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A Qualitative Feasibility and Acceptability Study of an Adapted Mindfulness Program for Children with Executive Function Impairments

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A Qualitative Feasibility and Acceptability Study of an Adapted Mindfulness Program for Children with Executive Function Impairments

A dissertation submitted in partial satisfaction of the

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in Education

by

Everest Sherlock Mueller

2019

ABSTRACT OF THE DISSERTATION

A Qualitative Feasibility and Acceptability Study of an Adapted Mindfulness Program for Children with Executive Function Impairments

By

Everest Sherlock Mueller

Doctor of Philosophy in Education

University of California, Los Angeles, 2019

Professor Connie Kasari, Co-Chair

Professor Edith Omwami, Co-Chair

Executive Functions are those cognitive mechanisms that moderate regulatory behavior, self-directed behavior and adaptive behavior. When executive functions are impaired, it is often, but not always, associated with a developmental disability. An impairment in executive functions may result in maladaptive behaviors which can lead to poor social integration and poor academic outcomes. Interventions designed to improve executive functions are gaining interest in the scientific literature, specifically mindfulness-based interventions. Mindfulness-based interventions are designed to improve cognitive functions through the regulation of attention and early studies demonstrate improvement in cognitive functions, emotional regulation, physical health and neurological function. However, few studies have examined the feasibility and acceptability of mindfulness-based interventions, particularly for adolescents with executive function impairments. Therefore, this study was designed to assess the feasibility and acceptability of an adapted Mindful Schools middle school aged mindfulness program for adolescents with executive function impairment. Participant observation, interviews and document review were utilized to gather qualitative data from three adolescent males with executive function impairments. Direct interpretation and

categorical aggregation were used to analyze the data. Results demonstrated that the adapted mindfulness program was feasible and acceptable to these three adolescents with executive function impairments.

The dissertation of Everest Sherlock Mueller is approved.

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Introduction

Executive Functions

Models and definitions of executive functions (EF) differ considerably. However, EF are most commonly understood as those neuro-cognitive mechanisms that regulate adaptive behaviors, such as: the ability to inhibit impulsive responses, modulate emotions, sustain working memory, maintain attention or shift attention, and are generally associated with the self-monitoring and self-regulation of behavior.

The EF network is thought to provide important neuro-cognitive mechanisms for goal-directed behavior and decision making throughout development and are also considered foundational for youth and adolescent sociomoral behavior (Barrasso-Catanzaro & Eslinger, 2016; Merriam, 1998). Therefore, but not always so, an impairment in EF typically indicates the presence of a developmental disability (Bryce, Whitebread, & Szűcs, 2014).

Challenges of EF impairment

Children and adolescence with EF impairment often encounter challenges in academics and social integration. For example, in a review paper by Wiebe, Morton, Buss, and Spencer (2014), they point out research that indicates strong EF in children has been correlated with stronger language abilities and impairment in EF has been linked to deficits in language capacity. Furthermore, higher EFs skills have had a positive influence on early math skills and reading proficiency. The authors also point out that EF has been linked to theory of mind, which requires children to interpret and understand the perspective of others, thus making it difficult for children with EF impairments to integrate into social situations. They also examine research for children with EF impairments, particularly those children with ADHD or Autism, reporting that often

these children show deficits in several components of EF, displaying weaker inhibition, a poorer working memory, and greater difficulty switching tasks. Finally, they note that strong EF in early development can enhance school performance and reduce the prevalence of psychopathology and is more important for school readiness than IQ (see also: Booth, Charlton, Hughes, & Happé, 2003; Happe, Ronald, & Plomin, 2006; Nyden, Gillberg, Hjelmquist, & Heiman, 1999; Semrud-Clikeman, Walkowiak, Wilkinson, & Butcher, 2010). These EF impairments have been connected to a number of behavioral symptoms (Kenworthy, Black, Harrison, della Rosa, & Wallace, 2009).

For children and adolescents with EF impairments or developmental disabilities, these challenges are associated with maladaptive behaviors such as: emotional outbursts, forgetting instructions, difficulty paying attention in class or at home, restrictive-repetitive behavior and difficulty controlling erratic behavior (Andersen, Skogli, Hovik, Egeland, & Øie, 2015; Hill, 2004b; Lopez, Lincoln, Ozonoff, & Lai, 2005; Ozonoff & Jensen, 1999). Therefore, attempting to promote the development of EF in adolescents and decrease maladaptive behavior, particularly for those adolescence with EF impairments, could be integral to their academic achievement, social integration and improve the quality of home life.

Mindfulness Based Interventions

Studies implementing a variety of interventions have reported success in improving the EF of adolescents with no clinical diagnoses (Diamond, Barnett, Thomas, & Munro, 2007; Holmes, Gathercole, & Dunning, 2009; Pandey et al., 2018). Similar studies demonstrate improvement of EF in adolescents with developmental disabilities or EF impairments (Kenworthy et al., 2014; Kirk, Gray, Ellis, Taffe, & Cornish, 2017). Mindfulness meditation has been increasingly studied as an EF intervention program for adolescents both at school and at

home (Davidson, Dunne, & Eccles, 2012) and has been shown to improve several EF mechanisms such as: sustained attention (Chambers, Lo, & Allen, 2008) and attention switching (attentional flexibility, Hodgins and Adair, 2010), working memory (Chambers, Lo & Allen, 2008;), inhibitory control, (Heeren, 2009;), decision making and goal management (Alfonso, Caracuel, & Delgado-Pastor 2011), and the self-monitoring and self-regulation of emotions (Teasdale, 1999). Furthermore, mindfulness has been shown to improve cognition by developing and integrating the neural structure in those areas associated with EF impairment, mainly the Pre-Frontal Cortex (PFC) and Anterior Cingulate Cortex (ACC), thus promoting adaptive behavior (Kilpatrick et al., 2011; Lutz et al., 2009; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010).

Due to its capacity to improve cognition and develop neural structures, mindfulness-based interventions (MBI) have gained attention for the treatment of adolescents with developmental disabilities (Hastings & Manikam, 2013). Mindfulness is a form of meditation that trains cognitive and emotion regulation skills by teaching individuals to impose some discipline on a normally unregulated mental, physical or emotional habit. It requires individuals to exercise volitional, attentional or executive control in order to sustain a focused attention on objects, mental contents (thoughts, cognitions) or emotions (Davidson et al., 2012). The intention is to develop awareness around the experience, a cognitive gap, that allows the practitioner to develop a *new* behavioral response, a conscious, intentional action to the experience, rather than react or engage in unconscious reactive behavior.

When used as a teaching strategy or intervention program, MBI are geared toward developing the individuals capacity for self-regulation of attention and emotion in an effort to manage behavior (Meiklejohn et al., 2012). There have been several recent studies that

demonstrate the effectiveness of MBI for improving the behavior of adolescents with developmental disabilities or EF impairments (Hastings & Manikam, 2013; Hwang & Kearney, 2013; Singh, Lancioni, Singh, et al., 2011; Zylowska et al., 2008, see following section for further review). These studies indicate that MBI could help individuals with developmental disabilities or EF impairments to display their potential to self-regulate their behavior and to function independently which would be beneficial for this vulnerable population and their families.

Premise of this Study

However promising, this research on MBI and adolescents with EF impairments is still in its infancy and little research has been done on the feasibility and acceptability of mindfulness programs, especially when done in the home (Zylowska et al., 2008). Therefore**, the aim of this study was to assess the feasibility and acceptability of an adapted Mindfulness program for adolescence with EF impairments.** The individuals were assessed prior to engagement in the study and were found to have impairments in different EF areas: working memory (P1), emotional control (P2) and inhibitory control (P3).

The mindfulness program was based on a Mindful Schools middle school program and was adapted in two ways. One, the amount of time in formal meditative practice was reduced and restructured to slightly increase over time. This was done in attempt to meet the needs of a highly distractible and emotionally sensitive population. The types of formal meditation practices were also reduced to two: mindfulness of body and mindfulness of breath. This was done to reduce the number of concepts taught so the participants could focus on the core mindfulness teachings.

Literature Review

Does Mindfulness Improve the Executive Functioning of Typically Developing Adolescents?

Several reviews on mindfulness and youth indicate that mindfulness is feasible and beneficial to both typical and clinical youth populations (Black, Milam, & Sussman, 2009; Burke, 2009; Zenner, Herrnleben-Kurz, & Walach, 2014). In this section I will review literature for typically functioning youth, both inside and outside of school settings, and I will focus on the capacity for mindfulness to effectively improve: Inhibition Control, Emotion Regulation and Working Memory. I am limiting the review to these areas of EF because they are the areas of EF impairment demonstrated by the participants in my study. Lastly, I will review one study demonstrating improvement in EF and adaptive behavior overall. In the following section I will examine the capacity for mindfulness to improve the EF for youth with EF impairments or other developmental disabilities such as ADHD, Autism and other learning disorders.

Improvements in Inhibitory Control

While EF can be assessed broadly using rating scales like the Behavior Rating Inventory of Executive Functions (BRIEF) many studies use computerized tasks to assess specific components of EF. Oberle, Schonert-Reichl, Lawlor, and Thomson (2012) examined ninety-nine students ranging in age from nine to eleven years and assessed their inhibition control. Students were recruited from four different schools across two grade levels: fourth and fifth grade. The Mindful Attention-Awareness Scale (MAAS) was used to assess levels of dispositional mindfulness, a natural state of mindfulness often understood as trait mindfulness. A computerized Dots task was used to assess correct responses and response times for inhibition control. Since the study was assessing dispositional mindfulness there was no mindfulness intervention program. Students were given the MAAS and then subsequently tested on inhibitory

control. Four practice sessions were used to ensure that the participants understood the required protocols for the cognitive task. The aim of the study was to assess whether dispositional mindfulness was a predictor of inhibitory control. Results showed that dispositional mindfulness was a significant predicator of inhibitory control with individuals that had greater levels of attentional control, more capable of regulating their adaptive behavior. Their findings are consistent with other studies examining mindfulness and its relation to inhibitory control during adolescence (i.e. Adams, 2018; Dunning et al., 2018).

Improvements in Emotion Regulation and Meta-Cognition

In a study by Britton et al. (2014), the effect of a mindfulness intervention on sixth graders metacognition and self-regulation of emotion was tested. A normative sample of one hundred and one sixth graders were placed in their classrooms by a school committee. Each classroom was then randomized into either the intervention group, which consisted of the mindfulness intervention or the control group, which consisted of an active control activity. The mindfulness intervention lasted six weeks. The meditation periods ranged from three to twelve minutes.

Results yielded small to medium effect sizes, and in some analyses, there was no difference between the meditation group and controls. For example, a statistically significant time effect was found in both groups for meta-cognition (Internalizing & Externalizing Problems) indicating that both groups improved meta-cognitive abilities equally post intervention period. However, group-by-time interactions ran counter to predictions (that there would be a significant improvement in the mindfulness group) again, confirming little difference in either group. The most promising result for mindfulness and meta-cognition was in the suicidality and self-harm conditions suggesting that mindfulness improved meta-cognition and

decreased ruminative thinking around suicide or self-harm (Britton et al., 2014). For the self-regulation of emotion, there was little difference between each group, with only small effect sizes indicating minor improvements for the mindfulness group. However, individuals did show a significant improvement in affect disturbance, indicating that the mindfulness group was less disturbed by difficult emotions. Despite some mixed results for Britton et al., the results for mindfulness' ability to improve the EF of adolescents in the areas of emotion regulation and meta-cognition are interesting and merit further research. When considered in the context of other studies examining the relationship between mindfulness, emotion regulation and cognition, the efficacy of mindfulness could be considered preliminary and much more research is needed.

A study that buttresses Britton et al. is Deplus, Billieux, Scharff, and Philippot (2016). Deplus et al. (2016) included twenty-one adolescents in a nine-session group intervention and measured outcomes across several measures including depression. The study revealed a significant increase in the level of mindfulness from pre to post intervention and suggested that this improvement resulted in a significant decrease in depressive symptomology, improved emotional regulation and increased meta-cognition. According to Deplus et al. (2016) mindfulness improved emotional regulation in the areas of urgency, the feeling of a raised sense of anxiety, and lack of perseverance, a difficulty in persisting while feeling challenged indicating a decrease and improved regulation of both feelings. But there was not a significant change for the lack of premeditation or sensation seeking scales, indicating a mixed effect on the regulation of impulsive feelings. Further analysis revealed a significant change for internal-dysfunctional strategies indicating the capacity for mindfulness to help with the internal regulation of difficult emotions and thoughts. Lastly, Deplus et al. (2016) demonstrated that "unconstructive repetitive thoughts decreased significantly from pre-test to post-test, whereas the score on constructive

repetitive thoughts increased significantly" (p. 783). Despite some mixed results, this study indicates that mindfulness could improve emotional regulation and meta-cognition. However, this study is a pre-post test design, randomized controlled trials examining MBIs are necessary to elucidate efficacy. When this study is considered alongside Britton et al. and others not reviewed here (e.g. Biegel, Brown, Shapiro, & Schubert, 2009; Bögels, Hoogstad, van Dun, de Schutter, & Restifo, 2008; Raes, Griffith, Van der Gucht, & Williams, 2014) we can understand that the capacity for mindfulness to improve emotion regulation and meta-cognition for adolescents is preliminary and hopeful. Further research is necessary to determine the efficacy of mindfulness for improving emotional regulation and meta-cognition and continuing this research is particularly important considering the period of adolescence is often one fraught with difficult thoughts about oneself, aggravation and low-self-esteem.

Improvements in Working Memory Capacity

A study by Quach, Mano, and Alexander (2016) examines the effect of a mindfulness intervention on the working memory capacity (WMC) of adolescents in a school setting. One hundred and ninety-eight students were recruited from a large public middle school in the United States and were randomly assigned to three groups: meditation, yoga and waitlisted control. Participants were measured using several scales but here I will focus on the outcomes regarding mindfulness and WMC. The authors utilized a computerized test: the Automated Operation Span Task, to measure WMC. The students completed a baseline test on all measures before being randomly separated into their groups. The meditation group met eight times, twice a week for four weeks and each session was forty-five minutes long. The authors reported a significant time by group interaction, using a simple effects procedure to determine interaction effects for each group condition. Results indicated that the mindfulness group reported significant pre - post

improvements in WMC compared to the hatha yoga group and waitlisted controls.

Another study by Riggs, Black, and Ritt-Olson (2015), examined the associations between dispositional mindfulness and WMC. One hundred and fifty-two, 7th and 8th grade students were recruited from two separate schools. Dispositional mindfulness was assessed using the Mindfulness Awareness Scale-Adolescent Version (MAAS-A) and EF was measured using the BRIEF self-report version. It's important to note that the researchers did not examine all eight sub-scales in this study, they used inhibitory control, working memory and cognitive flexibility as the factors for EF. Results revealed there was a significant association between mindfulness and EF such that greater [dispositional] mindfulness was associated with greater EF proficiency during early adolescence (Riggs et al., 2015). When mindfulness was analyzed in association with specific EF factors a significant association between mindfulness and inhibitory control and WMC such that greater mindfulness was associated with greater inhibitory control and working memory proficiency was revealed (Riggs et al., 2015). The studies by Quach et al. (2016) and Riggs et al. (2015) can be considered alongside other studies that have successfully demonstrated increased WMC due to mindfulness intervention in adolescence (e.g. Jaiswal, Tsai, Juan, Liang, & Muggleton, 2018; Mrazek, Franklin, Phillips, Baird, & Schooler, 2013)

While it is impossible to review all the literature examining the effect of mindfulness on the EF of youth and adolescence, this chapter reviewed evidence that mindfulness could improve the proficiency of EF relevant to this study: inhibitory control, emotion regulation, working-memory capacity. The current research is promising and further studies, particularly randomized controlled trials, could demonstrate that mindfulness can improve the EF of typically developing school aged youth.

Improvements in Other Areas of EF

An initial example is by Flook et al. (2010), in which they examined sixty-four children across four second and third grade classrooms from the same school. The children were aged seven to nine years of age. Students were randomly assigned into intervention and control groups. The intervention group practiced mindfulness for thirty minutes a week, twice a week for eight weeks. The BRIEF was used to collect data on EF functioning before and after the mindfulness program, both teacher and parent formats were used. Initial results showed no significant group main effects, indicating that there were no overall differences between the two groups from pre- to posttest based on either the BRIEF teacher or parent reports (Flook et al., 2010). However, there were significant effects on the level of the individual, that is, baseline levels of EF moderated the effect of the mindfulness program. In the teacher report format, those children with higher scores on the BRIEF (indicating lower EF), showed lower scores on the BRIEF post program, compared to controls. (Flook et al., 2010). Similarly, in the parent report form, those children with lower EF pre-program showed higher EF post program (Flook et al., 2010). Further analysis revealed significant improvement in the EF subscales of Shift, Initiate, Monitor, Plan and Organize, as reported by both teachers and parents on the BRIEF. Emotional Control and Inhibit were significant for the parent report from only and the Organization of Materials was significant for the teacher report form only. Flook et al. (2010) concluded that mindfulness is a potentially useful tool for improving executive functioning.

Does Mindfulness Improve the Executive Functioning of School-Aged Youth with EF Impairments or Developmental Disabilities?

In the previous section, I asked the question as to whether mindfulness improves the EF of typically developing school-aged children. The evidence reviewed, provided promising

support for mindfulness' capacity to improve the proficiency of EF in typically developing school-aged children. In this section I ask the question as to whether mindfulness can improve the EF of school-aged adolescence with EF impairments or developmental disabilities.

The use of mindfulness for people with developmental disabilities is just emerging. In a review by Hwang and Kearney (2013) 12 studies were examined for the effects of mindfulness on patients with moderate to severe developmental disabilities. Most participants had LD or ID and six participants were diagnosed with ASD. None of the studies measured the effect of mindfulness on EFs directly. However, data was collected on adaptive behavior that is highly associated with EF. The authors of the review concluded that all twelve studies reported successful improvement of target behaviors although they do mention some methodological limitations.

While mindfulness has demonstrated some interesting results for adolescents with developmental disabilities, there is not yet a body of literature examining the direct effects of mindfulness on the EF of adolescence with ASD or LD. However, there is some literature on the direct effect of mindfulness on the EF of children with AD/HD, primarily examining inhibition control and cognitive flexibility, the results of which will be discussed in a later section. Despite a lack of literature on the direct cognitive effects of mindfulness for adolescents with developmental disabilities there have been some studies that examine the adaptive behavior for this population. Adaptive behavior is highly associated with EF.

Improvements in Adaptive Behavior for Individuals with ID, ASD and LD

In one study by Singh, Lancioni, Winton, Adkins, Singh, et al. (2007) the researchers taught mindfulness to three adolescents with moderate ID. These three adolescent participants were at risk of losing their placement in their supported living facility. The objective of the study

was to utilize mindfulness as an intervention to reduce aggressive behavior and maintain the supported living placement. This was a single case study using a baseline, intervention and follow-up design. The measures used were self and staff reports on incidents of aggressive behavior. Results from the intervention indicated a "significant decrease in incidences of aggression, use of physical restraints, self and resident injuries" and also reports improved adaptive behaviors of "self-control and participation in community activities significantly increased" (Singh et al., 2007, p. 316).

Furthermore, after the mindfulness intervention, all three participants were able to maintain community placement. While the Singh et al. (2007) study does not examine EFs directly it is reasonable to assume that the decrease in aggressive behavior was due to an increase in the proficiency of EF processing, although confirming the assumption would require further research.

An interesting pair of studies from the Hwang and Kearney (2013) review is by Singh, Lancioni, Manikam, et al. (2011) and Singh, Lancioni, Singh, et al. (2011). For both of these studies, the main objective was to reduce aggressive behaviors like verbal aggression, biting, kicking and hitting, through mindfulness meditation for three adolescent boys diagnosed with ASD (six total participants). Both studies used a multiple baseline, single subject design and did follow-ups at 3-4 years. Both studies utilized self and parent reports to measure behavior changes. In this pair of studies, instead of teaching the participants directly, the participants mothers were taught the mindfulness practice and then the mothers taught their sons. Singh, Lancioni, & Manikam (2011) reported a significant reduction in aggressive behaviors during and after the intervention with further reduction at follow-up. The Singh, Lancioni, & Singh (2011) study eradicated aggressive behavior both during the intervention and at follow-up reporting:

"zero instances of aggression in three consecutive weeks [during intervention]" and "no aggressive behavior during four-year follow-up" (p. 320). In both studies the authors mention that a reason for such a steep drop in behavior could have been that the mothers were intervening with mindfulness just before an aggressive behavior occurred. Therefore, it is difficult to assume any changes in EF for either study. Furthermore, it's interesting to note that these positive results from the studies above were in-line with similar results from other studies in the Hwang & Kearney's (2013) review, although many of those studies were examining adults with LD or ID, not adolescents.

Improvement in Executive Functioning and AD/HD Symptomology

Some initial work by Smalley et al. (2009) examined the feasibility of mindfulness interventions for children with AD/HD. Her study revealed that youth with AD/HD could effectively learn mindfulness and she further suggested that mindfulness interventions could help with symptoms of AD/HD and increase self-direction. Nine years later a review of mindfulness' effect on youth with AD/HD was done by Chimiklis et al. (2018). In their review they examined eleven articles that met their inclusion criteria: youth participants between the ages of 5-17 years, had an AD/HD diagnosis or met symptom thresholds, symptoms were a treatment outcome and published in a peer-reviewed English-language journal. The authors reported that most of the studies they reviewed had a statistically significant effect on improving the outcomes of AD/HD symptoms, hyperactivity/inhibition control, inattention and EF. The results from this meta-analysis are promising and indicate mindfulness can produce beneficial changes in the EF of adolescents with AD/HD. However, the authors caution the interpretation of the effect sizes, by pointing out several methodological limitations. Due to these limitations they conclude that mindfulness and meditation are effective interventions for treating AD/HD symptomology but

argue that they are not a first line of defense for these disabilities (see Chimiklis et al. 2018).

Improvement in Emotional Regulation for Adolescents with AD/HD

In an early study by Grosswald, Stixrud, Travis, and Bateh (2008) the authors use mindfulness meditation to decrease the stress and anxiety of adolescents. Ten children with AD/HD diagnosis were selected from a single private school. Teachers and administrators were taught to administer the twice daily meditations at a length of 10 minutes. Teachers and parents completed the Behavior Rating Inventory of Executive Function (BRIEF) and other behavioral questionnaires to assess overall emotional, behavioral and cognitive functioning. Measures were employed six weeks before the intervention period to establish baseline scores and then again after the 3-month intervention period. Results revealed a significant reduction is stress and anxiety, resulting in improvement of AD/HD symptoms. These results were corroborated with improvements in EF measured by the BRIEF scales.

In a study examining both impulsivity and emotional regulation, defined by the author as feelings of urgency, Rynczak (2013) utilized a four-week mindfulness intervention in an attempt to improve outcomes. A pre-test post-test design was used, and a battery of child report and parent report questionnaires were used to collect data on behavior, emotional regulation and inhibitory control of feelings of urgency. Results demonstrated a main effect score from pre – post indicating a significant difference between scores on the pre and posttests however there was no significant interaction effect of group. Similar studies confirm this improvement in impulsivity/inhibition control (see Hendrickson & Rasmussen, 2017; Kiani, Hadianfard, & Mitchell, 2017) and emotional control (see Haydicky, Wiener, Badali, Milligan, & Ducharme, 2012). In these studies, some initial change is found, but it is difficult to attribute these changes to mindfulness directly without the evidence from more randomized controlled trials.

Improvement in Inhibition Control and Working Memory Capacity for Adolescence with AD/HD

Another 2008 study was conducted by Zylowska et al. In their study, twenty- four adults and eight adolescence with AD/HD participated in an eight-week mindfulness program. The intervention consisted of one weekly meditation that lasted 2.5 hours and at home practice. Assessments were given pre and post intervention utilizing a battery of cognitive tests. Inhibition was assessed using the Trail Making Test and working memory was assessed using the Digit Span test. Due to participant drop out pre and post test results were based on twenty-three total participants. Furthermore, data from adults was combined with data from adolescents. Results indicated a significant improvement in inhibition control but not in working memory. Interesting to note is that " eighteen of the 23 (78%) participants reported a reduction in their total AD/HD symptoms, with 7 of the 23 (30%) participants reporting at least a 30% symptom reduction (considered a clinically significant improvement)" (Zylowska et al., 2008, p. 742). While some evidence indicates that mindfulness may improve inhibition control in adolescents with AD/HD more research is needed to verify its effects for WMC.

In another study examining inhibition control van der Oord, Bögels, and Peijnenburg (2012) examined the behavioral outcomes of twenty-two parents and their children with AD/HD. The study utilized an eight-week mindfulness program for children aged 8-12 years and conducted a parallel training for the parents. The participants were assesses using a battery of cognitive-behavioral questionnaires. Results indicated there was a significant reduction of inattention and a significant decrease in hyperactivity/impulsivity (inhibition control). It is also interesting to note that the study revealed reductions in parent stress, over-reactivity and parent AD/HD symptoms.

A study by van de Weijer-Bergsma, Formsma, de Bruin, and Bögels (2012) was done in

conjunction with van der Oord et al., (2012). Similarly, van de Weijer-Bergsma et al. (2012), utilized an eight-week mindfulness training for both parents (n= 19) and adolescence with AD/HD aged 11-15 years (n=10). Baseline tests were given before the intervention and post-testing was done immediately after intervention, at eight-weeks and then again at sixteen-weeks. Several behavioral scales were used to measure AD/HD symptom outcomes, the Behavior Rating Inventory of Executive Functions (BRIEF) was used to measure changes in overall EF processing, including working memory and inhibition control. Results for EF yielded mixed results, some EF problems reduced borderline significantly as reported by tutors but not by fathers or mothers. Furthermore, at follow-up, fathers, but not mothers, reported a significant reduction in EF problems. Interestingly, the authors noted that a significant reduction in symptomology was reported on all behavioral questionnaires. The authors feel "the vast majority of results point to improvement, although there are some noticeable findings that need further consideration" (van de Weijer-Bergsma et al., 2012, p. 783).

All of these studies are pilot studies, so while some initial findings might indicate that mindfulness could be promising, there is no strong evidence for the efficacy of mindfulness for children with AD/HD.

Feasibility of Mindfulness Based Interventions for Individuals with EF Impairment

There are many studies confirming the feasibility and acceptability of mindfulness based programs across several populations (e.g. Conner & White, 2018; Ruscio, Muench, Brede, MacIntyre, & Waters, 2016; Valley, 2017). However, few studies exist that examine the feasibility and acceptability of mindfulness meditation for individuals with developmental disabilities or EF impairments. One study was done by Boon (2018), who examines the feasibility and acceptability of an adapted Mindful Schools intervention for adolescents with

ASD. A total of ten adolescents diagnosed with ASD and ranging in age from eleven to sixteen completed the study. Participants practiced for nine-weeks, two sessions per week, each lasting one- and one-half hour. Results indicated that the program was feasible and acceptable "evidenced by a high rate of participant group completion, strong group leader adherence to the treatment protocol, and favorable satisfaction ratings from both adolescents and parents" (Boon, 2018, p.iii).

Zylowska et al. (2008) examined the feasibility of an MBI on twenty-four adults and eight adolescents. The program lasted for eight weeks and consisted of eight, two and a half our sessions, with at home voluntary practice. Feasibility was assessed using the completion rate and participant satisfaction ratings. Seventy-eight percent of adults completed the study, alongside eighty-seven percent of the adolescents. On the self-report satisfaction form, where one is least satisfied and ten is most satisfied, adult participants reported a mean score of 9.40 and adolescents reported a mean score of 9.35. Evidenced by high completion rates and high satisfaction ratings the authors concluded that the MBI was feasible.

Methods

Theoretical Framework

My theoretical approach to this study is constructivism. Constructivism is the notion that "reality is constructed by individuals interacting with their social worlds" (Merriam, 1998, p.6). That is, individuals co-construct knowledge and meaning in response to one another and their environments. Therefore, reality is not an objective phenomenon, there are multiple interpretations of reality. It's important to note a difference in order to further elucidate what I mean by constructivism. For example, my notion of constructivism differs from that of Seymour Papert's. Papert stresses the importance of externalization of thought and emotion in learning and meaning making. While I find this process valuable and an integral part of meaning making and learning I feel it is too narrow and limits the scope of analysis to externalizing phenomena. I prefer Merriam's definition, centering on the concept of interaction, which may not require a particular externalization in order for learning or reality-constructing to occur. This epistemological commitment guided the design, analysis and reporting of the evidence.

Research Question

Will the mindfulness program be feasible and acceptable for adolescents with an EF Impairment?

Theoretical Propositions

Due to the general feasibility and acceptability of MBI in the current literature, I posit that the mindfulness program will be feasible to conduct and acceptable for the participants. I posit little challenges to program feasibility and acceptability; however, I do posit that some challenges may arise. I propose that successes or positive experiences will promote participation in the program and help facilitate feasibility and acceptability.

Design Overview

This was a pilot study using a qualitative and descriptive design. It can be considered a The aim was to describe, explain, interpret, and/or understand a complex phenomenon using multiple cases. For this study I examined the feasibility and acceptability of the mindfulness program across three participants with EF impairments. Data collection and the mindfulness program were conducted simultaneously in the home of the participants during their summer breaks. Program length lasted for eight weeks with three sessions per week. Each session was 45 minutes. The mindfulness program was a modified version of the Mindful Schools middle school mindfulness program. The original program was designed to meet the needs of non-clinical adolescents in a public-school setting. Based on my previous experience, I adapted the program to suit the needs of children with EF impairment and to be conducted in a one to one setting. The primary modification was reducing the amount of time required to sit in the formal meditation. The unit of analysis for this study was the program itself. The primary sources of data are the adolescent participants (the individuals undergoing the mindfulness program) and researcher/instructor observations. Secondary sources of data were the parents of the participants who provided comments on both the program itself and the participants behavior during the program. Methods of data collection were participant observation, non-formal interview probes of the participants (both recorded in a research journal) and document review. Data collection began at the commencement of the mindfulness program and ended one week after the last session, when follow-up interviews were given. Data analysis was done utilizing Stake (1995)'s methods of categorical aggregation and direct interpretation. In categorical aggregation the researcher looks for multiple instances from the data, identifying issue relevant data that

connects theory to conclusions. In direct interpretation the researcher selects a single instance and draws meaning from it to connect theory to conclusion.

Recruitment and Selection Criteria

Participants were recruited through contacts in two schools in the Ventura county area: The Lighthouse School of Ojai and the Ojai Valley School (Lower Campus). I presented the study to administrators and teachers. Teachers then talked to potential students and parents, who called me if they were interested. A meeting with both the parent and participating child was held to discuss the study procedures, informed consent was obtained at this time. If both parent and child consented to the study, the parent completed the BRIEF assessment.

The BRIEF is designed to assess "eight interrelated subdomains of executive function: Inhibit, Shift (Mental Flexibility), Emotional Control, Initiate, Working Memory, Plan–Organize, Organization of Materials, and Monitor" through parent, teacher and self-reporting, in real-life settings such as the home, school or community (Gioia, Isquith, Guy, & Kenworthy, 2000 p.146). The BRIEF scale was selected because it was developed to capture the real-world behavioral manifestations of EF and thus has the ecological validity required for the case study approach. It has been demonstrated to have, "appropriate psychometric integrity," with "good content validity, internally consistent, and has appropriate reliability properties" as well as "high ecological validity" with strong "verisimilitude and veridicality" (Gioia et al., 2000 p.147-149).

In this study the parent form was administered. Participants were asked to report, never (N), sometimes (S) or often (O), in response to descriptive sentences. For example: "Has trouble completing homework on time…….N S O" (Gioia et al., 2000 p.1). The participant then circles the appropriate response. Assessments were conducted online through the Psychological Assessment Resources (PAR) website. If the child demonstrated an EF impairment, we

proceeded with the study.

Participants

Participants included three males ranging in age from 9-12 years old. Participant one and two had no diagnosis for a developmental disability, participant three had a diagnosis of AD/HD. All participants demonstrated an impairment in EF on one of the subscales of the BRIEF. Participant one demonstrated an impairment in working memory capacity. Participant two demonstrated an impairment in emotional control and participant three demonstrated an impairment in inhibition control. Two participants attended the Lighthouse School of Ojai which provides behavior analytic services and the third attended the Ojai Valley School, which does not. All participants were observed during their summer breaks and were not receiving any interventions or drug therapies during the duration of the study. During discussions with parents they reported poor adaptive behaviors for all participants when encountering challenges with school or home tasks.

Procedures

First, an initial meeting was held with the parents and potential participants to obtain consent to participate. After permissions were obtained, the BRIEF was given to assess whether the child would demonstrate an EF impairment and thus meet selection criteria for this study. Once the participant demonstrated EF impairment the results were reviewed with the parent and the study. The program was eight-weeks long with three sessions per week. Each session was 45 minutes. All other home dynamics were kept the same. The mindfulness program was delivered by the researcher who is trained in mindfulness (completed a twelve-week training course). Mindfulness of Body and Mindfulness of Breath were the techniques used. Data collection began when the program began.

Mindfulness Intervention Procedures

In weeks 1-3, the participant was taught the formal sitting and mindfulness meditation position. The child was instructed to focus on the body: sitting in a chair, feet flat on floor, back and neck straight (but at ease), hands in a comfortable resting position (usually on the top of the thighs), eyes open or closed (based on participant preference), the body is held still and silent as the participant scans for bodily sensations with their mind. In the first 1-3 weeks meditations were kept short (3-5 minutes) and repeated, punctuated by discussions of the experience. These discussions served a dual purpose, one for the participant to reflect on the mediation experience and ensure learning and comprehension of program concepts. The second was for the researcher to collect data using informal interview probs. These probes were aimed at understanding the participants experience during the meditation and their thoughts about the program itself. How the meditation could be applied in daily life was also discussed.

During the Mindfulness of breath meditation, the same seated posture was used, but instead of focusing attention on the body, the participant was instructed to focus on the breath. They were asked to notice the point of entry for the breath, where it traveled from there, and the expansion and contraction of the belly. If distracted, they were instructed to gently and non-judgmentally return their attention to the breath. The practice is to stay with the breath as much as possible. In weeks 4-6, the length of meditation time was extended to 5-7 minutes. In weeks 6-8, the length of meditation time was extended to 7-10 minutes.

The aim of the meditation was to practice a still, silent, focus on the body/breath, which places the participant in a state of constant self-regulation. Because adolescence with EF impairments have difficulty maintaining self-regulation compared to their peers the meditation time was shortened and then re-lengthened in graduating phases: weeks 1-3 was 3-5 minutes,

weeks 4-6 was 5-7 minutes and weeks 6-8 was 7-10 minutes. This was the main adaptation made from the original Mindful Schools program.

Data Collection

Data collection began at the start of the program and continued simultaneously with the student progression through program completion. The primary sources of data were the researcher's experience, the participants and document analysis. Secondary sources were the parents. The methods of data collection were participant observation, informal interview probes and document review. A researcher's journal was used for recording the researcher's experience and data from the informal interviews. The aim of the researcher's journal was to gather both single instances of data and contextual information or narrative that can provide broader meaning to single or aggregated data. Interview probes, also recorded in the journal, were conducted each session, three probes were taken each session. The probes were conducted between meditations. These interview probes were aimed at gathering data directly from participants while undergoing the program being evaluated.

Due to the informal nature of the probes not every probe was conducted the exact same way. However, an informal three tier structure emerged during the data collection. The first tier occurred directly after the meditation and was aimed at understanding the participants experience while engaged in the meditation. First, I asked open-ended questions, like: How was that? How did that feel or what did you notice? However, to most open-ended questions participants reported feeling "good." I felt "good" was not a particularly revealing response. The second tier was further inquiry questions like: What does good mean? Can you name a feeling? (happy, joyful, calm, relaxed sad, angry, disgusted, fearful, etc.). Did you notice any thoughts? Did your mind wander? Did you notice any sensations in your body? Sometimes after being asked the

open-ended questions and further inquiry questions, participants still had trouble elaborating their experiences outside the word "good." So a third tier emerged, I asked more discrete questions like; did you notice any calmness, peace, ease etc? Did you notice any thoughts, remembering, worrying, planning, etc? Did you notice any sounds, ticking, breathing, outside noises, etc? Did you notice any bodily sensations like wiggles or fidgets, etc? Did you feel your body moving, which part? By narrowing of the scope of the questions, it allowed for the participant to digest their experience and provide a more enriched response. By allowing the interview probes to be emergent and fluid, it allowed me to be adaptive and responsive, ensuring the collection of useful data regarding program feasibility and acceptability.

Document analysis was also conducted. Parent report forms were created to track behavior for a single-subject study that was conducted concurrently with this study and on the same participants but is not presented in this report. These forms requested parents to track and comment on behavior before during and after the mindfulness program. Comments made in the *description* section of these documents were analyzed for instances of feasibility and acceptability during the mindfulness program.

Analysis and Report

Coding

When analyzing the data, I operationalized core concepts and developed codes which were used to identify specific instances in the data. Core concepts were feasibility/acceptability, and unfeasibility/unacceptability which came directly from the research questions. I conceptualized feasibility in two ways, one is a procedural feasibility, the feasibility of the implementation of the program from the experience of the instructor/researcher. Procedural feasibility was measured by attendance, participation and completion rates. The other conceptualization was experiential feasibility, which was aimed at analyzing data on whether the experience of the program was feasible for the participants. I operationalized experiential feasibility as: *instances of ease and convenience experienced by the participant related to program participation*. Acceptability was conceptualized as experiences of the participant when engaging in the program and I operationalized acceptability as: *instances of tolerance, allowability or enjoyment experienced by the participant related to program participation.* Ease and convenience were used as codes that indicated experiential feasibility and were coded as EC in the data. Tolerated, allowed or enjoyed were the codes for acceptability and were coded as TAE in the data.

Procedural feasibility was isolated and analyzed separately from experiential feasibility. Instances of experiential feasibility and acceptability were compared to instances of experiential unfeasibility and unacceptability. I operationalized experiential unfeasibility as: *instances of inconvenience or impracticality experienced by the participant related to program participation that facilitate or result in the unsustainability of the subject's participation in the program.* Instances of inconvenience and impracticality we considered to indicate unfeasibility and were coded as II in the data. I operationalized unacceptability as: *instances of dissatisfaction or un*

allowability experienced by the participant related to program participation that facilitate or result in the unsustainability of the subject's participation in the program. Instances of dissatisfaction and un-allowability were considered to indicate unacceptability and were coded as DUA in the data.

Procedural Feasibility

Procedural feasibility was measured by calculating attendance, participation and completion rates. Attendance was tracked and counted each time a participant attended a session. There were 24 sessions in total. Participation was measured by the completion of each meditation, three per session. There was a total of 72 meditations during the entire 8-week program. The duration of each meditation increased over time, in weeks 1-3 the meditations were from 3-5 minutes. In weeks 4-6, meditations were 5-7 minutes and in weeks 7-8, meditations were 7-10 minutes. A timer was used to track the duration of each meditation. Completion of each session was met if the participant attended and completed each meditation. Program completion was met if the participant attended and completed each session and meditation for the entire 8-week program. Attendance, Participation and Completion Rates are reported in Table 1.

Table 1:

Participant	Attendance Rate	Participation Rate	Session Completion Rate	Program Completion Rate
1	24/24 Sessions Attended Attendance Rate = 100%	72/72 Meditations Completed Participation Rate = 100%	24/24 Sessions Completed Completion Rate = 100%	100%
2	24/24 Sessions Attended Attendance Rate = 100%	72/72 Meditations Completed Participation Rate = 100%	24/24 Sessions Completed Completion Rate = 100%	100%
3	24/24 Sessions Attended Attendance Rate = 100%	72/72 Meditations Completed Participation Rate = 100%	24/24 Sessions Completed Completion Rate = 100%	100%

No participant missed, avoided or completely resisted attending a session. Some sessions were rescheduled for logistical purposes not relevant to the participants desire to attend, participate or complete as session or the program as a whole. During meditations participants did report difficult feelings such as feeling bored, tired, distracted, hungry, etc. (discussed further in subsequent sections). However, in meditation difficult feelings arise naturally. The practice is to manage these feelings as they arise and attempt to continue or reengage with the meditation. These difficult feelings were experienced, however no participant found them so unfeasible or unacceptable to request or demand that they not attend a particular session in the future or exit the current session. Each participant was observed to successfully regulate or manage these feelings and then re-engage with the meditation, which is the core practice of the meditation. Therefore, managing these difficult feelings can be understood as program participation and thus program feasibility rather than program unfeasibility. Because attendance, participation and completion rates were all 100% this indicates that mindfulness meditation is procedurally feasible for adolescents with EF impairments.

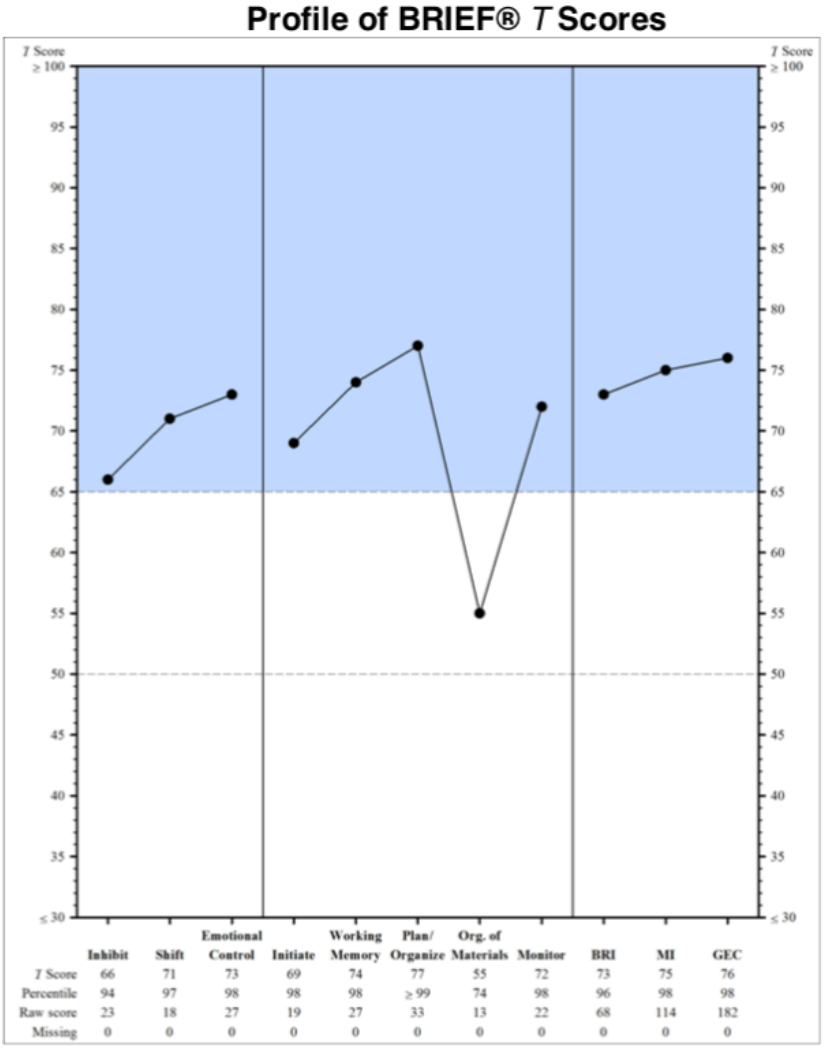
Unique Instances of Experiential Feasibility and Acceptability from Participant Observation

In this section I examine unique instances of feasibility and acceptability for each participant. The data for this section is presented in narrative format to encapsulate evidence for feasibility and acceptability from boarder context. While several unique instances of feasibility and acceptability were observed, I limited the presentation of data to one or two important instances per participant. I utilized the same codes EC and TAE to identify instances of feasibility and acceptability and I used II and USUA to identify instances of unfeasibility or unacceptability. Similar to the aggregated data no instances of unfeasibility or unacceptability occurred.

Participant 1

Participant 1 has no formal diagnosis. The BRIEF assessment revealed that participant 1 has impairments in inhibit, shift (cognitive flexibility), emotional control, initiation, working memory, plan/organize, and self-monitor. Data from the BRIEF is displayed in figure 1.

Figure 1: BRIEF Data for Participant 1



	Inhibit	Shift	Emotional Control	Initiate	Working Memory	Plan/ Organize	Org. of Materials	Monitor	BRI	MI	GEC
T Score	66	71	73	69	74	77	55	72	73	75	76
Percentile	94	97	98	98	98	≥ 99	74	98	96	98	98
Raw score	23	18	27	19	27	33	13	22	68	114	182
Missing	0	0	0	0	0	0	0	0	0	0	0

During the first week of programing and observations, it became abundantly clear that participant 1 exhibited hyperactive and inattentive behavior. He demonstrated very little eye contact during conversation. He would often speak while looking away, seemingly splitting his

attention between the conversation and some other event in the environment or thought in his head. This led, often, to incomplete conversations. He also demonstrated difficultly listening or comprehending oral discourse for the same reasons. His divided attention led me and his parents to have to repeat ourselves multiple times.

He also demonstrated an abundant lack of bodily control. He was constantly moving. During meditation sessions we sat on the couch in his living room. He was quite flexible and would begin the meditation sitting cross-legged or with one foot above the knee of the opposite leg (which happens to be a traditional sitting style called the Lotus position). However, shortly into the meditation, roughly 10-20 seconds of a three-minute sit, he would struggle with bodily regulation. It would usually start with slouching or he would rest his head on his hands, or he would lean forward over his legs. Often, he would be twiddling his fingers or wiggling his toes. He also would completely unfold himself and lay down on his back. During the discussion sessions between meditations, he would be moving all over the couch. He would sit on the top of the couch or the arm of it. He would also sit upside down, with his head on the floor, his back arching onto the seat of the couch and his legs resting on the back of it. I would constantly have to remind him to "use your mindful body even when were talking." This prompted him to find and remain in an upright seated position.

In the early weeks of the program, even after repeated reminders to practice his mindful body, participant 1 struggled to control his bodily movements. He often reported feeling itchy, wiggly or "like I have ants on my skin." I would ask him if he could get a sense of the feeling that is underneath his wiggly-ness and he would often say "I just have to move my toes, I don't know why, I just have to." He also expressed a disconnection between his bodily movement and his experience of it. I would ask if he noticed any movement in his toes, fingers, arms etc. and he

would often reply “no” suggesting a level of unawareness or perhaps even avoidance of his feelings of urgency. Because in the early sessions, participant 1 had difficulty identifying the feeling that underlined his behavior, I suggested his wiggly-ness was the result of a feeling of urgency or impulsivity in his body. We discussed the nature of impulsivity as a feeling to do or want something, a desire that pulls us toward something, in his case to move his body.

If we understand hyperactive behavior as the result of uncontrolled feelings of urgency, then it is reasonable to understand participant 1’s behavior as the result of his impairment in emotional control. He experiences feelings of urgency or impulsivity in his body, which he then, without inhibition or regulation, expresses in his hyperactive behavior. It could be argued that the expression of urgency through hyperactive behavior, *is* the child’s method of self-regulation. By expressing hyperactive behavior, the child is attempting to release the hyperactive feelings in his body. The challenge is that this method is socially and functionally maladaptive. Therefore, during our discussions we talked about how we disengage from that feeling during mindfulness, that we do this by observing the feeling and allowing it to be there, in our body, but we don’t need to react to it. We don’t need to engage with it as a method of trying to release it. What we do, is bring our attention to the breath.

Theoretically, this shift in attention reduces the magnitude of the experience of urgency and increases the magnitude of the experience of breathing, which comes with feelings of calmness and relaxation. By maintaining focus on the breath and thus maintaining feelings of calmness and relaxation the child may now express the new feelings of calmness and relaxation through stillness of the body. This becomes the new method in responding to the feelings of urgency and impulsivity, rather than engaging with the them.

Over the course of the next several weeks I noticed a change, in participant 1's hyperactive behavior. He completely stopped laying down on his back during meditations and he stopped sitting on his head during discussions. He continued to slouch, rest his head on his hands, scratch his body and wiggle his toes and fingers but in week six, session two, during a five-minute meditation he managed to sit almost entirely still. I only observed some slight slouching, the wiggling of toes and scratching of his body. When the bell rang to signal the end of our meditation, he opened his eyes, and with a sense of excitement looked at me and said, "I did it! I sat still though the whole thing!" To which I joyfully replied, "you did, I'm so proud of you buddy!" I chose not to mention the movements I saw so as not to discourage him about the progress he had made. I interpreted his excitement as a result of his awareness of calmness and relaxation because his increased ability to regulate his urgency and bodily movement. The excitement of this success can be understood as an inherent reward for participating and thus satisfaction with program participation and results.

This notion is further evidence by the participant getting excited about how much time we were going to meditate for. In many sessions, with a sense of excitement and anticipation he would ask, "how long are we going to meditate for?" Often, if the time was insufficient for him, he would suggest that we meditate for longer periods. In a few sessions we would joke about what might happen if we meditated for certain periods of time. He would say "what if we meditated for fifteen minutes?" and I would exaggeratingly say, "what if we meditated for *thirrrrrty* minutes?" then he would top me by saying, "what if we meditated for *one-thouuuuuuusand* minutes?" and it would go on, back and forth for a bit until we settled ourselves down to really begin. These experiences of excitement about success and joking about prolonged meditation times, were coded as experiences of enjoyment, which indicate program

acceptability. Participant 1 would not have had instances of enjoyment and satisfaction and thus acceptability if the program was regarded as unsatisfactory to him.

Another instance that indicates program feasibility and acceptability for participant 1 occurred at the end of the program. On the last day, when I explained to participant 1 that I would not be returning to his home to teach him mindfulness, he expressed sadness and disappointment. With disappointment he said, "I like practicing mindfulness" and he expressed that he was "sad that I was leaving." He gave me a hug and I encouraged him that now was the time to practice on his own and that maybe I would return to continue our practice sometime in the future.

It's important to note here that one could interpret this instance as the participant being disappointed that I, the instructor, was leaving and thus an indication that the disappointment expressed, was about the termination of our relationship and not the program itself. I understand it to be both. As the instructor of the one-to-one mindfulness program whether or not the participant will find the program acceptable is, in large degree, dependent on the nature in which the instructor delivers program content and provides program guidance. By expressing disappointment that I was leaving, and thus indicating that our relationship was enjoyable, he is simultaneously expressing that our relationship and as a major part of that relationship, program delivery and guidance, was also enjoyable.

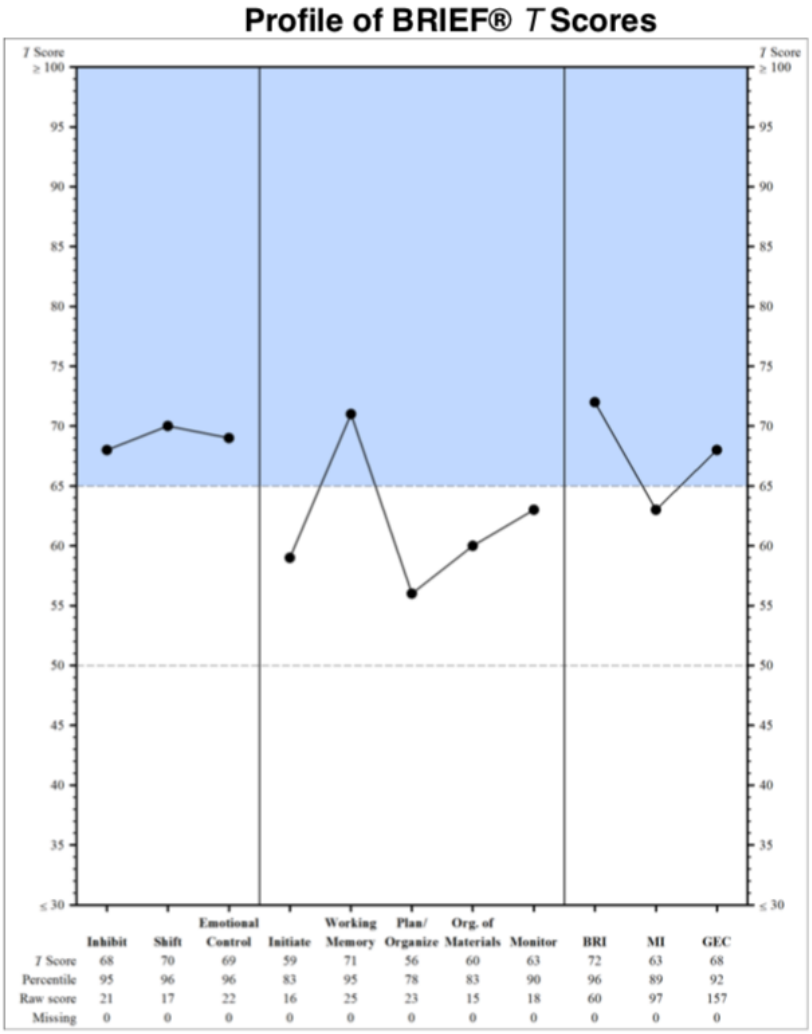
His sadness and disappointment at the discontinuation of the program and our relationship is another indication that the program had meaning and value for the participant. While this is not an instance of EC or TAE directly, it is an instance of the lack of enjoyment upon removal of the program, implying enjoyment in the participation of the program. This

implied enjoyment indicates program acceptability. The participant would not have been sad or disappointed upon program termination if the program was unacceptable to him.

Participant 2

Participant 2 had no formal diagnosis. BRIEF data indicated that participant 2 had EF impairments in inhibition control, shift (cognitive flexibility), emotional control and working memory. Data from the BRIEF assessment is displayed in figure 2.

Figure 2: BRIEF Data for Participant 2



During early programing and observations participant 2 demonstrated hyperactive, inattentive and restricted/repetitive behavior alongside emotional outbursts. Like participant 1 he

demonstrated very little eye contact. He would often speak and listen while looking away. He would also interrupt conversations with topics that were not relevant, or he would ask questions about the definitions of words that were not pertinent to the conversation. Also, like participant 1, he had trouble regulating his body. When asked to sit, he would often rock back and forth in a repetitive motion or get up and pace about the room shortly after the request to sit. During meditations he had difficulty sitting still, he would repetitively rock his body, bite his nails, wiggle his toes and fingers and shake his legs. Often participant 2 would just walk out of conversations without any indication as to why or what he was doing. He had difficulty standing still during conversations too, his parents and I would let him pace around the room while listening. It took very little for participant 2 to have an emotional outburst. Commonly, when just asking his name to get his attention, he would raise his hands in frustration and aggravatingly yell, "what!?!" He often yelled at his parents when given simple requests, instructions or warnings. He would also walk off and slam doors if frustrated with a request, instruction or unexpected situation. His parents reported that at school he is often given poor behavior marks because of his angry, disrespectful tone and language with teachers and students.

However, despite participant 2's challenges there were several instances in which I found participant 2 to demonstrate that the mindfulness program was feasible and acceptable. For example, during our first session, just after the first mediation, I asked him how it was. He replied, "good." I probed a little further to see if I could get a more robust response. I asked, "what was good about it?" Questioningly and with a slight hint of frustration he said, "I don't know… nothing?" I laughed and probed further, "ha ha, nothing was good about it? There must be some reason you felt good. Did you feel calm? At ease? Relaxed? Can you name the feeling that is good?" In a frustrated tone he responded by saying, "I'm not a clam person and I don't

like it when people tell me to calm down, everybody is always telling me to calm down." "I'm not asking you to calm down," I replied, "I'm asking you if you *felt* calm." He said, "I don't think I feel calm, I'm not a calm person, I'm angry all the time, I don't think I know what calm feels like and I don't like it when people tell me to calm down, can you not tell me to calm down, I don't like that word." He was growing increasingly frustrated in the tone of his voice, and he was beginning to raise his hands in the air, which meant he was nearing his frustration tolerance. I attempted to dissipate the situation, "oh, I see, you don't like to be told to calm down, I can understand that. Did you feel anything else? Did you feel relaxed or quiet?" He seemed to perk up and with a quick and excited response he said, "yes! Quiet. It was so quite I could hear the clock on the wall, it was ticking." "Oh, I see, you felt quiet, was that what felt good?" "Yeah" he said, "it felt good to be quiet." He continued, "can we not use the word calm, I don't like to feel calm, I'm not a calm person and I don't like to be told to calm down." I told him, "I'll make you a deal, we won't use the word calm unless *you* want to, ok?" To which he replied, "I don't think I'll ever want to calm down, I don't like it when people tell me to calm down." I took this as a confirmation of the agreement, and I assured him we won't use the word calm unless he wanted to.

It was clear at this point, that participant 2 had negative associations with the term calm down, and in fact, over the course of the program, I heard his mother tell him many times to calm down. Typically, it would be after participant 2 had an emotional outburst. The mother and father had instilled a rating scale to try to provide feedback on his levels of anger and frustration. Once, after we completed a session his mother instructed him to pack his clothes because he was going to stay the night at his nephew's house (his nephew is 3 years old). He threw up his hands and with angry dismay yelled, "Awww, what!?!? Why do I have to stay the night with (nephew) he's

so annoying!" With a stern tone his mother replied, "calm down, you're at an 8 and your attitude needs to be at a 3" indicating to the child that his level of emotional response is inappropriate. His parents referenced the anger scale quite often, and quite often it came with the instruction to calm down. In response, he usually just threw his hands in the air and would say "whatever" and would walk off, run away or go slam the door to his room. It became apparent that participant 2 was being asked to calm down several times a day and that being asked to calm down was agitating and punitive for the child. In the case of staying at his nephew's he said sternly, "well, I'm not going!" To which his mother replied, "I'm sorry (participant 1), I have been telling you all week, now go pack your clothes." "Awww, whatever" he replied in an aggravated tone, throwing his hands in the air.

Just before the second session, he asked me what calm meant. I told him that feeling calm was like feeling relaxed and at ease at the same time. I explained that when you're calm, you might want to be gentle with yourself and others, or you feel lighthearted or you may feel peaceful or happy. He said, "ok" and began to pace about the room until I started the session. In the coming weeks he continued to ask me repeatedly about the word calm and what it meant, it became a bit of a tradition, and I would give him roughly the same answer each time. Then, during week seven, session two, after the first meditation, I asked him my typical open-ended probing questions, "How was the meditation? What did you notice?" He replied with an inquisitive hesitancy, "you know what Everest… I think I felt… calm?" "Did you?" I reiterated with enthusiasm. "I think so, I felt like I calmed down, but it wasn't a bad thing." He had emphasized the words calm and down, stretching out the A sound and OW sound, like *caaalmed dowwwwn.* And he made a motion with both hands, as if he was pushing down on an invisible box in front of him. I interpreted this behavior as an attempt to communicate the feeling of

calming down or the dissipation of frustrated feelings. I asked, “Ok, did you feel at ease and relaxed at the same time?” He said “yeah, that’s what calm means right? It’s like being relaxed and peaceful, it’s not a bad thing like calm down.” “No” I affirmed, “it’s not a bad thing.” For the next several minutes we had a nice discussion about how feeling calm was not the same as being asked to calm down, which he had clear negative associations with. Towards the end of the discussion he said, “yeah, I can feel calm now,” and with a slight hint of enthusiasm he said, “thanks mindfulness for helping me.” He smiled, bobbing his body up and down on his chair while snapping his fingers repetitively, which he did when he was excited.

The crux to this instance is participant 2’s appreciation of the mindfulness program. By thanking mindfulness, he indicated that his participation in the program had a positive effect on his reconceptualization of the word calm and thus helped him to be able to differentiate between being asked to calm down and the feeling of being calm itself. I coded this instance of appreciation as TAE and more specifically as enjoyment and thus understand it as an instance of acceptability. Therefore, this moment of appreciation, which unfolded over the course of the program is an indication that the program itself was acceptable to participant 2.

Another instance of feasibility and acceptability occurred during week 5. It did not occur while I was present, it was told to me by his mother. Participant 2 has an older sister; we’ll call her Sally. She is high school aged and reportedly, also has social-emotional challenges. According to their mother, one afternoon Sally was jumping on the trampoline in their backyard. Participant 2 wanted to join, but Sally wanted to jump alone and didn’t allow participant 2 to enter the trampoline. There is a large net about eight feet high that surrounds the trampoline. To gain access you have to go through a single zipper door, so there is only one way on and off the trampoline, which Sally blocked with her body. Their mother told me that disputes over

trampoline usage were common, but that participant 2's response to this particular incident was unique.

After several attempts, participant 2 relinquished the battle for trampoline access to his older sister. He then stormed back into the house, flung open the sliding glass door and stomped across the living floor. His mother was in the kitchen and he yelled to her, "Sally is pissing me off! I'm going to my room to use my mindfulness!" Oddly enough he didn't go to his room at all, his mother said he went straight into the spare bedroom and sat on the bed, in the precise spot where we practice mindfulness during our program sessions. His mother said he sat there for about thirty minutes, until he finally came out and said "ok, I'm over it, I don't care anymore."

Because participant 2 displayed many emotional outbursts, expressing anger and frustration in a mal-adaptive way, discussing mindful strategies for dealing with these difficult emotions was a regular topic during our discussions. In mindfulness we allow difficult emotion to be present, but we practice being non-reactive to it, it's there, in our experience, but we don't need to act from it. We often talked about how when were angry it can be the most difficult time, but also the most important time to practice mindfulness. And that instead of yelling, insulting, running away from or defying people, that maybe, when were angry, we can stop and focus on our breath.

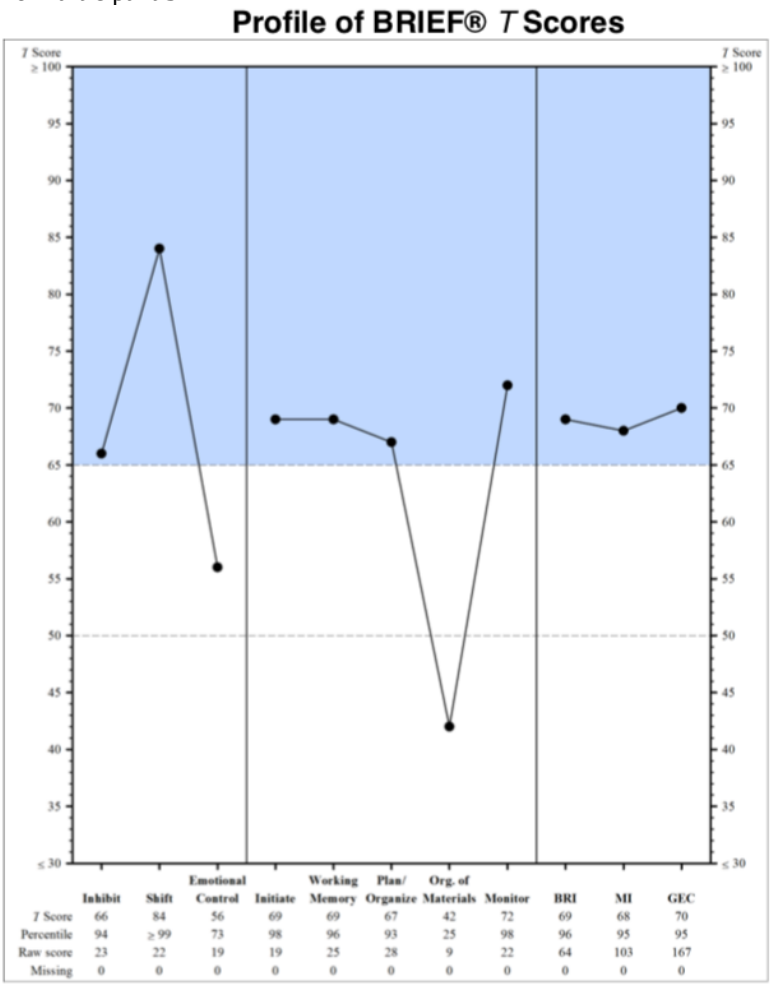
In this instance, participant 2 applied what he had learned from the mindfulness program. By discontinuing the battle for trampoline access and stepping away from the situation to *use his mindfulness*, participant 2 demonstrated that the mindfulness program is useful, practical, and valuable to him. Furthermore, participant 2 made a choice to return to his usual meditation spot, in the spare bedroom, on the bed. Which indicates that he was attempting to recreate program contexts. I coded this instance as EC, ease and convenience. Because participant 2 decided on his

own accord to practice mindfulness and particularly because he chose to practice it in the same location as when we're formally meditating, it indicates that engaging in the mindfulness practice and attempting to re-creating program contexts is easy and convenient for the child. I believe this instance of self-applicability and replicability indicated that the program itself is feasible and acceptable to participant 2.

Participant 3

Participant 3 had a formal diagnosis of AD/HD at the time of the study. The BRIEF indicated that he had impairments in inhibit, shift (cognitive flexibility), initiation, working memory, plan/organize and the self-monitoring of behavior. Data from the BRIEF assessment is displayed in figure 3.

Figure 3: BRIEF Data for Participant 3



	Inhibit	Shift	Emotional Control	Initiate	Working Memory	Plan/ Organize	Org. of Materials	Monitor	BRI	MI	GEC
T Score	66	84	56	69	69	67	42	72	69	68	70
Percentile	94	≥ 99	73	98	96	93	25	98	96	95	95
Raw score	23	22	19	19	25	28	9	22	64	103	167
Missing	0	0	0	0	0	0	0	0	0	0	0

Like participants 1 and 2, participant 3 demonstrated hyperactive and inattentive behavior and had difficulty with regulating his body. During conversations and interactions, participant 3 would spin in circles. He had wood flooring throughout his house and his parents required that shoes be taken off at the door, so often he would be in only socks. He enjoyed the increased capacity to spin in circles due to the reduction in friction with the floor and had difficulty regulating his desire to spin. His parents and I had to ask him several times to stop spinning and give us his attention. If not spinning, he would hang on his parent, climb on the couch or lay on the floor. He also frenetically shook his legs while sitting. We meditated in his kitchen, sitting around the kitchen table. The chairs we sat it were dining chairs with padded seats and backs.

Participant 3's feet couldn't reach the floor. They rested on a bar connecting the two front legs, which gave him the resistance he needed to constantly bounce his legs. During program sessions he also was constantly distracted by items in the house, the toaster on the counter, the blinds in the window behind him, snacks or items on the table, he would constantly fiddle or play with these items until asked not to and often it took several requests to terminate the behavior. After a few sessions we started clearing off the table and putting away distractible items before we began. He also demonstrated similar fidgetiness to participants 1 and 2, constantly fidgeting with any items in reach and when those weren't available, he would fidget with his own fingers, toes or body.

Unlike participants 1 and 2, participant 3 had little to no difficulty with eye contact. Although, hyperactive and distracted behavior would often break eye contact, participant 3 didn't actively avoid it in the same way as the other participants. During attentive interactions, he never looked away or appeared to be anxious about creating eye contact. He also had little difficulty controlling difficult emotions. During observations he never demonstrated an emotional outburst, yelling or inappropriate defiance. Outside of his hyperactive mobility he was an even-tempered child.

A profound instance of acceptability occurred on week five, session three and continued until the end of the program. Participant 3 was a runner. He ran track for his local middle school and was competing in weekly events while our program was underway. At the end of week one we were discussing how we could apply mindfulness in our daily lives. It was not difficult for participant 3 the realize that mindfulness was applicable while running and he pointed out that both mindfulness and running require the participant to focus on their breath. I asked if he would be willing to try mindfulness at practice or during his next meet and he said he would.

Unfortunately, at the subsequent sessions, when I asked if he used mindfulness at practice or during a meet, he told me he forgot. It wasn't until week five, session three that participant 3 reported using mindfulness during his practice. He said he was reminded to use mindfulness because that week his track coach was teaching importance of breathing and focusing on your breath while running. He said he mentioned to his coach that he is learning mindfulness and that he was going to use it while he was running. He told me his coach supported this idea and that his coach was familiar with some of the research indicating that mindfulness can help with focus and self-regulation.

Continuing the conversation, I asked him, "How did you feel when you were running and practicing mindfulness?" He replied that he felt "like my breath was an ocean." Interested, I pressed for clarification, "Do you mean that all you could feel was the experience of breathing? Like it was so big in your experience it was all you could feel?" "Yeah, kinda" he replied, "I could feel myself running and I knew I was running well, I just felt like my breath was throbbing in my whole body." It was difficult to know exactly what he meant by his *breath was an ocean* and that it was *throbbing in his whole body*, so I asked him how he felt while this was happening, and he told me that he felt "focused." I also asked if he thought it helped his running and he said it did. I garnered from this conversation that it was a positive experience for him, he applied his mindfulness during running and was able to focus his attention primarily on his breath and that that focus helped him regulate his breathing, which in turn improved his stamina and performance on the track.

In the following sessions I continued to ask him if he was using his mindfulness while training and competing and he said yes. On the last day of our program, week eight, session 3, participant 3 had his final track meet. It was a huge competition between his school and several

others. He competed against several hundred students. When he arrived at our session, shortly after his meet, he was very excited to tell me how he had done. He had gotten 13th place! I was very excited for him and I told him how happy I was for him. I asked, "did you use your mindfulness?" To which he confirmed, "yeah, it really helped me stay focused on running as fast as I could."

I coded this experience as an instance of ease and convenience (EC). By applying mindfulness to his running, participant 3 demonstrates that the meditation, and thus the core element of the program, is easy and convenient to use and apply. If participant 3 regarded the program as difficult, inconvenient or otherwise unfeasible he may not have applied the meditation practice to his running. Furthermore, I believe the positive results in his running performance was an experience that facilitated further continuation in the program. The enhanced performance acts as a reward for utilizing the meditation. By continuing to engage in the program, participant 3 increases his ability to meditate, and he can then apply that increased ability to his running and further enhance his performance. The enhanced performance in running acted as a reward system for further participation.

Common Occurrences of Experiential Feasibility and Acceptability Across Participants

This section presents common instances in the data that indicate experiential feasibility and acceptability and occurred for all three participants. They can be understood as common patterns that occurred for all three participants.

For example, all participants completed the mindfulness program and furthermore each session within the program was completed in full. While some difficulty was observed for the participants during the program, these difficulties were not seen as instances of unfeasibility or unacceptability. Most difficulties occurred in the form of difficult emotions or irritating bodily

sensations. For example, at different times throughout the program all participants reported feeling bored, tired or distracted. They also exhibited bodily discomfort and often squirmed or re-positioned their body to find comfort. Despite these difficulties no participant requested to exit a session or to discontinue a meditation or the program as a whole, so these difficulties were coded as either tolerable or allowable and thus indications of program acceptability.

At various times all participants reported or expressed enjoyment or appreciation of the program and disappointment that the program was ending. Participant 1 had a large glass window in his living room from which you could see individuals walking up the driveway to the front door. I often observed him excitedly running to the door as he saw me coming up the driveway. I would ask him, "you excited to get started?" and he would always reply in the affirmative, indicating he was looking forward to participation in the program.

Participant 2 did something very similar; he would often be riding his bike in the driveway just as I arrived for the session. I asked him if he was waiting for me and if his bike riding meant he was excited to get started. He would always reply in the affirmative as well, indicating he too was looking forward to the program. While participant 2 did demonstrate some resistance in the first few weeks, he continued to ride his bike and wait for me in the driveway throughout the program. He never requested to exit a session and never felt uncomfortable to the point that continuing in the program was unsustainable. In the final weeks he did come to express appreciation for the program. In week seven, he thanked *mindfulness* directly or helping him calm down (this instance is discussed further below).

Even from early on in the program participant 3 reported feeling happy and joyful much more than both the other participants, he often mentioned that he "enjoyed the stillness of the meditation" or that he "liked practicing mindfulness." Participant 3 was also observed to apply

the mediation in his daily life more repeatedly then other participants, which is discussed more below. Furthermore, all participants expressed disappointment at completion of the program and participants 1 and 3 requested that the program continue, suggesting that they enjoyed the program and did not want to terminate it. All these instances were coded as enjoyment and were taken to indicate acceptability of the program.

Another interesting factor that facilitated feasibility and acceptability was the setting. Conducting the program in the home seemed to help with feasibility as participants appeared to be at ease and comfortable in such a familiar setting. Furthermore, I allowed them to select the specific place within the home where they felt most comfortable conducting the meditation. Participant 1 selected the couch in the living room. It was a soft, comfy and wide based couch. It was wide enough for him to cross his legs during meditation, which was his preferred style. When he felt too restless to sit cross-legged, he used the couch to lay down on. Sitting on the couch seemed to allow participant 1 to feel more at ease during program sessions and to release difficult emotions through bodily movement. Participant 2 elected to sit on the bed in a spare bedroom. He said he liked the privacy and he would always request that the door be shut, and the fan be turned on. He also utilized a pillow to sit on, allowing him to cross his legs more easily in front of himself. The comfort and privacy of the spare bedroom allowed for participant 2 to feel more at ease doing program sessions and it makes dealing with program difficulties more convenient. Participant 3 chose to sit in the kitchen. During our sessions his little sister had tutoring in her upstairs bedroom, which was directly across from his bedroom. He selected the kitchen because he thought we would avoid the distraction of the tutoring session in the next room. Meditating in the kitchen also allowed for him to easily access snacks and drinks during his session. Participant 3 was the only participant to request food and drink during his session.

This was probably due to the fact that participant 3 was coming directly from his track practices and meets, he was hungry and thirsty, so meeting these needs during program sessions was a way to make the program easier and more convenient for him.

Although it has its recommendations, the program does not require that meditation be practiced in a specific setting, place, or bodily position, so the inherent flexibility of the program design allows for the selection of comfortable settings and contexts, which was observed to make the program more feasible and acceptable to the participants.

One alteration was made to the original Mindful Schools program. The original program prescribes meditations of five to ten minutes throughout its entirety. Considering that individuals with EF impairments often have challenges with attention and impulsivity I adjusted the time prescriptions to one to three minutes in the beginning and then increased those boundaries to five to seven minutes and then seven to nine minutes if the participant was demonstrating the capacity to do so. All participants demonstrated interest in their capacity to meditate for a certain amount of time. The duration of meditation time became a rewarding challenge for each participant, like a game, where if they increased the meditation time, they reached the next level. They all expressed wanting to try for longer and longer periods of time. And when they reached those longer intervals, they were quite satisfied with their accomplishment. The enjoyment and satisfaction of the time intervals made the program enjoyable, easy and convenient for the participants and thus were accounted as instances of feasibility and acceptability.

Another factor that promoted feasibility and acceptability was the emotional environment or mood in which the program took place. Mindfulness is conducted with an attitude of non-judgement. This means that when the participants moved from their meditative position or became distracted in some way, that these were not viewed as errors or mistakes that needed

correction. Therefore, there was little correcting or scolding during program sessions and participants rarely appeared frustrated with their progress and no complaints about program participation occurred. This non-judgmental attitude is also complimented with an attitude of compassion and positivity. When a participant moved or was distracted but then returned to the meditation, which occurred frequently, this moment was responded to with positive reinforcement and encouragement. This created a program where aspects of one's behavior that are mal-adaptive and scolded in the home or society are transformed into opportunities to succeed in the meditation practice. This non-judgmental and positive attitude created an emotional environment in which the participants were comfortable trying something new and thus facilitated ease, convenience and enjoyment when participating in the program, which in turn indicates feasibility and acceptability of the program.

Furthermore, the core element of the program, the meditation itself, is not complicated. There are no strict requirements around breathing technique, body position or the setting in which the meditation takes place. While the practice of meditation comes with its guidelines of best practices these guidelines are simplistic and flexible. Breathing is allowed to be relaxed and natural. The body, (while sitting up-right is encouraged) can be in any position and the setting, as discussed, is extremely flexible. The participants all tried various breathing techniques to find which was best for them. At times they would breath fast or slow, through the nose or through the mouth, loud or quiet. They all tried various body positions as well, sitting cross legged, sitting with feet touching the floor, in chair, on pillow or laying down. This flexibility in the meditation requirements allows for a variety of practices to be acceptable. Because multiple methods of meditating are accepted it makes the program easy and convenient and thus feasible to participate in, each participant can find the best practices for themselves.

Aggregated Instances of Experiential Feasibility and Acceptability from Interview Probes

Data responses from the interview probes were discrete and thus easy to aggregate and tabulate. Table 2 presents the aggregated instances of feasibility and acceptability from the interview probe data. The sources of data are citations from across the participants during the informal interview probes. Data from the probes was examined for examples of when participants expressed instances of EC, TAE, II or DUA in relation to engaging in the mindfulness program. The number of times that a particular instance occurred was tabulated and is indicated by the (#) next to the data.

Conversely, no instances of unfeasibility or unacceptability occurred. Perhaps this has to do with the definition of the concept. Instances of unacceptability and unfeasibility would only have been coded and tabulated if they occurred *to the degree that program participation was unsustainable.* At no point in the program did a participant refuse to participate for any reason. They never ended a session early, they finished each meditation (three per session), and never requested to stop, each session and each meditation was completed in full. It's also worth discussing here that one could interpret instances of tolerance and allowance to be instances of unfeasibility or unacceptability. However, feeling bored, tired, itchy, being distracted etc. are natural occurrences that arise in the present moment. The nature of the mindfulness program is to deal with or regulate these feelings and sensations. Thus, when a difficult feeling arises and one tolerates or allows the meditation to continue, this can be understood as a moment of program engagement and participation rather than unfeasibility or unacceptability of the program. Furthermore, by acknowledging the awareness of a difficult feeling the participant is already demonstrating an awareness of a feeling or thought which could be understood as engagement in the program. This can be likened to the notion of productive struggle, where the participant

recognizes that engaging in or dealing with a difficult thought or feeling may not be pleasant, but may allow them to achieve a certain end. Because each participant was able to manage their difficult feelings and did not choose to exit the session, it was interpreted that these instances were in fact feasible and acceptable to the participant, insomuch as they were tolerable and allowable.

Table 2:

Concept, Definition & Code	Data	Data Source
Feasibility: Instances of ease and convenience when participating in the program. **Code:** EC	I felt good (54) I felt calm (46) I felt relaxed (11) I felt at ease (7) I felt peaceful (13)	Participant 1
	I felt good (48) I felt at ease (13) I felt quite (40) I felt calm (5)	Participant 2
	I felt good (54) I felt calm (58) I felt relaxed (31) I felt peaceful (25)	Participant 3
Sub Total:	**405**	
Acceptability: Instances of being tolerated, allowed or enjoyed. **Code:** TAE	I felt bored (33) I felt tired (42) I felt hungry (24) I was distracted (54) My skin felt like it has ants (16) I felt like I have to wiggle my toes (27) I felt itchy (28)	Participant 1
	I felt bored (43) I felt tired (36) I felt hungry (13) I was distracted (54) I had to fidget my fingers and/or toes (27) I had to open my eyes (19) I felt itchy (41)	Participant 2
	I felt bored (11) I felt tired (17) I was distracted (55) I felt hungry (7) I had to open my eyes (23) I felt happy/joyful (31)	Participant 3
Sub Total:	**581**	
Total:	**986**	

As we can see from table 1 there were a total of 405 instances of ease or convenience (EC) which were aggregated into 405 instances of feasibility. There were 581 instances of tolerance, allowance and enjoyment (TAE) aggregated into 581 instances of acceptability. It's important to note here, that during the interview probes only participant 3 reported feelings of happiness and joy, which were coded as enjoyment. In total there were 986 instances of feasibility and acceptability.

Instances of Feasibility and Acceptability from the Document Review

Behavior charts were created to track target behaviors for a single subject research project that was conducted concurrently with this feasibility study. On the chart, parents were asked to indicate the behavior, date, time, setting and then provide a brief description of the behavioral occurrence. The description section of these behavior charts was reviewed for instances of feasibility and acceptability using the codes outlined above. Unfortunately, no behavioral descriptions were connected or related to program feasibility or acceptability. It was assumed that in the description section, alongside behavioral descriptions, parents might mention aspects of the program that they found valuable or invaluable. However, no behavioral descriptions were related or connected to programming and thus could not be coded as instances of feasibility or acceptability.

Conclusion and Discussion

Feasibility and Acceptability

Common and unique instances of feasibility and acceptability were derived from participant observation and were analyzed across all three participants. Furthermore, discrete responses indicating feasibility and acceptability were derived from the informal interview probes. Unfortunately, no data indicating feasibility or unfeasibility was derived from the document review. Data from across participants and collection methods indicate that the program was procedurally feasible to conduct and experientially feasible acceptable to participants.

Procedural feasibility rates were high. All three participants were observed to attend, fully participate and complete each session, descriptive statistics indicate that attendance rates, participation rates and completion rates were 100%. These high rates were arguably due to the flexibility of meditation times, positive emotional experiences such as calmness and relaxation, the manageability of difficult emotional experiences and the non-judgmental and compassionate learning environment. This study suggests that these elements may be integral for the procedural feasibility of MBIs. The generalizability of the attendance, participation and completion rates are limited due to small sample size.

Experiential feasibility and acceptability, the experiences of ease, convenience, tolerance, allowance, and enjoyment were assessed through observation, informal interview probes and document review. They were analyzed alongside instances of unfeasibility and unacceptability, those experiences of inconvenience, impracticality, dissatisfaction or un-allowability. Data reveled that instances of ease, convenience, tolerance, allowance, and enjoyment were the only instances to occur. The occurrence of these feasible and acceptable experiences and the lack of unfeasible or unacceptable occurrences indicates that, for the participants, the experience of the program was both feasible and acceptable.

The greatest challenges to feasibility and acceptability were the reports of difficult emotions like boredom, impulsivity, distraction or hunger. However, these experiences only momentarily or mildly disrupted program participation. Because these emotions were well regulated or tolerated, and participants continued to engage in the meditation, they were not viewed as instances of unfeasibility or unacceptability. It was understood that by acknowledging the awareness of a difficult feeling the participant is already demonstrating an awareness of a feeling or thought which was interpreted as engagement in the program. These experiences were compared to productive struggle, where the participant recognizes that engaging in or dealing with a difficult thought or feeling may not be pleasant but may allow them to achieve a certain end.

Another reason these experiences were not viewed as unfeasible or unacceptable may have been due to the definition of the concept, which determined the coding of data. To be interpreted as an instance of unfeasibility or unacceptability the instance had to result in session or program unsustainability. Due to the fact that none of these more difficult occurrences resulted in the termination of a session or the program at large, they were not coded as instances of unfeasibility or unacceptability. Furthermore, the purpose of mindfulness meditation is not to avoid the experience of difficult emotion, it is the practice of regulating it. The experience of difficult emotion is natural, by regulating it properly and thus continuing the meditation the experience of difficult emotion cannot be understood as program disengagement.

Implications for Practice

The flexibility of the program design facilitated ease and convenience for each participant. Individuals with EF impairment can be quite distracted, intrigued or repulsed by certain stimuli in their environments. Seemingly innocuous objects or elements of their

environment can become large impediments to their progress in any program. This was certainly the case for all participants but particularly participant 3, who required the removal of several items within the meditation setting. The flexibility of this mindfulness program around setting, place and time seemed to allow the participants to be less involved with their surroundings and thus engage more easily in the program. When conducting MBIs for other adolescence with EF impairments flexibility in program setting, place and meditation time may improve participation and effects.

The emotional context was also found to facilitate feasibility and acceptability of the program for the participants. Individuals with EF impairments exhibit maladaptive behaviors that are often corrected or scolded by parents, teachers and others. The incorporation of these behaviors into the program and the treatment of these behaviors as opportunities rather than aberrations facilitated a positive and encouraging environment, which in turn promoted feasibility and acceptability for the participants. When conducting MBIs for other adolescence with EF impairments the ethos of non-judgement, compassion and positivity may increase participation and program effects.

The flexibility and simplicity in the meditation practice itself was also observed to aid feasibility and acceptability. Participants were observed to experiment with several breathing strategies and body positions. By not being too restrictive to the recommendations of mediation positions it allowed for participants to find practices that worked best for them. As long as these practices are acceptable to the instructor and not counterproductive to the engagement in meditation, the flexibility can facilitate feasibility and acceptability. The three participants in this study had difficulty regulating their body movements and many adolescents with EF impairments may have similar difficulties. Therefore, positions outside the recommended upright

seated position may be required and can promote feasibility and acceptability. Flexibility in program and meditation requirements alongside a non-judgmental, compassionate and positive learning environment may be the most important factors in promoting the feasibility and acceptability of MBIs for adolescence with EF impairments.

Due to the feasibility and acceptability of the mindfulness program, one should consider ways for bringing the program into school settings. One possible avenue is through teacher trainings. Providing workshops for teachers to learn the theory and practice of mindfulness programs could prove effective. These workshops could help teachers facilitate mindfulness programs based on the needs of students or other logistical constraints. Another avenue is to design programing that allows schools to offer mindfulness programs as stand-alone classes. Similar to math, science or social studies a student would have to take *mindfulness* as part of their graduation requirements.

Limitations and Future Research

While this study contributes to the current, but limited literature on mindfulness meditation. The results cannot be considered without understanding the limitations of the project. The study's findings are limited by such a small sample size. The small sample size calls into question of the generalizability of program feasibility and acceptability to other participants or age groups.

Findings are also limited by the lack of self-report and parent report satisfaction surveys or scales which can collect quantitative data. Specific surveys or scales such as the Children's Intervention Rating Profile (Witt & Elliott, 1985) and the Behavior Intervention Rating Scale (Elliott & Von Brock Treuting, 1991) are designed to asses participant satisfaction in an intervention or program. The inclusion of surveys and scales could provide quantitative data that,

if aligned with qualitative data could provide a sounder foundation for conclusions. The conclusions of this study remain limited due to the entirely qualitative nature of the data allowing for alternate explanations or misinterpretation of the data.

Considering the natal state of mindfulness research in general, future studies should continue to examine the feasibility and acceptability of MBIs for adolescents with EF impairments as well as other populations. Adapting existing or creating new programs designed to meet the needs of adolescents and other children with EF impairments may be necessary for future studies to be feasible and acceptable. Specific aspects of adapted or novel approaches should be assessed for feasibility before boarder implementation in research and practice. Furthermore, more randomized controlled trials and single-subject research is necessary to determine specific program effects. More studies need to examine the effects of mindfulness on cognition, specifically on EF and attention. Future studies should also examine the effects of mindfulness on adaptive behavior.

Studies could also examine parent involvement in treatment. Specifically, parents participating in a co-occurring mindfulness program designed to support their adolescent children in mindfulness skill development. Examination of teacher involvement is also interesting considering that improvement in EF could also impact academic outcomes.

Appendix A

What is Mindfulness?

A recent definition of mindfulness comes from Zeidan, Martucci, Kraft, McHaffie, and Coghill (2014), in an article examining mindfulness and its neural correlates they write, "mindfulness meditation is premised on stabilizing attention, acknowledging discursive sensory events as 'momentary' and 'releasing' them without affective reaction" (p. 751). That is, phenomena that enter the individual's awareness or experience during mindfulness practice are attended to but are not evaluated as good or bad, true or false, important or trivial. The practitioner may feel something (physical or emotional) and my think something, but no reaction is necessary. The practitioner is disciplining or focusing the mind to, simply pay attention to experience (Marlatt & Kristeller, 1999).

There is also an attitudinal component to mindfulness which emerges from the practice of non-judgement. It emphasizes pro-social behavior through cultivating the character traits of honesty, kindness and compassion for self and others (Davidson et al., 2012). Also noteworthy, is the ethical component of mindfulness which emphasizes nonviolence, the abolishment of ignorance in favor of *right action*, but as we will discuss in more detail in the next section, this aspect of mindfulness is less emphasized in the more secular approach adopted by scientists, clinicians and educators in America.

Mindfulness has become a recent and growing interest in clinical, intervention and educational studies (see Baer, 2003; Kabat-Zinn, 2003 for full reviews). Removed from its traditional context, it has become a form of mental and behavioral training that is intended to produce changes in cognitive and emotional processes, reduce stress or even reduce primary symptoms for many medical conditions, mental illnesses or developmental disabilities. Mindfulness has been shown to produce positive changes for clinical patients, atypical individuals and healthy

individuals. These changes are commonly measured in terms of attentional and cognitive abilities, the regulation of negative affect, ruminative thoughts and/or behavioral changes (Khoury et al., 2013). Early intervention studies have shown mindfulness to reduce both primary symptoms and related stress across a variety of medical conditions, including but not limited to: cancer (Witek-Janusek et al., 2008), brain injury (Bedard et al., 2005), fibromyalgia (Grossman, Tiefenthaler-Gilmer, Raysz, & Kesper, 2007), sleep disturbance (Howell, Digdon, Buro, & Sheptycki, 2008) and obesity (Singh et al., 2008). Other studies have shown mindfulness to reduce externalizing behavior, particularly oppositional-defiant problems and conduct problems in mental disorders such as Attention-Deficit Hyperactivity Disorder (Mitchell, Zylowska, & Kollins, 2015), anger and aggression problems (Singh, Lancioni, Winton, Adkins, Wahler, et al., 2007), and it has been shown to reduce ruminative thoughts, increase quality of life and prevent relapse in both depression (Kuyken et al., 2008) and generalized anxiety disorder (Evans et al., 2008) (see Baer, 2003; Kabat-Zinn, 2003; Khoury et al., 2013 for full reviews).

Under the umbrella of Mindfulness there are several techniques. The observational techniques are commonly known as Mindfulness of Body, Breath, Thought & Emotion. There is also the cultivate technique, which centers on using one's attentional abilities to cultivate positive emotions. Each technique brings with it a particular quality of awareness. I will not review all the techniques here but for example, in Mindfulness of Body, one's attention is centered on the *inner body*, as it is, moment by moment. The inner body is the felt experience of our body as a whole and its particular parts. Considering that all experience: physical, mental or emotional is experienced in the body, one is able to use this technique to gain awareness of these sensations as they arise. The goal is to develop a response to them, a mindful awareness of bodily sensations, so the practitioner can decide what to do with these sensations rather than simply react to them.

This technique is assumed beneficial in situations where some mental or physical restraint, inhibition or stability is required.

Another example is Mindfulness of Breath. In this technique, the practitioner is actually observing their patterns of thought. The breath is used as an *anchor* for the mind, a place where a mental effort is concentrated in order to restrain attention. While the goal of the technique is to focus on the breath, to be entirely present with the breath, of course, the mind naturally wonders. When one becomes aware that their mind has wondered, they gently and non-judgmentally bring their focus or attention back to the breath. This develops the ability to *know* or have awareness of when the mind is unfocused, distracted or getting of track. This technique is meant to develop attentional control or executive attention, which increases one's ability to *pay attention on purpose*. These various techniques are not different from mindfulness, they are all ways to practice paying attention to the present moment non-judgmentally. The techniques are various avenues that one can practice to bring awareness to different aspects of experience and reality. One way of understanding these techniques is to think of them as different doors to the same room. Whether you enter the front, back or side door, you will still arrive in the same place: mindful awareness.

When introducing new meditators to mindfulness, practitioners are commonly instructed to sit in a chair, with a straight spine, feet flat on the floor with hands on the thighs or held in the lap. However, there is no particular body positioning that is required by mindfulness. Mindfulness can be practiced laying down, sitting cross-legged on the floor or even while moving. Furthermore, there is no particular pattern or type of breathing, like in other meditative practices. The practitioner is instructed to find a bodily position that is comfortable, relaxed but activated and to breath naturally. The meditations can be for as little or as much time as one

wants, there is no minimum or maximum length of time (see Gunaratana, 2011, for a full description of mindfulness techniques and its practices). Several studies have shown significant changes or benefits for participants meditating for as little as 5-minutes a day for periods as short as 6-8 weeks (Khoury et al., 2013).

Origin and History of Mindfulness in the U.S.

While American scientific institutions have separated mindfulness from its traditional context and focused on its cognitive and affective qualities, some argue that mindfulness cannot be fully understood outside of its traditional context. Therefore, it's important to consider the history and the constitution of the western notion of mindfulness when considering utilizing it in secular settings.

The English word mindfulness already existed before it was applied in the meditative context in the states. It comes to us from the translation of a French word *pensee* which means thought, translated by John Palsgrave in 1530 as: mindfulness (Stein, 2004). In 1881, Thomas Williams-Rhys Davis, a Pali language scholar, translated the Pali word *sati* to "right mindfulness; the active, watchful mind" (p.21). Pali is particularly important, as it is the language used in many ancient Hindu religious texts as well as all the Theravada Buddhist texts which are the religious traditions most commonly associated with mindfulness (Stargardt, 2000). It was translation by the Pali language scholars of the time that provided the West with access to Eastern religious thought and traditions (McMahan, 2008).

It is worth noting that practices of attention, awareness and concentration as methods for spiritual insight are recognized across a variety of religious traditions, such as Hinduism, Christianity and Islam (Davidson et al., 2012; Williams & Kabat-Zinn, 2013). For example, Gunaratana (2011) points out two practices in the Judeo-Christian tradition: prayer and

contemplation. He defines prayer as "a direct address to a spiritual entity" (p.23) and contemplation "as a prolonged period of conscious thought about a specific topic, usually a religious ideal or scriptural passage" (p.23). He argues that from the perspective of mental cultivation practices, both of these activities are exercises in concentration, as normal thought patterns are restricted and awareness is *concentrated* to one area of operation. Therefore, in a technical sense, mindfulness could be considered to have a plurality of histories when discussing its influence in the West, each lineage stemming from a different religious context.

While mental cultivation practices can be found across several religious traditions, each having their unique history, the Theravada Buddhist tradition of Vipassana meditation is most closely associated with mindfulness. Vipassana is the oldest of the Buddhist meditation practices and Gunaratana (2011) defines it as "insight into the true nature of reality" (p.21). Gunaratana describes Vipassana as a gradual cultivation of mindful awareness, piece by piece over time, where one's attention is turned inward to become increasingly aware of one's own life experiences. He describes the objectives of Vipassana meditation as "leaning to see the truths of impermanence, unsatisfactoriness, and selflessness of phenomena" (Gunaratana, 2011, p.25). Vipassana and mindfulness are linked by their emphasis on turning attention and awareness inward to develop insight or self-discovery. In the Vipassana tradition there are many religious traditions, specific rites, rituals and gods that meditators (monks) must follow in order to be considered to have attained certain levels of awareness (Williams & Kabat-Zinn, 2013). However in America, mindfulness has become a growing interest in clinical, intervention and educational studies, in which these aspects of Vipassana are left behind, and the mental practices of mindfulness emerges (Baer, 2003; Kabat-Zinn, 2003).

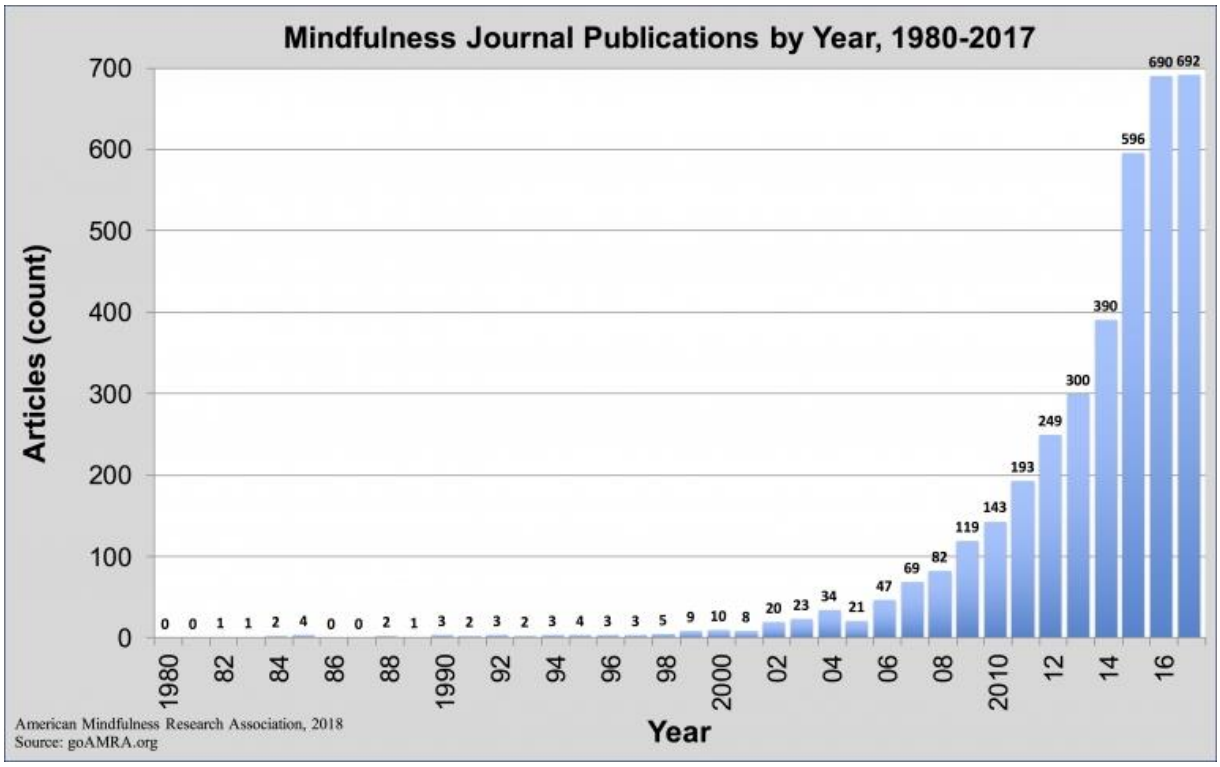
The man responsible for peeling off the shell of religious traditions and bringing scientific attention to the core aspect of mental cultivation is Jon Kabat-Zinn. In 1979, Kabat-Zinn founded the Mindfulness-Based Stress Reduction Program (MBSR) at the University of Massachusetts and started the scientific investigation into mindfulness practices for both unhealthy and healthy individuals. Kabat-Zinn studied mindfulness under several Buddhist teachers, including Thich Nhat Hanh (who has published books on a Western approach to mindfulness and meditation himself). One of several techniques in the MBSR program is the *body scan*, a practice where one directs their attention to their inner body and scans from top to bottom, bringing awareness to tense or painful areas in hopes of reducing pain or related stress, this practice is known as *sweeping* in traditional Vipassana meditation (Kabat-Zinn & Hanh, 2009). However, MBSR leaves the religious traditions of Vipassana behind and focuses solely on its methods of mental cultivation.

To date there have been two major reviews of MBSR, one in 2003 by Dr. Ruth Baer and the other in 2011 by Fjorback et. al. Throughout the 90's and early 2000's mindfulness was primarily used in medical settings, treating patients with chronic pain, mental illnesses like anxiety or depression and other conditions like cancer, fibromyalgia or psoriasis (Baer, 2003). In Baer's review, ample evidence was found to support MBSR as an effective method for the reduction of pain, stress and primary symptoms across all these categories (2003). While the application of mindfulness to medical conditions has continued (see Gotink et al., 2015, for review) in the late 2000's there was a turn towards mental health, with a new focus on mood disorders like generalized anxiety disorder and depression. In Fjorback's review MBSR was found to be effective for improving mental health and reducing symptoms of stress, anxiety and

depression for multiple disorders (2011). Kabat-Zinn's integration of mindfulness with Western science was a crucial aspect in helping mindfulness gain widespread popularity in the West.

The understanding of mindfulness is growing in scientific complexity and is treated much more as a psychosocial construct, than a religious or traditional practice. In the 20 years from 1980 to 2000 a mere 58 studies utilizing mindfulness were published (Association, 2018). In the following years from 2001-2017, a flourishing of 3,636 studies have been published, spanning the fields of medicine, education, psychology, neuroscience, and more (Association, 2018).

Figure 4:



Today, mindfulness itself is a pop culture icon. There is *Mindful* magazine which offers guidance and connections to mindfulness institutions as well as featuring the stories of celebrities, athletes and scientists and their experiences with mindfulness. Articles have been published in Time Magazine, Jon Kabat-Zinn was interviewed by Oprah for her Super-soul Sunday Podcast and Pete Carroll of the NFL's Seattle Seahawks was featured by Wisdom 2.0, a

group dedicated to spreading the message of mindful living, for his incorporation of mindfulness into his coaching philosophy and practice. Mindful Schools was founded in 2007, an online certification program that focuses on integrating mindfulness into the everyday learning environment of K-12 classrooms. The flourishing of research has continued as well, there are mindfulness centers at every UC school in California and The American Mindfulness Research Association was founded in 2013, which hosts a data base for all published articles utilizing mindfulness and funds research nationwide. This history outlines how mindfulness has grown in the U.S. from obscure Eastern tradition to a well-studied cognitive-affective intervention and that the results of mindfulness practice are scientifically predictable, measurable and verifiable.

How Does Mindfulness Work? A Neuro-Cognitive Approach

The cognitive mechanisms of mindfulness that produce effective results are not fully understood. However, most theories pose an interactive model that involves attention and attitude that form a meta-mechanism or meta-cognition (see Grecucci, Pappaianni, Siugzdaite, Theuninck, & Job, 2015; Hayes-Skelton & Graham, 2012; Hölzel et al., 2011; Shapiro, Carlson, Astin, & Freedman, 2006 for various models). This meta-cognition is

> "characterized by a decentering from environmental and internal psychophysiological stimuli or processes, to produce a reflective space in which new ways of perceiving and responding become possible, rather than enacting habitual automatic or ruminative patterns" (Grecucci et al., 2015).

From this slightly detached, non-judgmental, meta-cognitive state, it is hypothesized that one can modify cognitions and affective evaluations to sensory events through cognitive and emotional reappraisal processes (Shapiro, 2006; Garland, 2009; Goldin and Gross, 2010). Mindfulness meditation is thus, the practice of creating a cognitive gap between the observing self and one's emotions and cognitions in an attempt to reappraise oneself and respond with volitional, adaptive or functional behavior.

In Shapiro et al. (2006) the authors termed this reappraisal process *reperceiving* and they

likened it to other psychological concepts such as *decentering* (Safran & Segal, 1990, cited in Shapiro et al.), *deautomatization* (Deikman, 1982; Safran & Segal, 1990, cited in Shapiro et al.) and *detachment* (Bohart, 1983, cited in Shapiro et al). Shapiro et al. further define the concept of reperceiving within a developmental context in which reperceiving is the natural process by which an individual gains objectivity towards the subjective experiences of their life. The authors note the developmental processes of young children who, over time are eventually able to see themselves as separate from the objective world in which they had previously been embedded. They posit that mindfulness is an extension and acceleration of this natural developmental process and that through sustained practice more consistent and effective reperceiving can be attained (2006).

In Grecucci et al. (2015), a review paper exploring mindful self-regulation and its neurocognitive mechanisms, the authors point out that executive attention or attentional control processes "may be involved in the purposeful focusing of attention and reappraisals that allow for a new way of understanding the person's observing position and the transitory nature of external and internal experience" (p.4). Refining attentional control is a central concept of all models of mindfulness practices (Malinowski, 2013). There are typically two types of attentional control in mindfulness practice: Focused Attention (FA) and Open Monitoring (OM).
In the context of mindfulness, FA is commonly associated with executive attention or attentional control a "top-down processes whereby the meditator engages executive attention and control in order to engage with experience" (Grecucci et al., 2015, p.4). OM is commonly understood as a bottom-up experiential processes "whereby the person remains conscious of raw unprocessed present-centered experiencing" (p.4).

While FA and OM can be considered distinct, during meditation the practitioner is often

experiencing some aspect of both. Typically beginning meditators will start by practicing FA (by focusing on the breath, for example) to develop attentional stability, clarity and awareness of the current cognitive state (Malinowski, 2013). Once a degree of FA is achieved the practitioner can then move into the OM practices, which involve an attentiveness to all aspects of experience.

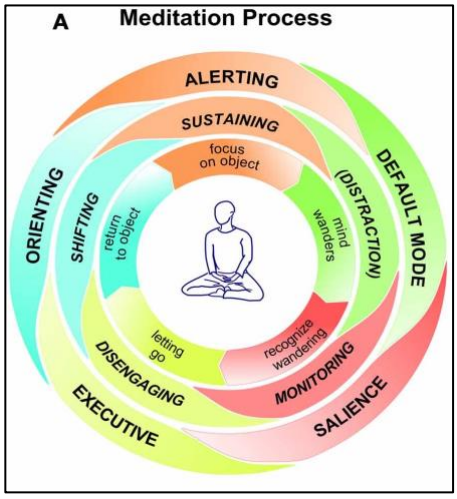
Attentional processes are typically understood as having three main attentional networks: Alerting, Orienting and Executive control (Jha, Krompinger, & Baime, 2007). Each of these functions is coordinated by different neural networks in the brain, which I will discuss further in the following section (see Malinowski, 2013 for a full description of the attetional neural networks). Important to note however, is that the anterior cingulate cortex (ACC), lateral ventral cortex, prefrontal cortex, and basal ganglia contribute to the executive control network, which, as we will discuss further in chapter 2, are also part of the neural networks that facilitate executive functions.

Malinowski (2013) adds two more neuro-cognitive networks supported by recent neuroimaging research. He points out that the executive attention process is subdivided into what he calls the salience network. The salience network is utilized by the practitioner to detect, "subjectively relevant or *salient* events across modalities (cognitive, homeostatic, or emotional) and provides signals to the executive network to act upon in accordance with the current goal set" (p.3). Using the work of Schooler et al. (2011) he points out the second additional network, that during meditation the default mode network becomes active. However, this is only when the practitioner becomes distracted or is mind-wandering.

The following figure A is taken from Malinowski (2013) where he considers the 5 networks interacting in the meditation process on three levels. The first level is the phenomenological level, the level of the meditators experience. On the second level are the

attentional processes and the third level is the underlying brain networks facilitating those processes. One can understand the process as follows: the meditator begins by focusing on an object or aspect of experience like the breath, the meditator tries to sustain attention and the alerting network is active. When the mind wanders or gets distracted the default mode network is more active. Eventually the meditator will notice the mind wandering via the attention monitoring process and the salience network becomes activated. The executive network activates as the meditator transitions or lets go of the distracting thoughts or feelings and works with the

Figure 5:



orienting network to shift attention back to the object of meditation, where sustaining attention is re-engaged, and the process begins again.

It's important to note that Malinowski designed the figure with overlapping edges to indicate that these attentional processes and neural networks are often working in conjunction with one another and may be more or less active at the same time (2013). Whether its focused attention (top-down attentional control) or open monitoring (bottom-up experiential monitoring) it is attention and the attentional brain networks that facilitate the meta-cognition and reappraisal processes and allow for the self-in-situation to be properly regulated.

Does Mindfulness Improve Executive Functions?

Although models and definitions of executive function (EF) differ considerably, EF are those cognitive mechanisms that regulate adaptive behaviors such as; the ability to inhibit impulsive responses, modulate emotions, initiate problem solving or activity, sustain working memory and attention, attention switching, organize or plan, and conduct the self-monitoring of behavior. The EF network is highly associated with PFC activation and is thought to provide important neuro-cognitive mechanisms for goal-directed behavior and decision making throughout development and are also considered foundational for adolescent and adult sociomoral behavior (Barrasso-Catanzaro & Eslinger, 2016). We will discuss the relationship between EF and the brain in more detail in the following section.

EFs are an important area of study because EF has a broad effect on our ability to achieve academic success and social integration. For example, in a review by Wiebe et al. (2014), they point out research that indicates strong EF has been correlated with stronger language abilities and impairment in EF has been linked to deficits in language capacity. Furthermore, higher EF skills have had a positive influence on early math skills and reading proficiency. The authors also point out that EF has been linked to theory of mind, which requires children to interpret and understand the perspective of others, thus making it difficult for children with EF impairments to fit in. They also examine research for Children with EF impairments, particularly those children with ADHD or Autism, reporting that often these children show deficits in several components of EF, displaying weaker inhibition, a poorer working memory, and greater difficulty switching tasks. Finally, they note that EF in early development can enhance school performance and reduce the prevalence of psychopathology and is more important for school readiness than IQ. Mindfulness has been shown to improve several EF processes such as: both sustained attention

(Chambers, Lo, & Allen, 2008) and attention switching (attentional flexibility, Hodgins and Adair, 2010), working memory (Chambers, Lo & Allen, 2008;), inhibitory control, (Heeren, 2009;), decision making and goal management (Alfonso, Caracuel, & Delgado-Pastor 2011), and self-monitoring and self-regulation of emotions (Teasdale, 1999).

For example in a study by Chambers, Lo, and Allen (2008) twenty non-clinical adults were recruited voluntarily from a meditation course and placed into a meditation group. Twenty more adults were recruited from the wait-list for the course and from university psychology classes and were placed into a non-meditation, control group. Participants from the meditation group underwent a 10-day meditation course while the control group did not. Both groups were tested twice (T1 and T2), utilizing self-report scales and performance measures of EF. The Digit Span Backward (DSB) was used as a measure of working memory and a new scale developed by the researchers, the Internal Switching Task, was used to measure sustained attention and attention switching. T1 occurred directly after the meditation course and T2 was administered 7-10 days later. Results for the digit span backwards test indicated that "the mindfulness training group demonstrated a significant increase across the two time points, while the control group demonstrated no significant change. This was underscored by a significant time by group interaction for DSB scores" (p. 312). Results were similar for the internal switching task which showed "that the mindfulness training group's overall RTs significantly improved from T1 to T2, whereas the controls' did not" (p. 313). These findings indicate that mindfulness may improve the executive functions of working memory, sustained attention and attention switching. It's also worth noting that during this study those in the mediation group showed significant improvements on the self-report scales for mindfulness, rumination (less ruminative thinking) and negative affect (decreased depressive symptoms). This study is consistent with results from

other studies that include the examination of mindfulness' ability to improve working memory, (Quach et al., 2016; Salazar, 2018), sustained attention (de Bruin, van der Zwan, & Bogels, 2016; Moore & Malinowski, 2009) and attentional flexibility (Chiesa, Calati, & Serretti, 2011).

Another study by Sahdra et al. (2011) examined the relationship between mindfulness, inhibition control and what they operationalized as adaptive functioning. Sixty participants were recruited by advertising in various mindfulness magazines, meditation centers and websites. They were split into two groups, one meditation retreat group (R1) and the other was a wait-listed group that underwent the same retreat after the comparison (R2). Through stratified matched assignment the groups were matched in age, sex, meditation experience, education, marital status and annual income. Participants practiced meditation for six to ten hours a day for three months in an isolated retreat setting. Laboratory assessments which included a response inhibition task to measure inhibitory control and self-report questionnaires were conducted at pre- mid and post retreat 1 and 2 with a follow-up at five months.

Pre-retreat, participants in R1 were given the inhibition task for difficulty calibration and were required to score an 85% or higher, while being assessed for speed and accuracy. Post-retreat, and using hierarchical linear regression, results on the change in the inhibition task were significant for R1 (R1: $B = .046$, $p < .0001$) demonstrating an increase in average speed and accuracy rates and suggesting improved inhibitory control compared to that of the control group. Once the control group went through their own meditation retreat, improvements in the inhibition task were significant (R2: $B = .011$, $p = .02$). Results from both groups support the hypothesis that mindfulness improves inhibition control. It should also be mentioned that post retreat both groups reported significant improvements in adaptive functioning. This study supplements that of others reporting improvements in inhibition control after periods of

mindfulness meditation (Chiesa et al., 2011; Friese, Messner, & Schaffner, 2012; Heeren, Van Broeck, & Philippot, 2009).

Another area where mindfulness is showing improvements in EF is in the self-monitoring of thoughts and behaviors. The self-monitoring of thoughts and behaviors is often referred to as meta-cognition, the ability to have thoughts or to be aware of your own thinking, and often, mindfulness has been construed as a model for meta-cognition more broadly (Jankowski & Holas, 2014). In a study by Kok and Singer (2017) two hundred and forty two adult, non-clinical participants were divided into three training cohorts. There were no significant differences between the groups in gender, age, personality or mental health. Participants received thirteen weeks of training from the ReSource Project, a nine-month, module-based training program consisting of four meditation techniques across three modules: presence, affect, and perspective. A battery of assessments were utilized consisting of mostly pre and post training questionnaires (see Singer et al., 2016 for a full list). Using a three-level hierarchical linear model results showed that after the perspective module for all three groups, "observing-thought meditation led to the largest statistically significant increase in thought awareness of all four practices [and] observing thoughts also significantly decreased distraction by thoughts" (p. 224). Indicating that after the nine-month training (thirteen weeks for the perspective module) participants were able to improve their meta-cognitive abilities.

These results are supported by another study from Sanger and Dorjee (2016). Their non-randomized study of 16 - 18-year-olds as compared to a control group, examined the indexing of attention processing using an EEG to monitor event related brain potentials (ERP). Of particular examination in the brain was the N200 (N2) ERP component, which is activated in conflict tasks and is a marker of response inhibition. More negative N2 responses indicate better target

detection and inhibition of automatic responses. Alongside a battery of self-report questionnaires assessing mindfulness, mind-wondering and meta-cognition, ERPs were monitored during an oddball attention task. Results showed "significantly more negative N2 amplitudes after training," indicating "enhanced task-relevant inhibitory control of attention" (p. 8). This enhanced control of attention was "associated with improvements in negative thought controllability and reductions in students' hypercritical self-beliefs" (p. 5). The results of these studies alongside others (Jankowski & Holas, 2014; Teasdale, 1999) provide evidence for the efficacy of mindfulness and its ability to improve the self-monitoring of thoughts and behavior.

Perhaps the most widely known area of research concerning mindfulness and EFs is in the area of emotional control and self-regulation. For example, returning to the study done by Kok and Singer (2017) during the affect module participants were taught the loving-kindness meditation, a meditation designed to produce other-centered thought and cultivate positive emotional states as well as prosocial motivations. Using mostly self-report measures and a three-level hierarchical liner model to analyze the data, results showed that "during loving-kindness meditation, participants reported the greatest increase in positively valanced thoughts and in fact, were the only group to show statistically significant positive change in that variable" (p. 223-224). The authors also report that after the loving kindness meditation thoughts of self and others were experienced as subjectively warmer, kinder or more loving. Furthermore, "this thought pattern was negatively associated with negatively valanced, past-focused thoughts" (p. 227). Suggesting that after the loving-kindness module participants were more capable of monitoring the content of their thoughts and actively changing thought from negative or past centered, to positive and present centered indicating an ability to positively regulate affective states through the self-monitoring or self-regulation of thought.

A study by Chambers et al. (2008) examined the effect of a short but intensive meditation training on a non-clinical adult population. Using self-report scales and cognitive performance measures a group of twenty novice meditators were tested before and after a ten-day intensive mindfulness retreat and compared to a control group. The Ruminative Responses Scale (RRS) was used to assess rumination and reflection, while rumination and reflection are thought processes studies have shown them to be linked with depressive symptoms and as such it can serve as a measure of affect (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Aspects of dysphoria were assessed using the Beck Depression Inventory (BDI), levels of anxiety were assessed using the Beck Anxiety Inventory (BAI) and mood was assessed using the Positive and Negative Affect Schedule (PANAS). Using a series of repeating measures t-test procedures and ANOVA results showed:

> "the mindfulness training group demonstrated significant improvements in scores on the MAAS, [mindfulness scale] RRS reflection, BDI, and PANAS Negative Affect scales. These improvements were specific to the mindfulness group, as indicated by significant group by time interactions combined with the fact that each of these measures displayed a significant within-group repeated measures change for the mindfulness training group, but not the controls" (p. 311-312).

Furthermore, a correlation analysis was done to assess whether the improvement of mindfulness, as according to the MAAS scale results, were significantly associated with improvements in the other affect scales. Results demonstrated significant correlation between improvements in mindfulness and "decreased scores on the BDI ($r = .49$), BAI ($r = .28$), RRS reflection ($r = .36$), and increased scores in the PANAS positive affect ($r = .37$). These results demonstrate that mindfulness can reduce depressive and anxiety symptoms and decrease negative mood states while enhancing positive mood states.

In another study by Schonert-Reichl et al. (2015) the authors examined the effects of a social-emotional learning program (SEL) for fourth and fifth grade children called MindUp (Hawn-Foundation, 2008) which is based on Mindfulness practices, and compared them to a

control group of children the same age who underwent a social responsibility program. The study assessed the students across several variables: 1) executive functions, using the flanker task and a hearts of flowers dots task, (2) stress regulation, assessed through samples of the students salivary cortisol levels (3) well-being and prosociality, assessed though various self-report scales (e.g, empathy, perspective taking, optimism, emotional control, social responsibility etc.), (4) peer nominations of prosociality, assessed by having peers vote for their classmates that fit particular behavioral characteristics and (5) year-end teacher-rated math grades, collected from school records. It was hypothesized that students would demonstrate an increase in every area except on the self-report scale of social responsibility because control group procedures focused on this area as well.

Via multilevel modeling, the EF data revealed that children in the SEL group were faster but no less accurate in all EF tasks:

> "For the flanker switch trials task at posttest, MindUP children showed significantly shorter RTs than comparison children, $F(1, 92) = 4.32$, $p = .04$, $d = -.21$, and outperformed comparison children on incongruent flanker and reverse flanker trials as well, indicating a greater ability to selectively attend and inhibit distraction, $F(1, 92) = 5.54$, $p = .02$, $d = -.31$. Similar results were obtained for the hearts and flowers task: At posttest, the MindUP children showed significantly shorter RTs on trials in the hearts and flowers incongruent condition than did comparison children, $F(1, 87) = 4.00$, $p = .04$, $d = -.22$ but were not less accurate, as reported earlier" (p. 59)

Results from ANCOVA of salivary cortisol levels revealed no significant differences between groups after posttest, however after conducting a MANCOVA for the entire set of self-report scales results showed "a significant main effect for group, $F(7, 88) = 2.14$, $p = .04$" (p.59) and

> "follow-up ANCOVAs indicated that, in contrast to children in the [control] group, children in MindUP showed significant improvements from pre- to posttest in empathy, $F(1, 97) = 4.42$, $p = .03$, $d = .42$; perspective-taking, $F(1, 97) = 4.17$, $p = .04$, $d = .40$; optimism, $F(1, 97) = 5.40$, $p = .02$, $d = .48$; emotional control, $F(1, 97) = 8.78$, $p = .004$, $d = .59$; school self-concept, $F(1, 97) = 5.60$, $p = .02$, $d = .50$; and mindfulness, $F(1, 97) = 7.94$, $p = .006$, $d = .55$; and significantly decreased depressive symptoms, $F(1, 97) = 4.14$, $p = .04$, $d = -0.45$" (p.59).

The opposite was true for children in the control group, who demonstrated decreases in all of the above self-report scales. No significant difference was found for the social responsibility scale,

as hypothesized.

The author's conducted another MANCOVA for the entire set of peer nominations and results showed "a significant multivariate effect for intervention across all measures, $F(7, 88) = 4.36$, $p = .001$" (p.60) they then continued with ANCOVA of the difference scores. Results revealed that children from the MindUp group were:

> "more likely to improve from pretest to posttest on almost every dimension of peer-nominated prosocial behavior: sharing, $F(1, 97) = 4.42$, $p = .04$, $d = .42$; trustworthiness, $F(1, 97) = 13.44$, $p = .001$, $d = .76$; helpfulness, $F(1, 97) = 13.05$, $p = .001$, $d = .72$; and taking others' views, $F(1, 97) = 18.90$, $p = .001$, $d = .87$" (p.60).

The findings for the *kind* dimension were not significant however, the MindUp group also had "significant decreases in peer-nominated aggressive behavior from pretest to posttest for breaks rules, $F(1, 97) = 8.07$, $p = .006$, $d = -.55$, and starts fights, $F(1, 97) = 13.95$, $p = .001$, $d = -.71$" (p.60). Results on the math grades also demonstrated a trend toward higher year-end math grades for children in the MindUp group. Schonert-Reichl et al. (2015) provides evidence that after a mindfulness program, students are more capable of emotional control and have the ability to reduce their own depressive symptoms and that they are also able to self-regulate behavior and improve both prosocial behaviors like sharing and trustworthiness while avoiding anti-social behavior like fighting and breaking school rules.

Mindfulness can also alter the way individuals process emotion in the brain. In a study by Farb et al. (2010) the authors examined recovery from emotional challenge and the increased tolerance of negative affect measured by fMRI and self-reports. Thirty-six participants were recruited through their enrollment in a Mindfulness Based Stress Reduction (MBSR) class. Twenty of them were placed in the mindfulness group and were scanned after their mindfulness training and sixteen were placed in a waitlisted control group, who were scanned before their mindfulness training. The Beck Depression Inventory–Second Edition (BDI-II) was used to

assess depressive symptoms, The Beck Anxiety Inventory (BAI) was used to assess anxiety and the Symptom Checklist 90 Revised (SCL-90-R) was uses to assess across participant psychopathology. Mindfulness was delivered through the MBSR training program and consisted of eight weeks of training at two hours per week.

The researchers used a sadness provocation procedure during the study to examine participants recovery and tolerance of negative emotion. Participants were shown 4 sets of film clips with accompanying audio. The clips were considered sad and neutral. The order of presentation was always the same; neutral/sad/neutral/sad (they were presented in alternating order so as not to load too heavy on the sad clips). While in the fMRI participants were shown 4 clips from the neutral set, and then given a 36 second baseline. They were then presented with 4 clips from the sad set and given another 36 second baseline. The baseline between each set was used as a baseline to establish the independent effects of the sad and neutral clips.

Initial ANOVAs demonstrated that the sad clips did indeed have a significant negative mood effect compared to the neutral clips and post training analysis revealed "the mindfulness training group showed substantial reductions in depression, anxiety, and somatic distress following training" (p. 27). And when analyzing the brain scans it was indicated that the mindfulness group altered the way they processed sadness in the brain. In the control group, analysis revealed a midline network that is associated with ruminative and self-reflective thought processing. This network activated the ventral medial prefrontal cortex (vmPFC), dorsal medial prefrontal cortex (dmPFC), and the posterior cingulate and was accompanied by several left-brain activations. There were also notable areas of deactivation in the right viscerosomatic cortices and bilaterally in superior parietal regions and extending into the somatosensory regions. Upon comparing the mindfulness group to the control group, the authors "found that despite

similar levels of self-reported dysphoria, the MT group demonstrated less neural reactivity to sadness provocation than the control group" (p. 31) despite the fact that both groups showed midline activation when responding to sadness "the MT group demonstrated reduced reactivity to both medial and lateral regions" (p.31). And significantly reduced deactivation associated with the mindfulness training group "specifically, the reduced deactivation in the insula during dysphoric challenge may therefore be associated with increased interoceptive awareness" (p. 31) and the down regulation of the response to sadness. The authors suggest that mindfulness training cultivates a metacognitive or interoceptive awareness, that shifts the processing of sadness from a more cognitive process, that may induce more negative appraisals of the emotion, to a more sensory process that allows for more bodily processing of the emotion and thus requires less of a regulatory response. This study is supported by other evidence that mindfulness produces changes in the neural pathways associated with self and emotion regulation (Gotink, Meijboom, Vernooij, Smits, & Hunink, 2016; Hatchard et al., 2017; Y. Y. Tang, Holzel, & Posner, 2015).

Thousands of studies have been published in just the past few years that provide evidence for mindfulness' ability to improve EF and it would be impossible to review them all here. The purpose of this section has been to review several key studies outlining and providing evidence for the capacity of mindfulness to produce cognitive changes in EF and suggest that those changes are underwritten by alterations in the associated neural mechanisms. Here we have provided evidence that mindfulness can positively increase working memory, inhibition control, sustained attention and attentional flexibility, self-monitoring or meta-cognition and emotional and behavioral control. While there are limitations is study design and some studies demonstrate negative results, it is commonly understood that mindfulness is an effective practice for

improving EF (for further reviews see Chiesa et al., 2011; Davidson et al., 2012; Leyland, Rowse, & Emerson, 2018).

How Does Mindfulness Alter Executive Functions? A Neuro-Cognitive Hypothesis.

This section will examine some of the neuro-cognitive networks that substantiate and develop attention and EF. The propose of this section will be to highlight the centrality of the prefrontal cortex activation in EF, executive attention and Mindfulness and from there examine the theory that mindfulness is able to improve EF through the development of executive attention in the pre-frontal cortex.

The prefrontal cortex (PFC) is the largest lobe of the human brain and has very complex patterns of neuronal interconnectivity, both within the lobe and to the rest of the brain. It receives information from all of the major senses and other important areas and requires the longest time to fully mature, continuing its development at least into the late 20s (Barrasso-Catanzaro & Eslinger, 2016). The PFC is most associated with top-down executive or cognitive control of emotion, behavior and thought (Cole & Schneider, 2007; Miller & Jonathan, 2001) and is also thought to underlie the process of cognitive reappraisal (Shapiro et al., 2006). In their encyclopedic work Murray, Wise, and Graham (2016) map the areas of the PFC. They describe the PFC as composed of 5 subdivisions which, in turn, are composed of 15 smaller areas known as the Brodmann areas. The first main sub-division is the medial prefrontal cortex (mPFC) which encompasses the anterior cingulate cortex (ACC) the infralimbic cortex and prelimbic cortex. The second is the orbitalfrontal cortex (ofPFC) then the ventrolateral prefrontal cortex (vlPFC), dorsolateral prefrontal cortex (dlPFC) and lastly the caudal prefrontal cortex (cPFC).

As mentioned in the previous section, scientific understanding of the EF construct is not complete. It seems to be on a spectrum of theoretical and empirical understanding. Initial

theories argued that EF was a unitary construct, a central executive system that controls other aspects of cognition (Wiebe et al., 2014). This was actually a theory of executive dysfunction because this view was anchored to evidence that when the Pre-Frontal Cortex (PFC) is impaired due to injury or disease, behaviors associated with EF were also impaired (Banich, 2009; Hill, 2004a). Later on, other theories became more modular, some suggesting that specific regions within the PFC were responsible for specific tasks. For example, Petrides (2005) suggested the inferior lateral regions of the PFC were responsible for holding information in working memory while other regions, namely the mid-dorso-lateral prefrontal cortex perform executive control processes on that information, suggesting that EF tasks are divided into distinct modules. Other neuroimaging studies of EF have revealed active networks outside the PFC. For example, Dosenbach et al. (2007) & Fair et al. (2007), identified distinct networks involved in different aspects of cognitive control. They found one network is comprised of frontoparietal connections across regions such as dorsolateral prefrontal cortex, intraparietal sulcus, and precuneus. They hypothesized this network "to be involved in trial-to-trial adaptation, task-initiation, and error adjustment" (Dosenbach et al., 2007, p.11073) The other network is composed of "cinguloopercular connections across areas used in the continuous maintenance of task-sets, including anterior prefrontal cortex, anterior cingulate cortex, anterior insula, and ventral prefrontal cortex, along with sensory areas in the occipital and temporal cortex" (Dosenbach et al., 2007, p.11076).

Work by Banich (2009) reviews several models of EF before proposing her own *integrated account*, where the dorsolateral pre-frontal cortex (DLPFC) engages an attentional system that focuses on task relevant responses and ignores task-irrelevant responses, while the mid-DLPFC selects specific items that are only task relevant. She notes that posterior portions of

the anterior cingulate cortex (ACC) become involved if information could result in two competing responses and that the dorsal ACC is related to response evaluation and becomes more active when inaccurate responses are more likely. In Banich's model she proposes a *cascading-of-control*, meaning that the more one is utilizing the attentional system of the DLPFC the less one is reliant on the subsequent processing systems and the less active those systems become. Meaning that attentional development could result in the selection of the most appropriate stimuli and goal related behaviors could be governed by the executive control areas of the pre-frontal cortex rather than the downstream areas which can become active during EF tasks, but may not be the result of attentive, goal-directed cognitive processing (2009). Whether the model is unitary, multi-modal or integrated all models revolve around the activation and utilization of the pre-frontal cortex (PFC), making the PFC an integral aspect of EF.

Evidence of the centrality of the PFC in EF comes to us from two main sources, cases of PFC injury or damage and from cases of atypical development. Because structural PFC damage is rare in the childhood population most of the evidence in this area is built on individual cases, which is quite extensive, but for our purposes I will only review a couple of examples. Barrasso-Catanzaro and Eslinger (2016) highlight a young boy named "JP." JP was of average intelligence and language capacity, but his EF was uniquely impaired and unresponsive to any treatment. In school he was disliked by his class mates, his school work was erratic, and his behavior was often self-serving and rule-breaking. "There were no indications of birth trauma, developmental anomaly, or family stressors. Medical evaluation revealed congenital damage to the prefrontal cortex and hence a lack of prefrontal cortex to mediate EF" (Barrasso-Catanzaro & Eslinger, 2016, p.111). Similarly, Barrasso-Catansaro and Elsinger (2016) point to another case from Eslinger, Grattan, Damasio, & Damasio (1992): "DT" had normal developing EF until the age of

7 when she underwent the removal of a left pre-frontal lesion.

> "By early adolescence she began showing progressive and chronic change in her EF, emotions, and social adjustment, having difficulties in school and with friends. When evaluated as an adult, DT demonstrated profound EF and sociomoral reasoning deficits" (Barrasso-Catansaro & Elsinger, 2016, p.111).

Thus, the removal of the left prefrontal lesion was associated with the arrest of her EF and psychosocial development (for a more thorough review see Eslinger, Flaherty-Craig, & Benton, 2004).

The second body of research that highlights the centrality of the PFC in EF is the literature on Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactive Disorder (ADHD). Research has demonstrated that atypical development in PFC regions has led to EF impairment for individuals with ASD, most commonly resulting in social, emotional and communication disfunctions (Chen et al., 2016; Pellicano, 2012). In addition, the ridged and repetitive behavior linked with ASD is typically associated with alterations in the PFC and reduced connectivity between the PFC and other regions. The reduced connectivity between the PFC and other regions has been shown to impair cognitive functions like memory, EF and emotion regulation (Just, Keller, Malave, Kana, & Varma, 2012). Similarly, ADHD is commonly associated with an underdevelopment or delayed development in the PFC, as well as reduced activity in the PFC when children with ADHD are given EF tasks (Helpern et al., 2011). Of these tasks, children with ADHD have been found to have the greatest impairments in the EF areas of inhibition control and working memory (Merz & McCall, 2011), whereas children with ASD have the most profound EF deficit in theory of mind abilities (Mundy, Sigman, & Kasari, 1994). This evidence, taken with the evidence from the cases of structural damage, highlight the centrality of the PFC in EF.

Mentioned in the previous chapter, we know that the PFC is involved in cognitive

reappraisal processes: the ability to monitor and re-evaluate ongoing subjective experience (Cole & Schneider, 2007) and we also know that the process of mindfulness meditation is very akin to the process of cognitive reappraisal (Hayes-Skelton & Graham, 2012). Therefore, the rest of this section will cover some of the research connecting mindfulness to the PFC. However, as we examine the link between mindfulness and the PFC it's important to note that mindfulness mediation engages a set of brain regions, not just the PFC, and PFC activation varies across levels of training (Zeidan, 2014).

In a study by Creswell, Way, Eisenberger, and Lieberman (2007) they examined what is called dispositional mindfulness, a type of mindfulness believed to be inherent to an individual, this could be analogous to a level of awareness or conscientiousness that an individual has. Despite individual differences in this capacity, people who reported high levels of dispositional mindfulness have also been shown to have low stress reactivity, lower levels of amygdala activity at rest (a brain structure associated with emotion regulation), fewer posttraumatic stress symptoms, better sleep quality and physical health. A key aspect of dispositional mindfulness and mindfulness in general is its ability to regulate emotion, which may underlie the fore mentioned benefits (Zeidan, 2014). In their study 27 participants completed an affect labeling task while undergoing functional magnetic resonance imaging (fMRI). They were compared to a control group that went through a gender-appropriate naming task. "After controlling for multiple individual difference measures, dispositional mindfulness was associated with greater widespread prefrontal cortical activation, and reduced bilateral amygdala activity during affect labeling, compared with the gender labeling control task" (Creswell et al., 2007, p.562).

In another study of dispositional mindfulness Modinos, Ormel, and Aleman (2010) found that individuals with high dispositional mindfulness were more successful at regulating

emotional responses to negative mood-inducing images. Using the fMRI, 18 people engaged in the negative image appraisal task and reported on their emotional experiences afterward. Similar to Creswell et al. (2007), Modinos et al. (2010) found that dispositional mindfulness was associated with the top-down regulation of the amygdala by the PFC, with greater activity in the PFC inversely correlated with decreasing activity in the amygdala, suggesting that higher dispositional mindfulness modulates cognitive control of negative emotion through the PFC.

Other similar results have been found when individuals, (who did not report their dispositional mindfulness or trait mindfulness) went through brief mindfulness trainings. Trainings of less than 1 week have resulted in improved cognitive skills (Mirams, Poliakoff, Brown, & Lloyd, 2013) and both pain and stress reduction (Zeidan et al., 2014). Using fMRI Zeidan et al. (2014) assessed the neural correlates of three groups of meditators undergoing a brief four-day training (20-minutes a day). The first group was a pain free, healthy group, the second had reports of physical pain and the third group reported experiences of anxiety. Each group was taught a slightly different aspect of mindfulness, the healthy group was taught to focus on their breath in a non-judgmental way, the pain group was taught to attend to the experience of their pain in a non-judgmental way and the anxiety group was trained to attend to their anxiety in a non-judgmental way. For each group "the brain mechanisms supporting mindfulness meditation, revealed that this training engaged multiple brain regions that process executive level cognitive control (PFC, ACC) and sensory evaluation (anterior insula and secondary somatosensory cortices)" (Zeidan et al., 2014, p. 254). Several studies on brief mindfulness trainings, those less than one week, yield similar results as well (e.g. Mirams et al., 2013; Y.-Y. Tang, Tang, & Posner, 2013; Zeidan et al., 2010).

Evidence of longer trainings also support the activation of the PFC by mindfulness

meditation. Mindfulness based stress reduction (MBSR) is an eight-week training program where participants receive daily group practice, weekly home practices (recorded meditations) and a one-day silent mediation retreat. In a randomized controlled trial by Kilpatrick et al. (2011) thirty two healthy women were assigned to either the MBSR group (n=17) or an eight week waiting period (n=15). After the eight weeks, participants in both groups were instructed to meditate while in the fMRI scanner. Results demonstrated an increase in neural connectivity relative to those in the control group. "Increased connection from the PFC and ACC were found between the auditory cortex associated with attentional and self-referential processes, stronger anticorrelation between auditory and visual cortex and stronger anticorrelation between visual cortex and areas associated with attentional and self-referential processes" (Kilpatrick et al., 2011, p.293). Not only does the study highlight the connection between the eight-week MBSR training and the activation of the PFC and other executive control areas but Kilpatrick et al. also concluded that "These findings suggest that 8 weeks of mindfulness meditation training alters intrinsic functional connectivity in ways that may reflect a more consistent attentional focus, enhanced sensory processing and reflective awareness of sensory experience" (2011, p. 296). In a similar study done by Farb, Segal, and Anderson (2013) they examined the brain activity of graduate students who completed the MBSR training and compared them to a waitlisted control group and again, found activation of the PFC and ACC with increased connectivity to other regions, they suggest that "PFC modulation of attention networks may be an important mechanism by which mindfulness training alters information processing in the brain" (p.22). The results found by Kilpatrick et al. (2011) and Farb et al. (2007) are reinforced by several other studies examining mindfulness through MBSR and that demonstrate neural activation in the executive control processes of the PFC (see P. Goldin, Ziv, Jazaieri, & Gross, 2012; P. Goldin,

Ziv, Jazaieri, Hahn, & Gross, 2013; P. R. Goldin & Gross, 2010 for further review). It is also worth pointing out that the evidence from dispositional mindfulness, short-term mindfulness and 8-week training and its relationship to the PFC is supported by the examination of long-term meditators as well (e.g. Hölzel et al., 2011; Manna et al., 2010; Short et al., 2010; Zeidan, 2014). Although, often in long-term meditators the PFC and other top-down control mechanisms like the ACC can show deactivation compared to naive-meditators. It is hypothesized that this deactivation is associated with a *shift* towards a "higher-order awareness reflecting a greater acceptance of sensory experiences without the contextual elaboration or interpretation of those respective events" (Ziedan, 2014, p. 178). This theory is supported by the evidence demonstrating a greater activation in the sensory regions of the brain for long-term meditators (Manna et al., 2010).

It is importatnt to note here, that at least one and typically several sub-divisions of the PFC are activated and utilized in every model of EF mentioned above and to remember that the PFC and ACC are also activated in Malinowski (2013)'s model of mindfulness and the executive attention network. When taken together this evidence suggests that the PFC may serve as the neurobiological link between the attentional development of mindfulness meditation and its ability to improve EFs. (see also Abdullaev & Posner, 2009; Engle & Kane, 2004; Kane & Randall, 2002; Posner, Rothbart, Sheese, & Voelker, 2014 for PFC activation associated with attentional control).

With the knowledge that mindfulness, attention and EF all share an executive attention network in the PFC and other top-down cognitive control areas of the brain, it seems plausible that mindfulness is able to improve EF through the development of attentional abilities and the executive attention network. In fact, there is evidence that executive attention is the foundational

cognitive mechanism that moderates cognitive control and EF more broadly. In a study by McCabe, Roediger, McDaniel, Balota, and Hambrick (2010), the authors point out how executive attention has been conceptualized in neuropsychology as executive functioning and conversely, defined as working memory capacity by experimental psychologists. In their study of 206 participants aged 18-90, using factor analytics, they found "the correlation between working memory capacity and executive functioning constructs was very strong (r = .97)" (p.14), and after applying tests of EF, working memory capacity, perceptual speed, vocabulary and episodic memory the authors concluded "that tests of working memory capacity and executive function share a common underlying executive attention component that is strongly predictive of higher-level cognition" (p.15). McCabe et al. (2010) points out two clear ways in which executive attention may play a role in EF: "The first is the ability to maintain a goal in an active state during task performance" (p.15) which is also associated with the role of working memory capacity. The second "is the ability to resolve interference, particularly when there is conflict between a prepotent response and task demands" (p.15) which is commonly associated with EF (also see Banich, 2009; Braver, Gray, & Burgess, 2007).

A follow up to McCabe et al.'s (2010) study, was done by Samarina (2014). Samarina used a population of 121 older adults and a battery of tests that were designed to be used in a shorter period of time. One-tailed Pearson correlations were used to determine if there was a significant relationship between working memory and executive functioning. Results indicated "that working memory was correlated with all but one executive functioning measure" (p.64). More specifically, she notes "EF measures were correlated with working memory (ps < .05), with the exception of the D-KEFS Category Switching task (r = .145, p = .056). Color Naming and Word Reading tasks, which are parts of the D-KEFS Color-Word Interference test, were

highly correlated (r = .795, p < .001)" (p.62). Results of this study demonstrated a high correlation between working memory and EF. Similar to McCabe et al. (2010), Samarina (2014) used factor analysis to load working memory and EF into a single factor to produce the executive attention construct and she hypothesized that executive attention would then uniquely predict memory. A regression analysis was conducted to examine if executive attention correlated with verbal memory. Results indicated that executive attention "significantly accounted for 16.1% of the total variance of the Delayed Recall condition from the RAVLT ($R2$ = .161, F = 22.75, p < .001) Therefore, the executive attention factor was a significant predictor of verbal memory (β = -.401, p < .001)" (p.72). A regression analysis was also done to see if the executive attention construct was related to visual memory. Results indicated that the "executive attention factor significantly accounted for 24.4% of the total variance of the Delayed Recall condition from the Visual Reproduction II (R^2 = .244, F = 38.41, p < .001). Therefore, the executive attention factor was a significant predictor of visual memory (β = -.494, p < .001)" (p.72-73). The results of Samarina (2014) support those found by McCabe et al. (2010) and indicate a strong correlation between working memory and EF and both studies suggest that a unitary construct of executive attention underlies their functioning. This evidence, taken into the context of mindfulness seems to support the idea that mindfulness can improve executive functions through the strengthening or development of the executive attention network of the prefrontal cortex. It is worth noting here that the evidence presented by both McCabe et al. (2010) and Samarina (2014) seem to support a unitary construct for EF, but both researchers were reluctant to make such a claim and offered suggestions for further research.

Attention is typically understood as having three networks: alerting, orienting and executive control/executive attention (Petersen & Posner, 2012) and most evidence indicates that

these are distinct and separable networks (Fan, McCandliss, Fossella, Flombaum, & Posner, 2005). Despite evidence that mindfulness improves all three of these attentional networks (see Jha et al., 2007) I will focus briefly on the evidence that mindfulness improves executive attention because it seems likely that it is through the development and activation of the executive attention networks, that mindfulness is able to improve EF.

For example, in a study by Zeidan et al. (2010) a group of sixty-three, meditation naive, students from the University of North Carolina were placed into two groups: meditation or book listening. Self-report measures on mindfulness and mood were used alongside a battery of cognitive measures that included the Symbol Digit Modalities Test, verbal fluency test, and the hit runs on n-back task, which are understood to require sustained attention and executive attention processing efficiency. At start, baseline measures indicated no differences in mindfulness, attentional or other cognitive abilities between the two groups. After baseline, participants in the meditation group underwent four sessions of meditation (20-minutes per session) while the control group listened to twenty minutes of reading. Results revealed "that brief mindfulness training was effective at improving performance on several cognitive tasks—Symbol Digit Modalities Test, verbal fluency, and the n-back task" (p.601) with MANOVA scores demonstrating "a significant group by session interaction, $F(6, 42) = 2.28$, $p = .05$, $g2 = .25$; a main effect of session, $F(6, 42) = 10.66$, $p < .001$, $g2 = .60$; and no effect of group, $F < 1$"(p.601). The researchers concluded that their mindfulness protocol "promoted significant effects on several cognitive tasks that require sustained attention and executive attention (i.e. improvement on the Symbol Digit Modalities Test, verbal fluency, and the hit runs on n-back task)" (p. 602).

In another study by Moore and Malinowski (2009) they used two groups, a group with

previous meditation experience and a matched control group. The meditation group consisted of 25 Buddhist meditators from a local center where mindfulness meditation is the prominent practice. All members had completed at least a 6-week course on mindfulness meditation. The naïve group consisted of local adults from several professions. The Kentucky Inventory of Mindfulness Skills (KIMS) was used to assess levels of mindfulness and the d2-concentration and endurance test was used to assess attentional performance and attentional flexibility. The d2 test allows for an estimation of individual attention and concentration performance as it measures processing speed, rule compliance, and quality of performance. Scores from a Stroop task were also included. A correlational matrix was used to correlate the KIMS scores with performance scores from the Stroop and d2 tasks. The researchers found "positive correlations with the d2-scores TN ($r = .510$, $p < .001$), TN - E ($r = .620$, $p < .01$), CP ($r = .667$, $p < .01$) and the Stroop-score TNP ($r = .331$, $p < .05$)" (p.180). Indicating that high levels of mindfulness correlate with better performance in processing speed and attentional control. They also found "negative correlations with the d2-errors E ($r = -.527$, $p < .001$), E1 ($r = -.493$, $p < .001$), E2 ($r = -.398$, $p < .01$) and the Stroop error SE ($r = -.780$, $p < .001$) signifying that higher levels of mindfulness are linked to reduced errors across measures, suggesting greater attentional control" (p.181).

These studies suggest that both brief mindfulness training for individuals with no mindfulness experience and those with a particular level of mindfulness can develop or have greater attentional abilities such as greater sustained attention or attentional control and they support the hypothesis that mindfulness can improve or develop executive attention. These studies are congruent with other studies of mindfulness and attention. For example, a study by A. Moore, Gruber, Derose, and Malinowski (2012) found increases in sustained attention and increased neural activity in executive attention networks after a brief mindfulness training.

Suggesting that mindfulness not only increased the cognitive aspect of attentional abilities but alters the underlying neural substrates. In a recent study by Peng, Wenna, Chengjing, and Lingfeng (2018) after a seven week meditation course they found improvements in the executive attention networks as assessed by the Attention Network Test relative to controls. Another study utilizing the Attention Network Test and the Flanker test (another task utilizing sustained, executive attention) Norris, Creem, Hendler, and Kober (2018) found superior performance in novice meditators compared to control groups, again, supporting the notion that mindfulness can improve or develop cognitive attentional abilities, specifically executive attention.

In review, EF is the neuro-cognitive mechanism that supports goal-directed behavior, decision making and is foundational for adolescent and adult sociomoral behavior. EF is also crucial for more effective learning, academic achievement and social integration. While there is debate over the precise model of EF, there is emerging evidence that suggests that executive attention is the primary construct that underlies executive functions. Interestingly, EF, executive attention and mindfulness, share and activate similar neural networks in the brain, mostly in the PFC, the region most associated with cognitive control and cognitive reappraisal. This suggests that mindfulness, as the practice of attentional skills, may alter and improve EF through the development of a shared executive attention network.

In fact, a study by Taren et al. (2017) provides some evidence for this model. In their study the authors examined the dorsolateral prefrontal cortex (dlPFC), because it is a central region of the executive control network and has a primary role in moderating EF tasks and controlling behavior. The authors hypothesis a dlPFC-specific pathway by which mindfulness may improve EF by creating more functional connectivity between the dlPFC and other regions that coordinate EF, specifically: intraparietal sulcus, frontal and supplementary eye fields,

posterior parietal cortex, temporoparietal junction, ventrolateral frontal cortex and the inferior frontal gyrus. By using fMRIs to measure resting state functional connectivity (a proven method for evaluating inter-regional connectivity (Greicius, 2008)) before and after meditation training Taren et al. (2017) found the:

> "left dlPFC showed increased connectivity to the right inferior frontal gyrus (T = 3.74), right middle frontal gyrus (T = 3.98), right supplementary eye field (T = 4.29), right parietal cortex (T = 4.44), and left middle temporal gyrus (T = 3.97; all $p<0.05$) following mindfulness training relative to the relaxation control. Right dlPFC showed increased connectivity to right middle frontal gyrus (T = 4.97, $p < 0.05$)" (p. 16-17).

Upon these results the authors concluded that mindfulness training increased resting state functional connectivity between the dlPFC and other regions. This study, alongside others (see Froeliger et al., 2012; Qin, Hermans, van Marle, Luo, & Fernández, 2009), provides evidence that mindfulness improves EF by increasing connectivity between the executive attention network and other control regions in the brain.

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