# A NEUROPSYCHOLOGICAL EXAMINATION OF THE EFFECTS OF MINDFULNESS MEDITATION IN ELEMENTARY SCHOOL CHILDREN

by

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This thesis was prepared under the direction of the candidate's thesis advisor, Dr. Nancy Aaron Jones, Department of Psychology, and has been approved by the members of her supervisory committee. It was submitted to the faculty of the Charles E. Schmidt College of Science and was accepted in partial fulfillment of the requirements for the degree of Master of Science.

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ABSTRACT

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Many recent studies have confirmed that mindfulness meditation has wide ranging potential to improve the mental health and well-being of adults, though few studies have explored its potential to help younger populations. In the current study, a sample of 4th and 2nd grade students was trained in the techniques of mindfulness meditation. Baseline electroencephalograms (EEGs) were taken before the training, and again after a 10 week period of daily meditation practice. Measures of attention, creativity, affect, depression, behavioral inhibition/activation, emotion regulation, impulsive/aggressive behaviors, and social anxiety were also administered before and after the meditation practice period. Results indicate that mindfulness meditation produces increased relative left-frontal alpha activation, a brain pattern that has been associated with increased positive affect and more adaptive coping responses to aversive events. Significant post-meditation improvements in depression and creativity were also found in the experimental condition.

This thesis is dedicated to my Aunt Sue

And to the light and beauty that burns within us all

“There is a place on the mountain nearby

Deep in a cave, but it’s up rather high

There in the darkness I’ve safely concealed

All of the dreams that you never revealed

And if you go there

And after you do

All of these dreams will be yours to pursue

The rest of your lifetime, devoid of a care

If you keep your eyes open

~if you keep your heart open~

You may find yourself there”

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## *Introduction*

For thousands of years, meditation has been practiced to enhance the well-being of individuals seeking clarity, relaxation, and enlightenment. There are two traditional forms of meditation, concentrative meditation and mindfulness meditation. Concentrative meditation (the most commonly practiced of the two) (Kristeller, 2007) entails focusing on a single object, such as a mantra, a flame, or a concept like world peace. Mindfulness meditation, which has made recent gains in research interest, differs in that one's attention is more diffuse and fluid during practice. Mindfulness stems from the Buddhist practice of Vispassana, or "insight meditation" and is most often associated with the Thai Theravadan tradition (Kristeller, 2007). Both of these meditation forms have the common goal of relaxation and quieting of the mind.

Mindfulness is defined as "the awareness that emerges through paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn 2003). When practicing mindfulness meditation, one cultivates a certain type of attention that nonjudgmentally reflects on the contents of the mind. Any type of external or internally generated stimuli that impinges upon one's consciousness (wondering what to cook for dinner, joy, the phone ringing, etc.) is acknowledged, but not pursued - it receives no further judgment or analysis. Instead, the meditator is instructed to bring her or his focus back to the breath. Through many repetitions of this process, one cultivates a sense of non-reactance. The result is that the meditator is no longer preoccupied with the

past or the future - the attention is completely and nonjudgmentally engaged in the present.

Since the 1970's, there has been a growing interest in studying the clinical applications of meditation. Psychologists began by citing meditation's relaxation and stress-reducing effects as its primary benefit (Benson, 1975), but current research indicates that its practice has much broader implications for mental health and well-being. There are several well-known forms of psychological treatment utilizing mindfulness techniques, including Jon Kabat-Zinn's Mindfulness-Based Stress Reduction program (MBSR; Kabat-Zinn, 2003), Marsha Linehan's Dialectical Behavioral Therapy (DBT; Bohus et al., 2000), and Steven Hayes's acceptance and commitment therapy (ACT; Hayes, Strosahl, & Wilson, 1999). Mindfulness techniques have also been used in group therapy, retreats, and individual therapy for the treatment of stress and other mental health issues (Kristeller, 2007).

Research has demonstrated that mindfulness is a promising treatment for a wide range of issues, including anxiety (Kabat-Zinn et al., 1992; Miller et al., 2005), depression (Teasdale et al., 2000), attention and ADHD in adults and children (Semple et al., 2006; Zylowska et al., 2008), anger management (Singh et al., 2007, Woolfolk, 1984), conduct disorder (Singh et al., 2007), borderline personality disorder (Linehan, 1993), emotion regulation (Arch & Craske, 2006; Kurtz el al., 1985), addiction (Marlett et al.), a variety of eating problems (Kristeller & Hallett, 1999; Kristeller et al., 2006), psychosis (Bach & Hayes, 2002; Chadwick, Taylor, & Abba, 2005), sexual difficulties (Brotto & Heiman, 2007), chronic pain (Kabat-Zinn et al., 1985, 1987), fibromyalgia (Goldenburg et al., 1994; Astin et al., 2003), psoriasis (Zabat-Zinn, Wheeler et al., 1998),

and immune functioning (Davidson et al., 2003; Carlson et al., 2003). These studies often combine mindfulness with other treatments such as cognitive therapy and stress reduction. Although multi-treatment approaches can be very successful, this becomes problematic when the direct effects of mindfulness are obscured by the effects of the other treatment approaches. It is therefore essential to direct research efforts towards the exclusive examination of mindfulness meditation.

The vast majority of mindfulness research has concentrated on adult populations, which suggests an important need to explore its effects throughout the course of development. Notably, a few studies exist that have begun to examine the effects of mindfulness meditation on children. A review of some such studies by Semple, Lee, and Miller concludes that "mindfulness in children is acceptable and feasible," although "research in this area has barely begun" (2006, p.164). It seems likely that children would benefit from meditation in many of the same ways that adults do (by reducing their stress, anxiety, depression, etc.). Additionally, there are many potential benefits that are specifically relevant to children. The majority of children lead lives that are frequently controlled by adults which may lead them to experience a lack of personal agency or a sense of running on "auto-pilot" (Fodor & Hooker, 2008). Mindfulness can help to reverse this trend of absent-minded detachment. Mindfulness is also of particular relevance to children because of its implications for improved emotion regulation. Since children often experience emotions more intensely than adults (Fisher, 2006), it is crucial that they develop effective means of regulating them early in life. Additionally, mindfulness shows potential for improving children's attention (Chambers, Lo, & Allen, 2008; Zylowska et al., 2008). This line of research is highly salient in the current

psychological climate where ADHD diagnoses have gone from rare to almost 8% of American children and stimulant prescriptions are steeply rising (Eisenberg, 2007). Meditation has the potential to be a healthy, effective, and free alternative to prescribing amphetamines to our children.

Many psychologists are beginning to encourage schools to incorporate meditation into their curriculum. Teachers who have experience with meditation in the classroom note that "it helps to create a happier, healthier, and more focused learning environment" (Fisher, 2005). Others have called it "the purest form of personalized learning" (Fisher 2006). Since meditation requires no special materials or costly resources, it seems to be a highly practical addition to a child's education.

It is important to heed the advice of Piaget that children are not merely "miniature adults,"- it is crucial that the teaching of mindfulness to children be developmentally appropriate (Jha, 2005). Thus, certain steps must be taken to ensure that meditation training is effective in a younger population. For example, instead of using the typical 20-40 minute sessions, shorter 5-10 minute sessions can be used for children (Foder & Hooker, 2008). Additionally, it can be helpful to use metaphors when teaching mindfulness (Thompson & Gauntlett-Gilbert, 2008). For example, attention can be likened to a young puppy learning to sit. At first, it will only sit for a moment before wandering off. This is to be expected of a puppy, and it does not make sense to react angrily. The best solution is to notice where the puppy ran off to, gently bring it back, and try again. Through time, the puppy and the child's attention will learn to be still (Kornfield, 2003).

It is also important to note the age of the children that are being taught mindfulness techniques. It has been thought that children need to be in Piaget's stage of formal operations (starting around age 12) before they can learn these methods (Wagner, Rathus, & Miller, 2006), but it has also been suggested that those in the concrete operations stage (approximately ages 7-12) can benefit from mindfulness (Veruyn, 2000). To our knowledge, there has been no empirical research performed to determine a lower age boundary at which children can be taught meditation skills.

The current research seeks to expand the knowledge of the effects of mindfulness meditation on children. The first dimension that we wish to examine is brain wave activity, especially in light of the paucity of research on the subject (Ivanovski & Malhi, 2007). In general, it has been demonstrated that meditation produces increased activity in the alpha and theta bands as well as a decrease in overall frequency (Andresen, 2000; Davidson, 1976; Delmonte 1984). Davidson et al. (2003) used electroencephalographs (EEG) to conclude that mindfulness meditation produces significant increases in left-sided anterior activation in an adult population. This area has been found to be associated with positive affect, including both transient experiences of positive emotion and dispositional positive affect (Davidson et al., 1990; 1992).

Therefore, we found it pertinent to assess mood in our study. In addition to assessing transient mood states, we wish to investigate more stable mood issues such as depression. Mindfulness' efficacy in alleviating adult depressive symptoms has been explored by several researchers, including extensive use in John Teasdale and colleagues' Mindfulness-Based Cognitive Therapy. It has been found to be effective at treating adult

depression (Ma & Teasdale, 2004; Teasdale et al., 2000), but has not been studied extensively in younger populations.

We also seek to examine the relationship between mindfulness and children's creativity. Some researchers have suggested that mindfulness is an "ideal preparation for creative activity" (Fisher, 2006). Studies have concluded that mindfulness meditation has the potential to increase creativity through the removal of perceived incompetence (Grant et al., 2004). Research done by Sanchez and Jones (2008) has found that mindfulness meditation increased children's elaboration scores on a divergent thinking task, which is currently one of the foremost methods for assessing creativity.

Additionally, this study will look at mindfulness' effect on social anxiety in children. Since mindfulness meditation has been extensively linked to decreases in adult anxiety (Kabat-Zinn et al., 1992; Miller et al., 1995; Kabat-Zinn, Chapman, & Salmon, 1997) it seems that it would also be effective in younger populations, although research investigating this hypothesis is very sparse (for example, see Semple et al., 2005). To our knowledge, there is no research regarding mindfulness' effects on social anxiety in children. However, previous adult research has demonstrated that mindfulness techniques are effective in increasing performance in social situations and reducing social anxiety (Block & Wulfert, 2000). Dekeyser et al. support the idea that mindfulness and social anxiety are negatively correlated, and have concluded that people who are more mindful express themselves in social situations more frequently (2008).

We will also examine the effect of mindfulness on impulsive behaviors in children. These types of behaviors include verbal/physical aggression, speaking out inappropriately, taking things that don't belong to the child, and disrupting class or other

social activities. Due to mindfulness' ability to strengthen the ability to suspend immediate reaction (Kristeller, 2007), it seems plausible that it would assist children in recognizing their impulsive desires and reassessing their appropriateness. It has been found that mindfulness meditation ameliorates anger management issues by increasing inhibition of violent tendencies for adolescents with conduct disorder (Singh et al., 2007). Additionally, Sanchez and Jones found that teachers rated students who had undergone mindfulness meditation training as less aggressive 10 weeks after the intervention (2008). Mindfulness meditation has also been examined for usefulness in treating issues regarding impulse control in adults. It has been demonstrated that mindfulness can decrease aggressive behavior in healthy (Woolfolk, 1894) and mentally ill (Singh et al., 2007) adult populations. Research concerning substance abuse (Marlatt et al., 2004; Bowden et al., 2006), criminal rehabilitation, crime prevention (Alexander et al., 2003), and eating disorders and obesity (Kristeller & Hallett, 1999) has also suggested the efficacy of mindfulness practice.

Though there are several studies that examine the effects of mindfulness, very few have sought to explain why it is effective. The current study hypothesizes that this is due to improvements in attention and emotion regulation. Evidence for this idea is existent, although limited. Davidson & Goleman (1977) and Semple (2006) support the idea that attention regulation is the essence of meditation, and Zylowska et al. (2008) concluded that mindfulness is a feasible treatment for ADHD. Research examining emotion regulation is even sparser. A couple of studies, however, indicate that emotion regulation plays a large part in mediating the effects of mindfulness (Coffey & Hartman, 2008; Arch & Craske 2006). Research has also suggested that attention and emotion regulation are

integrally linked, even in infancy (Posner & Rothbart, 2000; Ruff & Rotherbart, 1999). If mindfulness does indeed suspend immediate rection, this would allow one more time to use healthy coping skills, such as increasing the use of reappraisal. This is a process in which thoughts regarding the self or an external situation are deliberately reframed in order to alter their emotional impact (Lazarus & Alfert, 1964) and has been associated with increases in mental and physical health (Klco & Vernon, 2008).

In summary, this study seeks to assess the effects of mindfulness meditation on brainwave activity, mood, attention, emotion regulation, creativity, social anxiety, and impulsive behaviors. We hypothesize mindfulness meditation will cause increases in left-sided anterior alpha activity, positive mood, attention, emotion regulation, and creativity, and will cause reductions in social anxiety, negative mood, depression and impulsive behaviors. These hypotheses will be examined in a population of 4th graders and 2nd graders. The latter group has been included to help establish a lower boundary to determine who may benefit from mindfulness training.

## *Method*

### *Participants*

70 students from Henderson Elementary school volunteered for the study. Of these, 68 students volunteered to have their EEG recorded. Three classes of 4th graders and three classes of 2nd graders were used. Two classes from each grade level (four classes total) were randomly assigned to the experimental condition, and the other two classes (one 4$^{th}$ grade and one 2$^{nd}$ grade) functioned as control groups. The 4th grade

experimental group consisted of 23 girls and 21 boys, mean age = 9.7 years, age range= 9 to 10. The 2nd grade experimental group consisted of 16 girls and 10 boys, mean age = 7.6 years, age range= 7 to 9. See Table 1 for further demographic details.

*Measures*

All measures were administered in all six classes at pre-intervention (Time 1) and again at post-intervention (Time 2), 10 weeks after the meditation training, with the exception of the CES-D, which was only administered in the 4th grade (this measure are not developmentally appropriate for most 2nd graders), and the meditation conduct and success scales (which were only administered at Time 2). All self-designed measures were subjected to factor analysis and reliability testing (with the exception of the meditation conduct scale – this measure consists of only one item, thus these analyses were non-applicable). Factor analysis revealed that all measures with subscales had appropriately loading factors. Cronbachs' alphas were computed for all self-designed measures, including subscales where appropriate (see Table 2).

Creativity: A divergent thinking task based on Guilford's Alternate Uses Test (Christensen, Guilford, Merrifield, & Wilson, 1960) was used. This task requires students to list as many alternate uses as possible of common household items, such as a towel or paperclip. Responses were rated for fluency (number of items, flexibility (number of categories of items), and elaboration (amount of detail per item). Also, Ratings on a self-designed measure were completed by parents and teachers at Time 1 and Time 2. Sample items include "How often does this child express interest in creative projects?" and "How often does this child come up with unique solutions to problems?"

Social Anxiety: Ratings on a self-designed measure were completed by parents and teachers at Time 1 and Time 2. Each item was rated on a Likert scale ranging from 1 to 5 (almost never to almost always). Sample items include "How often does this child feel at easy when speaking with others?" and "How often does this child remain quiet or nervous in social situations?" The social and emotional skills dimension of the Teacher Social Competence Rating Scale (TSCRS; Kam & Greenberg, 1998) was also used. Ratings were on a 1 to 5 Likert scale.

Impulsivity: Ratings on a self-designed measure of impulsive behaviors were completed by parents and teachers at Time 1 and Time 2. Each item was rated on a Likert scale ranging from 1 to 5 (almost never to almost always). Sample items include "How often does this child disrupt class or other activities?" and "How often does this child say inappropriate things?" Teachers also completed the aggressive behaviors dimension of the Teacher Social Competence Rating Scale (TSCRS; Kam & Greenberg, 1998).

Affect and Depression: The Positive and Negative Affect Schedule for Children (PANAS-C; Laurent et al., 1999) was administered. This test consists of 30 single-word items indicating positive or negative affect that the children rated on a 1 to 5 Likert scale according to their personal relevance. The CES-D was used to assess depression levels in 4th graders. It is a 20 item questionnaire which uses a four-point Likert scale ranging from 1 (rarely) to 4 (most of the time). Subjects scoring higher than 16 points qualify as depressed.

Emotion Regulation:A self-modified version of the Emotion Regulation Questionnaire (Gross & John, 2003) was used to assess reappraisal and emotional

suppression use. Items are on two subscales (reappraisal and suppression) and are rated on a five-point Likert scale ranging from one, 'strongly disagree' to five, 'strongly agree.' The original scale was modified to be more easily comprehended by children. Sample items include "I keep my feelings to myself" and "When I have to do something hard or scary, I make myself think about it in a way that helps me stay calm."

Attention: The coding task of the Wechsler Intelligence Scale for Children (Collaer et al., 1982) was used in which participants are given a key of shapes with smaller shapes circumscribed within them. Below was a grid of shapes without smaller shapes within them. The subjects were given 2 minutes in which they were asked to fill in the empty shapes with the corresponding smaller shapes. The 4th grade and the 2nd grade were given two different versions of the coding task to account for developmental differences in skill between the two age groups.

Meditation Success: The Meditation Conduct form was completed weekly by the teachers. They were asked to use one item on a 1-5 Likert scale to rate how well the children were behaved during meditation practice. The meditation success questionnaire was completed by the students at Time 2. The scale consists of 10 items, with each item rated on a Likert scale ranging from 1 to 5 (almost never to almost always). Sample items include "When I notice that my attention is wandering during meditation, I can bring it back to my breath" or "Meditation made me bored."

*Apparatus*

EEG was used to measure participants' brain wave activity before and 10 weeks after the meditation intervention. EEG equipment is made by James Long, Inc. A stretch

lyrca cap (ElectroCap, Inc.) with the international 10-20 system was used. Electrodes F3, F4, F7, F8, C3, C4, P3, P4, O1, and O2 were recorded, using Cz as a reference. Electrode gel (to conduct) and Omni Prep (to abrade) was also used. Snapstream data acquisition software was used to analyze the data (v. 3.21, HEM Data Corp., 1991).

*Mindfulness Meditation Training*

A meditation training session was conducted for each of the 4 classes assigned to the experimental condition. The session, lasting approximately 45 minutes, was performed by a meditation trainer who was also a school psychologist and neurotherapist. The trainer began the session by explaining to the children that thoughts, though they are usually conceptualized as being beneficial, can become a problem sometimes. After the class provided examples of when thinking is not beneficial, he explained that when you are in a situation where thinking is not helpful, you can choose to not pay attention to the thoughts. When you meditate, he said, you "work out" your attention by redirecting it from a distraction to your breath. He used a metaphor about teaching a puppy to walk on a leash to describe this process – the puppy (or your attention) will naturally begin to stray, but you can use your leash (your breath) to redirect the puppy back to walking beside you. The group then participated in guided meditation. The trainer instructed the students to sit up very straight and to begin to pay attention to their breath. Whenever they were distracted by a thought, sound, etc., they were asked to note where their attention had strayed to, then to return it to their breath. After 5 minutes of practice, the students discussed their initial reactions and were given an opportunity to ask questions. The trainer acknowledged that this was a difficult task, but encouraged the students to use

discipline (defined as continuing to do something hard because it's good for you in the end) to persist. He concluded by stating that if they continued to practice, the students would be calmer, more focused, and would have clearer thinking.

*Procedure*

Consent forms were collected from the parents/legal guardians of the participants and assents were obtained from the children. At Time 1, the measures were administered to each group, including the collection of baseline EEG data. EEG was recorded for 3 minutes with the subjects' eyes closed. Teachers completed the Teacher Social Competence Rating Scale and teachers and parents completed measures of social anxiety, impulsive behaviors, and creativity. A week later the mindfulness meditation intervention was performed with the four experimental groups. The children practiced mindfulness meditation each day in class for 10 weeks and were instructed to practice on the weekends as well. Fourth graders meditated for one 10-15 minute session per day, and the 2nd graders meditated for one 5-10 minute session per day. At Time 2 (10 weeks after Time 1) participants were given all measures again, and follow-up EEG data was collected. Teachers completed the post-treatment portion of the Teacher Social Competence Rating Scale, and parents and teachers completed post-treatment measures of social anxiety, impulsive behaviors, and creativity. Participants were debriefed.

*Design*

The two independent variables that we examined were age and meditation training versus no training. There were multiple dependent variables: creativity, social

anxiety, impulsive behaviors, emotion regulation, attention, affect, depression, and brain wave activity.

## *Results*

Questionnaire Measures:

Analysis began by intercorrelating all pre-test measures and intercorrelating all post-test measures. See Table 3 for significant results. Repeated measures MANOVAS were then performed for the PANAS-P, PANAS-N, ERQ-R, ERQ-S, BIS, BAS-D, BAS-F, BAS-R, CES-D, Alternate Use Task, Coding Task, Parent/Teacher Social Anxiety, Parent/Teacher Creativity, and Parent/Teacher Impulsive Behaviors scales, using pre and post test scores as within subjects factors and group (control or experimental) as a between subjects factor. Data from grades 4 and 2 were combined to increase our sample size, therefore increasing power. All analyses yielded nonsignificant results. It was hypothesized that this was due to a portion of subjects in the experimental condition not meditating effectively. To correct for this, two subdivisions within the experimental condition were created, which we will call "high meditation success" and "low meditation success" (the term "success" is being used here for lack of a better word, as it is difficult to conceptualize meditation as a success or failure rather than a process). This measure was created by combining two of our scales which were moderately correlated with one another - the self-reported meditation success scale and the teacher-reported meditation behavioral conduct report ($r = .302$, $p = .05$). The two measures (each rated on a 1-5 Likert scale) were averaged together and subgrouped by a mean split. 4th graders showed higher success rates, with 22 in the high success group, and 12 in the low success

group, whereas 2nd graders had only 6 subjects in the high success group, and 12 subjects in the low success group. Repeated measures MANOVAS were performed again, using the high success, low success, and control groups as a between subjects factor. Significantly different post-test results were found for depression, $F(2,39) = 9.003$, $p < .01$ (see Figure 1). Post hoc tests revealed that the low success group differed significantly from the high success and control groups at post-test. All groups decreased their levels of depression, with the high success group decreasing the most.

Significant post-test differences were also found for creativity (fluency) $F(2,53) = 6.418$, $p < .05$ (see Figure 2), and creativity (flexibility) $F(2,53) = 3.984$, $p < .05$ (see Figure 3). For the fluency subscale, post hoc tests indicated that the high success group had significantly higher post-test fluency scores than the low success and control groups. On the flexibility subscale, post hocs indicated that the high success group had significantly higher scores than the control group. Post-test scores on the PANAS-P approached significance with the high success group showing more positive mood at the post-test than the control group $F(1,26) = 2.465$, $p < .10$. All other analyses yielded nonsignificant findings.

EEG:

After manually removing the artifact from the EEG, alpha asymmetry scores were calculated by subtracting the natural log of the left hemisphere sites from the natural log of the right hemisphere sites. (lnR-lnL).

Using asymmetry scores, a 2x2x5x2 MANOVA was conducted with group (experimental, control) and grade as between subjects factors, and brain region (frontal, lateral frontal, central, parietal, occipital) and time (pre-test, post-test) as within subjects

factors. Though some effects reached significance, it seemed more appropriate to account for differences in subjects' abilities to meditate. We therefore conducted a 3x2x5x2 MANOVA with group (high success experimental, low success experimental, control) and grade as between subjects factors, and brain region (frontal, lateral frontal, central, parietal, occipital) and time (pre-test, post-test) as within subjects factors. Notable effects are as follows. Analyses revealed a main effect for region, $F(1,60) = 9.741$, $p < .05$, so subsequent 3x2x5x2 MANOVAs with group and grade as our between subjects factors and time as our within subjects factor were performed for each region. The frontal region (leads F3 and F4) showed a significant time by group interaction, $F(2,60) = 4.609$, $p < .05$. Examination of the group means revealed that the high success experimental group showing significantly more relative left activation in their posttest EEG. The parietal region had a significant time by group interaction $F(2,60) = 3.879$, $p < .05$. Examination of the group means revealed that the high success group shifting from relative left activation to less relative left activation. The central region (leads C3 and C4) approached significance for a time by group interaction $F(2,60) = 2.649$, $p < .079$. Analyses on the occipital and frontal lateral regions yielded nonsignificant results. Group means for significant effects are presented in Figures 4 and 5.

## *Discussion*

Our findings confirm the hypothesis that mindfulness meditation increases relative left-sided anterior brain activation, which replicates the findings of Davidson et al. (2003). Activation in this brain area has been associated with both state and trait

positive affect, and has been linked to more adaptive coping responses after provocation by negative stimuli (Davidson, 2000; Davidson et al., 2000). It is interesting to note that the increases in activation were within the alpha band (8-12 Hz), and that early biofeedback studies have demonstrated that such increases result in positive affect, feelings of calmness, and decreased anxiety (Delmonte, 1984; Fenwick 1987). The parietal regions of successful meditators were found to respond in the opposite way, with relative left activation decreasing over time. This might be expected, as reversed asymmetry in anterior vs. posterior regions is a pattern frequently found in emotional neuroscience research (Davidson, 1983; Matousek et al., 1981; Flor-Henry & Koles, 1980).

Consistent with our neurological findings are our conclusions regarding affect and depression. The high meditation success experimental group decreased their depression scores by twice the amount of the control group, bringing them from a "depressed" group average to a "non-depressed" average. We hypothesize that this is because meditation increased the participants' relative left activation in the alpha band, therefore increasing their abilities to cope with negative situations. Perhaps for the same reason, this group shows a trend for increased positive affect. These results show promising support for mindfulness meditation's ability to improve affect and emotional coping in children.

In addition to these findings, our study indicates that mindfulness meditation has the ability to increase certain dimensions of children's creativity. Several theories could explain this change. Horon (2009) suggests that attention mediates the relationship between meditation and creativity, insomuch as it "increases the insight and incubation periods of creativity" (p. 202). Creativity may also be related to the alpha band-increased

alpha power in the frontal lobe has been associated with creativity after a divergent thinking training session (Fink, Grabner, Benedek, & Neubaeur, 2006). An alternate explanation may be that when children are less depressed, they are motivated to engage in more activity, including creative projects. In the current study, creativity was negatively correlated with depression and suppressive coping at Time 1 and positively correlated with positive affect at Time 2, which supports the latter hypothesis.

While our results indicate that meditation is helpful for some children, it does not appear to be effective across the whole of the experimental group. A larger portion of the 4th graders than 2nd graders were ranked as "successful meditators", which hints that meditation is not developmentally appropriate for the majority of 2nd grade children. The answer to this question remains unclear for several reasons. Firstly, the pre-test scores of the 2nd grade experimental group show significantly higher levels of relative left frontal activation than the other groups, making it difficult to accurately assess brain changes across time and groups. Secondly, many of the questionnaire measures may not be as age appropriate as we had assumed pre-experimentation. Many of the 2nd graders had questions regarding the definitions of words during administration, and it is suspected that many were motivated by response bias (particularly with dichotomously valenced items such as positive and negative affect). We also detected a strong ceiling effect in the attention task, making it impossible to accurately interpret these results. Some of these issues were relevant to a lesser degree in the 4th grade subjects, which may further obscure the significance of our results. Also, it is this author's subjective opinion that the 2nd grade teachers were not as committed to in-classroom meditation practice as the 4th grade teachers. They also reported more behavioral interruptions

during meditation practice, which may have reduced their total meditation time (which was already half that of the 4th graders).

In future studies, it is important to ensure that questionnaire measures are easily comprehended, which can be partially achieved through pilot testing. Different ways of assessing children's ability to meditate should also be explored. This is a significant challenge, as it is quite difficult to quantify the inner world of a child engaging in a process as unique and abstract as meditation. Additionally, it is critical that we examine not only those with a proclivity for meditating, but also those children who seem to have difficulties meditating effectively. "Low meditation success" was correlated at Time 1 with impulsive, aggressive behaviors, poor attention, and depression, indicating that these children may be at particular at risk for social and mental health issues.

Despite the lack of statistical significance in some of our measures, we conclude that mindfulness meditation is a promising means of increasing the mental health and well-being of children. This idea was well-substantiated by the verbal reports of students and teachers during debriefing. While some found it to be "boring," most students reported that they enjoyed meditation and found it useful in diverse circumstances. "It helps me calm down" said one 2nd grader. Other students reported benefiting from meditation before bed to help them sleep, when they are sad after fighting with friends or witnessing disagreements amongst parents, and to calm anxiety before tests. "I like it a lot," one 4th grader commented. "My grades have gone up since I started."

Teachers likewise reported positive experiences with meditation, with at least one incorporating mindfulness techniques into her personal life. Some teachers reported that

the children were much calmer after meditating in the morning, and that they looked forward to practicing.

Our children live in a world that is becoming increasingly overwhelming with rapidly expanding technology, soaring rates of mental health issues, and mounting pressure to conform to external expectations and standards. It is crucial to their health and happiness that we provide them with tools to cope with such circumstances. For this and many other reasons, it is important that we continue to examine the promising potential of mindfulness meditation, and that we continue to consider the possibility of incorporating it universally into the school curriculum.

FIGURES

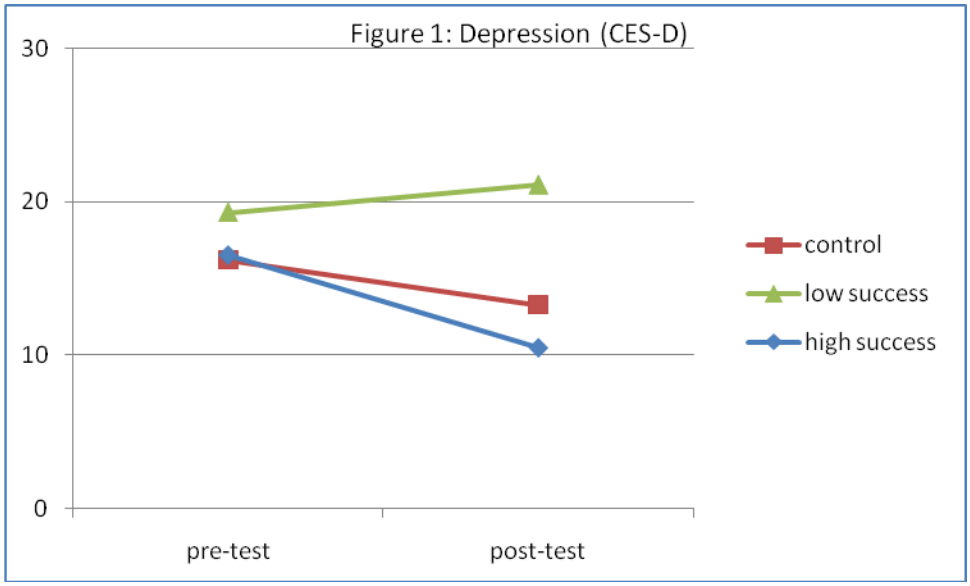


Figure 1: Depression (CES-D)
30
20
10
0
pre-test
post-test
control
low success
high success

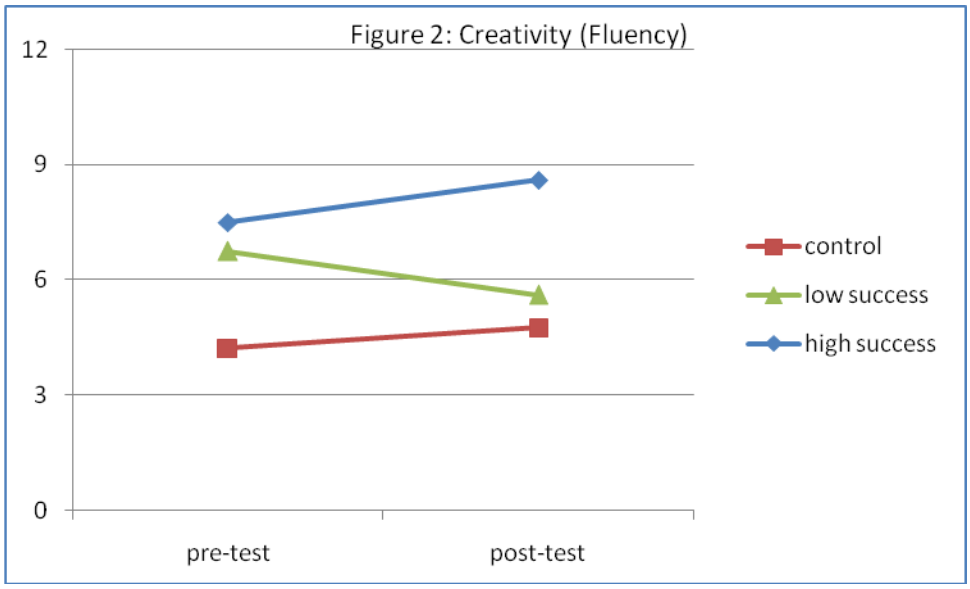


Figure 2: Creativity (Fluency)
12
9
6
3
0
pre-test
post-test
control
low success
high success

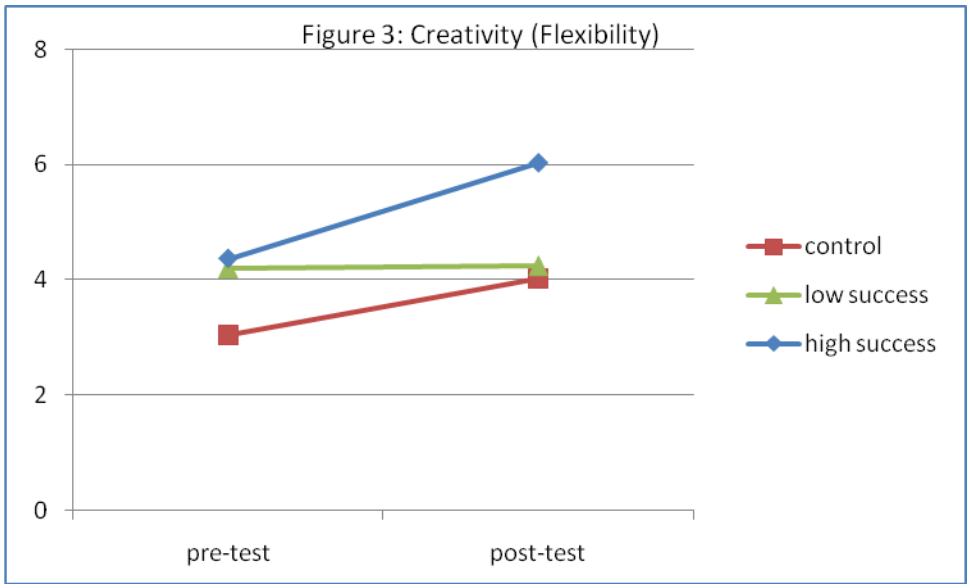


Figure 3: Creativity (Flexibility)
8
6
4
2
0
pre-test
post-test
control
low success
high success

Figure 4

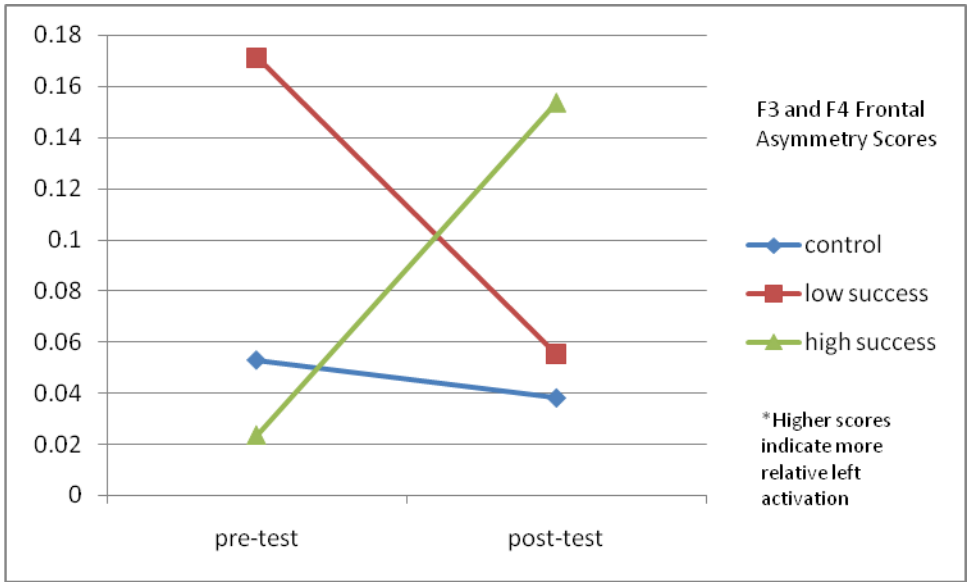
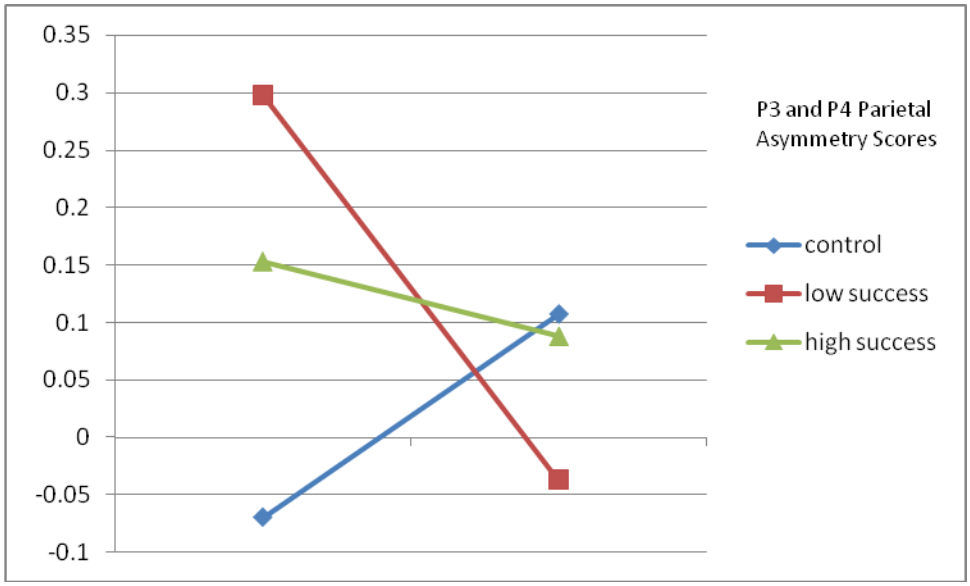

0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
pre-test
post-test
F3 and F4 Frontal Asymmetry Scores
control
low success
high success
*Higher scores indicate more relative left activation

Figure 5


0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
P3 and P4 Parietal Asymmetry Scores
control
low success
high success

TABLES

| Table 1a: Demographics (Gender) | | |
|---|---|---|
| Gender | Frequency | Percentage |
| Female | 39 | 55.7 |
| Male | 31 | 44.3 |

| Table 1b: Demographics (Grade) | | |
|---|---|---|
| Grade in School | Frequency | Percentage |
| Fourth | 44 | 62.9 |
| Second | 26 | 37.1 |

| Table 1c: Demographics (Age) | | |
|---|---|---|
| Age | Frequency | Percentage |
| 10 | 30 | 42.9 |
| 9 | 15 | 21.4 |
| 8 | 14 | 20 |
| 7 | 11 | 15.7 |

| Table 1d: Demographics (Ethnicity) | | |
|---|---|---|
| Ethnicity | Frequency | Percentage |
| Black | 13 | 18.6 |
| Hispanic | 12 | 17.1 |
| White | 38 | 54.3 |
| Other | 7 | 10 |

| Table 2: Reliability Analyses | | |
|---|---|---|
| Measure | Cronbach's Alpha (Time 1) | Cronbach's Alpha (Time 2) |
| Parent Social Anxiety Scale | .69 | .64 |
| Parent Creativity Scale | .75* | .67 |
| Parent Impulsive Behaviors Scale | .77* | .85* |
| Teacher Social Anxiety Scale | .86* | .87* |
| Teacher Creativity Scale | .84* | .88* |
| Teacher Impulsive Behaviors Scale | .93* | .94* |
| Emotion Regulation Questionnaire-(reappraisal) | .60 | .46 |
| Emotion Regulation Questionnaire (suppression) | .74* | .54 |
| Meditation Success Scale (self-report) | n/a | .72* |

* Scale deemed to be acceptably reliable (alpha > .70)

| Table 3: Correlations Between Mood and Creativity at Time 1 | | | | | | |
|---|---|---|---|---|---|---|
| | Creativity (fluency) | Creativity (flexibility) | Creativity (elaboration) | Depression | Positive Mood | Negative Mood |
| Creativity (fluency) | - | - | - | - | - | - |
| Creativity (flexibility) | .850** | - | - | - | - | - |
| Creativity (elaboration) | .079 | .103 | - | - | - | - |
| Depression | .075 | -.040 | -.379* | - | - | - |
| Positive Mood | .093 | .116 | .128 | -.217 | - | - |
| Negative Mood | -.101 | -.130 | -.248* | .475** | -.188 | - |

*p < .05 **p < .01

| Table 4: Correlations Between Mood and Behavior at Time 1 | | | | | | |
|---|---|---|---|---|---|---|
| | Negative Mood | Depression | Impulsive Behaviors | Aggressive Behaviors | Behavioral Disregulation | Attention |
| Negative Mood | - | - | - | - | - | - |
| Depression | .475** | - | - | - | - | - |
| Impulsive Behaviors | .143 | .207 | - | - | - | - |
| Aggressive Behaviors | .296* | .137 | .716** | - | - | - |
| Behavioral Disregulation | .288 | .142 | .701** | .840** | - | - |
| Attention | -.001 | -.281 | .031 | -.085 | -.033 | - |

*p < .05 **p < .01

Table 5: Correlations Between Mood and Creativity at Time 2

| | Creativity (fluency) | Creativity (flexibility) | Creativity (elaboration) | Depression | Positive Mood | Negative Mood |
|---|---|---|---|---|---|---|
| Creativity (fluency) | - | - | - | - | - | - |
| Creativity (flexibility) | .933* | - | - | - | - | - |
| Creativity (elaboration) | .550** | .647** | - | - | - | - |
| Depression | -.249 | -.188 | -.160 | - | - | - |
| Positive Mood | .277* | .266* | .044 | -.104 | - | - |
| Negative Mood | -.208 | -.171 | -.047 | .296 | -.188 | - |

*p < .05 **p < .01

| Table 6: Correlations Between Mood and Behavior at Time 2 | | | | | | |
|---|---|---|---|---|---|---|
| | Negative Mood | Depression | Impulsive Behaviors | Aggressive Behaviors | Behavioral Disregulation | Attention |
| Negative Mood | - | - | - | - | - | - |
| Depression | .296 | - | - | - | - | - |
| Impulsive Behaviors | .281* | .434** | - | - | - | - |
| Aggressive Behaviors | .038 | .086 | -.059 | - | - | - |
| Behavioral Disregulation | -.158 | -.200 | -.226 | .455** | - | - |
| Attention | -.056 | -.235 | -.279* | -.383** | -.068 | - |

*p < .05 **p < .01

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