INFLUENCE OF ACUTE ONLINE GUIDED MEDITATION ON INHIBITORY CONTROL AND STIMULUS DISCRIMINATION IN COLLEGE-AGE ADULTS

by

Praveen Astalakshmi Pasupathi, B. Tech

A Thesis Presented in Parital Fulfillment
Of the Requirements for the Degree
Master of Science in Kinesiology

COLLEGE OF EDUCATION
LOUISIANA TECH UNIVERSITY

February 2022

LOUISIANA TECH UNIVERSITY

GRADUATE SCHOOL

February 17, 2022
Date of thesis defense

We hereby recommend that the thesis prepared by

Praveen A. Pasupathi

entitled **Influence of acute online guided meditation on inhibitory control and stimulus discrimination in college-aged adults**

be accepted in partial fulfillment of the requirements for the degree of

Master of Science in Kinesiology, Sports Performance Conc.

Dr. Andrew C. Parks
Supervisor of Thesis Research

Dr. David Szymanski
Head of Kinesiology

Members of the Thesis Committee:
Dr. Jordan A. Blazo
Dr. Jane Jacob

Approved:

Don Schillinger
Dean of Education

Approved:

Ramu Ramachandran
Dean of the Graduate School

GS Form 13
(01/20)

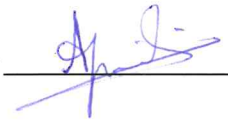
ABSTRACT

Today's young adult experience a world designed to constantly demand the individual's attention through a barage of stimuli, making the ability to adequately inhibit irrelevant stimuli a necessary skillset for this population. While health behaviors such as exercise have shown positive effects on this ability, other behaviors such as mindfulness meditation have been less explored. Therefore, the purpose of this study is to examine the influence of an acute bout of guided mindfulness meditation on inhibition aspects of attention in college-age adults. Using a within-subjects repeated measures design, twenty-four participants (age = 21.35 ± 0.92 years) engaged in both a 15-minute guided mindfulness meditation intervention and a control condition across two separate days. Prior to and following the experimental conditions, participants completed a cognitive assessment battery including a modified Eriksen flanker task and a three-stimulus oddball task. In addition, participants completed the Mindfulness Attention Awareness Scale and Five Facet Mindfulness Questionnaire during each session. Results from this study indicated no effect of either condition on any of the measures of cognitive performance (mean reaction time and response accuracy) or on either of the questionnaires. These findings suggest that an acute bout of mindfulness mediation may not be sufficient to elicit detectable changes in cognitive performance, indicating either a need for more sensitive measurement tools for future studies or a greater duration/frequency for the intervention protocol.

APPROVAL FOR SCHOLARLY DISSEMINATION

The author grants to the Prescott Memorial Library of Louisiana Tech University the right to reproduce, by appropriate methods, upon request, any or all portions of this Thesis. It is understood that "proper request" consists of the agreement, on the part of the requesting party, that said reproduction is for his personal use and that subsequent reproduction will not occur without written approval of the author of this Thesis. Further, any portions of the Thesis used in books, papers, and other works must be appropriately referenced to this Thesis.

Finally, the author of this Thesis reserves the right to publish freely, in the literature, at any time, any or all portions of this Thesis.

Author 

Date 02-18-2022

DEDICATION

I would like to dedicate this thesis to ALLAH Subhana Wa Ta'ala, my spiritual gurus: Prophet Muhammad peace be upon him, Sheikh Abdul Qadir Al-Jilani (R.A), Sheikh Hazarath Jaleel Muhieddeen Qadiri, and to my beloved family. My spiritual gurus – I'm nothing without you all and I wouldn't have come this far without your blessings and grace. You all have been merciful, just, forgiving and supportive in every way possible. I consider myself lucky to be one of your million disciples and I humbly continue to seek your guidance, blessing, and protection throughout my life. My family- I take this opportunity to thank each one in the family from the bottom of my heart for providing good education, wealth, and support over the years. I thank my father, mother, and Roshan for your support, encouragement, affection, bringing me into this world.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

Firstly, I would like to thank Dr. David Szymanski for having faith in my interest and admittance into the master's program in kinesiology at Louisiana Tech University. My mentor, Dr. Andrew Parks. I wholeheartedly thank you for your mentorship during my time at Tech. I take the time to humbly thank you for refining my research interest and molding me for the future. Every time I needed you for my PhD applications, thesis meetings or discussions or data collection, you have always stepped in, took charge, and gave your best in every way possible so that I could have the best. I thank you for your support and encouragement.

I am thankful to all my professors and instructors in the Department of Kinesiology. You all have given your time and resources in sharing your best knowledge in the field of kinesiology with me through classes and research. Without hesitation, I would say that you all have been a lovely group of teachers I have ever had in my lifetime. My thesis committee, if not for your support and collaboration, this project would not have come into place. I heartily thank my participants for being involved in my thesis project. Without you, all the project is in the air.

Finally, I would like to thank my family and friends for their immense support in helping me grow as an individual.

KEY TO ABBREVIATIONS

ACC	Anterior Cingulate Cortex
ANOVA	Analysis of Variance
ANT	Attention Network Test
EEG	Electroencephalography
EF	Executive functions
FFMQ	Five Facets of Mindfulness Questionnaire
FA	Focused Attention
HHD	Health History Demographic
HMP	Healthy Minds Program
HR	Heart Rate
IBMT	Integrative Body-Mind Training
ITI	Inter Trial Interval
MAAS	Mindful Attention Awareness Scale
MAC	Mindfulness Acceptance Commitment
MBCT	Mindfulness-Based Cognitive Therapy
MBSR	Mindfulness Based Stress Reduction
MMI	Mindfulness meditation Intervention
MSPE	Mindful Sports Performance Enhancement
OM	Open Monitoring

PFC	Pre-frontal Cortex
PST	Psychological Skill Training
PA	Physical Activity
RT	Reaction time
SES	Socioeconomic Status
TM	Transcendental Meditation
WASI-II	Wechsler Abbreviated Scale of Intelligence Version two
VM	Vipassana Meditation

CHAPTER 1

INTRODUCTION

Today's society is designed to draw the individual's attention to hundreds of stimuli at any given point in time, making it difficult to sort through abundance of information and focus on what is important. This challenge can lead to social and personal obstacles in everyday life that when consistent may lead to developmental distress and the potential to deter attention, memory, perception, decision-making abilities, feelings, and behaviors in individuals (Kitzrow, 2003). Researchers have suggested that engaging in health-related behaviors like exercise/mental practices may aid in the maintenance and potential improvements of neural processes associated with attention (Pozuelos et al., 2019; Themanson et al., 2008), which may lead to improved cognitive performance relative to daily life. Given the demands of daily life, it is crucial for individuals to monitor attention, differentiate between stimuli, monitor action to inhibit habitual or prepotent responses, learn and overcome errors/mistakes to achieve desired goals in the future (Hoffmann & Falkenstein, 2012; Polich, 2007); as each of these skills directly effects how we manage and interact with the world we experience. While much of the prior literature has focused on potential improvements in cognitive performance by examining varying modes of physical activity (PA) and differing populations (Gomez-Pinilla & Hillman, 2013; Hillman et al., 2008), recent interest in mindfulness practices has grown with researchers suggesting that actively engaging the mind with intentional purpose will lead to improved cognitive performance. However, to

date, interventions designed to incorporate psychological skill training (PST; such as goal setting, self-talk, relaxation, and imagery) as a mindfulness technique have shown contradicting effects. Individuals have reported negative emotions and have encountered challenges in completing cognitive tasks following PST training. Furthermore, this practice aims to suppress, or control, one's internal processes like thoughts and emotions (Gardner & Moore, 2004; Sappington & Longshore, 2015). Although studies implementing practices like PST have yet to show consistent findings for cognitive health and psychological well-being (Gardner & Moore, 2004), interventions that include alerting, orientation, monitoring of thoughts, emotions, physical sensations, and responses to external cues and targets have been shown to enhance cognitive performance and psychological well-being (Gardner & Moore, 2004). In this way, mindfulness meditation with its unique approach and style may be tailor-fit to influence cognitive performance and psychological well-being in the adult population (Andreu et al., 2017; Pozuelos et al., 2019; Teper & Inzlicht, 2013).

Mindfulness meditation has emerged from the eastern part of the world and is defined as "the awareness that emerges through paying attention on purpose, in the present moment by moment, and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003). Two forms of meditation have been reported, a mindfulness practice that uses breath, thoughts, and sounds to anchor moment to moment attention is described as focused attention (FA), whereas open monitoring (OM) involves having open awareness and non-reactivity (i.e., observing) to thoughts, emotions, and experiences rather than disengagement in selective attention (Lutz et al., 2008). Mindfulness-based interventions focus on non-judgmental and acceptance of the present

moment, paying attention and awareness of thoughts, emotions, responses to cues, and physical sensations. Over the years, mindfulness-based interventions like awareness to breathing, thoughts and sounds, mindfulness-based stress reduction (MBSR), mindfulness acceptance commitment (MAC), mindful sports performance enhancement (MSPE), integrative body-mind training (IBMT), transcendental meditation, tai chi and many more have been shown to positively impact those engaging in the practice relative to controls and those completing alternative psychological training practices (Gallant, 2016). In essence, the basic rudiment of meditation is refraining from the outside world to direct one's attention onto the self. This is done by harmonizing and silencing thoughts, emotions, and feelings that arise from within the self and the outside world through a non-judgmental fashion. Thereby, improving the ability to pay attention and awareness within oneself, and the surroundings by increasing self-acceptance. Furthermore, meditation allows individuals to mentally "unpackage" themselves and establish a relationship with the inner self which may then improve the knowledge of the self and lead to psychological and cognitive growth.

Research studies have established a positive relationship between meditation and psychological wellbeing (Sampaio et al., 2017). In a 2009 study assessing well-being in adults, a variable indicating psychological performance differentiated between meditators and non-meditators (Lykins & Baer, 2009), meditators experienced significantly higher levels of mindfulness, well-being, self-compassion, decreased emotional fear, suppression of thought, and regulation of emotions compared to non-meditators. Furthermore, other studies have reported that meditators have decreased anxiety, depression, anger, and stress that impairs individuals mental health (Bühlmayer et al.,

2017; Fissler et al., 2017; Khoury et al., 2015; Noetel et al., 2019). Interestingly, it appears that these positive changes may be reproduced regardless of the method of mindfulness meditation (Keng et al., 2011).

Mindfulness related interventions have also been shown to alter cognitive and neural processes (Jha et al., 2007; Moore et al., 2012; Pozuelos et al., 2019; Tang et al., 2007; Teper & Inzlicht, 2013) in meditators compared to non-meditators. A major aspect of cognition targeted by mindfulness training is attention, which can be divided into 3 subsystems: alerting, orienting and executive functions (Posner & Rothbart, 2007). During the early stages of meditation practices, individuals often continue to waver between thoughts, emotions, physical sensations and external cues rather than anchoring moment to moment attention (i.e., sound, breath). It is suggested that novice meditators incorporate a form of meditation practice that involves sustained attention on anchoring tools like breath and sound rather than the OM meditation as they tend to delve or react to emerging thoughts, emotions, internal and external cues (Lutz et al., 2008). When consistent meditation practice lead to potential improvements in these attentional subsystems (Malinowski, 2013).

Very few meditation studies, however, have focused on inhibition of actions and stimulus discrimination together (Pozuelos et al., 2019; Nick Yeung et al., 2004), although mindfulness induced interventions have been shown to alter these neural networks (Andreu et al., 2017; Pozuelos et al., 2019; Teper & Inzlicht, 2013). This study will explore the acute effects of guided mindfulness meditation in a population of college-age adults, specifically focusing on the stimulus discrimination and inhibitory control aspects of attention. It is our hope that by focusing on college-age adults we may

ascertain insight that can help to combat many of the common daily challenges experienced by this population ranging from academics, environment, and nutrition to mental distress and cognitive disfunction (Kitzrow, 2003). A key focus of meditation is to improve awareness and acceptance of oneself and the environment, which may lead to improved maintenance of networks involved in neural processing of attention (Pozuelos et al., 2019; Teper & Inzlicht, 2013). Previous studies examining whether the effects of online mindfulness meditation on inhibition or stimulus discrimination are limited and inconsistent among college-aged adults. To our knowledge, no other studies have explored the acute effects of online guided mindfulness meditation and cognitive performance in college-aged individuals. Furthermore, minimum meditation practice to notice cognitive changes related to performance monitoring are yet to be explored.

Therefore, the primary aim of this study is to examine the influence of a brief 15-minute bout of mindfulness meditation on behavioral indices of inhibitory control and stimulus discrimination. Using a guided meditation application that uses breath awareness to anchor attention, it is suggested that participants will display enhanced performance following the meditation bout relative to a resting control condition. Studies have reported mindfulness practices may improve the individual's ability to sustain focus and awareness of a stimulus without the influence of negative actions, thoughts, and distractions (Gardner & Moore, 2004). These changes are crucial in differentiating target stimuli and inhibiting pre-potent or habitual responses to a sequence of environmental stimuli thereby improving cognitive processes of attention (Holroyd & Coles, 2002).

CHAPTER 2

REVIEW OF LITERATURE

Meditation

The term meditation is derived from the ancient Indian language called Sanskrit, a direct translation of meditation that refers to dhyana, meaning the practice of attention and contemplation (Sampaio et al., 2017). Meditation has existed for more than 3000 years in Ayurvedic tradition from India and has been a part of religious, non-religious traditions and used for mental training purposes. Furthermore, meditation has been practiced in reaching spiritual status in religious traditions. There are two kinds of meditation practice: concentrative or focused attention meditation and mindfulness or open-monitoring meditation (Barrows & Jacobs, 2002; Krisanaprakornkit et al., 2006; Lutz et al., 2008).

Traditional Meditative Practices

Concentrative or focused attention meditation is a practice that requires focusing attention on an object or sensations like breath, image, sound, or mantras that has traditionally been used to sustain attention until thoughts are silenced by the mind. Sustained attention is discussed as the ability to remain vigilant over an extended period of time (Posner & Rothbart, 1992). Noticing distractions that lead to mind wandering and bringing attention back from the wandering state to the subject of focus (i.e., breath, sound, image) requires switching skills, or the ability to alter the focus of attention flexibly from one task to another (Posner, 1980). Disengaging from distraction and

redirecting attention to the intended object or sensation is practiced by acknowledging the distraction rather than controlling or suppressing them (Gardner & Moore, 2004). Finally, inhibition is refraining from further rumination of thoughts, emotions feelings, and sensations while encountering them during the focused attention meditation practice. During the initial stages of any meditation practices, novice meditators encounter distractions from thoughts, emotions, and feelings that lead to a mind-wandering state however sustaining attention over time like experienced meditators on an object could be done at ease (Lutz et al., 2008).

On the other hand, mindfulness or open-monitoring meditation refers to the practice of monitoring moment to moment experience (i.e., non-judgmental observation of thoughts and emotions) without any explicit focus like breath or sound or mantra. The term mindfulness is defined as "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003). Mindfulness meditation has been practiced for more than 2500 years and has been the heart of Buddhist tradition. Buddha discloses two core sutras or teachings which define mindfulness, the Satipathana sutra & the Anapanasati sutra, upon the two core teachings various mindfulness practice and traditions which symbolize the idea of non-harming behavior on the self (individual). Unnoticed behaviors, thoughts, and actions could potentially lead to the suffering of the individual and might affect (i.e., harming) other individuals to a certain extent. This could be changed by transforming thoughts and behaviors through the practice of mindfulness thereby developing open-mindedness, calmness and improving attention (Kabat-Zinn,2003). The attitude of the mind while engaging in mindfulness practice defines

mindfulness to a certain extent (Bishop, 2004). An attitude of acceptance is defined as the experience of openness to the reality of the present moment (Roemer & Orsillo, 2002). For instance, contemplation of failures, encountering emotional hardships or pain could be detrimental however under such circumstances developing an accepting attitude might help individuals to observe and develop awareness to thoughts, emotions, and actions rather than worrying and contemplating on them. This kind of practice aims to improve emotional stability (Lutz et al., 2008). In summary, the difference between focused and mindfulness meditation is that focused meditation requires an explicit focus of sustained attention on a particular object and actively disengaging from distractors like thoughts, emotions, and feelings while mindfulness meditation requires sustained awareness of arising thoughts, emotions, and feelings without explicit focus in a non-judgmental manner. Overall, meditation is a practice of taking a step back from worldly actions or events to focusing and establishing a connection to the inner self by monitoring thoughts, emotions, and actions.

Alternative Meditative Practices

Over years meditation practices have reached different parts of the globe and have led to the rise of diverse practices like Transcendental meditation (TM), Vipassana meditation (VM), mindfulness-based cognitive therapy (MBCT), mindfulness-based stress reduction (MSBR), Integrative body-mind training (IBMT), Mindfulness meditation therapy (MMT), Mindfulness/Acceptance/Commitment (MAC), Tai-chi and many more that have developed from either concentration or mindfulness meditation or both together. Each of these practices has its influences on physiology and psychology.

Effects of Meditation on Physiological Factors

Initial meditation research on physiology, elicited decreased oxygen consumption, increased skin resistance and EEG frequencies (Wallace, 1970). In the subsequent year, (Wallace et al., 1971) confirmed the decreased blood lactate concentration, pH, carbon dioxide elimination, and increased skin resistance with larger sample size. Decreased plasma cortisol levels were seen in long-term Transcendental meditators compared to controls and when the controls were re-studied after practicing TM for 3 to 4 months, decreased cortisol levels were recorded from the controls however remained lower than experienced meditators (Jevning, 1978). A fourteen-minute mindfulness meditation bout that focused on paying attention to the breath and awareness of the present moment showed decreased systolic blood pressure in undergraduate students with no meditation experience (Larson et al., 2013). Physiological changes induced from practicing meditation suppresses the sympathetic nervous system and promotes the activity of parasympathetic nervous activity thereby reducing the release of stress hormones like cortisol (Rajaraman, 2013). T CD4+ lymphocytes are responsible for fighting infections in the body and aid in the production of immune cells. Decreased levels of T CD4+ could be difficult in treating HIV-1 patients (Sampaio et al., 2017). In a randomized control study on the effects of MSBR on T CD4+ lymphocytes, patients in the control group showed a decline in T CD4+ lymphocyte counts contradicting with the MBSR group with no change from pre-to post-intervention irrespective of antiretroviral medication. MSBR is an 8-week split routine that constitutes mindfulness meditation, stretching, exercises, body awareness activities that were performed by the HIV diagnosed patients (Creswell et al., 2009).

Effects of Meditation on Psychological Factors

A meta-analysis analyzed the effects of different practices of meditation that includes MBSR, VM, TM, Zen, mindfulness, and other focused attention meditation on 3515 individuals from 47 trials suffering from mental ailments such as stress, depression, anxiety, addiction, post-traumatic disorder, eating disorder, chronic pain, and quality of life. Results showed meditation has a positive impact on depression, anxiety, pain, stress, health-related quality of life. The study also concluded by saying that clinicians should consider introducing meditation practice in patients hoping to improve mental health and stress-related behavior (Goyal et al., 2014). Furthermore, drug use, cravings, addictive behaviors, have altered in participants through the practice of meditation. Thirty days of mindfulness training for cigarette addicts reduced cigarette usage during the training and maintained the effect in the follow-up period after 17 weeks compared to the standard smoking treatment group. A longitudinal study reported reduced drug and heavy drinking relapse in individuals practicing meditation compared to the 12-step treatment group (Bowen et al., 2014). Finding qualified meditation teachers or mentors, appropriate meditative centers and going to retreats could be tedious and expensive. In recent years with the access to technology, studies recently have used online mediums to educate, test, and provide free access to different meditation practices that are developed based on research that has brought interest (Linardon, 2020). In this way, the efficacy of a smartphone-based application called Healthy Minds Program (HMP) was tested in individuals on psychological distress like stress, depression, and anxiety. The results showed reduced psychological distresses and improvements in other outcome measures like social connectedness and well-being.

In addition to improved physiological and psychological alignments meditation practice has induced electrophysiological and structural changes in the brain correlating to improved attention (Cahn & Polich, 2009; Grant et al., 2010; Jha et al., 2007; Tang et al., 2007), conflict, and error monitoring (Andreu et al., 2017; Moore et al., 2012; Teper & Inzlicht, 2013), working memory (Zeidan et al., 2010), emotion regulation (Goldin & Gross, 2010), thicker grey and white matter integrity in the anterior cingulate cortex (ACC), Pre-frontal cortex (PFC), amygdala and hippocampus in both experienced and novice meditators with at least 30 days of meditation experience (Grant et al., 2010; Hölzel et al., 2011; Tang et al., 2010, 2012). However, these claimed results are yet to be studied on acute meditation training.

Cognitive Control

Cognitive control, also known as executive function (EF), plays a crucial role in the attention, planning, and execution of an action (Davidson et al., 2006; Diamond, 2012; Pontifex et al., 2019). Cognitive, or executive, control is classified into three distinct functions: inhibition, working memory and cognitive flexibility (Davidson et al., 2006; Miyake et al., 2000). Inhibition is referred to as controlling one's pre-potent or habitual behavior, inhibition of thoughts to direct one's attention and monitoring of emotions (Diamond, 2012; Miyake et al., 2000). Controlling one's behavior, for instance, monitoring and overriding habitual reactions and responses to make a corrected or ideal response. Controlling attention is directing one's complete attention to their focused goal. Controlling emotions is to act by monitoring and acting appropriately. Working memory refers to the monitoring, manipulation, and updating of information. This requires the coding of new information, comparing to the pre-existing information and replacing the

newly updated information in the mind when necessary. Replacing old information or events with new information aids in keeping track of the information, for instance, understanding the steps involved in deriving a mathematical equation. Finally, cognitive flexibility refers to the ability to switch from one task to another task, for instance, mentally working with basic arithmetic operations (addition, subtraction, multiplication, and division). To assess cognitive processes and differences among individuals from healthy and non-healthy populations, several cognitive assessments like the attention network test (ANT), oddball task, flanker task, go/no-go task, stroop task, simon task, or N-back are used.

Inhibitory Control

Inhibitory control refers to the ability to inhibit irrelevant/pre-potent response preparation during stimulus presentation to improve memory-related operations (Polich, 2007). Inhibition is formulated when two or more possible responses compete to be the answer made, while also competing for the greatest allocation of attentional resources in processing the stimulus. The anterior cingulate cortex (ACC) has shown to be active when different responses to stimuli compete and overcome by sending neural feedback to the dorsolateral prefrontal cortex (dlPFC) to inhibit the incorrect response preparation by overriding pre-potent/habitual/irrelevant responses (Botvinick et al., 2001a; Nieuwenhuis et al., 2003).

Flanker Task. The Eriksen flanker task is one of the most commonly used assessments for inhibitory aspects of cognition performance (Pontifex et al., 2019). Traditionally presented as a letter-based task, in this version of the flanker participants are required to attend to the central target letter from congruent “MMMMM” or

incongruent stimuli “MMNMM” and respond by pressing an assigned key for the letter presented as the target. During the incongruent trials, the inhibitory control between the central target and flanking stimuli are high compared to congruent stimuli. This conflict presents as longer reaction times and poorer accuracy scores due to the need to override the pre-potent response associated with the flanking letters. Due to the suggested benefits for attention associated with mindfulness mediation, a modified version of the flanker task has been included in this study as a means to help identify any behavioral changes in performance associated with inhibitory control that may arise from an acute bout of guided meditation using the breath as an attention anchor.

Stimulus Discrimination

Stimulus discrimination is a process where the individual is tasked with distinguishing between stimuli, often requiring the identification of a new, or novel, stimulus amongst a number of repetitive stimuli. This process is associated with aspects of attentional orienting due to the requirements in evaluation the stimulus information presented, the disengagement of attention from the prepotent response, and the reallocation of attentional resources from processing non-stimulus related events to orienting attention towards stimulus-related events (Kao et al., 2020). The performance of this process dictates the amount of attentional focus directed towards discriminating stimuli from standard, or non-target, stimuli.

Oddball Task. Traditionally offered as an auditory task, the oddball paradigm is used in assessing attentional orienting and resource allocation aspects of cognition. In recent decades, the paradigm has been modified to be presented as a visual task altering the applications of the test and adding versatility to the ways in which researchers can

assess this process. For this study a perceptually challenging three-stimulus oddball paradigm is used, requiring participants to discriminate between a non-frequent target stimuli and many frequently presented non-target stimuli. The third stimulus in this design is a distractor stimulus, presented here as a checkerboard pattern on the screen. This distractor stimulus is infrequently displayed throughout the task in order to increase discriminating complexity (Pontifex et al., 2009).

Meditation and Attention

Meditation practice has been shown to alter attention in a wide spectrum of individuals varying in sex, age, heathy and non-healthy individuals, novice, and experienced meditators. Initial studies on meditation and attention reported reduced neural indices of attention between meditator and control groups (Cahn & Polich, 2009; Slagter et al., 2007). Further, three months of intensive Vipassana meditation training alters the allocation of attentional resources required for efficient cognitive control processing in experienced meditators (Slagter et al., 2007). Control participants were asked to meditate for 20-minutes for a week before taking the attentional blink task pre- and post- three months. The attentional blink task required participants to report two numbers (targets) presented in a timely fashion along with additional digits (distractors). In addition, intertrial intervals were altered such that the 2nd target numbers were presented in rapid succession of the 1st target number to determine if participants directed their attention to both the target numbers. Results revealed meditators elicited smaller inhibitory responses to the 1st target by the end of three months compared to controls suggesting a greater devotion of resources for the 2nd target number.

Meditation and Inhibitory Control

Meditation a unique mental practice led to an increase in inhibitory control mechanisms (Pozuelos et al., 2019). This is achieved by improving one's ability to direct attention to the stimulus environment, distinguish between relevant and irrelevant stimuli and inhibit response to irrelevant stimuli. Thereby, improving individuals' ability to inhibit pre-potent or habitual response to a stimulus. Previous studies have provided inconsistent evidence on the effects of meditation and cognitive processes of attention (Pozuelos et al., 2019). Moreover, the effects of online guided meditation training and cognitive processes of attention have not yet been explored. The present study investigates the impact of online guided mindfulness meditation on inhibitory control and stimulus discrimination in healthy young adults. Furthermore, will extend the research in studying the effects of meditation on cognitive processes of attention by using a letter flanker task that will demand frequent inhibition between intended and actual responses to stimulus. This is intended to evaluate how individuals accurately process stimuli in space.

Meditation and Stimulus Discrimination

A study evaluating the effects of Vipassana meditation on stimulus discrimination randomized experienced meditators to either meditating or neutral thinking groups (Cahn & Polich, 2009). The meditators group engaged in meditation while the control condition sat quietly with their eyes closed to evoke a neutral thinking state. Following 25-minutes of the experimental conditions, meditators performed an auditory three stimulus oddball paradigm. In this task, participants are directed to respond only to the "odd" sound stimuli while ignoring standard and distractor stimuli. Results from the

electroencephalography (EEG) analysis indicated a decrease in the P3a amplitude (associated with stimulus discrimination processing) to the distractor stimuli in meditators over neutral thinking group implying the ability to orient attentional focus towards discriminating the distractor stimulus from other stimulus dictates reduced stimulus evaluation (i.e., decrease in dedicated attentional networks) to irrelevant/distractor stimulus reflecting from a better meditative state (Cahn & Polich, 2009). In addition, it was suggested that changes were to be seen only in the meditative individuals and not in novice individuals because long term meditators were able to preserve and accurately use attentional networks to distinguish between different stimuli.

Purpose

Young adults are functionally at their best from a cognitive standpoint. However, social, and personal challenges hinder their ability to direct appropriately in discriminating relevant stimuli from irrelevant stimuli. Furthermore, inhibition of irrelevant stimuli from the environment and behaviors/actions/thoughts from themselves could hinder cognitive and physiological performance. Interventions such as mindfulness meditation have been shown to alter neural correlates of attention and improve self-awareness in individuals. However, inconsistent results have been drawn regarding the cognitive processes related to inhibition and stimulus discrimination induced by meditation practices among young adults. Therefore, the purpose of this study is to assess the acute effects of a single 15-minute guided mindfulness meditation practice on inhibitory aspects of cognitive function.

Rationale

Young adults determine the future, however living in an environment that hinders one's ability to accurately inhibit irrelevant information from the environment. Practicing a simple 15-minute meditation training prior to exams, presentations, sporting events, or any other activities could potentially elicit changes in the way an individual perceives oneself and their surrounding through improved self-awareness and attention. This study aims to provide guided meditation through an online platform, that is cost-effective, easily accessible and can be practiced from any part of the world. Additionally, improvements in cognitive performance have the potential to impact various aspects of life such as academic performance, relationships, and quality of life.

Hypotheses

The purpose of this investigation was to determine the effects of a single-bout of mindfulness meditation on behavioral indices of inhibition in college-age adults during two cognitive tasks requiring different aspects of inhibitory control. Accordingly, given the prior research in this area the following specific hypothesis are proposed:

1. When comparing mindfulness level scores obtained via the Mindfulness Attention Awareness Scale and the Five Facet Mindfulness Questionnaire, it was predicted that levels reported during the meditation condition will be greater than those reported during the control condition, indicating increased awareness of and attention to events taking place in the present.
2. Relative to the control condition, it was predicted that a single bout of guided mindfulness meditation would result in faster reaction times and greater response

accuracy on the flanker task, indicating that acute mindfulness practices are beneficial to behavioral indices of inhibitory control.

3. Relative to the control condition, it also predicted that the mindfulness meditation intervention would result in faster reaction times and greater response accuracy on the oddball task, indicating a beneficial impact of the intervention on behavioral indices of stimulus discrimination.

CHAPTER 3

METHODOLOGY

This study investigates inhibitory control and stimulus discrimination aspects of attention in young adults following an acute guided online mindfulness meditation intervention (MMI). Participants from this study are college-age adults between the ages of 18 and 30-years-old. A within-subjects pre-post comparison design was used to assess any potential changes in performance associated with each experimental approach.

Participants and Recruitment

A sample of 24 college-age adults, average age 21.35 years (± 0.92), were recruited to complete this study. Upon enrollment in the study, participants were randomly assigned to experimental condition order with half completing the MMI condition first, and the remaining half completing the control condition first. All participants then completed the remaining condition not done on day one, during a second visit to the lab. This design ensured that all participants acted as their own control comparison within the statistical analysis. Participants were recruited through a number of possible avenues including, 1) announcements made in academic courses at the university, 2) email correspondence with interested individuals, and 3) support from regional networks that work with college-age adults. As all participants were over the age of 18, written informed consent was completed by the participant before engaging in the

study in accordance with the Institutional Review Board (IRB) at Louisiana Tech University.

Exclusionary Criteria

Participants aged below 18 and over 30 years of age are not eligible for the study. Non-consent of the individual resulted in the participant being excluded from the investigation, and no data was collected for these individuals. Any participant reporting a history of neurocognitive impairment was screened at the beginning of the study. Those reporting conditions that would limit the ability to perform the cognitive tasks due to the stimuli presentation (i.e., diagnosed epilepsy, etc.) were excluded from the study. However, those with conditions that may influence findings, such as attention disorders, were screened during the analysis stage for any confounding influence on the data due to diagnosis. Intelligence quotient (IQ) assessed using the Wechsler Abbreviated Scale of Intelligence – Version 2 (WASI-II; Wechsler, 2011) was also assessed as cognition has been found to be sensitive to this factor (Davies, Segalowitz, & Gavin, 2004). While not used for exclusionary criteria, IQ was assessed as a potentially confounding variable within the statistical model.

Attention Assessments

Flanker Task

To assess inhibitory control aspects of attention, a modified letter flanker test was employed in this study (Eriksen & Eriksen, 1974). Stimuli “PPPPP” & “RRRRR” will be classified as congruent stimuli and “PPRPP” & “RRPRR” as incongruent stimuli. This test asks participants to attend to a centrally presented stimulus, while focusing on the letter presented in a five-letter row. The middle letter, the target, determines the

participant response with participants assigned response mappings for each letter presented prior to beginning the task. For example, for a block containing the letters “P” and “R”, each letter will be assigned to either a left or a right button press. Therefore, when the participant sees the letter in the center of the stimulus, they will respond by pressing the corresponding button. To increase the difficulty of the task in an effort to ensure a substantial rigor for the population examined, each letter pair was presented twice to the participants with the response mappings reversed during the second presentation. This task utilized six perceptually similar letter sets (M-N, E-F, O-Q, I-T, U-V, and P-R), presented as individual blocks of 80 stimuli each (40 with original mappings, 40 with the reverse mappings) for a total of 480 trials. Each block was balanced for equiprobable directionality of responses, and congruency. The stimuli were presented as white letters on a black background for a 100 ms duration, with a jittered inter-trial interval (ITI) balanced between 1200 ms and 1700 ms. Primary analysis for this study utilized central tendency measures of reaction time (RT; i.e., time in ms from the presentation of the stimulus to response) and response accuracy (i.e., number of correct and error responses). Stimulus presentation, timing, and measurement of behavioral response time and accuracy were controlled using Psychopy, 3.2.4 (Peirce, 2009).

Oddball Task

To assess stimulus discrimination aspects of attention a perceptually challenging three-stimulus oddball task was used. In this task, participants were instructed to respond with a right button press only to an infrequently presented target stimulus while ignoring all other stimuli (Hagen, Gatherwright, Lopez, & Polich, 2006; Polich & Criado, 2006; Pontifex, Parks, Henning, & Kamijo, 2015). Target stimuli were 55 mm diameter white

circles, while the non-target stimuli were frequently appearing 47 mm diameter white circles and a full-screen checkerboard was used as a distractor stimulus. The targets and distractors were presented with a 0.12 probability, while the non-target circles were presented with 0.76 probability. Participants completed two blocks containing 175 trials resulting in a total of 42 target trials for analysis. The stimuli were presented on a black background for a 100 ms duration, with a 1700 ms inter-trial interval (ITI). Primary analysis for this task utilized central tendency measures of RT and response accuracy. Stimulus presentation, timing, and measurement of behaviroal response time and accuracy were controlled using Psychopy, 3.2.4 (Peirce, 2009).

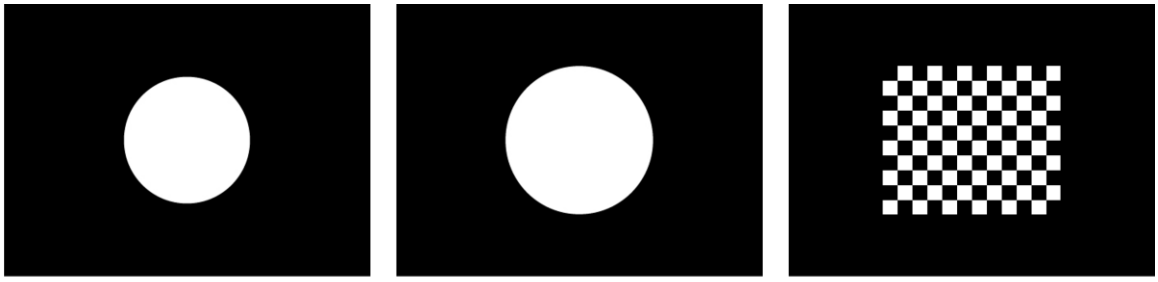
Figure 3.1

Flanker Stimuli

Note. Figure represents the P-R letter pairing.

Figure 3.2

Oddball Stimuli



a) Non-Target b) Target c) Distractor

Experimental Conditions

This study implemented a guided mindfulness meditation module from the Healthy Minds Program (HMP) mobile application obtained through the Google Play Store or Apple Appstore. This method of meditation was selected as it is analogous to many of the methods reported by novice meditators who rely on apps, online videos, recordings, and other digital programs as a means to engage in guided meditation. While the HMP program includes many meditation modules, only the awareness module was used in this study. Specifically, participants completed a 15-minute guided session focused on using breathing as the attentional anchor for the session.

For the control session, participants were instructed to engage in standard activities they may otherwise engage in outside of the lab, with the exception of being physically active or meditating. The majority of participants opted to engage in social media, online videos or listening to music. Similar to the MMI condition, the control lasted for 15-minutes. During both, the experimental conditions researchers stepped out of the testing space allowing the participants to focus on the guided meditation or the control condition with minimal distraction from the research team.

Mindfulness Attention Awareness Scale

To assess the participants state of mindfulness, the Mindfulness Attention Awareness Scale (MAAS) was used (Brown & Ryan, 2003). The MAAS consists of 15 statements each focused on assessing the degree to which the participant agrees with the statement. For example, the participant would read, “I find it difficult to stay focused on what’s happening in the present” or “I drive places on ‘automatic pilot’ and then wonder why I went there”, and then be asked to rate themselves using a 6-point Likert scale ranging from 1 (“almost always”) to 6 (“almost never”). In its entirety, the assessment takes 10 minutes or less to complete and has been shown to have a high construct, discriminant validity (Brown & Ryan, 2003) and reliability (Cronbach's alpha ≥ 0.82).

Five Facet Mindfulness Questionnaire

To assess the participant's trait mindfulness, the Five Facet Mindfulness Questionnaire (FFMQ) was used (Baer, Smith, Hopkins, Kretemeyer, & Toney, 2006). This tool measures five facets of mindfulness: 1) Nonreactivity to inner experiences (FFMQ-NR), Observing/noticing/attending to sensations/perceptions/thoughts/feelings (FFMQ-O), 3) Acting with awareness/automatic pilot/concentration/non-distraction (FFMQ-A), 4) Describing/labeling with words (FFMQ-D), & 5) Nonjudging of experience (FFMQ-NJ). The FFMQ consists of 39 statements each asking the subject to identify how ‘true’ the statement is for them, using a 5-point Likert scale to score themselves ranging from 1 (never or very rarely true) to 5 (very often or always true). For example, the participant would read, “I perceive my feelings and emotions without having to react to them”, and then be asked to rate themselves using the aforementioned

criteria in its entirety the assessment takes 10 minutes or less to complete and has been shown to have high validity (0.92) and reliability (Cronbach's alpha ≥ 0.75).

Procedure

A within-subjects repeated measures design was implemented in this study, during which participants visited the lab on two separate occasions no more than 48 hours apart. The 1st session was approximately 1.5 – 2 hours in duration, with participants completing the preliminary paperwork for the study including the informed consent, a health history demographic (HHD), the WASI-II, MAAS and FFMQ. Participants were then randomly assigned into an experimental order assigning half the sample to complete the MMI protocol on day 1, and the other half completing the control protocol on day 1. Participants were then given the instruction of the flanker task and were provided with a practice block (20 trials with the letters B-D) as an opportunity to become familiar with the task. After completing the practice, participants then completed all six perceptually matched/similar letter pairs taking a short break between the 3rd and 4th pairs. When a participant response accuracy score fell below 50% the block was repeated, however, only one repeat attempt was given per block. After completing the flanker, participants were then given a short break during which they were given the instructions for the oddball task. Participants were then given one practice block (40 trials) of the task, before completing two full blocks. Following completion of the oddball task, participants were then provided instructions for the experimental condition they would be completing that day. During the 15-minute experimental condition, the researcher left the testing space to allow the participant to focus on the condition. At the conclusion of the experimental condition, participants then completed a second round of cognitive tests beginning with

the flanker and ending with the oddball. Participants were then scheduled for their second session and informed that they would be completing the same tasks on the second day, but they would be completing the experimental condition not done on day 1. The second session was approximately 1.5 hours in duration and included the same protocols as day 1 with the exception of the consent, HHD, and WASI-II. At the conclusion of the 2nd visit, participants had completed all components of the study. All participants were volunteers, and no additional incentives were provided.

Statistical Analysis

Statistical analysis was conducted using PASW Statistics, 28.0 (IBM, Armonk, NY) using the Greenhouse-Geisser statistic with necessary post-hoc comparisons completed using univariate ANOVAs and Bonferroni corrected *t*-tests. A family-wise alpha level of 0.05 was implemented, and effect sizes for any significant finds are reported using partial-eta squared and Cohen's *d* based on the appropriate corrections for repeated measures (d_{rm}). Preliminary analyses were conducted to determine demographic factors known to potentially influence cognition and assess the potential for these factors as covariates within the larger model. The primary analysis of task performance measures (mean RT and response accuracy) was conducted using a 2 (Condition: Control, Meditation) x 2 (Time: Pre-test, Post-test) x 2 (Congruency: Congruent, Incongruent) repeated measures ANOVA for the Flanker task, and a 2 (Condition: Control, MMI) x 2 (Time: Pre-test, Post-test) repeated measures ANOVA for the Oddball task.

CHAPTER 4

RESULTS

Participant Characteristics

A preliminary descriptive analysis on several demographic variables was conducted to better classify and identify the sample. Participants in our sample had a mean IQ score of 99.96 (± 11.60), indicating average performance on this assessment. Additionally, the majority of the sample identified as Caucasian and had a relatively high level of socioeconomic status (SES) as indicated by household income and mother's education level. Beyond the majority for SES, our remaining participants reported a diverse SES level. Initial inferential statistics were then conducted to assess the differences in the MAAS and FFMQ surveys between the control condition and meditation conditions. A dependent samples *t*-test was conducted for each comparison. For the MAAS, findings indicated no significant differences on survey scores between conditions ($t_{(23)} = 1.34$, $p = 0.19$). For the FFMQ, no significant difference in scores between conditions was observed ($t_{(23)} = -0.41$, $p = 0.68$). Subscales for the FFMQ were also analyzed for potential differences with no significant findings observed for any of the subscales ($t's_{(23)} \leq 0.70$, $p's \geq 0.49$).

Flanker Task Performance

Reaction Time

A condition (2) x time (2) x congruency (2) repeated measures ANOVA was used to examine any potential influence of each factor on mean RT on the flanker task, and any interaction between the factors. The results indicated no significant interaction effect for the overall model ($F_{(1,23)} = 1.45$, $p = 0.240$), however there was a significant interaction effect found between time and congruency ($F_{(1,23)} = 4.64$, $p = 0.04$, $\eta_p^2 = 0.16$). A univariate ANOVA was run for post hoc analysis to further assess this interaction, with results indicating no main effect for time, but there was a main effect for congruency ($F_{(1,23)} = 410.629$, $p < 0.001$, $\eta_p^2 = 0.95$). To deconstruct this main effect, a bonferroni corrected dependent *t*-test was used to assess congruency. Findings indicate faster reaction times on the congruent trials compared to incongruent trials ($t_{(23)} = -20.26$, $p < 0.001$, $d = 1.29$). No other main effects were observed for mean RT ($F's_{(1,23)} \leq 0.66$, p's ≥ 0.79).

Response Accuracy

A condition (2) x time (2) x congruency (2) repeated measures ANOVA was also used to examine any potential influence of each factor on response accuracy on the flanker task, and any interaction between the factors. Results indicate no significant interaction effects for any level of the model ($F's_{(1,23)} \leq 2.95$, $p's \geq 0.10$). A significant main effect was found for congruency ($F_{(1,23)} = 48.74$, $p < 0.001$, $\eta_p^2 = 0.68$) indicating that congruent trials had better accuracy compared to incongruent trials. No other main effects were observed ($F's_{(1,23)} \leq 0.66$, p's ≥ 0.43).

Oddball Task Performance

Reaction Time

A condition (2) x time (2) repeated measures ANOVA was used to determine any significant differences in mean RT to targets from the oddball task based on the interaction and main effect of each factor. There were no significant interaction effects ($F_{(1,23)} = 1.25$, $p = 0.27$) observed for the model, and no significant main effects ($F's_{(1,23)} \leq 0.06$, $p's \geq 0.81$) for any of the factors included.

Response Accuracy

A condition (2) x time (2) repeated measures ANOVA was also used to determine any significant differences in mean response accuracy to targets from the oddball task based on the interaction and main effect of each factor. The interaction showed no significant difference on the target response accuracy ($F's_{(1,23)} = 1.20$, $p = 0.28$). Finally, there were no significant main effects on either condition or time for response accuracy ($F's_{(1,23)} \leq 1.36$, p's ≥ 0.64).

Table 4.1

Participant demographic values (Mean ± SD)

Measure	Participants
N	24 (11 female)
Non-White	5
Age (years)	21.35 ± 0.92
WASI-II Composite (IQ)	99.96 ± 11.61
Income (mode)	Greater than $100,000 (9)
Education (years completed)	14.71 ± 0.96
Sleep	
Weekday (mode)	5 – 6 Hours per Night (9)
Weekend (mode)	8 – 9 Hours per Night (7)
Prior Night (mode)	Less than 5 Hours (7)
Last Caffeine Intake (mode)	More than 8 Hours prior (15)

Note: WASI-II – Full scale-2 composite, utilizing vocabulary and matrix reasoning sub-tests.

Table 4.2

MAAS and FFMQ scores (Mean ± SD)

Measure	Participants
MAAS	
Control	3.62 ± 0.80
MMI	3.44 ± 0.80
FFMQ	
Control	
Total	121.63 ± 16.14
Observation	26.38 ± 5.95
Description	24.67 ± 6.47
Mindful Actions	23.58 ± 6.28
Non-Judgemental	26.33 ± 7.28
Non-Reactivity	20.67 ± 4.27
MMI	
Total	122.17 ± 17.88
Observation	26.67 ± 5.40
Description	25.96 ± 6.15
Mindful Actions	23.33 ± 5.40
Non-Judgemental	25.92 ± 6.39
Non-Reactivity	20.29 ± 4.92

Table 4.3

Mean ± SD Flanker Task Performance Characteristics

Measure	Reaction Time (ms)	Response Accuracy (%)
Control – Pre-test		
Congruent	337.10 ± 44.16	92.43 ± 6.39
Incongruent	390.55 ± 44.75	77.93 ± 14.78
Control – Post-test		
Congruent	341.75 ± 46.67	93.80 ± 3.97
Incongruent	393.91 ± 43.65	81.42 ± 12.50
MMI – Pre-test		
Congruent	338.34 ± 40.47	94.03 ± 4.86
Incongruent	394.29 ± 39.67	80.75 ± 12.03
MMI – Post-test		
Congruent	337.16 ± 47.42	92.69 ± 12.31
Incongruent	388.30 ± 49.36	79.55 ± 14.97

Note: MMI = Mindfulness Meditation Intervention

Table 4.4

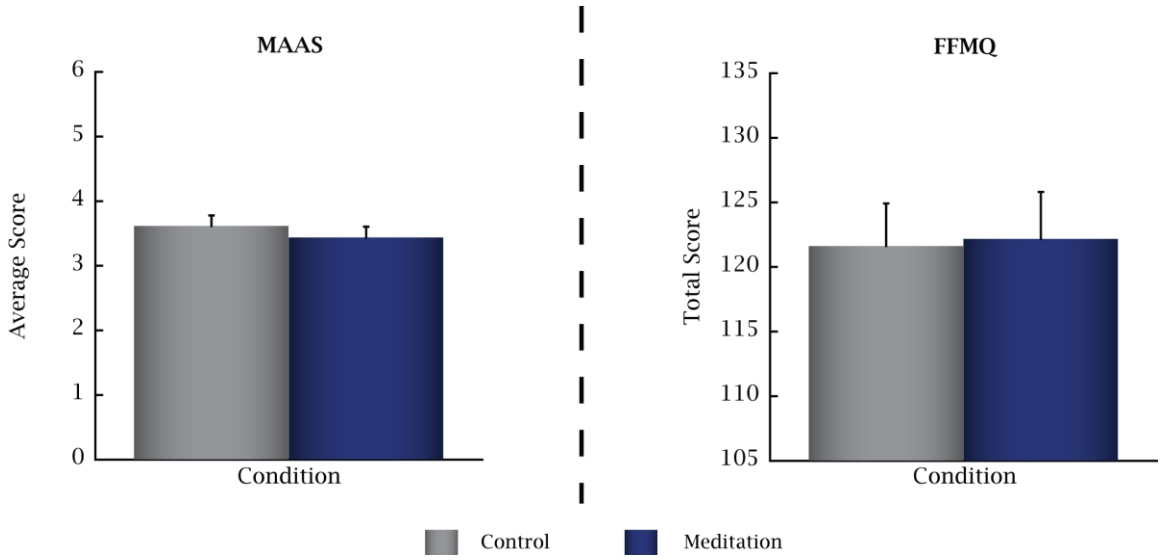
Mean ± SD Oddball Task Performance Characteristics

Measure	Reaction Time (ms)	Response Accuracy (%)
Control – Pre-test		
Target	481.35 ± 46.30	84.62 ± 11.62
Control – Post-test		
Target	475.80 ± 42.95	83.63 ± 15.13
MMI – Pre-test		
Target	473.78 ± 64.25	80.95 ± 16.88
MMI – Pre-test		
Target	478.57 ± 61.25	83.62 ± 15.44

Note: MMI = Mindfulness Meditation Intervention

Figure 4.1

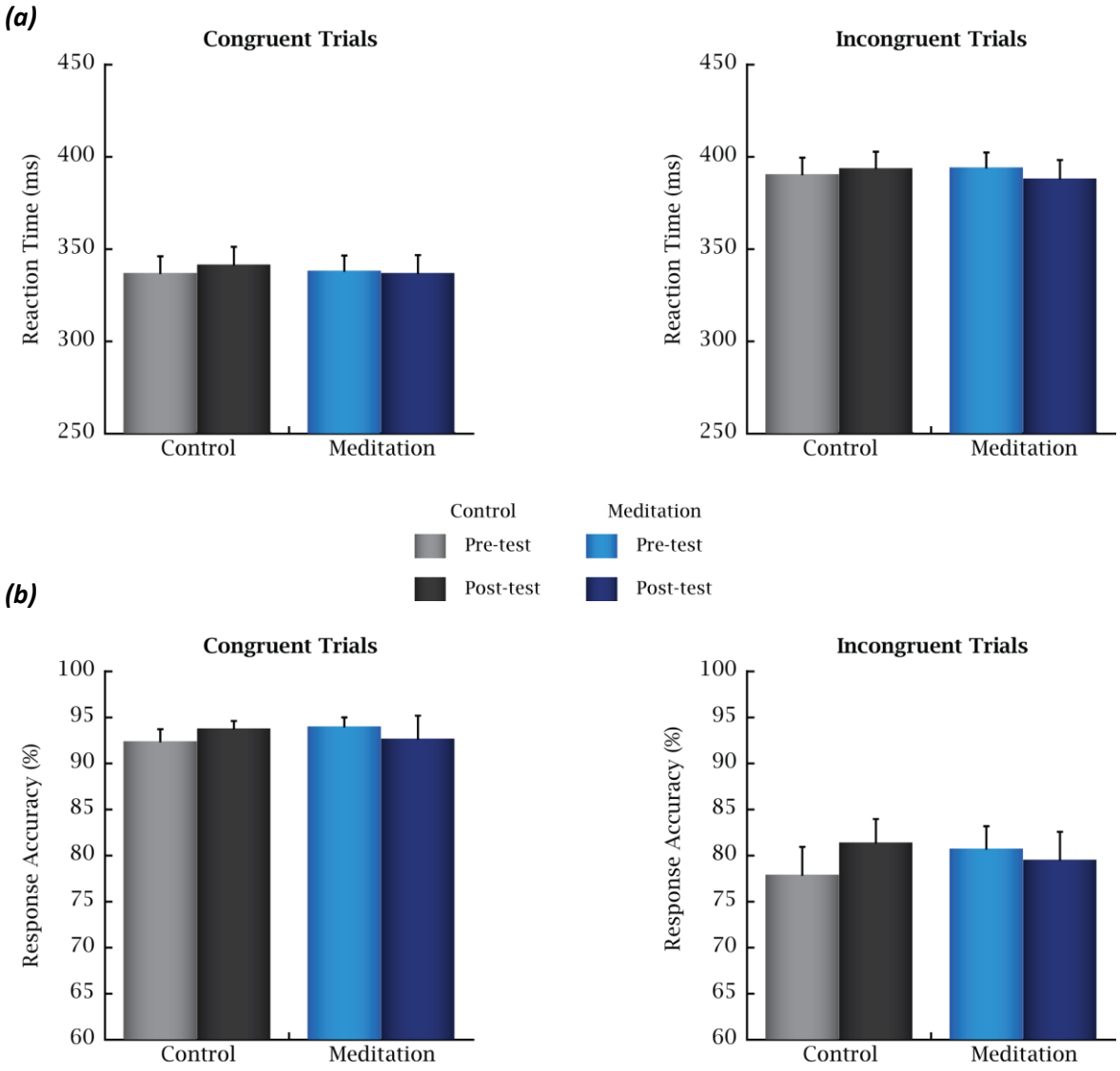
Scores for MAAS and FFMQ based on condition



Note. MAAS scores represent the average score across all 15 statements, while the FFMQ represents the total score for all 39 statements.

Figure 4.2

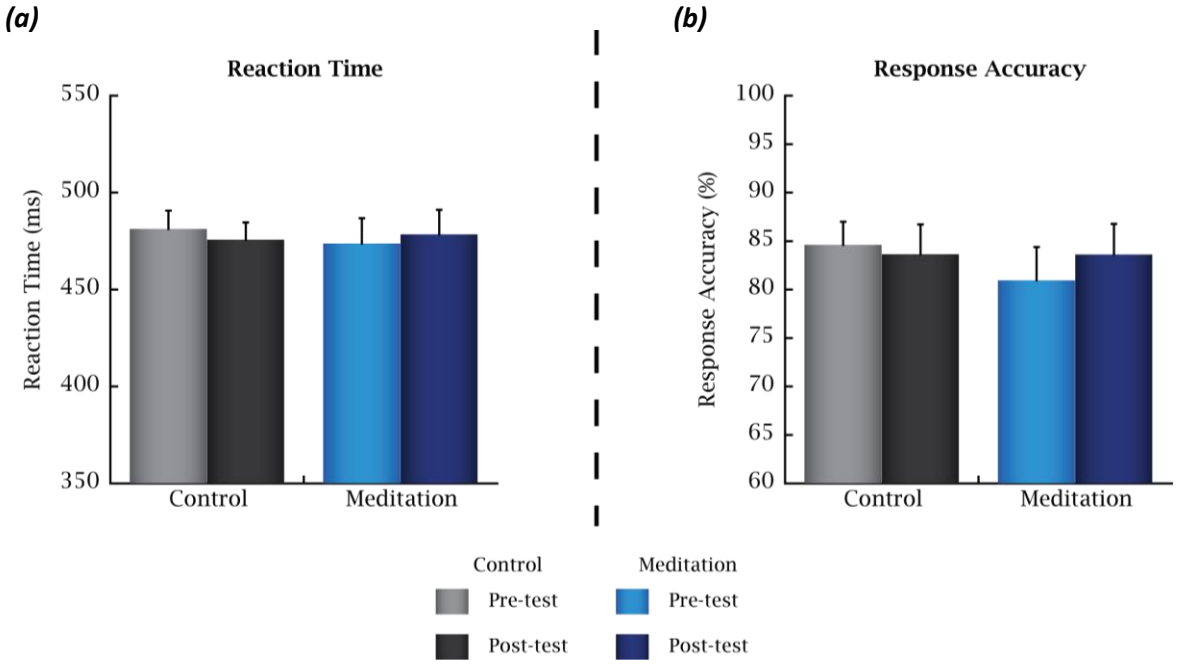
Average scores for (a) reaction time and (b) response accuracy for the Flanker task.



Note. Congruent Trials occur when all letters in the image are the same (i.e., RRRRR). Incongruent Trials occur when the flanking letters differ from the middle letter in the image (i.e., PPRPP).

Figure 4.3

Average scores for (a) reaction time and (b) response accuracy for the Oddball task.



Note. Target trials were used for determining these scores as there are no responses to the non-target or distractor stimuli.

CHAPTER 5

DISCUSSION

The purpose of the study was to investigate the influence of an acute online guided mindfulness meditation session on inhibitory control and stimulus discrimination aspects of attention in college-aged adults. It was hypothesized that following the meditation condition participants will present with greater mindfulness level scores on the MAAS and FFMQ questionnaires when compared to the control condition. It was also hypothesized that participants will have faster average reaction times and better response accuracy overall for both the flanker and oddball tasks. Our result, however, indicated no significant differences between meditation and control conditions for each of the hypotheses. These findings suggest no change in mindfulness levels from both the MAAS and FFMQ surveys between the two conditions. Additionally, behavioral measures of cognitive performance on the flanker task indicate that while there were no improvements in reaction time or response accuracy scores associated with the conditions, there was a significant difference in reaction time and accuracy associated with the congruency of the trials indicating that participants had faster reaction times and better accuracy on the congruent trials relative to the incongruent trials. These significant results align with previous studies on shorter or faster reaction time and higher response accuracy to congruent trials over incongruent trials (Moore et al., 2012). Furthermore, results from the oddball task for reaction time and response accuracy to targets were non-significant for either condition.

No previous studies have investigated the acute bouts of online guided mindfulness meditation on inhibitory control and stimulus discrimination together. Previous studies have established a positive relationship between cognitive control and meditation practices (Jha et al., 2007; Moore et al., 2012; Tang et al., 2007). In spite of the prior literature, our findings do not suggest the same potential outcomes. While our results are contrary, it is important to note that these findings may be explained by prior work in this area. For example, it has been suggested that in order to elicit reliable neural changes in response to integrative body-mind training a minimum of 1.5 hours per week may be necessary (Larson et al., 2013; Tang et al., 2007). We opted to implement a 15-minute bout in an effort to model a potential externally valid circumstance in which an individual is hoping to engage in the practice immediately preceding the event in which they hope to reap the benefit associated with meditating. Although reflective of a real-world circumstance, this brief bout may not be sufficient to elicit a noticeable change in performance as indicated by our findings.

Beyond the duration and frequency of the meditation bout, our result may also be a reflection of the subtlety in the cognitive changes associated with meditation. In recent years, it has become more common for researchers to increase the rigor of their studies in this area by incorporating neuroimaging techniques. The sensitivity of these measurement tools has vastly improved the likelihood of detecting modest adaptations in cognitive function that may be missed with less discerning techniques. While the decision to rely on behavioral indices of attention in this study maintains the possibility of detecting changes in performance, these changes will need to be much greater in order to be uncovered. A similar phenomenon has been observed in response accuracy scores for

college-age adults on less challenging cognitive tests where the performance is already so great that the margin for improvements is incredibly small. However, when measuring the same aspect of attention using tools such as electroencephalography these changes are magnified in the adaptation of neural processing for the task.

Practical Implications

The present study design allowed us to investigate both inhibitory control and stimulus discrimination aspects of attention together within a timely fashion. Although challenging for the participants, the ability to evaluate multiple aspects of inhibition within a single session across multiple time points provides a more comprehensive profile for cognitive performance for the individual. However, participant fatigue should always be factored in when considering the number of tasks that can reasonably be attempted in a single session without burdening the participant.

In addition, meditation training provided in the present study was easily accessible and cost-efficient through a well-established mobile application. One barrier that may prevent those interesting in meditation from engaging in the activity may be their ability to access quality guides and instruction. While these needs can often be met at the expense of joining programs, fitness centers, etc., the burden of access and cost can quickly add up. By incorporating a mobile application into this study, we hope to further increase our understanding of these methods for providing quality instruction.

Limitations & Future Directions

One of the major limitations of the present study was in the approach of the experimental conditions. In an effort to avoid influencing the participants and interrupting their focus, the researcher was instructed to leave the testing area during the experimental

conditions. This resulted in the participants not being directly monitored during the meditation and control conditions. As they were not monitored during the meditation practice, we would be tentative to claim that all participants actively engaged in the meditation as expected. Future studies should consider a physically present guide/mentor/researcher in delivering meditation instruction during the meditation training.

A second limitation may be the population selected for the study. During this developmental stage, individuals tend to perform comparatively better on cognitive tasks relative to other developmental age periods across life span, suggesting this may be a time point for peak cognitive function for the individual. As a result, it is often difficult to elicit noticeable changes in cognitive performance during this developmental age period when not using more sensitive measures of performance. While the inclusion of methods like EEG may be beneficial in the future, the goal of this study was to lay a preliminary foundation for the acute effects of meditation in this area of research which led to the prioritization of feasibility in the study design.

Finally, the majority of the participants in the present study reported a high SES level indicating that our sample may be a poor representation of the population as the population is often more diverse for these categories of measurement. In order for our sample to better reflect the population and increase the generalizability of our results, it is necessary that we increase the diversity found within our sample. This will also address concerns due to our limited sample size as it will increase the overall number of participants and increase the statistical power of the study design.

Conclusion

The present study did not find any significant difference in the mindfulness levels from both the surveys between meditation and control conditions. In addition, behavioral measures of cognitive performance (reaction time and response accuracy) from the flanker task did not show any significant difference between the conditions. However, participants showed faster reaction time and response accuracy to congruent trials than incongruent trials regardless of conditions replicating similar results from previous studies. Furthermore, no other behavioral differences were seen from the oddball task associated with the two conditions.

The present study indicates that either an acute bout of online mindfulness mediation might not be sufficient to elicit behavioral measures of cognitive performance from both flanker and the oddball task or the need for enhanced measurement tools to investigate the cognitive changes associated with mindfulness meditation. The present study design allowed in testing different aspects of attention within a timely fashion and the use of the Healthy minds program was cost-efficient and easily accessible in providing mindfulness meditation to the participants. However, means of monitoring meditation sessions or offering meditation instruction should be taken into consideration in the future on offering online guided mindfulness meditation.

REFERENCES

Andreu, C. I., Moënne-Loccoz, C., López, V., Slagter, H. A., Franken, I. H. A., & Cosmelli, D. (2017). Behavioral and electrophysiological evidence of enhanced performance monitoring in meditators. *Mindfulness*, *8*(6), 1603–1614. https://doi.org/10.1007/s12671-017-0732-z

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*, 27-45.

Barrows, K. A., & Jacobs, B. P. (2002). Mind-body medicine: An introduction and review of the literature. *Medical Clinics of North America*, *86*(1), 11–31. https://doi.org/10.1016/s0025-7125(03)00069-5

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review*, *108*(3), 624–652. https://doi.org/10.1037/0033-295x.108.3.624

Bowen, S., Witkiewitz, K., Clifasefi, S. L., Grow, J., Chawla, N., Hsu, S. H., Carroll, H. A., Harrop, E., Collins, S. E., Lustyk, M. K., & Larimer, M. E. (2014). Relative efficacy of mindfulness-based relapse prevention, standard relapse prevention, and treatment as usual for substance use disorders. *JAMA Psychiatry*, *71*(5), 547. https://doi.org/10.1001/jamapsychiatry.2013.4546

Bühlmayer, L., Birrer, D., Röthlin, P., Faude, O., & Donath, L. (2017). Effects of mindfulness practice on performance-relevant parameters and performance outcomes in sports: A meta-analytical review. *Sports Medicine*, *47*(11), 2309–2321. https://doi.org/10.1007/s40279-017-0752-9

Cahn, B. R., & Polich, J. (2009). Meditation (Vipassana) and the P3a event-related brain potential. *International Journal of Psychophysiology*, *72*(1), 51–60. https://doi.org/10.1016/j.ijpsycho.2008.03.013

Chiesa, A., Serretti, A., & Jakobsen, J. C. (2013). Mindfulness: Top–down or bottom–up emotion regulation strategy? *Clinical Psychology Review*, *33*(1), 82–96. https://doi.org/10.1016/j.cpr.2012.10.006'

Creswell, J. D., Myers, H. F., Cole, S. W., & Irwin, M. R. (2009). Mindfulness meditation training effects on CD4+ T lymphocytes in HIV-1 infected adults: A small randomized controlled trial. *Brain, Behavior, and Immunity*, *23*(2), 184–188. https://doi.org/10.1016/j.bbi.2008.07.004

Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, *44*(11), 2037–2078. https://doi.org/10.1016/j.neuropsychologia.2006.02.006

Davies, P. L., Segalowitz, S. J., & Gavin, W. J. (2004). Development of response-monitoring ERPs in 7- to 25-year-olds. *Developmental Neuropsychology*, *25*(3), 355–376. https://doi.org/10.1207/s15326942dn2503_6

Diamond, A. (2012). Activities and programs that improve children's executive functions. *Current Directions in Psychological Science*, *21*(5), 335–341. https://doi.org/10.1177/0963721412453722

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics*, *16*(1), 143–149. https://doi.org/10.3758/bf03203267

Fissler, M., Winnebeck, E., Schroeter, T. A., Gummbersbach, M., Huntenburg, J. M., Gärtner, M., & Barnhofer, T. (2017). Brief training in mindfulness may normalize a blunted error-related negativity in chronically depressed patients. *Cognitive, Affective, & Behavioral Neuroscience*, *17*(6), 1164–1175. https://doi.org/10.3758/s13415-017-0540-x

Gardner, F. L., & Moore, Z. E. (2004). A mindfulness-acceptance-commitment-based approach to athletic performance enhancement: Theoretical considerations. *Behavior Therapy*, *35*(4), 707–723. https://doi.org/10.1016/s0005-7894(04)80016-9

Gomez-Pinilla, F., & Hillman, C. (2013). The influence of exercise on cognitive abilities. *Comprehensive Physiology*, *3*(1), 403–428. https://doi.org/10.1002/cphy.c110063

Goyal, M., Singh, S., Sibinga, E., Gould, N., Rowland-Seymour, A., Sharma, R., Berger, Z., Sleicher, D., Maron, D., Shihab, H., Ranasinghe, P., Linn, S., Saha, S., Bass, E., Haythornthwaite, J., & Cramer, H. (2014). Meditation programs for psychological stress and well-being: A systematic review and meta-analysis. *Deutsche Zeitschrift Für Akupunktur*, *57*(3), 26–27. https://doi.org/10.1016/j.dza.2014.07.007

Grant, J. A., Courtemanche, J., Duerden, E. G., Duncan, G. H., & Rainville, P. (2010). Cortical thickness and pain sensitivity in zen meditators. *Emotion, 10*(1), 43–53. https://doi.org/10.1037/a0018334

Hagen, G. F., Gatherwright, J. R., Lopez, B. A., & Polich, J. (2006). P3a from visual stimuli: Task difficulty effects. *International Journal of Psychophysiology, 59*, 8–14. https://doi: 10.1016/j.ijpsycho.2005.08.003

Hillman, C. H., Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: Exercise effects on brain and cognition. *Nature Reviews Neuroscience, 9*(1), 58–65. https://doi.org/10.1038/nrn2298

Hoffmann, S., & Falkenstein, M. (2012). Predictive information processing in the brain: Errors and response monitoring. *International Journal of Psychophysiology, 83*(2), 208–212. https://doi.org/10.1016/j.ijpsycho.2011.11.015

Holroyd, C. B., & Coles, M. G. H. (2002). The neural basis of human error processing: Reinforcement learning, dopamine, and the error-related negativity. *Psychological Review, 109*(4), 679–709. https://doi.org/10.1037/0033-295X.109.4.679

Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science, 6*(6), 537–559. https://doi.org/10.1177/1745691611419671

Inzlicht, M., Bartholow, B. D., & Hirsh, J. B. (2015). Emotional foundations of cognitive control. *Trends in Cognitive Sciences, 19*(3), 126–132. https://doi.org/10.1016/j.tics.2015.01.004

Jeving, R. (1978). Adrenocortical activity during meditation. *Hormones and Behavior*, *10*(1), 54–60. https://doi.org/10.1016/0018-506x(78)90024-7

Jha, A. P., Krompinger, J., & Baime, M. J. (2007). Mindfulness training modifies subsystems of attention. *Cognitive, Affective, & Behavioral Neuroscience*, *7*(2), 109–119. https://doi.org/10.3758/cabn.7.2.109

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice*, *10*(2), 144–156. https://doi.org/10.1093/clipsy.bpg016

Kao, S., Cadenas-Sanchez, C., Shigeta, T. T., Walk, A. M., Chang, Y., Pontifex, M. B., & Hillman, C. H. (2019). A systematic review of physical activity and cardiorespiratory fitness on P3b. *Psychophysiology*, *57*(7). https://doi.org/10.1111/psyp.13425

Keng, S.-L., Smoski, M. J., & Robins, C. J. (2011). Effects of mindfulness on psychological health: A review of empirical studies. *Clinical Psychology Review*, *31*(6), 1041–1056.https://doi.org/10.1016/j.cpr.2011.04.006

Khoury, B., Sharma, M., Rush, S. E., & Fournier, C. (2015). Mindfulness-based stress reduction for healthy individuals: A meta-analysis. *Journal of Psychosomatic Research*, *78*(6), 519–528. https://doi.org/10.1016/j.jpsychores.2015.03.009

Kitzrow, M. A. (2003). The Mental Health Needs of Today's College Students: Challenges and Recommendations. *NASPA Journal*, *41*(1), 167–181. https://doi.org/10.2202/1949-6605.1310

Krisanaprakornkit, T., Sriraj, W., Piyavhatkul, N., & Laopaiboon, M. (2006). *Meditation therapy for anxiety disorders*. The Cochrane Collaboration: Wiley Publishers.

Larson, M. J., Steffen, P. R., & Primosch, M. (2013). The impact of a brief mindfulness meditation intervention on cognitive control and error-related performance monitoring. *Frontiers in Human Neuroscience*, *7*, 1-12. https://doi.org/10.3389/fnhum.2013.00308

Linardon, J. (2020). Can acceptance, mindfulness, and self-compassion be learned by smartphone apps? A systematic and meta-analytic review of randomized controlled trials. *Behavior Therapy*, *51*(4), 646–658. https://doi.org/10.1016/j.beth.2019.10.002

Lykins, E. L. B., & Baer, R. A. (2009). Psychological functioning in a sample of long-term practitioners of mindfulness meditation. *Journal of Cognitive Psychotherapy*, *23*(3), 226–241. https://doi.org/10.1891/0889-8391.23.3.226

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Moore, A., Gruber, T., Derose, J., & Malinowski, P. (2012). Regular, brief mindfulness meditation practice improves electrophysiological markers of attentional control. *Frontiers in Human Neuroscience*, *6*, 1-15. https://doi.org/10.3389/fnhum.2012.00018

Nieuwenhuis, S., Yeung, N., van den Wildenberg, W., & Ridderinkhof, K. R. (2003). Electrophysiological correlates of anterior cingulate function in a go/no-go task: Effects of response conflict and trial type frequency. *Cognitive, Affective, & Behavioral Neuroscience, 3*(1), 17–26. https://doi.org/10.3758/cabn.3.1.17

Noetel, M., Ciarrochi, J., Van Zanden, B., & Lonsdale, C. (2019). Mindfulness and acceptance approaches to sporting performance enhancement: A systematic review. *International Review of Sport and Exercise Psychology, 12*(1), 139–175. https://doi.org/10.1080/1750984X.2017.1387803

Peirce, J. W. (2009). Generating stimuli for neuroscience using PsychoPy. *Frontiers in Neuroinformatics, 2*, 10. https://doi: 10.3389/neuro.11.010.2008

Posner, M. I. (1980). Orienting of Attention. *Quarterly Journal of Experimental Psychology*, *32*(1), 3–25. https://doi.org/10.1080/00335558008248231

Polich, J., & Criado, J. R. (2006). Neuropsychology and neuropharmacology of P3a and P3b. *International Journal of Psychophysiology, 60*, 172–185. https://doi: 10.1016/j.ijpsycho.2005.12.012

Polich, J. (2007). Updating P300: An integrative theory of P3a and P3b. *Clinical Neurophysiology, 118*(10), 2128–2148. https://doi.org/10.1016/j.clinph.2007.04.019

Pontifex, M. B., Parks, A. C., Henning, D. A., & Kamijo, K. (2015). Single bouts of exercise selectively sustain attentional processes. *Psychophysiology, 52*(5), 618–625. https://doi.org/10.1111/psyp.12395

Pontifex, M. B., McGowan, A. L., Chandler, M. C., Gwizdala, K. L., Parks, A. C., Fenn, K., & Kamijo, K. (2019). A primer on investigating the after effects of acute bouts of physical activity on cognition. *Psychology of Sport and Exercise, 40*, 1–22. https://doi.org/10.1016/j.psychsport.2018.08.015

Pozuelos, J. P., Mead, B. R., Rueda, M. R., & Malinowski, P. (2019). Short-term mindful breath awareness training improves inhibitory control and response monitoring. In N. Srinivasan (Eds.), *Progress in Brain Research* (pp. 137–163). Elsevier. https://doi.org/10.1016/bs.pbr.2018.10.019

Rajaraman, S. (2013). Meditation Research: A Comprehensive Review. *International journal of Engineering Research and Application,* 3(6), 109-115.

Roemer, L., & Orsillo, S. M. (2002). Expanding our conceptualization of and treatment for generalized anxiety disorder: Integrating mindfulness/acceptance-based approaches with existing cognitive-behavioral models. *Clinical Psychology: Science and Practice, 9*(1), 54–68. https://doi.org/10.1093/clipsy.9.1.54

Sappington, R., & Longshore, K. (2015). Systematically reviewing the efficacy of mindfulness-based interventions for enhanced athletic performance. *Journal of Clinical Sport Psychology, 9*(3), 232–262. https://doi.org/10.1123/jcsp.2014-0017

Saunders, B., Rodrigo, A. H., & Inzlicht, M. (2016). Mindful awareness of feelings increases neural performance monitoring. *Cognitive, Affective, & Behavioral Neuroscience*, *16*(1), 93–105. https://doi.org/10.3758/s13415-015-0375-2

Slagter, H. A., Lutz, A., Greischar, L. L., Francis, A. D., Nieuwenhuis, S., Davis, J. M., & Davidson, R. J. (2007). Mental training affects distribution of limited brain resources. *PLoS Biology*, *5*(6), 1228-1235. https://doi.org/10.1371/journal.pbio.0050138

Tang, Y. Y., Ma, Y., Wang, J., Fan, Y., Feng, S., Lu, Q., Yu, Q., Sui, D., Rothbart, M. K., Fan, M., & Posner, M. I. (2007). Short-term meditation training improves attention and self-regulation. *Proceedings of the National Academy of Sciences*, *104*(43), 17152–17156. https://doi.org/10.1073/pnas.0707678104

Tang, Y. Y., Lu, Q., Geng, X., Stein, E. A., Yang, Y., & Posner, M. I. (2010). Short-term meditation induces white matter changes in the anterior cingulate. *Proceedings of the National Academy of Sciences*, *107*(35), 15649–15652. https://doi.org/10.1073/pnas.1011043107

Tang, Y. Y., Lu, Q., Fan, M., Yang, Y., & Posner, M. I. (2012). Mechanisms of white matter changes induced by meditation. *Proceedings of the National Academy of Sciences*, *109*(26), 10570–10574. https://doi.org/10.1073/pnas.1207817109

Teper, R., & Inzlicht, M. (2013). Meditation, mindfulness and executive control: The importance of emotional acceptance and brain-based performance monitoring. *Social Cognitive and Affective Neuroscience*, *8*(1), 85–92. https://doi.org/10.1093/scan/nss045

Themanson, J. R., Pontifex, M. B., & Hillman, C. H. (2008). Fitness and action monitoring: Evidence for improved cognitive flexibility in young adults. *Neuroscience*, *157*(2), 319–328. https://doi.org/10.1016/j.neuroscience.2008.09.014

Wallace, R. K. (1970). Physiological Effects of Transcendental Meditation. *Science, 167*(3926), 1751–1754. https://doi.org/10.1126/science.167.3926.1751

Wallace, R., Benson, H., & Wilson, A. (1971). A wakeful hypometabolic physiologic state. *American Journal of Physiology-Legacy Content*, *221*(3), 795–799. https://doi.org/10.1152/ajplegacy.1971.221.3.795

Wechsler, D. (2011). *Wechsler Abbreviated Scale of Intelligence-Second Edition Manual*. Bloomington, MN: Pearson.

Zeidan, F., Johnson, S. K., Diamond, B. J., David, Z., & Goolkasian, P. (2010). Mindfulness meditation improves cognition: Evidence of brief mental training. *Consciousness and Cognition*, *19*(2), 597–605. https://doi.org/10.1016/j.concog.2010.03.014

APPENDICES

Appendix A: IRB Approval Letter

LOUISIANA TECH UNIVERSITY

OFFICE OF
RESEARCH AND PARTNERSHIPS

MEMORANDUM

TO: Dr. Andrew Parks

FROM: Dr. Walter Buboltz, Professor/Elva L. Smith Endowed Professor
buboltz@latech.edu

SUBJECT: **Human Use Committee - Review DECISION**

DATE: February 4, 2022

In order to facilitate your project, an EXPEDITED REVIEW has been completed for your proposed study:

HUC No.: **HUC 1386, 22-055**

TITLE: **Influence of guided awareness meditation on conflict-and error-monitoring in the college-age adults**

HUC DECISION:

APPROVED *Yes* X *No* _____ *N/A* _____

The proposed study's procedures were found to provide reasonable and adequate safeguards against possible risks involving human subjects. The information to be collected may be personal in nature or implication. Therefore, diligent care needs to be taken to protect the privacy of the participants and to assure that the data are kept confidential. Informed consent is a critical part of the research process. The subjects must be informed that their participation is voluntary. It is important that consent materials be presented in a language understandable to every participant. If you have participants in your study whose first language is not English, be sure that informed consent materials are adequately explained or translated. Since your reviewed project appears to do no damage to the participants, the Human Use Committee grants approval of the involvement of human subjects as outlined. Projects should be renewed annually. ***This approval was finalized on February 04, 2022 and this project will need to receive a continuation review by the IRB if the project continues beyond February 04, 2023.*** **ANY CHANGES** to your protocol procedures, including minor changes, should be reported immediately to the IRB for approval before implementation. Projects involving NIH funds require annual education training to be documented. For more information regarding this, contact the Office of Sponsored Projects.

You are requested to maintain written records of your procedures, data collected, and subjects involved. These records will need to be available upon request during the conduct of the study and retained by the university for three years after the conclusion of the study. If changes occur in recruiting of subjects, informed consent process or in your research protocol, or if unanticipated problems should arise it is the Researchers responsibility to notify the Office of Research and Partnerships or IRB in writing. The project should be discontinued until modifications can be reviewed and approved.

Thank you for submitting your Human Use Proposal to Louisiana Tech's Institutional Review Board.

A MEMBER OF THE UNIVERSITY OF LOUISIANA SYSTEM
P.O. BOX 8597 • RUSTON, LA 71272-0034 • TEL: (318) 257-2871
AN EQUAL OPPORTUNITY UNIVERSITY

Appendix B: Informed Consent

Note: Use the Human Subjects Consent form to briefly summarize information about the study/project to participants and obtain their permission to participate.

HUMAN SUBJECTS CONSENT FORM

The following is a brief summary of the project in which you are asked to participate. Please read this information before signing the statement below.

TITLE OF PROJECT: Influence of guided awareness meditation on conflict- and error-monitoring in college-age adults.

PURPOSE OF STUDY/PROJECT: The purpose of this investigation is to examine the influence of mindfulness guided meditation practices on neuroelectric and behavioral indices of attention – specifically inhibitory control, conflict-monitoring, and error-monitoring.

PROCEDURE: You are invited to participate in this study because you are a college-age adult (18-30 yrs) with no history of neurological impairment. You will be provided with a consent form to complete once you agree to participate in this study, and will be asked to fill out a series of survey's related to your health history, and mindfulness practices. In addition, you will be asked to complete a series of cognitive tasks using an elastic cap designed to record electrical activity of the brain. While wearing the cap you will be asked to complete two computer-based cognitive assessments related to attention, and lastly, you will be asked to complete a second session 14-days after the first, during which you will repeat each of these assessments. During the 14-days between the sessions, you may be asked to either 1) participate in 10 app guided mindfulness sessions, or 2) refrain from all mindfulness practices. The researchers will analyze the data collected to determine the role mindfulness training plays in modifying aspects of attention associated with everyday function.

INSTRUMENTS: Only Dr. Parks and Mr. Pasupathi will have access to your data from the beginning to the end of the study. No information that may be used to identify you will be kept. You can choose to withdraw from the study at any time. No penalty will be assessed to you if you withdraw from the study, and all identifiable information about you will be removed and discarded.

RISKS/ALTERNATIVE TREATMENTS: The risks associated with the study are believed to be minimal and no greater than the risks of everyday life. As the surveys are conducted online, the server may also collect information and your IP address indirectly and automatically via "cookies".

BENEFITS/COMPENSATION: All participation in this study is purely voluntary, therefore no compensation will be given.

I, _____, attest with my signature that I have read and understood the following description of the study, "Influence of guided awareness meditation on conflict- and error-monitoring in college-age adults." and its purposes and methods. I understand that my participation in this research is strictly voluntary and my participation or refusal to participate in this study will not affect my relationship with Louisiana Tech University in any way. Further, I understand that I may withdraw at any time or refuse to answer any questions without penalty. Upon completion of the study, I understand that the results will be freely available to me upon request. I understand that the results of my survey will be confidential, accessible only to the primary investigators, myself, or a legally appointed representative. I have not been requested to waive nor do I waive any of my rights related to participating in this study.

_____ _____

Signature of Participant **Date**

CONTACT INFORMATION: The principal experimenters listed below may be reached to answer questions about the research, subjects' rights, or related matters.

Andrew Parks, Ph.D., Assistant Professor, parksac@latech.edu, (318) 257-2736
Praveen Pasupathi, Master's Degree Candidate, pas048@latech.edu, (318) 497-9241
Jordan Blazo, Ph.D., Assistant Professor, jblazo@latech.edu, (318) 257-4033

Members of the Human Use Committee of Louisiana Tech University may also be contacted if a problem cannot be discussed with the experimenters:

Dr. Richard Kordal, Director, Office of Intellectual Property & Commercialization Ph: (318) 257-2484, Email: rkordal@latech.edu

Appendix C: Health History Demographic

Basics

Participant ID

Date of Participation

2/1/2022

General Information

General Information

What is your date of birth?

Month

Day

Year

What is your current age?

How many years of education have you completed?

(High School = 12; College = 16)

What is your sex?

Male Female

Other

Prefer Not to Answer

Which is your dominate hand?

Left	No Preference	Right
○	○	○

Do you wear contacts or glasses?

Yes	No
○	○

If yes, what is their prescription for?

[ ]

Demographics

Demographics

Please answer the following questions about your home environment:

(If a specific question is not applicable, please skip it.)

	Yes	No
Do/did you work?	○	○
Does your Primary Guardian (Male/Female) work? *(Note: primary would be identified as the primary caregiver from your perspective)*	○	○

What is the highest level of education obtained by your primary parent:

(If a specific question is not applicable, please skip it.)

Mother / Female Guardian	[ ]
Father / Male Guardian	[ ]

How many biological siblings do you have?

[ ]

Do you consider yourself to be Hispanic or Latino?

(A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race)

Yes ○ No ○

What race/ethnicity do you consider yourself?

(Select one or more options below)

- ☐ American Indian or Alaska Native: a person having origins in any of the original peoples of North and South America (including Central America) and who maintains tribal affiliation or community attachment.
- ☐ Asian: a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
- ☐ Black or African American: a person having origins in any of the Black racial groups of Africa.
- ☐ Native Hawaiian or Other Pacific Islander: a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
- ☐ White or Caucasian: a person having origins in any of the original peoples of Europe, the Middle East or North Africa.

What is your approximate gross household income?

(Income includes wages and salaries, unemployment insurance, disability payments, child support payments received, as well as any personal business, investment, or other kinds of income received routinely.)

Habits

Habits

On an average day during the WEEK, how much time do you spend:

Watching Television	
On the Computer	

Playing Videogames

Being Physically Active

On an average day during the WEEKEND, how much time do you spend:

Watching Television

On the Computer

Playing Videogames

Being Physically Active

How much sleep do you get:

On an Average Week Night

On an Average Weekend Night

Last Night

How many drinks of the following substances do you consume on an average day?

Water

Caffeinated Soft Drinks

Cups of Tea

How often would you rate your stress level as HIGH?

Never

Rarely

Sometimes

Most of the Time

Always

What is your current relationship status?

How long has this been your relationship status?

How stressful would you rate your relationship/relationship status?

Low Stress

Moderate Stress

High Stress

How many drinks do you regularly have in a WEEK?

Beer

Glasses of Wine

Ounces of Liquor (1 shot = 2 ounces)

How many cigarettes/cigars/pipes do you regularly smoke in a WEEK?

If you have quit smoking, how long has it been since you quit?

Do you take Ginkgo Biloba supplements?

Yes No

Do you take any stimulant or sedative medications?

Yes No

How many hours since you last:

Had a Caffeinated Substance	
Ate a Meal or Snack	
Exercised	

General Health

General Health

When was the last time you saw a doctor?

Have you ever been diagnosed with:

	Yes	No
Any allergies?		
Dyslexia?		
An Attentional Disorder?		
Asthma?		
Epilepsy?		
Diabetes?		
Hearing Impairment?		

If you are diabetic, what type do you have?

Have you been hospitalized in the last 6 months?

Yes No

If so, please explain:

Cardiovascular Health

Cardiovascular Health

Do you have any of the following:

	Yes	No
Pain or discomfort in the chest, neck, jaw, arms, or other areas that may be related to poor circulation?	○	○
Heartbeats or palpitations that feel more frequent or forceful than usual or feeling that their heart is beating very rapidly?	○	○
Unusual dizziness or fainting?	○	○
Shortness of breath while lying flat or a sudden difficulty in breathing that wakes you up while sleeping?	○	○
Shortness of breath at rest or with mild exertion (such as walking two blocks)?	○	○
Feeling lame or pain in the legs brought on by walking?	○	○

Indicate your preference in what hand you use for each of the following activities:

	Only ever with the Left	Sometimes with the Left	No Preference	Sometimes with the Right	Only ever with the Right
Writing	○	○	○	○	○

	Only ever with the Left	Sometimes with the Left	No Preference	Sometimes with the Right	Only ever with the Right
Drawing	○	○	○	○	○
Throwing	○	○	○	○	○
Using scissors	○	○	○	○	○
Holding a toothbrush	○	○	○	○	○
Using a knife without a fork	○	○	○	○	○
Using a spoon	○	○	○	○	○
Using a broom (the hand on the top of the broom)	○	○	○	○	○
Striking a match (the hand holding the match)	○	○	○	○	○
Opening a box (the hand that opens the lid)	○	○	○	○	○
Kicking a ball	○	○	○	○	○
Looking through a microscope/telescope with one eye	○	○	○	○	○

Appendix D: Mindfulness Attention Awareness Scale

Default Question Block

Participant ID

Date of Participation

2/14/2022

Condition

Meditation Control

Please indicate the degree to which you agree with each of the following items using the scale below.

	Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
1. I could be experiencing some emotion and not be conscious of it until some time later.	○	○	○	○	○	○
2. I break or spill things because of carelessness, not paying attention, or thinking of something else.	○	○	○	○	○	○

	Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
3. I find it difficult to stay focused on what's happening in the present.	○	○	○	○	○	○
4. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.	○	○	○	○	○	○
5. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.	○	○	○	○	○	○
6. I forget a person's name almost as soon as I've been told it for the first time.	○	○	○	○	○	○
7. It seems I am "running on automatic" without much awareness of what I'm doing.	○	○	○	○	○	○
8. I rush through activities without being really attentive to them.	○	○	○	○	○	○
9. I get so focused on the goal I want to achieve that I lose touch with what I am doing right now to get there.	○	○	○	○	○	○
10. I do jobs or tasks automatically, without being aware of what I'm doing.	○	○	○	○	○	○
11. I find myself listening to someone with one ear, doing something else at the same time.	○	○	○	○	○	○
12. I drive places on "automatic pilot" and then wonder why I went there.	○	○	○	○	○	○

	Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
13. I find myself preoccupied with the future or the past.	○	○	○	○	○	○
14. I find myself doing things without paying attention.	○	○	○	○	○	○
15. I snack without being aware that I'm eating.	○	○	○	○	○	○

Appendix E: Five Facet Mindfulness Questionnaire

Default Question Block

Participant ID

Date of Participation

2/14/2022

Condition

Meditation Control

*Please rate each of the following statements using the scale provided. Select the number that best describes **your own opinion** of what is **generally true for you**.*

	Never or Very Rarely True	Rarely True	Sometimes True	Often True	Very Often or Always True
1. When I'm walking, I deliberately notice the sensations of my body moving.					
2. I'm good at finding words to describe my feelings.					
3. I criticize myself for having irrational or inappropriate emotions.					
4. I perceive my feelings and emotions without having to react to them.					

	Never or Very Rarely True	Rarely True	Sometimes True	Often True	Very Often or Always True
5. When I do things, my mind wanders off and I'm easily distracted.	○	○	○	○	○
6. When I take a shower or bath, I stay alert to the sensations of water on my body.	○	○	○	○	○
7. I can easily put my beliefs, opinions, and expectations into words.	○	○	○	○	○
8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.	○	○	○	○	○
9. I watch my feelings without getting lost in them.	○	○	○	○	○
10. I tell myself I shouldn't be feeling the way I'm feeling.	○	○	○	○	○

*Please rate each of the following statements using the scale provided. Select the number that best describes **your own opinion** of what is **generally true for you**.*

	Never or Very Rarely True	Rarely True	Sometimes True	Often True	Very Often or Always True
11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.	○	○	○	○	○
12. It's hard for me to find the words to describe what I'm thinking.	○	○	○	○	○
13. I am easily distracted.	○	○	○	○	○
14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.	○	○	○	○	○

	Never or Very Rarely True	Rarely True	Sometimes True	Often True	Very Often or Always True
15. I pay attention to sensations, such as the wind in my hair or sun on my face.	○	○	○	○	○
16. I have trouble thinking of the right words to express how I feel about things.	○	○	○	○	○
17. I make judgments about whether my thoughts are good or bad.	○	○	○	○	○
18. I find it difficult to stay focused on what's happening in the present.	○	○	○	○	○
19. When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.	○	○	○	○	○
20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.	○	○	○	○	○

*Please rate each of the following statements using the scale provided. Select the number that best describes **your own opinion** of what is **generally true for you**.*

	Never or Very Rarely True	Rarely True	Sometimes True	Often True	Very Often or Always True
21. In difficult situations, I can pause without immediately reacting.	○	○	○	○	○
22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.	○	○	○	○	○

	Never or Very Rarely True	Rarely True	Sometimes True	Often True	Very Often or Always True
23. It seems I am “running on automatic” without much awareness of what I’m doing.	○	○	○	○	○
24. When I have distressing thoughts or images, I feel calm soon after.	○	○	○	○	○
25. I tell myself that I shouldn’t be thinking the way I’m thinking.	○	○	○	○	○
26. I notice the smells and aromas of things.	○	○	○	○	○
27. Even when I’m feeling terribly upset, I can find a way to put it into words.	○	○	○	○	○
28. I rush through activities without being really attentive to them.	○	○	○	○	○
29. When I have distressing thoughts or images I am able just to notice them without reacting.	○	○	○	○	○
30. I think some of my emotions are bad or inappropriate and I shouldn’t feel them.	○	○	○	○	○

*Please rate each of the following statements using the scale provided. Select the number that best describes **your own opinion** of what is **generally true for you**.*

	Never or Very Rarely True	Rarely True	Sometimes True	Often True	Very Often or Always True
31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.	○	○	○	○	○

	Never or Very Rarely True	Rarely True	Sometimes True	Often True	Very Often or Always True
32. My natural tendency is to put my experiences into words.	○	○	○	○	○
33. When I have distressing thoughts or images, I just notice them and let them go.	○	○	○	○	○
34. I do jobs or tasks automatically without being aware of what I'm doing.	○	○	○	○	○
35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.	○	○	○	○	○
36. I pay attention to how my emotions affect my thoughts and behavior.	○	○	○	○	○
37. I can usually describe how I feel at the moment in considerable detail.	○	○	○	○	○
38. I find myself doing things without paying attention.	○	○	○	○	○
39. I disapprove of myself when I have irrational ideas.	○	○	○	○	○