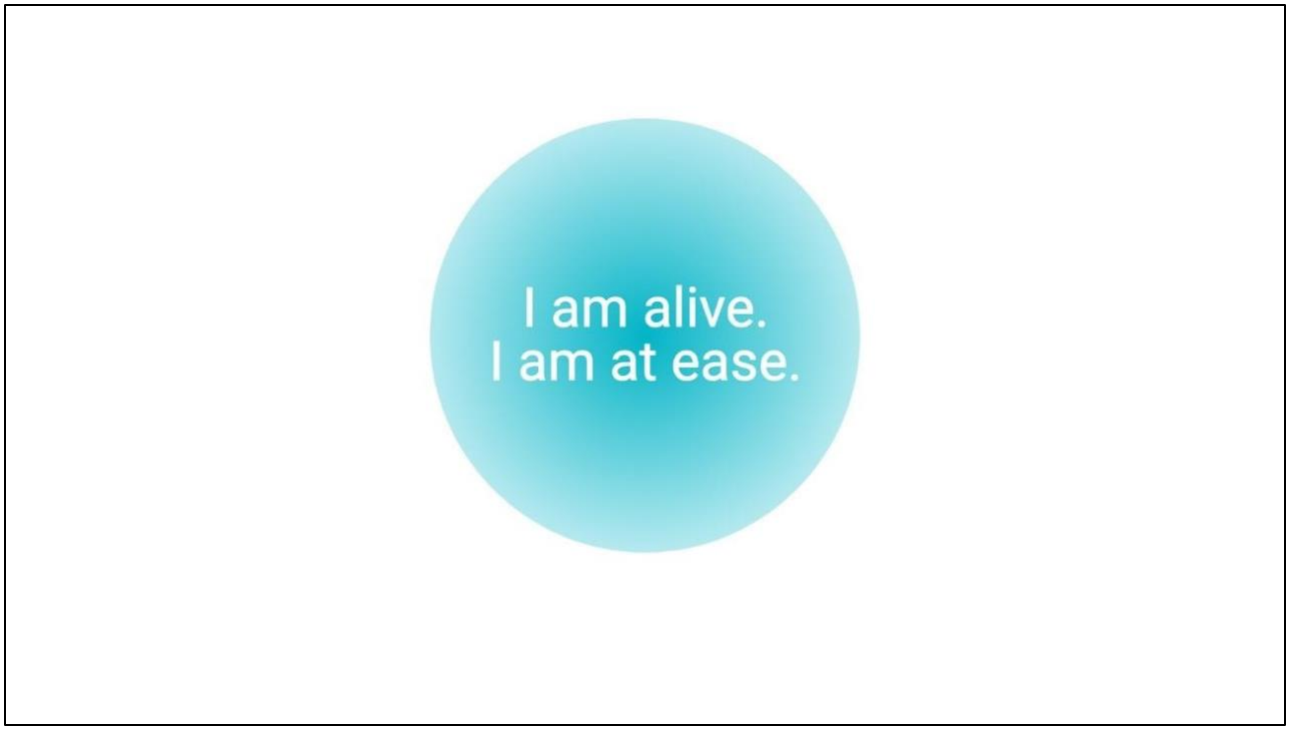
Do you need to refocus? It’s okay to be distracted. I am alive. I am at ease.

Do you need to refocus? It's okay to be distracted. I am alive. I am at ease.

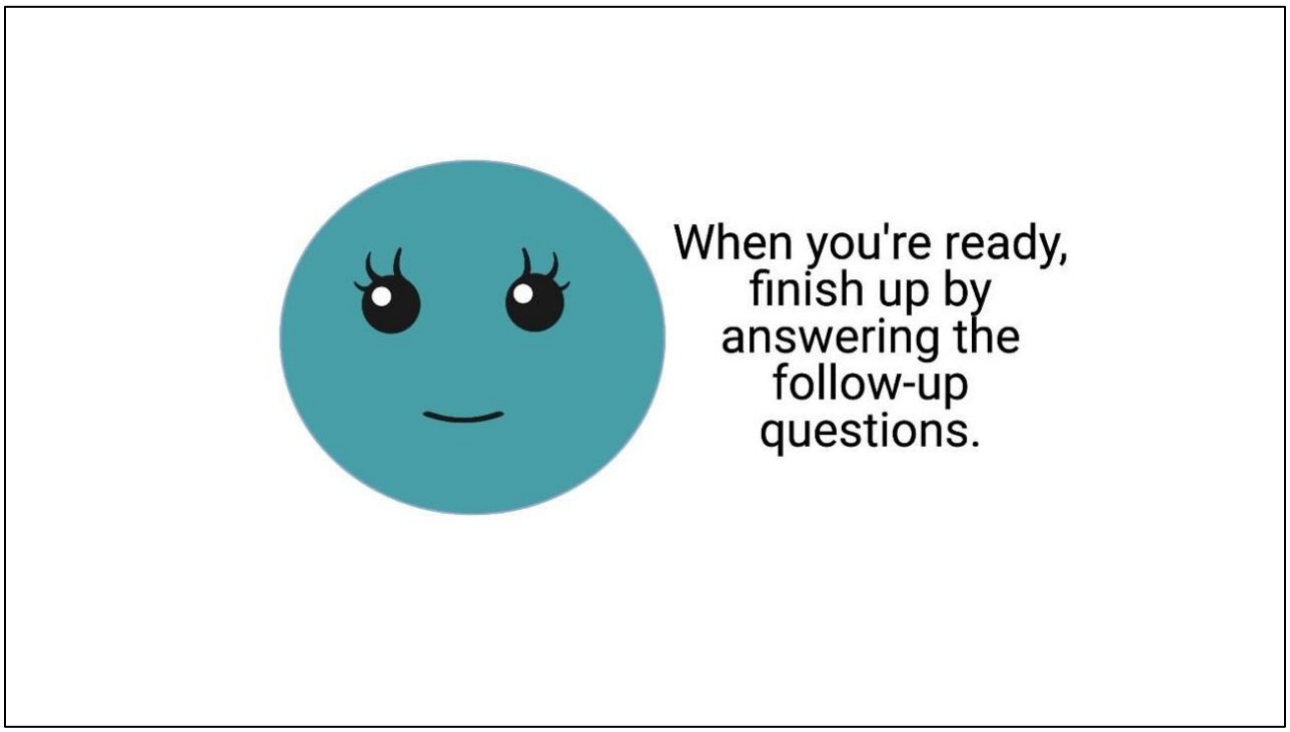
Do you need to refocus? It’s okay to be distracted. I am alive. I am at ease.



Do you need to refocus? It’s okay to be distracted. I am alive. I am at ease.



Do you need to refocus? It’s okay to be distracted. I am alive. I am at ease.



9:45
Begin to take bigger, fuller breaths. Inhale until your lungs and ribs are full and completely exhale. Wiggle. Squeeze. And open your eyes. When you are ready, finish up by answering the follow-up questions.

APPENDIX E

Neuroscience Knowledge Check

- ➔ Choose the best answer to each of the following questions.
- ➔ You may only select one option per question.
- ➔ Do not look up the answers, rather tell us what you know.
- ➔ Choose "I don't know" instead of guessing, if you do not know the answer to the question.

Neurons are

e. Groupings of cells, working together for optimal brain function
f. Single cells with many parts
g. The unit in the brain responsible for cleaning and maintaining the brain
h. I don't know

The synapse is

e. Where neurons join together
f. Marked with clear boundaries
g. The space between neurons
h. I don't know

Brain regions

e. Differentiate brain function
f. Usually work in isolation
g. Control every single function of the body
h. I don't know

The network of neurons in the brain

e. Creates the ability to perform complicated tasks in the body
f. Is limited to brain regions that touch each other
g. Requires neurons to actually touch each other
h. I don't know

Attention in the brain, is controlled by

e. The amygdala and hypothalamus
f. The will of an individual
g. The Prefrontal Cortex, Anterior Cingulate Cortex, and Striatum
h. I don't know

Attention requires you to

e. Resist distractions and sustain focus
f. Only resist distractions
g. Release decisions over to automatic function
h. I don't know

Mental Conflicts arise when

e. You want something you know you don't need
f. Your brain receives conflicting messages from various brain regions
g. Your brain has more than one region active at the same time
h. I don't know

The Anterior Cingulate Cortex

f. Works on executive functions, decision making and goal setting
g. Works on decision making, coordinating thoughts, voluntary movement
h. Works on self-regulation, empathy, and impulse control
i. I don't know

The Prefrontal Cortex

d. Works on executive functions, decision making and goal setting
e. Works on decision making, coordinating thoughts, voluntary movement
f. Works on self-regulation, empathy, and impulse control
j. I don't know

The Striatum

e. Works on executive functions, decision making and goal setting
f. Works on decision making, coordinating thoughts, voluntary movement
g. Works on self-regulation, empathy, and impulse control
h. I don't know

The Amygdala is part of the

e. Cortex
f. Brainstem
g. limbic system
h. I don't know

The amygdala primarily processes

e. Emotions of joy and happiness
f. Emotions of fear and stress
g. All emotions equally
h. I don't know

What are feelings?

e. Emotions
f. Physical Sensations
g. Both emotions and physical sensations
h. I don't' know

The Limbic System of the brain includes the

e. Prefrontal cortex, Anterior Cingulate Cortex and Striatum
f. Prefrontal cortex, Anterior Cingulate Cortex, Amygdala and Insula
g. Hippocampus, Hypothalamus, Amygdala and Insula
h. I don't know

Electro-Chemical Communication specifically happens

e. Only among neurons in the same brain region
f. Only across brain regions
g. In the synapse between neurons
h. I don't know

Emotional Regulation

e. Includes observing a reaction, then choosing to engage and alter a response
f. Is not possible
g. Requires extreme determination
h. I don't know

The enteric immune system

e. Is isolated in the digestive system
f. Links the digestive system and the brain
g. Is the brain's protective immune system
h. I don't know

Networking among brain regions

e. Happens in glial cells
f. Is faster when brain regions are closer together
g. Requires brain regions to touch each other
h. I don't know

An individual's emotional responses are determined by

e. That individual's previous experiences
f. The amount of neurotransmitters are in the brain at the time of stimulation
g. That individual's intelligence
h. I don't know

The limbic system helps regulate

e. The balance among thinking, feeling, and reacting to a situation
f. All your emotions about a situation
g. The intensity of your reaction to a situation
h. I don't know

Proprioception connects mind and body

e. By the mind telling the body what to do
f. As the mind knows where the body is in space
g. As the mind is aware of what's happening inside the body
h. I don't know

Interoception connects mind and body

e. As the mind knows where the body is in space
f. As the mind is aware of what's happening inside the body
g. By the mind telling the body what to do
h. I don't know

The connection among brain, spinal cord, and muscles are

e. Perkinji Cells
f. Pyramidal Neurons
g. Motor Neurons
h. I don't know

How are neurons grouped in your body?

e. Evenly through the entire body
f. More neurons closer to your brain
g. In areas where you need them most
h. I don't know

Top Down neuroscience emphasizes

e. How the brain and automatic responses tell the body what to do
f. How the brain and body communicate with each other
g. How the body and sensory input informs the brain
h. I don't know

Bottom Up

e. How the brain and automatic responses tell the body what to do
f. How the brain and body communicate with each other
g. How the body and sensory input informs the brain
h. I don't know

Balancing bottom up and top down brain activity support

e. The mind-body connection
f. The body to be strong
g. The mind to be in control
h. I don't know

Feelings are identified best by

e. Top down neuroscience
f. Bottom up neuroscience
g. Integration of top down and bottom up
h. I don't know

The Homunculus Man is a visual representation of

e. Where neurons need to be located
f. Where we have large numbers of neurons
g. How neuroscientists think
h. I don't know

The Striatum processes information

e. About voluntary movement
f. Using purkinje cells
g. Involved in involuntary movements
h. I don't know

When you see a threat, three common responses are

e. Fight, flight, or fantasize
f. Fight, flight or freeze
g. Freeze, flight, or fix
h. I don't know

The sympathetic nervous system

e. Regulates responses to life threatening situations
f. Helps the body to rest, repair and digest
g. Works in isolation from all other body systems
h. I don't know

The parasympathetic nervous system

e. Regulates life threatening responses
f. Helps the body to rest, repair and digest
g. Works in isolation from all other body systems
h. I don't know

The Vagus Nerve

e. Controls both conscious and unconscious actions in the body
f. Only controls body organs
g. Is named for its direct path through the body
h. I don't know

The Vagus Nerve

e. Turns off the digestive system
f. Amplifies action of the HPA Axis
g. Connects the diaphragm to conscious and unconscious actions
h. I don't know

Intentional slow breathing

e. Only makes you think you are slowing your body systems down
f. Happens when the diaphragm moves the ribs, expanding and contracting the lungs
g. Speeds up your heart rate
h. I don't know

The HPA Axis responds to stress,

e. Changing the way your body processes glucose through changed liver function
f. By slowing heart rate and respiration
g. When you sleep, aiding in rest and repair
h. I don't know

Balance of the vagus nerve and the HPA Axis

e. Requires more time spent with the HPA axis dominant
f. Allows people to react to and recover from stress
g. Means people always feel neutral
h. I don't know

When the diaphragm contracts

e. And upper chest muscles relax, it creates space in the ribs for expanding lungs
f. So does the heart, signalling the HPA Axis
g. Your abdominal muscles should also contract to maximize the size of a breath
h. I don't know

Resiliency

e. Can be cultivated through conscious engagement of the diaphragm and vagus nerve
f. Cannot be cultivated through conscious engagement of the the diaphragm
g. Is all about emotional regulation
h. I don't know

APPENDIX F

F = Functional Cues C = Compassion Cues T = Time T*G = Time by Group Pre and Post = mean (SEM)	Group	Pre	Post	N		F	Sig	Partial ETA squared
BAI	F	12.24(1.492)	10.5(1.185)	38	T	32.852	0	0.046
	C	14.92(1.690)	12.83(1.504)	40	T*G	1.988	0.163	0
BDI	F	10.71(1.251)	6.74(0.863)	38	T	32.852	0	0.296
	C	10.76(0.873)	8.36(0.873)	42	T*G	1.988	0.163	0.025
MAAS	F	51.88(1.753)	54.1(1.765)	40	T	2.15	0.147	0.027
	C	54.85(2.393)	56.33(2.121)	39	T*G	0.085	0.772	0.001
FFMQ	F	120.9(2.735)	127(2.834)	39	T	26.595	0	0.262
	C	123.18(3.136)	130.74(2.611)	38	T*G	0.3	0.586	0.004
FFMQ_Observing	F	26.33(0.810)	27.33(0.770)	39	T	12.68	0.001	0.145
	C	26(0.881)	27.5(0.007)	38	T*G	0.507	0.479	0.007
FFMQ_Describing	F	26.03(1.032)	27(1.040)	39	T	10.566	0.002	0.123
	C	26.26(1.026)	27.76(0.942)	38	T*G	0.477	0.492	0.006
FFMQ_Acting_with_awareness	F	23.59(0.909)	25.23(1.004)	39	T	5.706	0.019	0.071
	C	24.82(0.966)	25.89(0.942)	38	T*G	0.244	0.623	0.003
FFMQ_Nonjudging	F	26.38(1.010)	27.44(0.974)	39	T	8.108	0.006	0.098
	C	25.76(1.047)	27.97(0.957)	38	T*G	1.024	0.315	0.013
FFMQ_Nonreactivity	F	19.69(0.697)	21.38(0.772)	39	T	24.622	0	0.247
	C	20.82(0.778)	22.87(0.690)	38	T*G	0.228	0.634	0.003
CS	F	65.83(1.089)	65.44(1.165)	36	T	0.001	0.975	0
	C	66.05(1.125)	66.4(1.179)	40	T*G	0.345	0.559	0.005
CS_kindness	F	4.27(0.093)	17.17(0.358)	36	T	2313.212	0	0.969
	C	4.56(0.256)	16.95(0.349)	40	T*G	0.912	0.343	0.012
CS_Common_Humanity	F	4.15(0.074)	16.44(0.074)	36	T	1610.217	0	0.956
	C	4.34(0.297)	16.23(0.441)	40	T*G	0.48	0.491	0.006
CS_Mindfulness	F	4.08(0.096)	15.72(0.373)	36	T	2235.011	0	0.968
	C	4.46(0.285)	16.93(0.305)	40	T*G	2.565	0.114	0.033
CS_Indifference	F	3.97(0.105)	16.11(0.431)	36	T	1377.779	0	0.949
	C	4.24(0.266)	16.3(0.418)	40	T*G	0.016	0.899	0

Continued

SCS	F	76(2.896)	86(2.922)	35	T	26.406	0	0.274
	C	70.49(3.710)	77.68(3.266)	37	T*G	0.706	0.404	0.01
SCS_SelfKindness	F	3.02(0.131)	3.41(0.147)	35	T	15.942	0	0.185
	C	2.79(0.160)	3.02(0.125)	37	T*G	1.098	0.298	0.015
SCS_SelfJudgment	F	2.9(0.140)	3.07(0.149)	35	T	5.149	0.026	0.069
	C	2.63(0.164)	2.85(0.139)	37	T*G	0.1	0.752	0.001
SCS_Common_Humanity	F	4.01(0.142)	4.1(0.117)	35	T	0.689	0.409	0.01
	C	3.92(0.181)	3.99(0.114)	37	T*G	0.01	0.922	0
SCS_Isolation_Items	F	2.94(0.163)	3.26(0.165)	35	T	14.091	0	0.168
	C	2.61(0.183)	2.93(0.182)	37	T*G	0.004	0.949	0
SCS_Mindfulness_Items	F	3.2(0.139)	3.56(0.117)	35	T	16.07	0	0.187
	C	3.01(0.149)	3.28(0.115)	37	T*G	0.256	0.614	0.004
SCS_Overidentified	F	2.26(0.110)	3.18(0.099)	35	T	169.324	0	0.708
	C	2.12(0.124)	2.86(0.117)	37	T*G	1.803	0.184	0.025
NKC	F	17.59(1.286)	26.14(1.033)	44	T	126.387	0	0.592
	C	19.71(1.199)	28.04(0.943)	45	T*G	0.02	0.888	0

F = Functional Cues
C = Compassion Cues
T = Time
T*G = Time by Group
Pre and Post = mean (SEM)

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Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	1_Pre-Total - 1_Post-Total	5.456	5.685	0.599	4.265	6.646	9.104	89	0.000
Pair 2	2_Pre-Total - 2_Post-Total	5.011	4.684	0.494	4.030	5.992	10.148	89	0.000
Pair 3	3_Pre-Total - 3_Post-Total	4.067	4.173	0.440	3.193	4.941	9.246	89	0.000
Pair 4	4_Pre-Total - 4_Post-Total	4.233	4.014	0.423	3.393	5.074	10.005	89	0.000
Pair 5	5_Pre-Total - 5_Post-Total	4.056	4.012	0.423	3.215	4.896	9.589	89	0.000
Pair 6	6_Pre-Total - 6_Post-Total	3.622	3.770	0.397	2.833	4.412	9.114	89	0.000
Pair 7	7_Pre-Total - 7_Post-Total	3.444	3.860	0.407	2.636	4.253	8.465	89	0.000
Pair 8	8_Pre-Total - 8_Post-Total	3.689	3.324	0.350	2.993	4.385	10.529	89	0.000
Pair 9	9_Pre-Total - 9_Post-Total	3.456	3.184	0.336	2.789	4.122	10.296	89	0.000
Pair 10	10_Pre-Total - 10_Post-Total	3.267	3.765	0.397	2.478	4.055	8.231	89	0.000
Pair 11	11_Pre-Total - 11_Post-Total	4.067	4.086	0.431	3.211	4.922	9.443	89	0.000
Pair 12	12_Pre-Total - 12_Post-Total	4.067	3.859	0.407	3.258	4.875	9.997	89	0.000
Pair 13	13_Pre-Total - 13_Post-Total	3.833	3.312	0.349	3.140	4.527	10.979	89	0.000
Pair 14	14_Pre-Total - 14_Post-Total	3.744	3.568	0.376	2.997	4.492	9.956	89	0.000
Pair 15	15_Pre-Total - 15_Post-Total	3.489	3.458	0.365	2.765	4.213	9.570	89	0.000
Pair 16	16_Pre-Total - 16_Post-Total	4.089	3.833	0.404	3.286	4.892	10.121	89	0.000
Pair 17	17_Pre-Total - 17_Post-Total	3.611	3.463	0.365	2.886	4.336	9.892	89	0.000
Pair 18	18_Pre-Total - 18_Post-Total	3.789	3.146	0.332	3.130	4.448	11.425	89	0.000
Pair 19	19_Pre-Total - 19_Post-Total	3.567	3.130	0.330	2.911	4.222	10.809	89	0.000
Pair 20	20_Pre-Total - 20_Post-Total	3.900	3.687	0.389	3.128	4.672	10.034	89	0.000

Supplemental Document 4.5

9 Pages of a large correlations chart.

1,2,3 follow all rows down the chart while A,B,C follow columns across the chart

Page 1A

Correlations of Change Scores

		TOTAL_change	TOTAL_thoughts_change	TOTAL_emotions_change	TOTAL_body_change	Change_BDI	Change_BAI	Change_CS	Change_CS_Kindness	Change_CS_Common_Humanity
TOTAL_change	Pearson Correlation	1	.961**	.957**	.941**	0.137	0.149	0.032	-0.045	0.116
	Sig. (2-tailed)		0	0	0	0.236	0.199	0.791	0.704	0.33
	N	86	86	86	84	77	76	73	73	73
TOTAL_thoughts_change	Pearson Correlation	.961**	1	.894**	.843**	0.114	0.174	0.006	-0.061	0.09
	Sig. (2-tailed)	0		0	0	0.326	0.134	0.959	0.611	0.448
	N	86	86	86	84	77	76	73	73	73
TOTAL_emotions_change	Pearson Correlation	.957**	.894**	1	.855**	0.158	0.149	0.09	-0.035	0.123
	Sig. (2-tailed)	0	0		0	0.17	0.199	0.447	0.77	0.298
	N	86	86	86	84	77	76	73	73	73
TOTAL_body_change	Pearson Correlation	.941**	.843**	.855**	1	0.116	0.095	-0.025	-0.035	0.109
	Sig. (2-tailed)	0	0	0		0.323	0.419	0.839	0.769	0.363
	N	84	84	84	84	75	75	71	71	71
Change_BDI	Pearson Correlation	0.137	0.114	0.158	0.116	1	.502**	-0.153	-0.155	-0.164
	Sig. (2-tailed)	0.236	0.326	0.17	0.323		0	0.216	0.209	0.186
	N	77	77	77	75	80	69	67	67	67
Change_BAI	Pearson Correlation	0.149	0.174	0.149	0.095	.502**	1	-0.045	-0.16	-0.111
	Sig. (2-tailed)	0.199	0.134	0.199	0.419	0		0.723	0.202	0.381
	N	76	76	76	75	69	78	65	65	65
Change_CS	Pearson Correlation	0.032	0.006	0.09	-0.025	-0.153	-0.045	1	.386**	.385**
	Sig. (2-tailed)	0.791	0.959	0.447	0.839	0.216	0.723		0.001	0.001
	N	73	73	73	71	67	65	76	76	76
Change_CS_Kindness	Pearson Correlation	-0.045	-0.061	-0.035	-0.035	-0.155	-0.16	.386**	1	.566**
	Sig. (2-tailed)	0.704	0.611	0.77	0.769	0.209	0.202	0.001		0
	N	73	73	73	71	67	65	76	76	76
Change_CS_Common_Humanity	Pearson Correlation	0.116	0.09	0.123	0.109	-0.164	-0.111	.385**	.566**	1

Page 1B

	Sig. (2-tailed)	0.33	0.448	0.298	0.363	0.186	0.381	0.001	0	
	N	73	73	73	71	67	65	76	76	76
Change_CS_Mindfulness	Pearson Correlation	0.039	-0.028	0.027	0.126	-0.099	-0.093	.323**	.776**	.543**
	Sig. (2-tailed)	0.741	0.817	0.819	0.296	0.424	0.461	0.004	0	0
	N	73	73	73	71	67	65	76	76	76
Change_CS_Indifference	Pearson Correlation	0.094	0.076	0.096	0.078	-0.182	-0.074	.385**	.566**	.565**
	Sig. (2-tailed)	0.428	0.521	0.421	0.517	0.14	0.56	0.001	0	0
	N	73	73	73	71	67	65	76	76	76
Change_SCS	Pearson Correlation	-0.195	-0.142	-.258*	-0.178	-0.105	0.013	-0.02	0.225	-0.041
	Sig. (2-tailed)	0.109	0.243	0.033	0.147	0.413	0.919	0.883	0.086	0.758
	N	69	69	69	68	63	61	59	59	59
Change_SCS_SelfKindness	Pearson Correlation	-0.167	-0.119	-0.197	-0.169	0.006	0.098	-0.173	0.018	-0.098
	Sig. (2-tailed)	0.17	0.329	0.104	0.168	0.964	0.451	0.19	0.89	0.461
	N	69	69	69	68	63	61	59	59	59
Change_SCS_SelJudgement	Pearson Correlation	-0.083	-0.057	-0.088	-0.107	-0.156	0.065	0.07	0.16	0.067
	Sig. (2-tailed)	0.499	0.642	0.472	0.387	0.221	0.62	0.598	0.226	0.613
	N	69	69	69	68	63	61	59	59	59
Change_SCS_CommonHumanity	Pearson Correlation	-0.209	-0.211	-.247*	-0.156	0.202	0.099	-0.093	-0.108	-0.038
	Sig. (2-tailed)	0.085	0.082	0.041	0.203	0.112	0.45	0.485	0.416	0.775
	N	69	69	69	68	63	61	59	59	59
Change_SCS_Isolation	Pearson Correlation	-0.069	0.014	-0.164	-0.079	-0.13	0.065	0.138	.370**	0.122
	Sig. (2-tailed)	0.571	0.906	0.177	0.523	0.31	0.62	0.296	0.004	0.358
	N	69	69	69	68	63	61	59	59	59
Change_SCS_Mindfulness	Pearson Correlation	-.269*	-.239*	-.308**	-0.231	-0.087	0.061	-0.12	-0.008	-0.225
	Sig. (2-tailed)	0.025	0.048	0.01	0.058	0.497	0.642	0.365	0.953	0.086
	N	69	69	69	68	63	61	59	59	59
Change_SCS_Overidentified	Pearson Correlation	-0.212	-0.17	-.284*	-0.165	-0.142	0.152	0.028	.293*	-0.072
	Sig. (2-tailed)	0.08	0.162	0.018	0.18	0.267	0.241	0.831	0.024	0.589
	N	69	69	69	68	63	61	59	59	59
Change_FFMQ	Pearson Correlation	-.251*	-.249*	-0.196	-.298*	-.271*	-.266*	.326**	0.198	0.092
	Sig. (2-tailed)	0.03	0.031	0.092	0.01	0.026	0.031	0.009	0.117	0.472
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_O	Pearson Correlation	-0.139	-0.142	-0.06	-0.22	-0.089	-0.114	0.178	0.056	-0.056

Page 1C

		TOTAL_change	TOTAL_thoughts_change	TOTAL_emotions_change	TOTAL_body_change	Change_BDI	Change_BAI	Change_CS	Change_CS_Kindness	Change_CS_Common_Humanity
	Sig. (2-tailed)	0.234	0.226	0.611	0.062	0.473	0.362	0.159	0.66	0.662
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_D	Pearson Correlation	-0.086	-0.103	-0.043	-0.116	-.290*	-0.215	0.132	0.096	0.018
	Sig. (2-tailed)	0.461	0.378	0.717	0.329	0.016	0.082	0.297	0.451	0.887
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_AWA	Pearson Correlation	-.235*	-0.203	-0.178	-.301**	-.344**	-.274*	.378**	.252*	0.14
	Sig. (2-tailed)	0.043	0.081	0.126	0.01	0.004	0.026	0.002	0.044	0.27
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_NJ	Pearson Correlation	-0.044	-0.073	-0.013	-0.052	0.081	-0.17	.271*	0.2	0.165
	Sig. (2-tailed)	0.708	0.536	0.915	0.66	0.513	0.171	0.03	0.113	0.194
	N	75	75	75	73	68	66	64	64	64
Change_FFMQ_NR	Pearson Correlation	-.239*	-0.225	-.265*	-0.221	-.245*	-0.154	0.096	0.008	0.017
	Sig. (2-tailed)	0.039	0.052	0.022	0.06	0.044	0.216	0.449	0.951	0.896
	N	75	75	75	73	68	66	64	64	64
Change_MAAS	Pearson Correlation	-.352**	-.307**	-.327**	-.378**	-.314**	-.528**	0.229	0.174	0.091
	Sig. (2-tailed)	0.002	0.007	0.004	0.001	0.008	0	0.065	0.162	0.466
	N	76	76	76	74	70	68	66	66	66
Change_NKC	Pearson Correlation	-0.184	-0.204	-0.149	-0.163	0.056	0.063	-0.067	-0.075	-0.016
	Sig. (2-tailed)	0.089	0.059	0.17	0.139	0.619	0.584	0.563	0.521	0.893
	N	86	86	86	84	80	78	76	76	76

**** Correlation is significant at the 0.01 level (2-tailed).**

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Change_CS_Mindfulness	Change_CS_Indifference	Change_SCS	Change_SCS_SelfKindness	Change_SCS_SelJudgement	Change_SCS_CommonHumanity	Change_SCS_Isolation	Change_SCS_Mindfulness	Change_SCS_Overidentified	Change_FFMQ	Change_FFMQ_O	Change_FFMQ_D	Change_FFMQ_AWA	Change_FFMQ_NJ
0.039	0.094	-0.195	-0.167	-0.083	-0.209	-0.069	-.269*	-0.212	-.251*	-0.139	-0.086	-.235*	-0.044
0.741	0.428	0.109	0.17	0.499	0.085	0.571	0.025	0.08	0.03	0.234	0.461	0.043	0.708
73	73	69	69	69	69	69	69	69	75	75	75	75	75
-0.028	0.076	-0.142	-0.119	-0.057	-0.211	0.014	-.239*	-0.17	-.249*	-0.142	-0.103	-0.203	-0.073
0.817	0.521	0.243	0.329	0.642	0.082	0.906	0.048	0.162	0.031	0.226	0.378	0.081	0.536
73	73	69	69	69	69	69	69	69	75	75	75	75	75
0.027	0.096	-.258*	-0.197	-0.088	-.247*	-0.164	-.308**	-.284*	-0.196	-0.06	-0.043	-0.178	-0.013
0.819	0.421	0.033	0.104	0.472	0.041	0.177	0.01	0.018	0.092	0.611	0.717	0.126	0.915
73	73	69	69	69	69	69	69	69	75	75	75	75	75
0.126	0.078	-0.178	-0.169	-0.107	-0.156	-0.079	-0.231	-0.165	-.298*	-0.22	-0.116	-.301**	-0.052
0.296	0.517	0.147	0.168	0.387	0.203	0.523	0.058	0.18	0.01	0.062	0.329	0.01	0.66
71	71	68	68	68	68	68	68	68	73	73	73	73	73
-0.099	-0.182	-0.105	0.006	-0.156	0.202	-0.13	-0.087	-0.142	-.271*	-0.089	-.290*	-.344**	0.081
0.424	0.14	0.413	0.964	0.221	0.112	0.31	0.497	0.267	0.026	0.473	0.016	0.004	0.513
67	67	63	63	63	63	63	63	63	68	68	68	68	68
-0.093	-0.074	0.013	0.098	0.065	0.099	0.065	0.061	0.152	-.266*	-0.114	-0.215	-.274*	-0.17
0.461	0.56	0.919	0.451	0.62	0.45	0.62	0.642	0.241	0.031	0.362	0.082	0.026	0.171
65	65	61	61	61	61	61	61	61	66	66	66	66	66
.323**	.385**	-0.02	-0.173	0.07	-0.093	0.138	-0.12	0.028	.326**	0.178	0.132	.378**	.271*
0.004	0.001	0.883	0.19	0.598	0.485	0.296	0.365	0.831	0.009	0.159	0.297	0.002	0.03
76	76	59	59	59	59	59	59	59	64	64	64	64	64
.776**	.566**	0.225	0.018	0.16	-0.108	.370**	-0.008	.293*	0.198	0.056	0.096	.252*	0.2
0	0	0.086	0.89	0.226	0.416	0.004	0.953	0.024	0.117	0.66	0.451	0.044	0.113
76	76	59	59	59	59	59	59	59	64	64	64	64	64
.543**	.565**	-0.041	-0.098	0.067	-0.038	0.122	-0.225	-0.072	0.092	-0.056	0.018	0.14	0.165

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0	0	0.758	0.461	0.613	0.775	0.358	0.086	0.589	0.472	0.662	0.887	0.27	0.194
76	76	59	59	59	59	59	59	59	64	64	64	64	64
1	.523**	-0.001	-0.135	0.175	-0.119	0.146	-0.224	-0.026	0.05	-0.087	-0.034	0.09	0.168
	0	0.992	0.308	0.186	0.371	0.271	0.087	0.848	0.694	0.495	0.792	0.478	0.185
76	76	59	59	59	59	59	59	59	64	64	64	64	64
.523**	1	-0.041	-0.203	0.088	-0.04	0.153	-0.097	-0.008	0.157	0.026	0.041	0.2	.256*
0		0.759	0.123	0.506	0.763	0.249	0.467	0.952	0.214	0.839	0.751	0.114	0.041
76	76	59	59	59	59	59	59	59	64	64	64	64	64
-0.001	-0.041	1	.840**	.721**	.542**	.675**	.731**	.668**	.424**	0.108	.394**	.376**	0.1
0.992	0.759		0	0	0	0	0	0	0.001	0.409	0.002	0.003	0.448
59	59	72	72	72	72	72	72	72	60	60	60	60	60
-0.135	-0.203	.840**	1	.598**	.530**	.448**	.690**	.542**	.358**	0.058	.410**	.305*	0.078
0.308	0.123	0		0	0	0	0	0	0.005	0.662	0.001	0.018	0.552
59	59	72	72	72	72	72	72	72	60	60	60	60	60
0.175	0.088	.721**	.598**	1	.332**	.466**	.384**	.420**	.433**	0.197	.374**	.369**	0.121
0.186	0.506	0	0		0.004	0	0.001	0	0.001	0.132	0.003	0.004	0.356
59	59	72	72	72	72	72	72	72	60	60	60	60	60
-0.119	-0.04	.542**	.530**	.332**	1	0.149	.614**	0.146	0.016	-0.124	-0.086	-0.005	0.104
0.371	0.763	0	0	0.004		0.211	0	0.22	0.906	0.347	0.513	0.972	0.429
59	59	72	72	72	72	72	72	72	60	60	60	60	60
0.146	0.153	.675**	.448**	.466**	0.149	1	.361**	.511**	.319*	0.024	0.24	.258*	0.14
0.271	0.249	0	0	0	0.211		0.002	0	0.013	0.854	0.065	0.046	0.285
59	59	72	72	72	72	72	72	72	60	60	60	60	60
-0.224	-0.097	.731**	.690**	.384**	.614**	.361**	1	.530**	.271*	0.074	.339**	0.23	-0.062
0.087	0.467	0	0	0.001	0	0.002		0	0.036	0.575	0.008	0.077	0.639
59	59	72	72	72	72	72	72	72	60	60	60	60	60
-0.026	-0.008	.668**	.542**	.420**	0.146	.511**	.530**	1	.358**	0.09	.473**	.272*	0.052
0.848	0.952	0	0	0	0.22	0	0		0.005	0.494	0	0.035	0.692
59	59	72	72	72	72	72	72	72	60	60	60	60	60
0.05	0.157	.424**	.358**	.433**	0.016	.319*	.271*	.358**	1	.550**	.616**	.756**	.626**
0.694	0.214	0.001	0.005	0.001	0.906	0.013	0.036	0.005		0	0	0	0
64	64	60	60	60	60	60	60	60	77	77	77	77	77
-0.087	0.026	0.108	0.058	0.197	-0.124	0.024	0.074	0.09	.550**	1	.294**	0.175	0.143

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Change_CS_Mindfulness	Change_CS_Indifference	Change_SCS	Change_SCS_SelfKindness	Change_SCS_SelJudgement	Change_SCS_CommonHumanity	Change_SCS_Isolation	Change_SCS_Mindfulness	Change_SCS_Overidentified	Change_FFMQ	Change_FFMQ_O	Change_FFMQ_D	Change_FFMQ_AWA	Change_FFMQ_NJ
0.495	0.839	0.409	0.662	0.132	0.347	0.854	0.575	0.494	0		0.009	0.128	0.213
64	64	60	60	60	60	60	60	60	77	77	77	77	77
-0.034	0.041	.394**	.410**	.374**	-0.086	0.24	.339**	.473**	.616**	.294**	1	.316**	.238*
0.792	0.751	0.002	0.001	0.003	0.513	0.065	0.008	0	0	0.009		0.005	0.037
64	64	60	60	60	60	60	60	60	77	77	77	77	77
0.09	0.2	.376**	.305*	.369**	-0.005	.258*	0.23	.272*	.756**	0.175	.316**	1	.408**
0.478	0.114	0.003	0.018	0.004	0.972	0.046	0.077	0.035	0	0.128	0.005		0
64	64	60	60	60	60	60	60	60	77	77	77	77	77
0.168	.256*	0.1	0.078	0.121	0.104	0.14	-0.062	0.052	.626**	0.143	.238*	.408**	1
0.185	0.041	0.448	0.552	0.356	0.429	0.285	0.639	0.692	0	0.213	0.037	0	
64	64	60	60	60	60	60	60	60	77	77	77	77	77
0.022	-0.042	.307*	.257*	.314*	0.045	.315*	0.171	0.173	.593**	.275*	0.224	.348**	0.123
0.865	0.745	0.017	0.048	0.015	0.735	0.014	0.192	0.187	0	0.015	0.051	0.002	0.285
64	64	60	60	60	60	60	60	60	77	77	77	77	77
0.113	0.072	0.238	0.206	.333**	-0.061	0.132	0.127	0.149	.628**	0.226	.460**	.631**	.253*
0.365	0.565	0.062	0.108	0.008	0.635	0.307	0.323	0.248	0	0.066	0	0	0.039
66	66	62	62	62	62	62	62	62	67	67	67	67	67
-0.041	-0.059	0.171	0.103	0.13	.287*	0.024	0.228	0.002	0.083	0.085	-0.029	0.058	0.02
0.723	0.61	0.152	0.387	0.277	0.015	0.842	0.054	0.986	0.472	0.465	0.8	0.619	0.864
76	76	72	72	72	72	72	72	72	77	77	77	77	77

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Change_FFMQ_NR	Change_MAAS	Change_NKC		
-.239*	-.352**	-0.184	Pearson Correlation	**TOTAL_change**
0.039	0.002	0.089	Sig. (2-tailed)	
75	76	86	N	
-0.225	-.307**	-0.204	Pearson Correlation	**TOTAL_thoughts_change**
0.052	0.007	0.059	Sig. (2-tailed)	
75	76	86	N	
-.265*	-.327**	-0.149	Pearson Correlation	**TOTAL_emotions_change**
0.022	0.004	0.17	Sig. (2-tailed)	
75	76	86	N	
-0.221	-.378**	-0.163	Pearson Correlation	**TOTAL_body_change**
0.06	0.001	0.139	Sig. (2-tailed)	
73	74	84	N	
-.245*	-.314**	0.056	Pearson Correlation	**Change_BDI**
0.044	0.008	0.619	Sig. (2-tailed)	
68	70	80	N	
-0.154	-.528**	0.063	Pearson Correlation	**Change_BAI**
0.216	0	0.584	Sig. (2-tailed)	
66	68	78	N	
0.096	0.229	-0.067	Pearson Correlation	**Change_CS**
0.449	0.065	0.563	Sig. (2-tailed)	
64	66	76	N	
0.008	0.174	-0.075	Pearson Correlation	**Change_CS_Kindness**
0.951	0.162	0.521	Sig. (2-tailed)	
64	66	76	N	
0.017	0.091	-0.016	Pearson Correlation	**Change_CS_Common_Humanity**

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0.896	0.466	0.893	Sig. (2-tailed)	
64	66	76	N	
0.022	0.113	-0.041	Pearson Correlation	**Change_CS_Mindfulness**
0.865	0.365	0.723	Sig. (2-tailed)	
64	66	76	N	
-0.042	0.072	-0.059	Pearson Correlation	**Change_CS_Indifference**
0.745	0.565	0.61	Sig. (2-tailed)	
64	66	76	N	
.307*	0.238	0.171	Pearson Correlation	**Change_SCS**
0.017	0.062	0.152	Sig. (2-tailed)	
60	62	72	N	
.257*	0.206	0.103	Pearson Correlation	**Change_SCS_SelfKindness**
0.048	0.108	0.387	Sig. (2-tailed)	
60	62	72	N	
.314*	.333**	0.13	Pearson Correlation	**Change_SCS_SelJudgement**
0.015	0.008	0.277	Sig. (2-tailed)	
60	62	72	N	
0.045	-0.061	.287*	Pearson Correlation	**Change_SCS_CommonHumanity**
0.735	0.635	0.015	Sig. (2-tailed)	
60	62	72	N	
.315*	0.132	0.024	Pearson Correlation	**Change_SCS_Isolation**
0.014	0.307	0.842	Sig. (2-tailed)	
60	62	72	N	
0.171	0.127	0.228	Pearson Correlation	**Change_SCS_Mindfulness**
0.192	0.323	0.054	Sig. (2-tailed)	
60	62	72	N	
0.173	0.149	0.002	Pearson Correlation	**Change_SCS_Overidentified**
0.187	0.248	0.986	Sig. (2-tailed)	
60	62	72	N	
.593**	.628**	0.083	Pearson Correlation	**Change_FFMQ**
0	0	0.472	Sig. (2-tailed)	
77	67	77	N	
.275*	0.226	0.085	Pearson Correlation	**Change_FFMQ_O**

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0.015	0.066	0.465	Sig. (2-tailed)	
77	67	77	N	
0.224	.460**	-0.029	Pearson Correlation	**Change_FFMQ_D**
0.051	0	0.8	Sig. (2-tailed)	
77	67	77	N	
.348**	.631**	0.058	Pearson Correlation	**Change_FFMQ_AWA**
0.002	0	0.619	Sig. (2-tailed)	
77	67	77	N	
0.123	.253*	0.02	Pearson Correlation	**Change_FFMQ_NJ**
0.285	0.039	0.864	Sig. (2-tailed)	
77	67	77	N	
1	.498**	0.135	Pearson Correlation	**Change_FFMQ_NR**
	0	0.243	Sig. (2-tailed)	
77	67	77	N	
.498**	1	0.005	Pearson Correlation	**Change_MAAS**
0		0.962	Sig. (2-tailed)	
67	79	79	N	
0.135	0.005	1	Pearson Correlation	**Change_NKC**
0.243	0.962		Sig. (2-tailed)	
77	79	89	N	

Change_FFMQ_NR

Change_MAAS

Change_NKC

APPENDIX G

Supplemental Document 5.1

Multidimensional Impacts of Movement Scale (MIMS)

Respond to these statements with one mark per row.

Consider how your movement practice influences how you feel now, in this moment. While you may cross-train some, think about the movement practice that you most identify with as your primary movement practice.

	No Answer 0	Disagree 1	2	3	4	Agree 5
1. I am in control of my physical balance.						
2. I am thriving.						
3. I am able to learn new things.						
4. I am at ease.						
5. I am able to pay attention to the way my mind works.						
6. I am coordinated.						
7. I have an easy time remembering things.						
8. I am able to focus on the task at hand.						
9. I am comfortable with the unexpected.						
10. I make choices based on increasing the greater good.						
11. I am physically strong.						
12. I am not obligated to act as others expect.						
13. I am open.						
14. I am able to integrate my thoughts, emotions and senses.						
15. I am flexible.						
16. I am quick to recover.						
17. I can feel emotions in my body.						
18. I am whole.						
19. I am confident of my memories.						
20. I am able to release tension in my body.						
21. I am alert.						
22. I see beauty all around me.						
23. I am able to let go of fears.						
24. I fully understand who I am.						

Multidimensional Impacts of Movement Scale (MIMS)

Respond to these statements with one mark per row.

Consider how your movement practice influences how you feel now, in this moment. While you may cross train some, think about the movement practice that you most identify with as your primary movement practice.

	No Answer 0	Disagree 1	2	3	4	Agree 5
25. I am able to control my breath.						
26. I am able to observe my life without judgement.						
27. I am breathing easily.						
28. I am healthy in my body.						
29. I notice what I notice.						
30. I am comfortable expressing my feelings.						
31. I want to help others in need.						
32. I am physically able to do the things I want to do.						
33. I am open to the wisdom of the Universe.						
34. I have a full range of emotions.						
35. I am connected to the energy of the Universe.						
36. I am able to replenish my energy.						
37.I am at home in my body.						
38. I am filled with joy.						
39. I feel free of fatigue.						
40. I am aware of my bodily sensations.						
41. I am able to experience the physical sensations of emotions.						
42. I am comfortable with my own mistakes.						
43. My conscience is clear.						
44. I naturally know what to do next.						
45. I trust my intuitions.						

Scoring MIMS

- To figure s***ubscales*** of this tool, add the numbers indicated for each subscale below.
- For a ***total*** tool score, add all responses

Higher scores indicate a greater influence of exercise

	Score
Body 1, 6, 11, 15, 20, 25, 32, 37, 41	
Energy 2, 8, 13, 16, 21, 27, 36, 39, 44	
Mind 3, 7, 14, 17, 23, 30, 34, 40, 42	
Intuition 5, 10, 12, 19, 24, 26, 29, 33, 45	
Contentment 4, 9, 18, 22, 28, 31, 35, 38, 43	
Total Maximum 225	

Body

Awareness of and control over one's body

1. I am in control of my physical balance.
6. I am coordinated.
11. I am physically strong.
15. I am flexible.
20. I am able to release tension in my body.
25. I am able to control my breath.
32. I am physically able to do the things I want to do.
37.I am at home in my body.

Energy

Vitality and ability to turn energy into action

2. I am thriving.
8. I am able to focus on the task at hand.
13. I am open.
16. I am quick to recover.
21. I am alert.
27. I am breathing easily.
36. I am able to replenish my energy.
39. I feel free of fatigue.
44. I naturally know what to do next.

Mind

Integration of thoughts, emotions, and senses

3. I am able to learn new things.
7. I have an easy time remembering things.
14. I am able to integrate my thoughts, emotions, and senses.
17. I can feel emotions in my body.
23. I am able to let go of fears.
30. I am comfortable expressing my feelings.
34. I have a full range of emotions.
40. I am aware of my bodily sensations.
42. I am comfortable with my own mistakes.

Intuition

Trust in how thoughts and emotions guide decision-making.

5. I am able to pay attention to the way my mind works.
10. I make choices based on increasing the greater good.
12. I am not obligated to act as others expect.
19. I am confident of my memories.
24. I fully understand who I am.
26. I am able to observe my life without judgement.
29. I notice what I notice.
33. I am open to the wisdom of the Universe.
45. I trust my intuitions.

Contentment

Ease and contentment with oneself and the world around them

4. I am at ease.
9. I am comfortable with the unexpected.
18. I am whole.
22. I see beauty all around me.
28. I am healthy in my body.
31. I want to help others in need.
35. I am connected to the energy of the Universe.
38. I am filled with joy.
43. My conscience is clear.