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The Calming Effects of Modified Lighting

Jessica Foshee Simpson
University of Mississippi

THE CALMING EFFECTS OF MODIFIED LIGHTING

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Jessica F. Simpson

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ABSTRACT

This dissertation consists of three articles examining the effects of modified lighting on commonly observed behaviors in children diagnosed with behavior-based disabilities. Prior literature has evaluated the effect of lighting on academic skills. Unfortunately, there is an absence of evidence regarding the effect of lighting on behaviors. Taken together these three articles will clearly display the importance of carefully designing lighting in classrooms, specifically in classrooms that include children with behavior-based disabilities.

The first article (Chapter 2) evaluates the effect lighting with low level illumination has on the behaviors commonly observed in a child diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). The second article (Chapter 3) evaluates the same effect in a child diagnosed with Emotional Disorder (EMD) and ADHD. The third article (Chapter 4) is written with a practitioner focus including recommendation for environmental changes that potentially create a calmer environment.

The two studies were conducted using an ABAB design across twenty days in a general education inclusion setting. The researcher requested the general education teacher and special education teacher of record to complete the Behavior Assessment System for Children, Third Edition (BASC-3) to determine behaviors that were most common to the student participants. The Behavioral Observation of Students in Schools (BOSS) software was used to track frequency of behaviors throughout each phase of the studies. Visual analysis was used and

demonstrated change between baseline and intervention phases and sets of data collected by the BOSS software were statistically analyzed by using a nonparametric measure of nonoverlap called Improvement Rate Difference (IRD).

The third article consists of a brief literature review, simplified results from articles one and two, a brief case study, and author suggestions for implementation of variable lighting in additional classrooms. Recommendations regarding administrative responsibility in regard to classroom environment improvement are also discussed.

DEDICATION

This dissertation is dedicated to my students; past, present, and future.

ACKNOWLEDGEMENTS

I would first like to offer my sincerest appreciation to my dissertation committee chairs and members. Needless to say, this would not have been possible without your support, contributions, and guidance. I thank you all.

To my family and friends, thank you for your support, love, and prayers. All of you deserve credit for your part in this process. I will return the favor as you reach for your dreams and follow new paths.

Finally, I offer my eternal thanks to my husband, Matthew. When the path to the end of this process was dark, you shined the light. I love you and I love our life together.

LIST OF ABBREVIATIONS

ADHD	Attention Deficit Hyperactivity Disorder
APA	American Psychological Association
BASC-3	Behavior Assessment System for Children, 3rd Edition
BOSS	Behavioral Observation of Students in Schools
EMD	Emotional Disturbance
IDEIA	Individuals with Disabilities Education Improvement Act
IEP	Individualized Education Plan
IRD	Improvement Rate Difference
NCLB	No Child Left Behind
SCR	Single Case Research
SIT	Sensory Integration Theory
TRS	Teacher Rating Scale

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CHAPTER I:

INTRODUCTION TO THE DISSERTATION

Introduction

Abundant evidence demonstrates a connection between behavior problems and student outcomes (Elias, et.al. 2006; Novick, Kress, & Elias, 2002; Walker, Colvin, & Ramsey, 1995). As such, assistance addressing disruptive classroom behaviors continues to be one of the greatest needs identified by teachers (Coalition for Psychology in Schools & Education, 2006; Public Agenda, 2004). Disruptive behaviors in the classroom impact the learning process by taking time away from academic instruction (Kauffman, Wong, Lloyd, Hung, & Pullen, 1991; Weinstein, 2007), lead to decreased academic performance, and have a potential negative impact on the classroom environment (Goodlard, 1984).

A growing body of research in the United States and Europe identifies effects of the physical environment on children and adolescents' cognitive and socioemotional development (Ferguson, Cassells, MacAllister & Evans, 2013). Tanner (2008) identifies concerns regarding the physical design of schools and how design possibly affects academic achievement. Additionally, Chan (1996) reports how poor learning environments, particularly lighting, fosters negative attitudes regarding achievement. Recently, a team of researchers investigated effects on reading skills when a classroom environment was adjusted by the use of a variable lighting system (Mott, Robinson, Walden, Burnette & Rutherford, 2012).

Students identified with learning disabilities such as Attention Deficit Hyperactivity Disorder (ADHD), a neurological disorder with symptoms of inattention, impulsivity, and/or hyperactivity-impulsivity (American Psychiatric Association, 2000) are likely to have cognitive and behavioral conditions that are apparent in specific environmental situations (Schmiedeler, Niklas, & Schneider, 2013). Approximately 11% of children 4-17 years of age (6.4 million) have been diagnosed with ADHD as of 2011 (CDC report, Visser et al 2015) . Children in schools

who show symptoms of inattention, hyperactivity, and impulsivity, with or without formal diagnoses of ADHD, also show poor academic and educational outcomes. Although the United States Department of Education addresses various learning and behavioral needs through the Individuals with Disabilities Education Improvement Act (IDEIA), which identifies and accepts thirteen disabilities that can affect learning and behavior, more research on environmental lighting modifications is needed to determine whether or not modified lighting impacts behaviors frequently seen in children with ADHD (Fletcher, 1983).

Students with Emotional Disturbance (EMD) are characterized as having severe deficits in their social competence and academic performance as well as maladjusted and antisocial behavior (Robbins-Etlen, 2007). Emotional and behavioral concerns associated with EMD note that the disturbance can adversely affect a child's academic performance and cannot be explained by intellectual, vision/hearing ability, or other health factors (IDEA, 1997). The United States Department of Education reports 6.2% of students served through IDEIA have diagnosis of EMD (U.S. Department of Education, 2014). Although research has demonstrated that children with EMD exhibit high rates of problematic behavior, characteristics for their academic performance remain uncertain (Kauffman, Cullinan, & Epstein, 1987). Data on identification and adult outcomes suggests that educating youth with EMD is a daunting task for education professionals and family members (Smith & Coutinho, 1997). Reid, Gonzalez, Nordness, Trout, & Epstein (2004) identify the need for teachers to continue to measure and monitor academic performance of students with EMD but to also use interventions that address deficits across all academic subjects and settings. Although the United States Department of Education addresses various learning and behavioral needs through the Individuals with Disabilities Education Improvement Act (IDEIA), more research on environmental lighting modifications is needed to

determine whether or not modified lighting impacts behaviors frequently seen in children (Fletcher, 1983).

Statement of the Problem

Research currently lacks substantial evidence to support whether or not lighting increases or reduces the frequency of negative behaviors seen in students with disabilities in a general education classroom (Hathaway, 1993; Mott et. al, 2012).

Purpose of the Study

The purpose of this study is to determine whether or not modified lighting impacts behaviors seen in students identified as having Attention Deficit Hyperactivity Disorder (ADHD) and Emotional Disturbance.

Research Questions

To what extent does the use of lighting with low color temperature and low level of illuminance affect commonly observed behaviors of a student diagnosed with ADHD in a general education classroom?

To what extent does the use of lighting with low color temperature and low level of illuminance affect commonly observed behaviors of a student diagnosed with EMD in a general education classroom?

Hypothesis

There is no significant difference in observed student behaviors by lowering the color temperature and level of illuminance of the classroom lighting.

Summary

Both past and present research identifies the impact physical classroom environment has on the cognitive and socioemotional development of children and adolescents (Ferguson et. al,

2013; Tanner, 2008; Chan, 1996). Previous research (Mott et. al, 2012) indicates lighting does impact achievement but does not identify whether or not behaviors are impacted. More research is needed on how environmental lighting modifications can impact behaviors commonly seen in children with ADHD (Ruiter, & Johnson, 2013). This study seeks to identify to what extent lighting modification actually impacts the behaviors identified as problematic in a child with ADHD.

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CHAPTER II:

THE CALMING EFFECTS OF MODIFIED LIGHTING ON A STUDENT WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER

2.1 INTRODUCTION

A line of research is growing in the United States and Europe with a focus on how the physical environment affects the educational and behavioral progress of students (Hill & Epps, 2010). The classroom environment is inclusive of desks, chairs, whiteboards, computers, posters, student work, and the bodies of students and teachers (Edwards, 2000). Classroom arrangements should reflect the children, their needs, and their educational accomplishments (Edwards, 2000). Wall color is often determined by a school district, windows cannot be opened due to safety concerns, and light fixtures are incandescent or fluorescent (Gay, 2014). A study by Tanner (2008) acknowledges the physical design of schools can affect student achievement. This study will focus on how modification of traditional classroom lighting fixtures impacts student behavior.

Chan (1996) acknowledges poor lighting environments can foster negative attitudes in subjects just as exceptional lighting designs may boost achievement. In addition to wall color, paper used in classrooms is typically white, and classroom lighting often creates a glare on the paper (Irlen & Lass, 1989). In order to reduce the amount of glare that usually exists, the Irlen Institute created colored overlays that provide comfortable viewing of text (Wilkins, Lewis, Smith, & Rowland, 2001). More recently, researchers (Mott et. al, 2012) found a significant positive effect on oral reading as well as socially appropriate behaviors when classroom environment was modified by the use of a dynamic lighting system, which allows the teacher to control the color and intensity of the overhead lights in the classroom.

History of Lighting Conditions in Schools

In the early 1900s, daylight was a fundamental aspect of school buildings, due to the lack of electricity available for illumination (Baker, 2012). In 1918, the Illumination Engineering Society published the *Code of Lighting School Buildings* recommending each classroom contain 3 "footcandles" (a unit of illuminance or light intensity) minimum of artificial light along with windows (Baker, 2012). Osterhause (1993) suggests classrooms actually had between three and six footcandles during this time-period. In the 1930s, manufacturers of lighting systems and architects heavily influenced school lighting design by the use of fluorescent lights and large floor-to-ceiling windows (Baker, 2012). In his 1935 article, Holy noted that in the past learning in classrooms placed emphasis on completing tasks efficiently but educators should also focus on how physical environment, including lighting, impacted student work that is produced accurately and in a timely manner. Very few strides were made in the development of indoor environmental quality standards during the 30s, primarily due to the depression as well as World War II (Baker, 2012). However, significant changes emerged after the war. For example, during the 1940s and 1950s, fluorescent lighting created the opportunity to artificially light classrooms rather than rely primarily on natural sources of light. Lighting standards have not evolved dramatically since 1959 (Building Research Institute). The Building Research Institute (1959) noted that while artificial light and natural light were both used in classrooms, there was little research evidence in existence to suggest whether teachers and students preferred one type of light rather than the other. Castaldi (1969) noted that the emphasis in school lighting had shifted from a mix of natural and artificial to primarily using artificial lighting in any space where adequate lighting was desirable. McGuffey (1982) provided an overview of lighting research prior to 1982 and noted no significant difference in student performance in classrooms with or without windows

(natural light) had been found. Lighting fixture style and illumination standards for brightness in classrooms have been similar in recent years but there is still some disagreement about how much illumination is actually necessary in classrooms (Baker, 2012). Recent research (Mardaljevic, Heschong, & Lee, 2009) suggests that the lighting industry has moved toward the desire for natural lighting in classrooms and businesses again.

In contrast to Mardaljevic, Heschong, and Lee's report, special education departments of many schools use new-age sensory rooms to enhance the visual learning environment for students with specific sensory needs (Reynolds, 2010). These rooms offer students with visual sensory sensitivities support through the use of fiber optic light sources and low wattage light bulbs (Rodger, Ashburner, & Hender, 2012). Yellin (2014) acknowledges there are approximately two thousand sensory rooms across the United States that have been designed by therapists and are utilized to support students with sensory needs. Messbauer, the occupational therapist who designed and opened the first sensory room in the nation in 1992, acknowledges the benefits of these rooms are backed up by scientific research and trends. She identifies how sensory rooms, when used appropriately, not only influence student environment through the use of light, sound, touch et al., but also help students learn to control their behavior through understanding and utilizing a "sensory diet" (Yellin, 2014). Unfortunately, sensory rooms frequently contain the tools and resources of physical and occupational therapists and are limited in use due to student scheduling and professional availability (Ayer, 1998). Therefore, they do not benefit all students with visual and behavioral needs.

Attention Deficit Hyperactivity Disorder

Students identified with learning disabilities such as Attention Deficit Hyperactivity Disorder (ADHD), a neurological disorder with symptoms of inattention, impulsivity, and/or

hyperactivity-impulsivity (American Psychiatric Association, 2000) are likely to have cognitive and behavioral conditions that are apparent in specific environmental situations (Schmiedeler, Niklas, & Schneider, 2013). Children in schools who show symptoms of inattention, hyperactivity, and impulsivity, with or without formal diagnoses of ADHD, also show poor academic and educational outcomes. The diagnosis of ADHD is not a separate category of special education. Students with this medical diagnosis are served through the IDEIA disability of Other Health Impairment, Emotional Disturbance, or Learning Disability (Forness & Kavale, 2001). Forness & Kavale (2001) note that ADHD is a diagnosis of increasing concern to school professionals due to the nature of inability to attend, listen, and sit still in the school environment. Special classroom interventions such as strategic seating of children, additional structure, individualized instruction, cooperative learning, and cognitive approaches have been deemed effective interventions (Burcham, Carlson & Milich, 1993; DuPaul & Eckert, 1997). Although the United States Department of Education addresses various learning and behavioral needs through the Individuals with Disabilities Education Improvement Act (IDEIA), more research on environmental lighting modifications is needed to determine whether or not modified lighting impacts behaviors frequently seen in children (Fletcher, 1983).

Sensory Integration Theory (SIT)

Sensory Integration Theory (SIT), a theory of brain-behavior relationships, was originally developed by A. J. Ayres (Roley, Maillous, Miller-Kuhaneck, & Glennon, 2007). SIT explains that the brain is in interaction with its environment through its sensory systems, and the process of reaction, interaction, and learning are established during this neurological experience (Bundy & Murray, 2002). The human sense of sight, or vision, is impacted by lighting (Griffiths, 2003). Sensory integration has occurred once the brain receives sensory input from the environment an

individual is surrounded by and then, in some mysterious manner, makes an individual behave or feel in a specific way (Carter & Stephenson, 2011). Kayser (2007) argues integrating sensory input is fundamental to the thinking and learning process. He asserts there is plasticity within the central nervous system, and because the brain consists of systems that are hierarchically organized it is possible to stimulate and improve neuropsychological processing and integration thereby increasing learning capacity. Visual-perception is one component of SIT. Potential ramifications of not being able to read due to visual-perceptual difficulties can cause lifelong difficulties and have a powerful effect on the human condition (Boyle & Jindal-Snape, 2012). Irlen (1983) highlights these difficulties in her book, *Reading By the Colors*, and introduces the use of colored overlays with children who were struggling with reading due to a visual-perception difficulty. In a recent study, researchers used SIT as a theoretical framework to investigate the effectiveness of sensory therapy on children identified as having learning difficulties. The results suggest an unusual advancement in the children's development when various vestibular, proprioceptive, tactile, gross motor, fine motor, perceptual, and auditory activities were performed with children for thirty minutes per day (Reynolds, 2010). Golden et al. (2005) note the use of colored light can impact vestibular and proprioceptive skills.

Research Findings for School Lighting

Lighting is something all humans experience but quality of light varies in nature and classrooms (Aries, Aarts, & van Hoof, 2015). The visual and stimulatory impact of the classroom environment on educators and students is not ignored in current research with one of the most critical areas focusing on classroom lighting. Ott's research (1976) revealed that cool white fluorescent lighting in classrooms could improve the behavior of students who display hyperactive behaviors or have learning challenges. Grangaard, (1995) studied how color and

light affected on task and off task behaviors of students based on their blood pressure. Tanner (2008) stated the physical design of schools could affect a student's ability to learn. His study concluded there are variances in achievement when students were exposed to design elements including lighting.

As previously mentioned, Mott et al. (2012) followed a new line of research when they preformed a quasi-experimental study on a classroom with variable (dynamic) lighting, which means the overhead lighting can be varied in color and intensity by a control panel mounted on a wall. The control panel has four settings, "normal", "focus", "energy", and "calm". Mott et al. (2012) describe the "calm" setting as a red and yellow light designed for group activities requiring cooperation. They further explain the "calm" setting is designed to support a class's ability to settle (calm) down when the students have been overactive for a period of time. Mott and his colleagues did not include students with disabilities in their research population and sample. This study will replicate the "calm" color through the use of an overlay and investigate how the lighting color change impacts behaviors of a student with ADHD.

Recent literature (Simpson, Mott, Moore, McClelland, & Thomas, 2016) describes lighting color variation and the way humans process illumination. Rating scales for lighting sources are measured through Correlated Color Temperature (CCT). CCT values range from warm to cool in appearance. Lux is referred to as the measure of illumination. According to Sleegers, Moolenaar, Galetzka and van der Zanden (2013) a connection between the CCT value and student performance exists. Classrooms with a "blue-rich white light" represented in a 12,000K CCT value can stimulate students and create an energetic atmosphere. Whereas, a room filled with a "warm, red color tone" with a CCT value of 2900K could translate to a more calming atmosphere. However, the traditional light used within a classroom is rated between a

3000-4000K CCT value (Colau, 2013). Lighting choices are also influenced by age and visual acuity. Younger children can visually adjust to a light with higher level of glare while older children and adults have a more difficult time with glare adjustment (Fielding, 2002).

Chromotherapy, also referred to as color light therapy, has been explored in the medical field (Willis, 2007). Azeemi and Raza (2005) explain that light affects both the physical and etheric bodies. They also note that color therapy can generate biochemical and hormonal processes in the body that serve as stimulants and sedatives necessary to balance the body. Research conducted by the Irlen Institute has brought light sensitivity to the forefront of how color is used for individuals with visual perceptual disorders (2014). Irlen (2014) provides services for children and adults identified with various difficulties and disabilities through the use of colored overlays for traditional black text on white paper.

Closure and Moving Forward

Research has identified the positive academic and behavioral impacts variable lighting had on a classroom of students with no identified learning disabilities (Mott et al., 2012). Tosta (Irlen Institute, 2014) explains that children diagnosed with ADHD possibly suffer from light-based sensitivities. Vandewalle, Schwartz, Grandjean, Wuillaume, Balteau, Degueldre, . . . and Maquet (2010) suggest that lighting modifications are a promising treatment for mood affective disorders. They discuss the importance of better understanding the neural connection between emotions, behaviors, and neural processing of light. Therefore, it is necessary to determine the behavioral and academic effect of variable lighting on children diagnosed with ADHD This study, and future studies of this researcher, will seek to continue current classroom lighting research and expand the scope to include students with disabilities, particularly students diagnosed with ADHD.

Research Question

To what extent does the use of lighting with low color temperature and low level of illuminance affect commonly observed behaviors of a student diagnosed with ADHD in a general education classroom?

Hypothesis

There is no significant difference in observed behaviors by use of modified lighting.

2.2 METHOD

Introduction to Single Case Research

This study uses single-case research (SCR) design, also known as single-subject research. SCR is a quantitative experimental design in which the researcher gathers information on any system treated as a single unit (Lundervold & Belwood, 2000). SCR is useful to monitor change (or the lack thereof) within the individual, as opposed to comparing an individual to a control group (Parker, Vannest, & Brown, 2009). In SCR, baseline scores for each individual are used as a control in order to compare behavior between baseline conditions (no intervention) and an intervention condition (O'Neill et al., 2011). For this study, SCR design will be used to determine the behavioral impact of modified lighting on a student with ADHD. This design was chosen as it provides a means to describe the increase or decrease in observed behaviors in a single student without the need of a control group.

Improvement Rate Difference (IRD) will provide a nonparametric statistical analysis of nonoverlap data between two phases (Parker, Vannest, & Brown, 2009). IRD is calculated as the difference between the Improvement Rates (IRs) (Cochrane Collaboration, 2006; Sackett et al., 1997). The IR for each phase is defined as the number of "improved data points" divided by the total data points in a phase (Parker, Vannest & Brown, 2009) resulting in a percentage of improvement. For example:

$$\frac{\#\ of\ data\ points\ of\ improvement\ in\ baseline\ and\ treatment}{\#\ of\ total\ data\ points\ in\ the\ phase} = Improvement\ Rate$$

Parker, Vannest, and Brown (2009) field-tested IRD, a statistical method for summarizing effect size of single-case research data and found effect size calculation can serve as the way to establish a functional relationship between behavior and intervention. Therefore, it is appropriate to use this method to analyze the data collected in this single-case study.

Visual-analysis using a line graph will be used to show whether or not behavior (dependent variable) changed in a meaningful way and whether or not that change can be attributed to the independent variable (Lane & Gast, 2013; Spriggs & Gast, 2010), the modification of lighting (independent variable).

Participant and Setting

Student 1 is a twelve-year-old African-American male living in the Southeast United States. He has been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and is enrolled in sixth grade. He receives special education resource services for reading and math but is in an inclusive setting for science and social studies. Student 1 does take prescription medicine for ADHD but he does not take the medication on a consistent basis. At the time of this study, he did not have a Functional Behavior Assessment or Behavior Plan in place. Observations for this study occurred during his morning science class, which took place after a snack break but before lunch. The science class is composed of twenty-six students and one teacher. There is no paraprofessional used in this setting.

Research Design

This study was conducted within an ABAB design. In an ABAB design, the effects of the intervention are clear when performance improves during the first intervention phase (B1) returns to baseline when the intervention is withdrawn, and improves again when the second intervention phase (B2) is reinstated (Kazdin, 2011). The number of student off-task behaviors

were recorded using the Behavioral Observation of Students in Schools (BOSS) iPad application through direct observation for forty-five minutes per day for twenty days.

Baseline A1. Baseline data collection took place for five class sessions (days 1-5) for 45 minutes each session. Amid this condition, students were observed during teacher led instruction and independent classroom activities under the typical lighting condition of fluorescent light bulbs with a Kelvin (K) of 6500.

Intervention B1. Intervention B1 occurred for five class sessions (days 6-10) for 45 minutes each session. Before this condition, the fluorescent bulbs with wattage of 6500K were removed and replaced with fluorescent bulbs of 3000K.

Baseline A2. Prior to Baseline A2, the replacement bulbs from Intervention B1 were removed. Baseline data collection took place for five class sessions (days 11-15) under the original (BA1) lighting condition of 6500K.

Intervention B2. Intervention B2 occurred for five class sessions (days 16-20). Prior to this condition, the fluorescent bulbs with wattage of 6500K were again removed and replaced with 3000K fluorescent bulbs.

Independent and Dependent Variables

The dependent variable was observable student behaviors (e.g. hyperactivity, fidgeting, excessive talking, impatience, blurting out, interrupting, high level of distraction, inability to sustain attention until completion of activity, etc.). The independent variable was the intervention of a replacement light bulb to lower the color temperature and illumination level of the traditional fluorescent lights currently used in the classroom.

Measures and Instrumentation

The BASC-3. The Behavior Assessment System for Children, Third Edition (BASC-3) is a comprehensive set of rating scales and forms created by Pearson Education Corporation. The BASC is commonly used to identify problem behaviors prior to eligibility for disability services through IDEA, as well as for the development of behavior assessments and behavior plans (Reynolds & Kamphaus, n.d.). The BASC has high internal consistency, test-retest reliability, and offers various types of validity checks (Reynolds, 2010). The BASC-3 includes Teacher Rating Scales, Parent Rating Scales, Self-Report of Personality, Student Observation System, and Structured Developmental History. This study will utilize the Teacher Rating Scales (TRS) only. The general education classroom teacher as well as the school counselor will be provided with one TRS each to complete prior to intervention to identify the behavior index level of significance for the student participant. Requesting two school professionals complete the TRS along with previously established reliability for the BASC-3 TRS (coefficient alpha reliability ranging from .72 to .92) supports inter-rater reliability (Reynolds & Kamphaus, n.d.).

The BOSS. Behavioral Observation of Students in Schools (BOSS) is a software program created by Pearson Education Corporation that enables users to record observed student behaviors in real time within the school environment (Shapiro, 2013). BOSS software will be downloaded to the iPad of the researcher and a qualified colleague. It will be used to identify a baseline of behavior occurrences and as a progress-monitoring tool once the intervention of variable lighting has begun. The use of BOSS to record and track behaviors will provide the researcher with printable documents comprised of graphs and numerical data for each phase of data collection. The researcher and a trained colleague simultaneously used BOSS during observations and compared the individual sets of data based on generated reports by using *percent occurrence agreement formula* [sum of agreement / total number of agreement +

disagreements x 100] (Baird & Nelson-Gray, 1999). This is a method for calculation of inter-rater reliability between two raters. The comparison will provide inter-rater reliability for the data collected using BOSS.

iPad. The iPad is a touch tablet computer created by Apple, Inc. with multiple audio-visual applications (apps) available for download. The iPad is considered a groundbreaking educational tool, and it is anticipated to have academic implications for children of all ages (Arthanat, Curtin & Knotak, 2013). A recent qualitative study concluded that the iPad's main strengths are the way it provides quick access to information as well as the way it supports collaboration (Henderson & Yeow, 2012). For this study, the iPad will be used as a data-tracking tool through the use of a software program called Behavioral Observation of Students in Schools (BOSS) developed by Pearson Education Corporation (Shapiro, 2013).

Procedures

Prior to any observations or data collection, approval for this study was obtained from the dissertation committee and the University of Mississippi Institutional Review Board (IRB). Upon approval, the researcher met with the building principal of the pre-determined school to discuss the research study. The researcher explained the purpose and desired population of the study. Once the principal agreed to allow the researcher to conduct the study, the researcher met with the special education director for the district and the inclusion teacher who was asked to be a part of the study.

The teacher was asked by the special education director to identify a student she believed to have behavioral difficulties in the classroom due to ADHD. The special education director then sought parental approval to disclose student diagnosis of ADHD and eligibility documentation to the researcher. Once the special education director provided the student name

to the researcher, a consent form was sent home. In addition to sending the form home, the inclusion teacher contacted the parents to let them know why their child was selected to participate in the study and offered to answer any questions the parent had.

2.3 DATA COLLECTION

Parent approval was given and the classroom teacher and special education teacher used the BASC-3 TRS to identify current behaviors of concern. The TRS contains items that describe specific behaviors that are rated on a four-point scale of frequency. It can be completed in 10-20 minutes. The scale summary of this assessment produces identifiable behavior problems such as: externalizing problems, internalizing problems, school problems, behavioral symptoms index, and adaptive skills (Pearson Clinical, n.d.).

BASC-3 Scale Summary

This summary is based on the ratings of the general education inclusion science teacher and the special education teacher of record for Student 1 as provided by the BASC-3 Teacher Rating Scales (TRS) form. The narrative and scale classifications in this report are based on T scores obtained using norms. Scale scores in the "clinically significant" range suggest a high level of maladjustment. Scores in the "at-risk" range may identify a significant problem that may not be severe enough to require formal treatment or may identify the potential of developing a problem that needs to be monitored.

General Education Teacher Results for BASC-3. According to the BASC-3 TRS, the general education teacher rated Student 1 as having clinically significant problems in Externalizing Problems Composite (hyperactivity, aggression, and conduct problems) and School Problems Composite (attention problems and learning problems) as well as Behavioral Symptoms Index (hyperactivity, aggression, depression, attention problems, atypicality, and

withdrawl). The Externalizing Problems Composite scale T score is 97, with a 90% confidence interval range of 94-100 and a percentile rank of 99. The School Problems Composite scale T score is 79, with a 90% confidence interval range of 75-83 and a percentile rank of 99. The Behavioral Symptoms Index scale T score is 80 with a 90% confidence interval range of 77-83 and a percentile rank of 99. Additionally, according to the Adaptive Profile, the general education teacher reports that Student 1 demonstrates clinically significant deficits in the areas of social skills, leadership, and study skills. Adaptability fell within the at-risk range and should be monitored.

Special Education Teacher Results for BASC-3. According to the BASC-3 TRS, the special education teacher rated Student 1 as having clinically significant problems in specific areas, but no composite scores are identified as clinically significant. School Problems Composite is identified as at-risk. The School Problems Composite scale T score is 66, with a 90% confidence interval range of 62-70 and a percentile rank of 92. Specific areas in other composite scores identified as at-risk were hyperactivity, attention problems, and learning problems. Additionally, according to the Adaptive Profile, the special education teacher reports that Student 1 demonstrates at-risk deficits in the areas of social skills, leadership, and study skills.

Behavior Observation of Students in Schools

The baseline observations for the study began and continued through additional phases as outlined below. The researcher and the classroom teacher determined the time of day observations occurred based on student and teacher schedule.

Interval recording through the use of the Behavioral Observation of Students in Schools (BOSS) iPad application was used to determine the frequency of behaviors identified as

problematic by the classroom teacher on a daily basis during each phase of the study. The BOSS software was designed to enable observers to record student behavior in real time in natural settings such as a classroom (Shapiro, 2013).

Visual Analysis

Visual analysis using a line graph is used to show whether or not behavior (dependent variable) changed in a meaningful way and whether or not that change can be attributed to the independent variable (Lane & Gast, 2013; Spriggs & Gast, 2010), the modification of lighting (independent variable). Data is displayed in a visual graph format to indicate that interventions are evidence-based while also demonstrating causality and generalizability (Vannest, Davis, & Parker, 2013). A visual representation of the data is graphed in order to determine a pattern and analyze primary findings, such as trend, slope, stability, level, and overlap (Kennedy, 2005; Vannest, Davis, & Parker, 2013). The visual analysis this study offers can be used to determine both within and between phase patterns. For example, visual analysis will show whether or not the implementation and use of modified lighting made an immediate impact on behaviors before and after intervention is used and removed. O'Neill et al. (2011) states that significant change between the baseline and intervention phases is an important indicator of a change in the target behavior and that it is reliable for the hypothesis that the intervention is the reason for the change.

Improvement Rate Difference Analysis

Improvement Rate Difference (IRD) analysis involves calculating the rate of improvement. IRD is interpreted as the difference in the proportion of high or "improved" scores between phases B and A. In this case, the reduction of observed off-task motor behaviors between the baseline and intervention phases was calculated. The confidence obtained in IRD is

defined by its Confidence Interval (CI), which brackets the IRD, forming lower and upper limits (Parker, Vannest, & Brown, 2009). A CI significance level of 0.05 was calculated. Parker, Vannest, & Brown (2009) identify tentative benchmarks for IRD. Very small effects scored .50 and below. Moderate effects scored .50 to .70. Large and very large effects generally received IRD scores of .70 and higher.

Sets of data collected from the BOSS was analyzed by using a nonparametric measure of nonoverlap for comparing baseline and intervention called the Improvement Rate Difference (IRD). "IRD is defined as the improvement rate (IR) of the treatment phase(s) minus the improvement rate of the baseline phase(s)" (Parker, Vannest, & Brown, 2009, p. 138).

IRD Phases

Phase I includes Baseline A1 and Intervention B1. Phase II includes Baseline A2 and Intervention B2. Data collected during both of the phases was used to calculate the IRD score for Phase I, Phase 2, and a Total IRD for all twenty days of data collection.

Interobserver Reliability

The lead researcher trained a qualified colleague on the use of the BOSS iPad application, as a way to ensure valid and reliable observational data collection. This training included: downloading the iPad app to a secondary iPad, setting up the program, practicing data collection together, and comparing results. The aforementioned trained colleague completed direct observations and tracked behaviors for 20% of the total days observed by the lead researcher. *What Works Clearinghouse* (n.d.) identifies 20% as an appropriate percentage to ensure interobserver agreement and treatment integrity. Information gathered using the BOSS will be helpful to school district administrators and educators seeking to modify their classroom lighting environment to support the needs of students with ADHD. According to Hartmann et al.

(2004) minimum acceptable values of inter-assessor agreement range from .80 to .90 on average if measured by percentage agreement.

The *percent occurrence agreement formula* [sum of agreement / total number of agreement + disagreements x 100] (Baird & Nelson-Gray, 1999) was used to identify interobserver reliability for observation data collection. Baseline data collection for A1 and A2 as well as intervention data collection for B1 and B2 were collected by the lead researcher for twenty days. The trained colleague participated for one out of every five days (20% of the data points) for each condition. Interobserver reliability was calculated as 97.22% agreement for all conditions.

2.4 RESULTS

Both statistical and visual analysis were used to interpret the results of this study. IRD analyses was completed using the Improvement Rate Difference (IRD) calculator available online (Vannest, Parker, & Gonen, 2011). According to Kennedy (2005), visual analysis representation using a graph will show level (average), trend (slope), magnitude (increase or decrease in data), level of variability (deviation from the trend), and immediacy of effect (how quickly change in pattern is observed after a phase change). Results indicate to what extent the use of lighting with low color temperature and low level of illuminance affects commonly observed behaviors of a student diagnosed with ADHD in a general education classroom.

Dependent Variable Off-Task Motor

The dependent variable observed and measured was off-task motor. Types of behaviors considered off-task motor (e.g. out of seat, fidgeting in seat, playing with an object in hands, chewing an object, flipping the pages of a book aimlessly, drawing not related to an assigned activity) are discussed in this section.

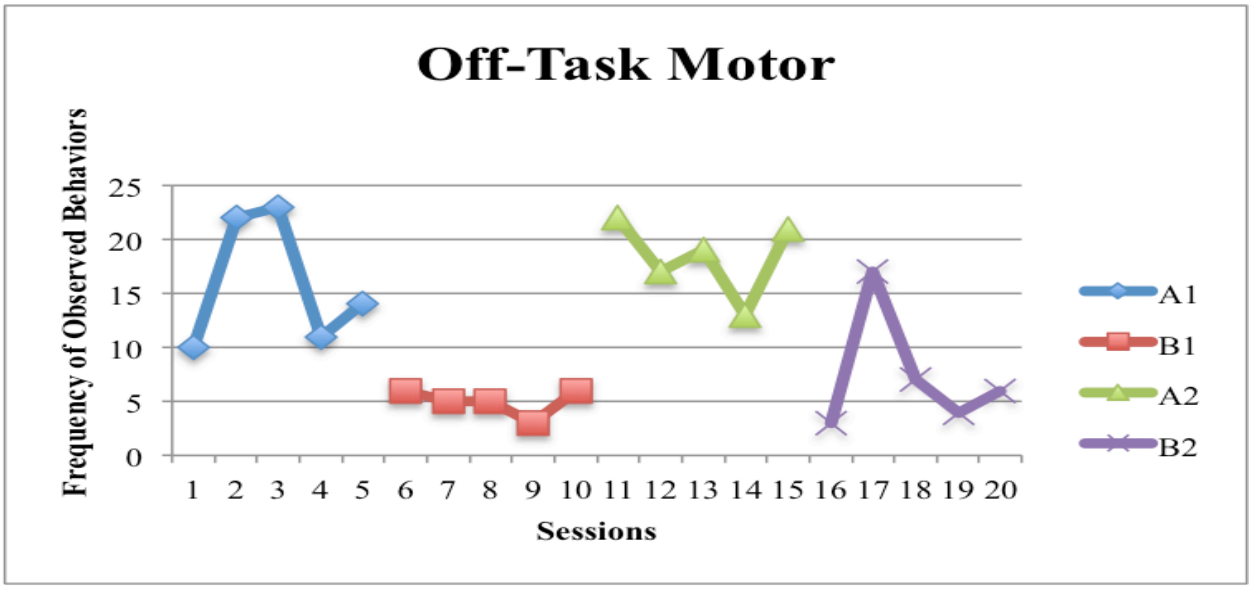

Figure 1.1. Frequency of off-task motor behaviors observed during all phases.

Visual Analysis A1 vs. B1 Off-Task Motor. Figure 1 indicates that during A1 there was some variability of the number of problematic motor behaviors observed. The level (mean) of A1 is $M = 16$. Although there was a decrease of behaviors observed during the final two days of A1, there was an immediate and significant decrease in problematic behaviors observed in the intercept gap (last day of baseline [5] and first day of intervention [6]) of A1 and B1 (14 behaviors to 6 behaviors). The level (mean) of B1 is $M = 5$ and the trend (slope) is stable.

Visual Analysis A2 vs. B2 Off-Task Motor. Figure 1 indicates that during A2 there was stability of number of problematic behaviors observed. The level (mean) of A2 is $M = 18.4$. There was an immediate and significant decrease in problematic behaviors observed in the intercept gap (last day of baseline [15] and first day of intervention [16]) of A1 and B1 (21 behaviors to 3 behaviors). The level (mean) of B2 is $M = 7.4$ and the trend (slope) is relatively stable other than the outlier [day 17].

Visual Analysis A1 A2 vs. B1 B2 Off-Task Motor. Figure 1 indicates that during A1 A2 vs. B1 B2 there was some variability of the number of problematic behaviors observed. The

level (mean) of A1 and A2 is *M* = 17.2. There was an immediate and significant decrease in problematic behaviors observed in the intercept gap (last day of baselines [5, 10] and first day of interventions [6, 16]) of B1 and B2. The level (mean) of B1 and B2 is *M* = 12.3 and the trend (slope) is stable.

IRD A1 vs. B1 Off-Task Motor. The sample size (number of days observed) of A1 vs. B1 was n = 10, SD = 7.14 and a margin of error of 4.42. There were no overlapping data points between A1 and B1. Thus, the percent of non-overlapping data was computed using the online calculator. IRD is 1.0 (95% CI [.96, 104]) between these two phases. The IRD of 100% indicates a very large effect.

IRD A2 vs. B2 Off-Task Motor. The sample size (number of days observed) of A2 vs. B2 was n = 10, SD = 7.30 and a margin of error of 4.52. There was one overlapping data points between A2 and B2 (17). Thus, the percent of non-overlapping data was computed using the online calculator. IRD is 0.80 (95% CI [.76, .85]) between these two phases. The IRD of 80% indicates a large effect.

IRD A1 A2 vs. B1 B2 Off-Task Motor. The sample size (number of days observed) of A1 and A2 vs. B1 and B2 was n = 20, SD = 7.13 and a margin of error of 3.13. There was one overlapping data point between A1, A2 and B1, B2 [17]. Thus, the percent of non-overlapping data was computed using the online calculator. IRD is .90 (95% CI [.87, .93]) between these four phases. The IRD of 90% indicates a large effect.

Dependent Variable Off-Task Verbal

The dependent variable observed and measured was off-task verbal. Types of behaviors considered off-task verbal behaviors (e.g. whistling, humming, talking to another student about

issues unrelated to assignment, calling out answers before being called on) are discussed in this section.

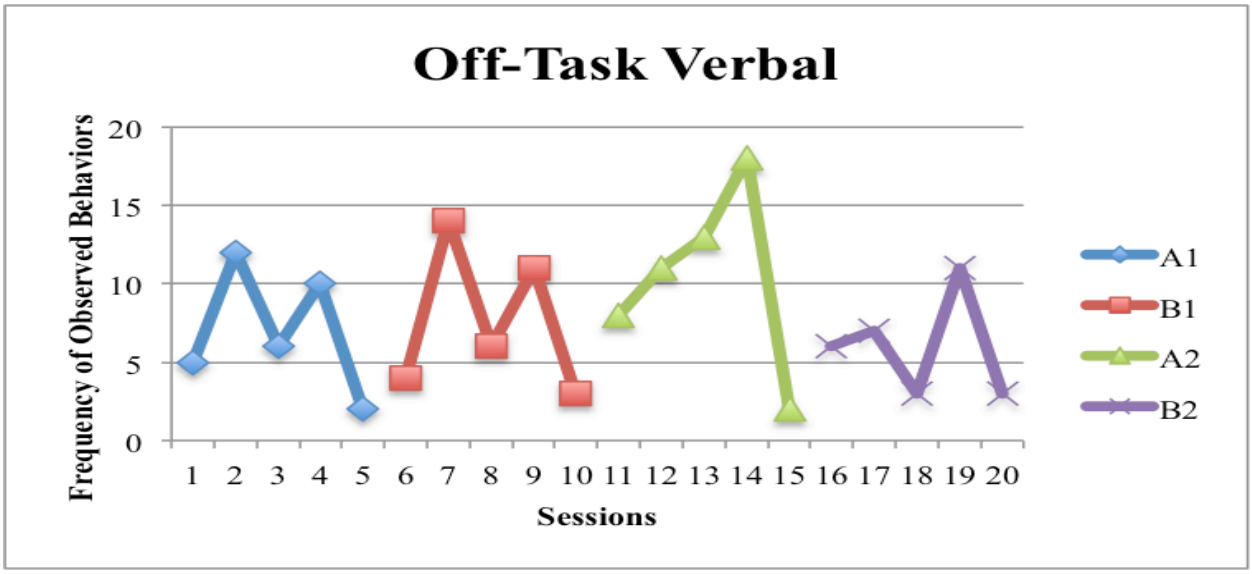

Figure 1.2. Frequency of off-task verbal behaviors observed during all phases.

Visual Analysis A1 vs. B1 Off-Task Verbal. Figure 2 indicates that during A1 there was variability of the number of problematic verbal behaviors observed. The level (mean) of A1 is *M* = 7. There was a decrease of behaviors observed during the final day of A1, and there was a slight increase in problematic behaviors observed in the intercept gap (last day of baseline [5] and first day of intervention [6]) of A1 and B1 (2 behaviors to 4 behaviors). The level (mean) of B1 is *M* = 7.6 and the trend (slope) is unstable.

Visual Analysis A2 vs. B2 Off-Task Verbal. Figure 2 indicates that during A1 there was some variability of the number of off-task verbal behaviors observed. The level (mean) of A2 is *M* = 10.4. There was a decrease of behaviors observed during the final two day A2. There was a slight increase in problematic verbal behaviors observed in the intercept gap (last day of baseline [15] and first day of intervention [16]) of A2 and B2 (2 behaviors to 6 behaviors). The level (mean) of B2 is *M* = 6 and the trend (slope) is unstable.

Visual Analysis A1 A2 vs. B1 B2 Off-Task Verbal. Figure 2 indicates that during observations there was variability of the number of problematic verbal behaviors observed in all phases. There was not a significant decrease in behaviors observed during baseline [A1 and A2] and treatment phases [B1 and B2] and the trend is unstable in all phases.

Improvement Rate Difference A1 vs. B1 Off-Task Verbal. The sample size (number of days observed) of A1 vs. B1 was n = 10, SD = 4.14 and a margin of error of 2.56. There was one overlapping data point between A1 and B1 [6]. Two other data points were removed by IRD [11,14] because they are considered outliers. The percent of non-overlapping data was computed using the online calculator. IRD is .20 (95% CI [.17, .23]) between these two phases. The IRD of 20% indicates a very small, possibly questionable effect.

Improvement Rate Difference A2 vs. B2 Off-Task Verbal. The sample size (number of days observed) of A2 vs. B2 was n = 10, SD = 5.09 and a margin of error of 3.16. There was one overlapping data point between A2 and B2 [11]. IRD also removed an outlier from A2 [2]. The percent of non-overlapping data was computed using the online calculator. IRD is .60 (95% CI [.57, .63] between these two phases. The IRD of 60% indicates a moderate effect.

Improvement Rate Difference A1 A2 vs. B1 B2 Off-Task Verbal. The sample size (number of days observed) of A1,2 vs. B1,2 was n = 20, SD = 4.54 and a margin of error of 1.99. There were several overlapping data points between the four phases [2,5,6,11,14], thus compromising IRD. The percent of non-overlapping data was computed using the online calculator. IRD is .30 (95% CI [.28, .32]) between these phases. The IRD of 30% indicates a very small effect.

Dependent Variable Off-Task Passive

The dependent variable observed and measured was off-task passive. Types of behaviors considered off-task passive behaviors (e.g. sitting quietly but unengaged, looking around the room, staring out the window, staring at object on wall) are discussed in this section.

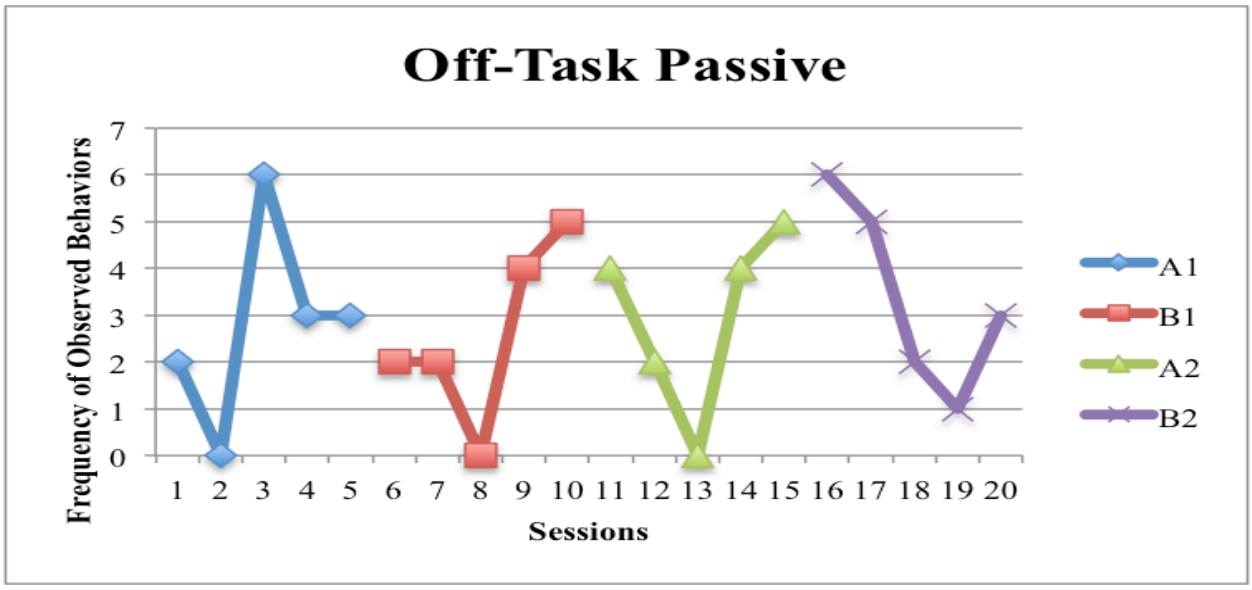

Figure 1.3. Frequency of off-task passive behaviors observed during all phases.

Visual Analysis A1 vs. B1 Off-Task Passive. Figure 3 indicates that during A1 there was variability of the number of problematic behaviors observed. The level (mean) of A1 is M = 2.8. Although there was a decrease of behaviors observed during the final two days of A1, there was an immediate, but small decrease in problematic behaviors observed in the intercept gap (last day of baseline [5] and first day of intervention [6]) of A1 and B1 (3 behaviors to 2 behaviors). The level (mean) of B1 is M = 2.6 and the trend (slope) is unstable.

Visual Analysis A2 vs. B2 Off-Task Passive. The level (mean) of A2 is M = 3. There was an increase of behaviors observed during the final two days of A2, and another increase in problematic behaviors observed in the intercept gap (last day of baseline [15] and first day of

intervention [16]) of A2 and B2 (5 behaviors to 6 behaviors). The level (mean) of B2 is *M* = 3.4 and the trend (slope) is relatively unstable.

Visual Analysis A1 A2 vs. B1 B2 Off-Task Passive. Figure 3 indicates that during A1 there was variability of the number of problematic behaviors observed. There was a small decrease in mean behaviors observed in A1 vs. B1 and a slight increase in mean behaviors observed in A2 vs. B2. Predictable patterns are not observed within and across phase data.

Improvement Rate Difference A1 vs. B1 Off-Task Passive. The sample size (number of days observed) of A1 vs. B1 was n = 10, SD = 1.95 and a margin of error of 1.21. There were two overlapping data points between A1 and B1 [2,0]. IRD also removed the outliers [4,5] from B1. The percent of non-overlapping data was computed using the online calculator. IRD is .20 (95% CI [18.79, 21.21]) between these two phases. The IRD of 20% indicates very small, likely questionable effect.

Improvement Rate Difference A2 vs. B2 Off-Task Passive. The sample size (number of days observed) of A2 vs. B2 was n = 10, SD = 1.93 and a margin of error of 1.20. There were two overlapping data points between A2 and B2 [2,5]. IRD also removed the outliers [0,6]. The percent of non-overlapping data was computed using the online calculator. IRD is .20 (95% CI [.18, .21]) between these two phases. The IRD of 20% indicates a very small, possibly questionable effect.

Improvement Rate Difference A1 A2 vs. B1 B2 Off-Task Passive. The sample size (number of days observed) of A1 A2 vs. B1 B2 was n = 20, SD = 1.90 and a margin of error of .83. There were many overlapping data points and outliers between A1 A2 and B1 B2 [0, 2, 3, 4, 5, 6]. . The percent of non-overlapping data was computed using the online calculator. IRD is .10 (95% CI [.9, .11]) between these four phases. The IRD of 10% indicates a very small effect.

Dependent Variable Total Off-Task Behavior

The dependent variable observed and measured was all problematic off-task behaviors (motor, verbal, and passive) are discussed in this section.

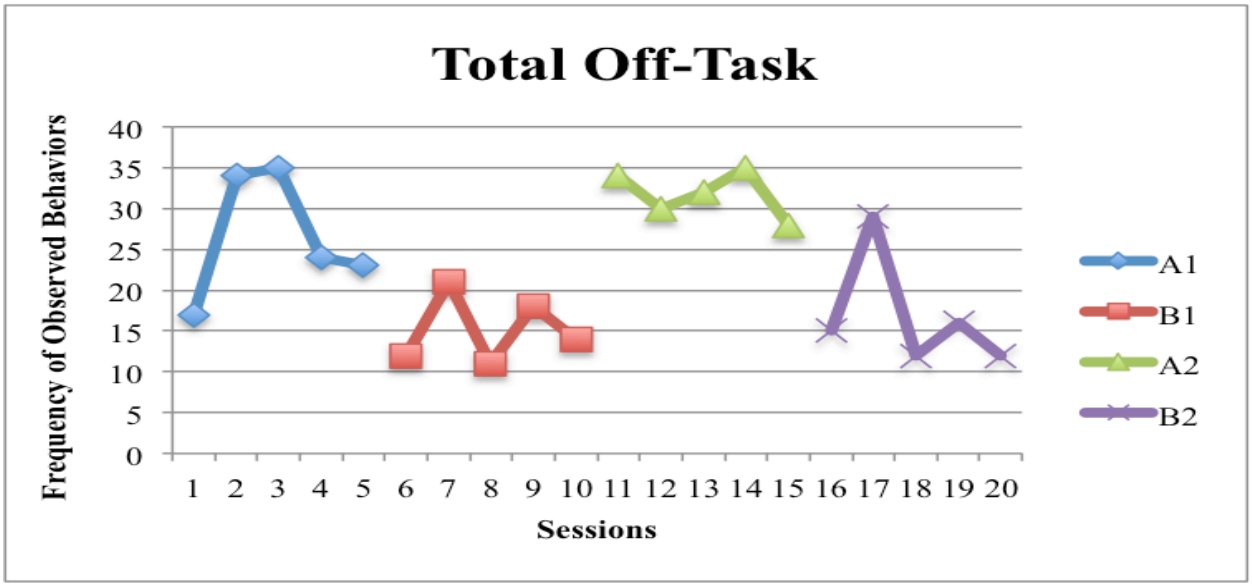

Figure 1.4. Frequency of total off-task behaviors observed during all phases.

Visual Analysis A1 vs. B1 Total Off-Task. Figure 4 indicates that during A1 there was some variability of the number of problematic behaviors observed. The level (mean) of A1 is *M* = 26.6. Although there was a decrease of behaviors observed during the final two days of A1, there was an immediate and significant decrease in problematic behaviors observed in the intercept gap (last day of baseline [5] and first day of intervention [6]) of A1 and B1 (23 behaviors to 12 behaviors). The level (mean) of B1 is *M* = 15.2 and the trend (slope) is relatively stable.

Visual Analysis A2 vs. B2 Total Off-Task. Figure 4 indicates that during A2 there was very little variability of the number of problematic behaviors observed. The level (mean) of A2 is *M* = 31.8. Although there was a decrease of behaviors observed during the final day of A1, there was an immediate and significant decrease in problematic behaviors observed in the intercept

gap (last day of baseline [5] and first day of intervention [6]) of A1 and B1 (28 behaviors to 15 behaviors). The level (mean) of B2 is $M = 16.8$ and the trend (slope) is stable other than one outlier.

Visual Analysis A1 A2 vs. B1 B2 Total Off-Task. Figure 4 indicates that during A1 there was some variability of the number of problematic behaviors observed in phases. However, there was a decrease in mean of observed off-task behaviors between baseline phases [A1 and A2] and intervention phases [B1 and B2].

Improvement Rate Difference A1 vs. B1 Total Off-Task. The sample size (number of days observed) of A1 vs. B1 was n = 10, SD = 8.38 and a margin of error of 5.19. One data point was removed from A [17] because it is an outlier. The percent of non-overlapping data was computed using the online calculator. IRD is .80 (95% CI [.75, .85]) between these two phases. The IRD of 80% indicates a large effect.

Improvement Rate Difference A2 vs. B2 Total Off-Task. The sample size (number of days observed) of A2 vs. B2 was n = 10, SD = 9.39 and a margin of error of 5.82. IRD removed one data point from B2 [29] because it was an outlier. The percent of non-overlapping data was computed using the online calculator. IRD is .80 (95% CI [.74, .86]) between these two phases. The IRD of 80% indicates a large effect.

Improvement Rate Difference A1 A2 vs. B1 B2 Total Off-Task. The sample size (number of days observed) of A1 A2 vs. B1 B2 was n = 20, SD = 8.84 and a margin of error of 3.87. Two outlier data points were removed [17, 29]. The percent of non-overlapping data was computed using the online calculator. IRD is .80 (95% CI [.76, .84]) between these two phases. The IRD of 80% indicates a large effect.

2.5 DISCUSSION

The purpose of this study was to determine the extent at which modifying classroom lighting by lowering color temperature affects commonly observed behaviors of a student diagnosed with ADHD in a general education classroom. Information regarding typical problematic behaviors was gathered using the BASC-3. Prior to the study, the general education science teacher noted occurrence of frequent and problematic behaviors within the clinically significant range in the areas of hyperactivity, aggression, and conduct problems (motor and verbal behaviors) in addition to attention problems and learning problems (passive behaviors) in the inclusive classroom setting. In contrast, the special education resource teacher, who is not present in the inclusive classroom, did not identify any behaviors as clinically significant. She did, however, identify hyperactivity (motor) and attention and learning problems (passive) as at-risk according to the clinical profile she completed. This difference may be attributed to the number of students in each classroom as well as the amount of one-on-one instruction offered in the special education resource classroom.

Visual analyses and statistical analysis of the data gathered by frequency tracking indicated the changes observed. Results of this study suggest that students with ADHD may benefit from a reduction in overhead lighting color and brightness, specifically if a reduction in physical motor skills is desired.

According to the literature, lighting environments can foster attitudes or feelings about school subjects and may boost achievement (Chan, 1996). More recently, researchers (Mott et.

al, 2012) found a significant positive effect on oral reading as well as socially appropriate behaviors when a teacher was able to control the color and intensity of the overhead lights in the classroom. Overall findings from this investigation lend initial support to the use of modified lighting in classrooms. Visual analysis and IRD of collected data identify modified lighting appears to reduce off-task motor behaviors observed in a student with ADHD. However, a very small reduction of negative verbal and passive behaviors was evident therefore the lighting change was less successful as an intervention.

Limitations

This study suggests that modifying classroom lighting can impact negative or problematic behaviors observed in a student with ADHD. However, future research should incorporate experimental designs that optimize external validity for a larger sample and population. The results of this study may only be generalizable to the single individual studied, which affects external validity. The researcher intends to replicate the study and determine generalizability in later research.

Additionally, there were differences or levels of behavior displayed by the student that could not be controlled. For example, Student 1 routinely takes medication for ADHD but frequently missed a dose or more during data collection, therefore atypical levels of behavior were observed during both baseline and treatment. This could have affected internal validity. The classroom behavior management style of the classroom teacher could have also had an affect on observed behaviors and internal validity. For example, the school did not complete a Functional Behavior Assessment information or implement a Behavior Plan for commonly observed behaviors in Student 1. Student 1 was often disciplined in front of other children, and there were no rules for group participation when it was required for an assignment so her often did not

participate. Students were not assigned seats in the classroom, and task avoidance was frequently overlooked.

Future Research

Because single intervention study evidence is not sufficient enough to identify the intervention as effective (Thompson, 2006), the researcher recommends performing multiple replications of the study to solidify the external validity and generalizability of the original experiment involving an individual student with ADHD. Once multiple replications occur, it is advised that a meta-analysis be conducted to identify the common effect size and confidence interval of the combined research studies. Effect size calculation is a comparison in the magnitude of change made from one study to another and may also be combined to produce an overall estimate of the relationship among variables across a field of study (Thalheimer & Cook, 2002).

In addition to a meta-analysis, there is potential benefit from the addition of a qualitative component. Qualitative inquiry through interview or field notes could possibly support and explain the findings of the quantitative IRD data. Because the focus of ecological psychology is on the relationship of human behavior and the environment, and it assumes individuals and the environment are interdependent (Barker & Wright, 1955) it is recommended that ecological psychology methods are used as qualitative analysis in future studies investigating classroom lighting environment and behavior change.

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CHAPTER III:

THE CALMING EFFECTS OF MODIFIED LIGHTING ON A CHILD WITH EMOTIONAL DISORDER AND ATTENTION DEFICIT HYPERACTIVITY DISORDER

3.1 INTRODUCTION

A line of research is growing in the United States and Europe with a focus on how the physical environment affects the educational and behavioral progress of students (Hill & Epps, 2010). The classroom environment is inclusive of desks, chairs, whiteboards, computers, posters, student work, and the bodies of students and teachers (Edwards, 2000). Classroom arrangements should reflect the children, their needs, and their educational accomplishments (Edwards, 2000). Wall color is often determined by a school district, windows cannot be opened due to safety concerns, and light fixtures are incandescent or fluorescent (Gay, 2014). A study by Tanner (2008) acknowledges the physical design of schools can affect student achievement. This study will focus on how modification of traditional classroom lighting fixtures impacts student behavior.

Chan (1996) acknowledges poor lighting environments can foster negative attitudes in subjects just as exceptional lighting designs may boost achievement. In addition to wall color, paper used in classrooms is typically white, and classroom lighting often creates a glare on the paper (Irlen & Lass, 1989). In order to reduce the amount of glare that usually exists, the Irlen Institute created colored overlays that provide comfortable viewing of text (Wilkins, Lewis, Smith, & Rowland, 2001). More recently, researchers (Mott et. al, 2012) found a significant positive effect on oral reading as well as socially appropriate behaviors when classroom environment was modified by the use of a dynamic lighting system, which allows the teacher to control the color and intensity of the overhead lights in the classroom.

History of Lighting Conditions in Schools

In the early 1900s, daylight was a fundamental aspect of school buildings, due to the lack of electricity available for illumination (Baker, 2012). In 1918, the Illumination Engineering Society published the *Code of Lighting School Buildings* recommending each classroom contain 3 "footcandles" (a unit of illuminance or light intensity) minimum of artificial light along with windows (Baker, 2012). Osterhause (1993) suggests classrooms actually had between three and six footcandles during this time-period. In the 1930s, manufacturers of lighting systems and architects heavily influenced school lighting design by the use of fluorescent lights and large floor-to-ceiling windows (Baker, 2012). In his 1935 article, Holy noted that in the past learning in classrooms placed emphasis on completing tasks efficiently but educators should also focus on how physical environment, including lighting, impacted student work that is produced accurately and in a timely manner. Very few strides were made in the development of indoor environmental quality standards during the 30s, primarily due to the depression as well as World War II (Baker, 2012). However, significant changes emerged after the war. For example, during the 1940s and 1950s, fluorescent lighting created the opportunity to artificially light classrooms rather than rely primarily on natural sources of light. Lighting standards have not evolved dramatically since 1959 (Building Research Institute). The Building Research Institute (1959) noted that while artificial light and natural light were both used in classrooms, there was little research evidence in existence to suggest whether teachers and students preferred one type of light rather than the other. Castaldi (1969) noted that the emphasis in school lighting had shifted from a mix of natural and artificial to primarily using artificial lighting in any space where adequate lighting was desirable. McGuffey (1982) provided an overview of lighting research prior to 1982 and noted no significant difference in student performance in classrooms with or without windows

(natural light) had been found. Lighting fixture style and illumination standards for brightness in classrooms have been similar in recent years but there is still some disagreement about how much illumination is actually necessary in classrooms (Baker, 2012). Recent research (Mardaljevic, Heschong, & Lee, 2009) suggests that the lighting industry has moved toward the desire for natural lighting in classrooms and businesses again.

In contrast to Mardaljevic, Heschong, & Lee's report, special education departments of many schools use new-age sensory rooms to enhance the visual learning environment for students with specific sensory needs (Reynolds, 2010). These rooms offer students with visual sensory sensitivities support through the use of fiber optic light sources and low wattage light bulbs (Rodger, Ashburner & Hender, 2012). A recent article by Yellin (2014) identifies there are approximately two thousand sensory rooms across the United States that have been designed by therapists and are utilized to support students with sensory needs. Messbauer, the occupational therapist who designed and opened the first sensory room in the nation in 1992, acknowledges the benefits of these rooms are backed up by scientific research and trends. She identifies how sensory rooms, when used appropriately, not only influence student environment through the use of light, sound, touch et al., but also help students learn to control their behavior through understanding and utilizing a "sensory diet" (Yellin, 2014). Unfortunately, sensory rooms frequently contain the tools and resources of physical and occupational therapists and are limited in use due to student scheduling and professional availability (Ayer, 2013). Therefore, they do not benefit all students with visual and behavioral needs.

Emotional Disturbance

Students with Emotional Disturbance (EMD) are characterized as having severe deficits in their social competence and academic performance as well as maladjusted and antisocial

behavior (Robbins-Etlen, 2007). Emotional and behavioral concerns associated with EMD note that the disturbance can adversely affect a child's academic performance and cannot be explained by intellectual, vision/hearing ability, or other health factors (IDEA, 1997). The United States Department of Education reports 6.2% of students served through IDEIA have diagnosis of EMD (U.S. Department of Education, 2014). Although research has demonstrated that children with EMD exhibit high rates of problematic behavior, characteristics for their academic performance remain uncertain (Kauffman, Cullinan, & Epstein, 1987). Data on identification and adult outcomes suggests that educating youth with EMD is a daunting task for education professionals and family members (Smith & Coutinho, 1997). Reid, Gonzalez, Nordness, Trout, & Epstein (2004) identify the need for teachers to continue to measure and monitor academic performance of students with EMD but to also use interventions that address deficits across all academic subjects and settings. Although the United States Department of Education addresses various learning and behavioral needs through the Individuals with Disabilities Education Improvement Act (IDEIA), more research on environmental lighting modifications is needed to determine whether or not modified lighting impacts behaviors frequently seen in children (Fletcher, 1983).

Sensory Integration Theory (SIT)

Sensory Integration Theory (SIT), a theory of brain-behavior relationships, was originally developed by A. J. Ayres (Roley, Maillous, Miller-Kuhaneck, & Glennon, 2007). SIT explains that the brain is in interaction with its environment through its sensory systems, and the process of reaction, interaction, and learning are established during this neurological experience (Bundy & Murray, 2002). The human sense of sight, or vision, is impacted by lighting (Griffiths, 2003). Sensory integration has occurred once the brain receives sensory input from the environment an

individual is surrounded by and then, in some mysterious manner, makes an individual behave or feel in a specific way (Carter & Stephenson, 2011). Kayser (2007) argues integrating sensory input is fundamental to the thinking and learning process. He asserts there is plasticity within the central nervous system, and because the brain consists of systems that are hierarchically organized it is possible to stimulate and improve neuropsychological processing and integration thereby increasing learning capacity. Visual-perception is one component of SIT. Potential ramifications of not being able to read due to visual-perceptual difficulties can cause lifelong difficulties and have a powerful effect on the human condition (Boyle & Jindal-Snape, 2012). Irlen (1983) highlights these difficulties in her book, *Reading By the Colors*, and introduces the use of colored overlays with children who were struggling with reading due to a visual-perception difficulty. In a recent study, researchers used SIT as a theoretical framework to investigate the effectiveness of sensory therapy on children identified as having learning difficulties. The results suggest an unusual advancement in the children's development when various vestibular, proprioceptive, tactile, gross motor, fine motor, perceptual, and auditory activities were performed with children for thirty minutes per day (Reynolds & Reynolds, 2010). Golden et al. (2005) note the use of colored light can impact vestibular and proprioceptive skills.

Research Findings for School Lighting

Lighting is something all humans experience but quality of light varies in nature and classrooms (Aries, Aarts, & van Hoof, 2015). The visual and stimulatory impact of the classroom environment on educators and students is not ignored in current research with one of the most critical areas focusing on classroom lighting. Ott's research (1976) revealed that cool white fluorescent lighting in classrooms could improve the behavior of students who display hyperactive behaviors or have learning challenges. Grangaard, (1995) studied how color and

light affected on task and off task behaviors of students based on their blood pressure. Tanner (2008) stated the physical design of schools could affect a student's ability to learn. His study concluded there are variances in achievement when students were exposed to design elements including lighting.

As previously mentioned, Mott et al. (2012) followed a new line of research when they preformed a quasi-experimental study on a classroom with variable (dynamic) lighting, which means the overhead lighting can be varied in color and intensity by a control panel mounted on a wall. The control panel has four settings, "normal", "focus", "energy", and "calm". Mott et al. (2012) describe the "calm" setting as a red and yellow light designed for group activities requiring cooperation. They further explain the "calm" setting is designed to support a class's ability to settle (calm) down when the students have been overactive for a period of time. Mott and his colleagues did not include students with disabilities in their research population and sample. This study will replicate the "calm" color through the use of an overlay and investigate how the lighting color change impacts behaviors of a student with ADHD.

Recent literature (Simpson, Mott, Moore, McClelland, & Thomas, 2015) describes lighting color variation and the way humans process illumination. Rating scales for lighting sources are measured through Correlated Color Temperature (CCT). CCT values range from warm to cool in appearance. Lux is referred to as the measure of illumination. According to Sleegers, Moolenaar, Galetzka and van der Zanden (2013) a connection between the CCT value and student performance exists. Classrooms with a "blue-rich white light" represented in a 12,000K CCT value can stimulate students and create an energetic atmosphere. Whereas, a room filled with a "warm, red color tone" with a CCT value of 2900K could translate to a more calming atmosphere. However, the traditional light used within a classroom is rated between a

3000-4000K CCT value (Colau, 2013). Lighting choices are also influenced by age and visual acuity. Younger children can visually adjust to a light with higher level of glare while older children and adults have a more difficult time with glare adjustment (Fielding, 2002).

Chromotherapy, also referred to as color light therapy, has been explored in the medical field (Willis, 2007). Azeemi and Raza (2005) explain that light affects both the physical and etheric bodies. They also note that color therapy can generate biochemical and hormonal processes in the body that serve as stimulants and sedatives necessary to balance the body. Research conducted by the Irlen Institute has brought light sensitivity to the forefront of how color is used for individuals with visual perceptual disorders (2014). Irlen (2014) provides services for children and adults identified with various difficulties and disabilities through the use of colored overlays for traditional black text on white paper.

Closure and Moving Forward

Research has identified the positive academic and behavioral impacts variable lighting had on a classroom of students with no identified learning disabilities (Mott et al., 2012). Tosta (Irlen Institute, 2014) explains that children diagnosed with ADHD possibly suffer from light-based sensitivities. Vandewalle, Schwartz, Grandjean, Wuillaume, Balteau, Degueldre, . . . & Maquet (2010) suggest that lighting modifications are a promising treatment for mood affective disorders. They discuss the importance of better understanding the neural connection between emotions, behaviors, and neural processing of light. Therefore, it is necessary to determine the behavioral and academic effect of variable lighting on children diagnosed with ADHD This study, and future studies of this researcher, will seek to continue current classroom lighting research and expand the scope to include students with disabilities, particularly students diagnosed with ADHD.

Research Question

To what extent does the use of lighting with low color temperature and low level of illuminance affect commonly observed behaviors of a student diagnosed with Emotional Disturbance in a general education classroom?

Hypothesis

There is no significant difference in observed behaviors by use of modified lighting.

3.2 METHOD

Introduction to Single Case Research

This study uses single-case research (SCR) design, also known as single-subject research. SCR is a quantitative experimental design in which the researcher gathers information on any system treated as a single unit (Lundervold & Belwood, 2000). SCR is useful to monitor change (or the lack thereof) within the individual, as opposed to comparing an individual to a control group (Parker, Vannest, & Brown, 2009). In SCR, baseline scores for each individual are used as a control in order to compare behavior between baseline conditions (no intervention) and an intervention condition (O'Neill et al., 2011). For this study, SCR design will be used to determine the behavioral impact of modified lighting on a student with EMD. This design was chosen as it provides a means to describe the increase or decrease in observed behaviors in a single student without the need of a control group.

Improvement Rate Difference (IRD) will provide a nonparametric statistical analysis of nonoverlap data between two phases (Parker, Vannest, & Brown, 2009). IRD is calculated as the difference between the Improvement Rates (IRs) (Cochrane Collaboration, 2006; Sackett et al., 1997). The IR for each phase is defined as the number of "improved data points" divided by the total data points in a phase (Parker, Vannest & Brown, 2009) resulting in a percentage of improvement. For example:

$$\frac{\#\ of\ data\ points\ of\ improvement\ in\ baseline\ and\ treatment}{\#\ of\ total\ data\ points\ in\ the\ phase} = Improvement\ Rate$$

Parker, Vannest, and Brown (2009) field-tested IRD, a statistical method for summarizing effect size of single-case research data and found effect size calculation can serve as the way to establish a functional relationship between behavior and intervention. Therefore, it is appropriate to use this method to analyze the data collected in this single-case study.

Visual-analysis using a line graph will be used to show whether or not behavior (dependent variable) changed in a meaningful way and whether or not that change can be attributed to the independent variable (Lane & Gast, 2013; Spriggs & Gast, 2010), the modification of lighting (independent variable).

Participant and Setting

Student 2 is a twelve-year-old African American male living in the Southeast United States enrolled in the sixth grade. He has been diagnosed with Emotional Disturbance (EMD) as a primary disability and Attention Deficit Hyperactive Disorder (ADHD) as a secondary disability. He receives special education resource services for reading and math but is in an inclusive classroom for science and social studies. Observations for this study occurred during his afternoon science class. The class contains 23 students and one general education teacher. There was not a paraprofessional or special educator present during the science class observations. The school nurse administered his medication daily after lunch, which was immediately prior to the start of science class.

Research Design

This study was conducted within an ABAB design. In an ABAB design, the effects of the intervention are clear when performance improves during the first intervention phase (B1) returns to baseline when the intervention is withdrawn, and improves again when the second intervention phase (B2) is reinstated (Kazdin, 2011). The number of student off-task

behaviors were recorded using the Behavioral Observation of Students in Schools (BOSS) iPad application through direct observation for forty-five minutes per day.

Baseline A1. Baseline data collection took place for five class sessions (days 1-5) for 45 minutes each session. Amid this condition, students were observed during teacher led instruction and independent classroom activities under the typical lighting condition of fluorescent light bulbs with a Kelvin (K) of 6500.

Intervention B1. Intervention B1 occurred for five class sessions (days 6-10) for 45 minutes each session. Before this condition, the fluorescent bulbs with wattage of 6500K were removed and replaced with fluorescent bulbs of 3000K.

Baseline A2. Prior to Baseline A2, the replacement bulbs from Intervention B1 were removed. Baseline data collection took place for five class sessions (days 11-15) under the original (BA1) lighting condition of 6500K.

Intervention B2. Intervention B2 occurred for five class sessions (days 16-20). Prior to this condition, the fluorescent bulbs with wattage of 6500K were again removed and replaced with 3000K fluorescent bulbs.

Independent and Dependent Variables

The dependent variable will be observable student behaviors (e.g. hyperactivity, fidgeting, excessive talking, impatience, blurting out, interrupting, high level of distraction, inability to sustain attention until completion of activity, etc.). The independent variable will be the intervention of a replacement light bulb to lower the color temperature and illumination level of the traditional fluorescent lights currently used in the classroom.

Measures and Instrumentation

The BASC-3. The Behavior Assessment System for Children, Third Edition (BASC-3) is a comprehensive set of rating scales and forms created by Pearson Education Corporation. The BASC is commonly used to identify problem behaviors prior to eligibility for disability services through IDEA, as well as for the development of behavior assessments and behavior plans (Reynolds & Kamphaus, n.d.). The BASC has high internal consistency, test-retest reliability, and offers various types of validity checks (Reynolds, 2010). The BASC-3 includes Teacher Rating Scales, Parent Rating Scales, Self-Report of Personality, Student Observation System, and Structured Developmental History. This study will utilize the Teacher Rating Scales (TRS) only. The general education classroom teacher as well as the school counselor will be provided with one TRS each to complete prior to intervention to identify the behavior index level of significance for the student participant. Requesting two school professionals complete the TRS along with previously established reliability for the BASC-3 TRS (coefficient alpha reliability ranging from .72 to .92) supports inter-rater reliability (Reynolds & Kamphaus, n.d.).

The BOSS. Behavioral Observation of Students in Schools (BOSS) is a software program created by Pearson Education Corporation that enables users to record observed student behaviors in real time within the school environment (Shapiro, 2013). BOSS software will be downloaded to the iPad of the researcher and a qualified colleague. It will be used to identify a baseline of behavior occurrences and as a progress-monitoring tool once the intervention of variable lighting has begun. The use of BOSS to record and track behaviors will provide the researcher with printable documents comprised of graphs and numerical data for each phase of data collection. The researcher and a trained colleague simultaneously used BOSS during observations and compared the individual sets of data based on generated reports by using

percent occurrence agreement formula [sum of agreement / total number of agreement + disagreements x 100] (Baird & Nelson-Gray, 1999). This is a method for calculation of inter-rater reliability between two raters. The comparison will provide inter-rater reliability for the data collected using BOSS.

iPad. The iPad is a touch tablet computer created by Apple, Inc. with multiple audio-visual applications (apps) available for download. The iPad is considered a groundbreaking educational tool, and it is anticipated to have academic implications for children of all ages (Arthanat, Curtin & Knotak, 2013). A recent qualitative study concluded that the iPad's main strengths are the way it provides quick access to information as well as the way it supports collaboration (Henderson & Yeow, 2012). For this study, the iPad will be used as a data-tracking tool through the use of a software program called Behavioral Observation of Students in Schools (BOSS) developed by Pearson Education Corporation (Shapiro, 2013).

Procedures

Prior to any observations or data collection, approval for this study was obtained from the dissertation committee and the University of Mississippi Institutional Review Board (IRB). Upon approval, the researcher met with the building principal of the pre-determined school to discuss the research study. The researcher explained the purpose and desired population of the study. Once the principal agreed to allow the researcher to conduct the study, the researcher met with the special education director for the district and the inclusion teacher who was asked to be a part of the study.

The teacher was asked by the special education director to identify a student she believed to have behavioral difficulties in the classroom due to EMD. The special education director sought parental approval to disclose student diagnosis of EMD and eligibility documentation to

the researcher. Once the special education director provided the student name to the researcher, a consent form was sent home. In addition to sending the form home, the inclusion teacher contacted the parents to let them know why their child was selected to participate in the study.

3.3 DATA COLLECTION

Parent approval was given and the classroom teacher and special education teacher used the BASC-3 TRS to identify current behaviors of concern. The TRS contains items that describe specific behaviors that are rated on a four-point scale of frequency. It can be completed in 10-20 minutes. The scale summary of this assessment produces identifiable behavior problems such as: externalizing problems, internalizing problems, school problems, behavioral symptoms index, and adaptive skills (Pearson Clinical, n.d.).

BASC-3 Scale Summary

This summary is based on the ratings of the general education inclusion science teacher and the special education teacher of record for Student 2 as provided by the BASC-3 Teacher Rating Scales (TRS) form. The narrative and scale classifications in this report are based on T scores obtained using norms. Scale scores in the "clinically significant" range suggest a high level of maladjustment. Scores in the "at-risk" range may identify a significant problem that may not be severe enough to require formal treatment or may identify the potential of developing a problem that needs to be monitored.

General Education Teacher Results. According to the BASC-3 TRS, the general education teacher rated Student 2 as having clinically significant problems in Externalizing Problems Composite (hyperactivity, aggression, and conduct problems) and School Problems Composite (attention problems and learning problems) as well as Behavioral Symptoms Index (hyperactivity, aggression, depression, attention problems, atypicality, and withdrawl). The

Externalizing Problems Composite scale T score is 99, with a 90% confidence interval range of 96-102 and a percentile rank of 99. The School Problems Composite scale T score is 89, with a 90% confidence interval range of 85-93 and a percentile rank of 99. The Behavioral Symptoms Index scale T score is 84 with a 90% confidence interval range of 81-87 and a percentile rank of 99. Additionally, according to the Adaptive Profile, the general education teacher reports that Student 2 demonstrates clinically significant deficits in the areas of social skills, leadership, and study skills, and functional communication. Adaptability fell within the at-risk range and should be monitored.

Special Education Teacher Results. According to the BASC-3 TRS, the special education teacher rated Student 2 as having clinically significant problems School Composite Problems. The School Problems Composite scale T score is 66, with a 90% confidence interval range of 62-70 and a percentile rank of 92. Specific areas identified as at-risk were aggression, attention problems, and withdrawal. Additionally, according to the Adaptive Profile, the general education teacher reports that Student 2 demonstrates clinically significant problems in adaptability, social skills, and leadership. At-risk deficits were identified in the areas of study skills and functional communication.

Behavior Observation of Students in Schools (BOSS). The baseline observations for the study began and continued through additional phases as outlined below. The researcher and the classroom teacher determined the time of day observations occurred based on student and teacher schedule.

Interval recording through the use of the Behavioral Observation of Students in Schools (BOSS) iPad application was used to determine the frequency of behaviors identified as problematic by the classroom teacher on a daily basis during each phase of the study. The BOSS

software was designed to enable observers to record student behavior in real time in natural settings such as a classroom (Shapiro, 2013).

Visual Analysis

Visual analysis using a line graph is used to show whether or not behavior (dependent variable) changed in a meaningful way and whether or not that change can be attributed to the independent variable (Lane & Gast, 2013; Spriggs & Gast, 2010), the modification of lighting (independent variable). Data is displayed in a visual graph format to indicate that interventions are evidence-based while also demonstrating causality and generalizability (Vannest, Davis, & Parker, 2013). A visual representation of the data is graphed in order to determine a pattern and analyze primary findings, such as trend, slope, stability, level, and overlap (Kennedy, 2005; Vannest, Davis, & Parker, 2013). The visual analysis this study offers can be used to determine both within and between phase patterns. For example, visual analysis will show whether or not the implementation and use of modified lighting made an immediate impact on behaviors before and after intervention is used and removed. O'Neill et al. (2011) states that significant change between the baseline and intervention phases is an important indicator of a change in the target behavior and that it is reliable for the hypothesis that the intervention is the reason for the change.

Improvement Rate Difference Analysis

Improvement Rate Difference (IRD) analysis involves calculating the rate of improvement. IRD is interpreted as the difference in the proportion of high or "improved" scores between phases B and A. In this case, the reduction of observed off-task motor behaviors between the baseline and intervention phases was calculated. The confidence obtained in IRD is defined by its Confidence Interval (CI), which brackets the IRD, forming lower and upper limits

(Parker, Vannest, & Brown, 2009). A CI significance level of 0.05 was calculated. Parker, Vannest, & Brown (2009) identify tentative benchmarks for IRD. Very small effects scored .50 and below. Moderate effects scored .50 to .70. Large and very large effects generally received IRD scores of .70 and higher.

Sets of data collected from the BOSS was analyzed by using a nonparametric measure of nonoverlap for comparing baseline and intervention called the Improvement Rate Difference (IRD). "IRD is defined as the improvement rate (IR) of the treatment phase(s) minus the improvement rate of the baseline phase(s)" (Parker, Vannest, & Brown, 2009, p. 138).

IRD Phases. Phase I includes Baseline A1 and Intervention B1. Phase II will include Baseline A2 and Intervention B2. Data collected during both of the phases will be used to calculate the IRD score for Phase I, Phase 2, and a Total IRD for all twenty days of data collection.

Interobserver Reliability

The lead researcher trained a qualified colleague on the use of the BOSS iPad application, as a way to ensure valid and reliable observational data collection. This training included: downloading the iPad app to a secondary iPad, setting up the program, practicing data collection together, and comparing results. The aforementioned trained colleague completed direct observations and tracked behaviors for 20% of the total days observed by the lead researcher. *What Works Clearinghouse* (n.d.) identifies 20% as an appropriate percentage to ensure interobserver agreement and treatment integrity. Information gathered using the BOSS will be helpful to school district administrators and educators seeking to modify their classroom lighting environment to support the needs of students with ADHD. According to Hartmann et al.

(2004) minimum acceptable values of inter-assessor agreement range from .80 to .90 on average if measured by percentage agreement.

The *percent occurrence agreement formula* [sum of agreement / total number of agreement + disagreements x 100] (Baird & Nelson-Gray, 1999) was used to identify interobserver reliability for observation data collection. Baseline data collection for A1 and A2 as well as intervention data collection for B1 and B2 were collected by the lead researcher for twenty days. The trained colleague participated for one out of every four days (25% of the data points) for each condition. Interobserver reliability was calculated as 91.67% for A1, 97.22% for B1 and A2, and 100% for B2.

3.4 RESULTS

Both statistical and visual analysis were used to interpret the results of this study. IRD analyses was completed using the Improvement Rate Difference (IRD) calculator available online (Vannest, Parker, & Gonen, 2011). According to Kennedy (2005), visual analysis representation using a graph will show level (average), trend (slope), magnitude (increase or decrease in data), level of variability (deviation from the trend), and immediacy of effect (how quickly change in pattern is observed after a phase change). Results indicate to what extent the use of lighting with low color temperature and low level of illuminance affects commonly observed behaviors of a student diagnosed with EMD and ADHD in a general education classroom.

Dependent Variable Off-Task Motor

The dependent variable observed and measured was off-task motor. Types of behaviors discussed in this section are off-task motor behaviors (e.g. out of seat, fidgeting in seat, playing with an object in hands, chewing an object, flipping the pages of a book aimlessly, drawing not related to an assigned activity).

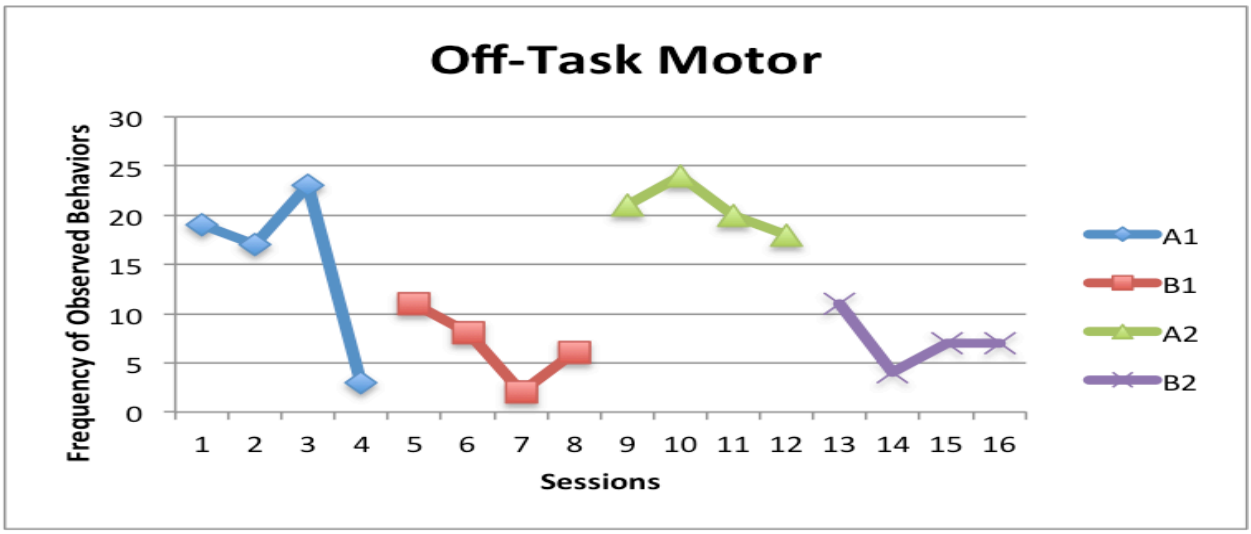

Figure 2.1. Frequency of off-task motor behaviors observed during all phases.

Visual Analysis A1 vs. B1 Off-Task Motor. Figure 1 displays the frequency of observed off-task motor behaviors during A1 and B1. Figure 1 indicates that during A1 there was some variability of the number of problematic behaviors observed. The level (mean) of A1 is *M* = 15.5. There was a decrease of behaviors observed during the final day of A1 followed by an increase of problematic behaviors observed in the intercept gap (last day of baseline [4] and first day of intervention [5]) of A1 and B1 (3 behaviors to 11 behaviors). The level (mean) of B1 is *M* = 6.75 and the trend (slope) decreases for the first three days of B1.

Visual Analysis A2 vs. B2 Off-Task Motor. Figure 1 displays the frequency of observed off-task motor behaviors during A2 and B2. Figure 1 indicates that during A2 there was some variability of the number of problematic behaviors observed but overall behaviors observed did increase when compared to B1. The level (mean) of A2 is *M* = 20.75. Although there was a decrease of behaviors observed during the final two days of A2, there was an immediate decrease in problematic behaviors observed in the intercept gap (last day of baseline [12] and first day of intervention [13]) of A2 and B2 (18 behaviors to 11 behaviors). The level (mean) of B2 is *M* = 7.25 and the trend (slope) is stable.

Visual Analysis A1 B1 A2 B2 Off-Task Motor. Figure 1 displays the frequency of observed off-task motor behaviors during baseline phases A1 A2 and intervention phases B1 B2. Figure 1 indicates that during A1 and A2 there was some variability of the number of problematic behaviors observed. The level (mean) of baseline A1 and A2 is $M = 18.13$. Similarly, there was variability of the number of behaviors occurring during B1 and B2. However, there was an overall decrease in mean number of problematic behaviors observed $M = 7$.

IRD A1 vs. B1 Off-Task Motor. The sample size (number of days observed) of A1 vs. B1 was n = 8, SD = 7.77 and a margin of error of 5.39. There were no overlapping data points between A1 and B1. However, IRD removed one outlier from A1 [3]. The percent of non-overlapping data was computed using the online calculator. IRD is .75 (95% CI [.70, .80.]) between these two phases. The IRD of 75% indicates a large effect.

IRD A2 vs. B2 Off-Task Motor. The sample size (number of days observed) of A1 vs. B1 was n = 8, SD = 7.63 and a margin of error of 5.29. There were no overlapping data points between A1 and B1. Thus, the percent of non-overlapping data was computed using the online calculator. IRD is 1.0 (95% CI [.95, .105]) between these two phases. The IRD of 100% indicates a very large effect.

IRD A1 B1 A2 B2 Off-Task Motor. The sample size (number of days observed) of A1 A2 vs. B1 B2 was n = 16, SD = 7.59 and a margin of error of 3.72. There were no overlapping data points between the phases but one data point [3] was removed from A1. Thus, the percent of non-overlapping data was computed using the online calculator. IRD is .88 (95% CI [.84, .91]) between these two phases. The IRD of 88% indicates a large effect.

Dependent Variable Off-Task Verbal

The dependent variable observed and measured was off-task verbal. Type of behaviors discussed in this section are off-task verbal (e.g. whistling, humming, talking to another student about issues unrelated to assignment, calling out answers before being called on).

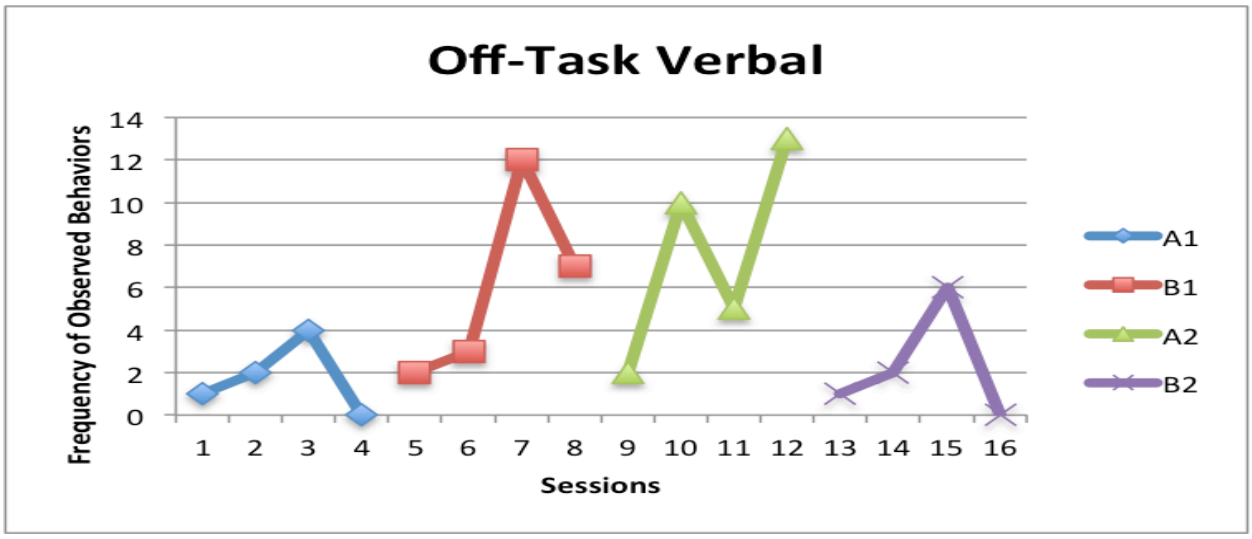

Figure 2.2. Frequency of off-task verbal behaviors observed during all phases.

Visual Analysis A1 vs. B1 Off-Task Verbal. Figure 2 displays the frequency of observed off-task motor behaviors during A1 and B1. Figure 2 indicates that during A1 there was some variability of the number of problematic behaviors observed. The level (mean) of A1 is *M* = 1.75. There was an increase of verbal behaviors observed during the first three days. However, there was a decrease of behaviors observed during the final day of A1. There was a small increase in problematic behaviors observed in the intercept gap (last day of baseline [4] and first day of intervention [5]) of A1 and B1 (0 behaviors to 2 behaviors). The level (mean) of B1 is *M* = 6 and the trend (slope) is unstable.

Visual Analysis A2 vs. B2 Off-Task Verbal. Figure 2 displays the frequency of observed off-task verbal behaviors during A2 and B2. Figure 1 indicates that during A2 there was variability of the number of problematic verbal behaviors observed. The level (mean) of A2 is *M* = 7.5. There was a increase of behaviors observed during the final day of A2. However,

there was an immediate and significant decrease in problematic behaviors observed in the intercept gap (last day of baseline [12] and first day of intervention [13]) of A2 and B2 (13 behaviors to 1 behavior). The level (mean) of B2 is *M* = 2.25 and the trend (slope) is stable other than one outlier.

Visual Analysis A1 B1 A2 B2 Off-Task Verbal. Figure 2 displays the frequency of observed off-task motor behaviors during A1 A2 and B1 B2. The mean of A1 A2 is M = 4.63 and the mean of A2 B2 is M = 4.1.

Improvement Rate Difference A1 vs. B1 Off-Task Verbal. The sample size (number of days observed) of A1 vs. B1 was n = 8, SD = 3.90 and a margin of error of 2.71. There was one overlapping data point between A1 and B1 [2]. IRD also removed the data point from day 6 [3] because it is an outlier. The percent of non-overlapping data was computed using the online calculator. IRD is .50 (95% CI [.47, .53]) between these two phases. The IRD of 50% indicates a small effect.

Improvement Rate Difference A2 vs. B2 Off-Task Verbal. The sample size (number of days observed) of A2 vs. B2 was n = 8, SD = 4.61 and a margin of error of 3.20. There was one overlapping data point between A2 and B2 [2]. Also, IRD removed the data point for day 15 [6] because it was an outlier. The percent of non-overlapping data was computed using the online calculator. IRD is .50 (95% CI [.47, 53]) between these two phases. The IRD of 50% indicates a small effect.

Improvement Rate Difference A1 B1 A2 B2 Off-Task Verbal. The sample size (number of days observed) of A1 A2 vs. B1 B2 was n = 16, SD = 4.16 and a margin of error of 2.04. Data points 1 and 2 were removed due to overlap. Data points 0,6,7,12 were removed as

outliers. The percent of non-overlapping data was computed using the online calculator. IRD is .13 (95% CI [.11, .15]) between these two phases. The IRD of 13% indicates a little to no effect.

Dependent Variable Off-Task Passive

The dependent variable observed and measured was off-task passive. Problematic behaviors discussed in this section are passive off-task behaviors (e.g. sitting quietly but unengaged, looking around the room, staring out the window, staring at object on wall).

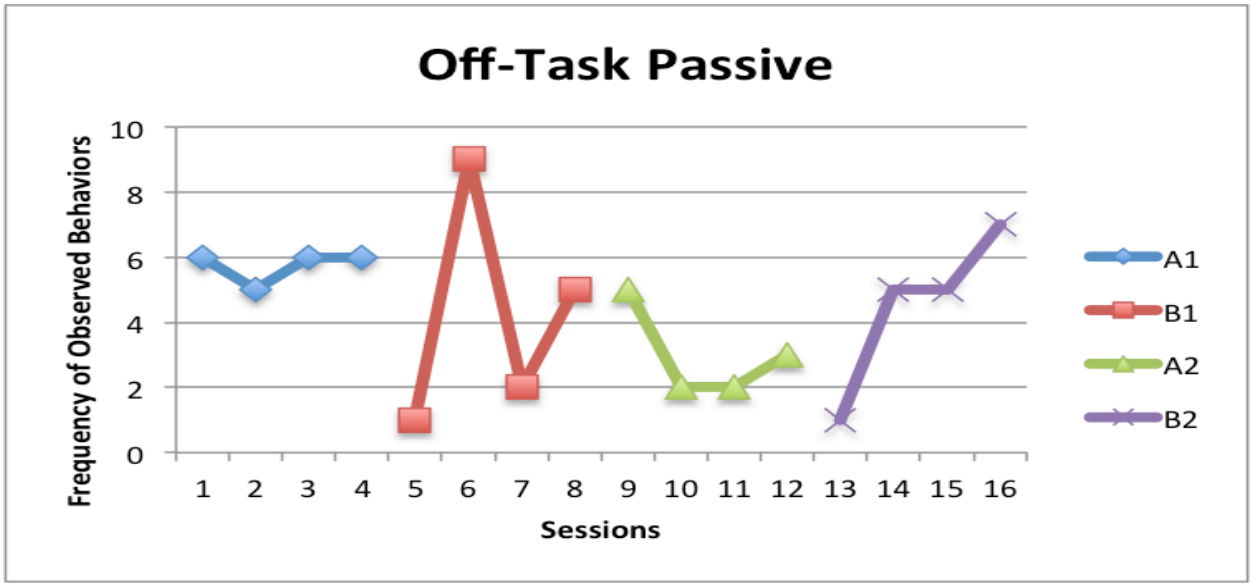

Figure 2.3. Frequency of off-task passive behaviors observed during all phases.

Visual Analysis A1 vs. B1 Off-Task Passive. Figure 3 displays the frequency of observed off-task passive behaviors during A1 and B1. Figure 1 indicates that during A1 there was some variability of the number of problematic behaviors observed. The level (mean) of A1 is $M = 5.75$. Stability is apparent in A1. There was an immediate and significant decrease in problematic behaviors observed in the intercept gap (last day of baseline [4] and first day of intervention [5]) of A1 and B1 (6 behaviors to 1 behavior). However, the level (mean) of B1 is $M = 4.25$ and the trend (slope) is unstable. There is a moderate decrease in overall mean from A1 to B1.

Visual Analysis A2 vs. B2 Off-Task Passive. Figure 3 displays the frequency of observed off-task passive behaviors during A2 and B2. Figure 1 indicates that during A2 there was some variability of the number of problematic behaviors observed. The level (mean) of A2 is $M = 3$. Although there was an increase of behaviors observed during the final day of A2, there was an immediate decrease in problematic behaviors observed in the intercept gap (last day of baseline [12] and first day of intervention [13]) of A2 and B2 (3 behaviors to 1 behavior). The level (mean) of B2 is $M = 4.5$ and the trend (slope) is increasing.

Visual Analysis A1 B1 vs. A2 B2 Passive. Figure 3 displays the frequency of observed off-task motor behaviors during A1 A2 and B1 B2. Figure 1 indicates that during baseline [A1 A2] there was some variability of the number of problematic behaviors observed. The level (mean) of A1 and A2 is $M = 4.38$. The level of B1 and B2 is 4.38. This does not indicate a decrease in overall off-task passive behaviors from baseline to treatment during the four stages of the study.

Improvement Rate Difference A1 vs. B1 Off-Task Passive. The sample size (number of days observed) of A1 vs. B1 was n = 8, SD = 2.51 and a margin of error of 1.74. There was one overlapping data points between A1 and B1 [5]. Data point 9 from B1 was removed as an outlier. Thus, the percent of non-overlapping data was computed using the online calculator. IRD is .50 (95% CI [.48, .52]) between these two phases. The IRD of 50% indicates a small effect.

Improvement Rate Difference A2 vs. B2 Off-Task Passive. The sample size of A2 vs. B2 was n = 8, SD = 2.05 and a margin of error of 1.42. There was one overlapping data points between A2 and B2 [5]. Thus, the percent of non-overlapping data was computed using the online calculator. IRD is .50 (95% CI [.49, .51]) between these two phases. The IRD of 50% indicates a small effect.

Improvement Rate Difference A1 B1 A2 B2 Off-Task Passive. The sample size (number of days observed) of A1A2 vs. B1 B2 was n = 16, SD = 2.31 and a margin of error of 1.13. Data points [2,5,7,9] were removed. The percent of non-overlapping data was computed using the online calculator. IRD is .25 (95% CI [.24, .26]) between these two phases. The IRD of 25% indicates a small effect.

Dependent Variable Total Off-Task Behavior

The total number of off-task behaviors(motor, verbal, passive) displayed during the study are discussed in this section.

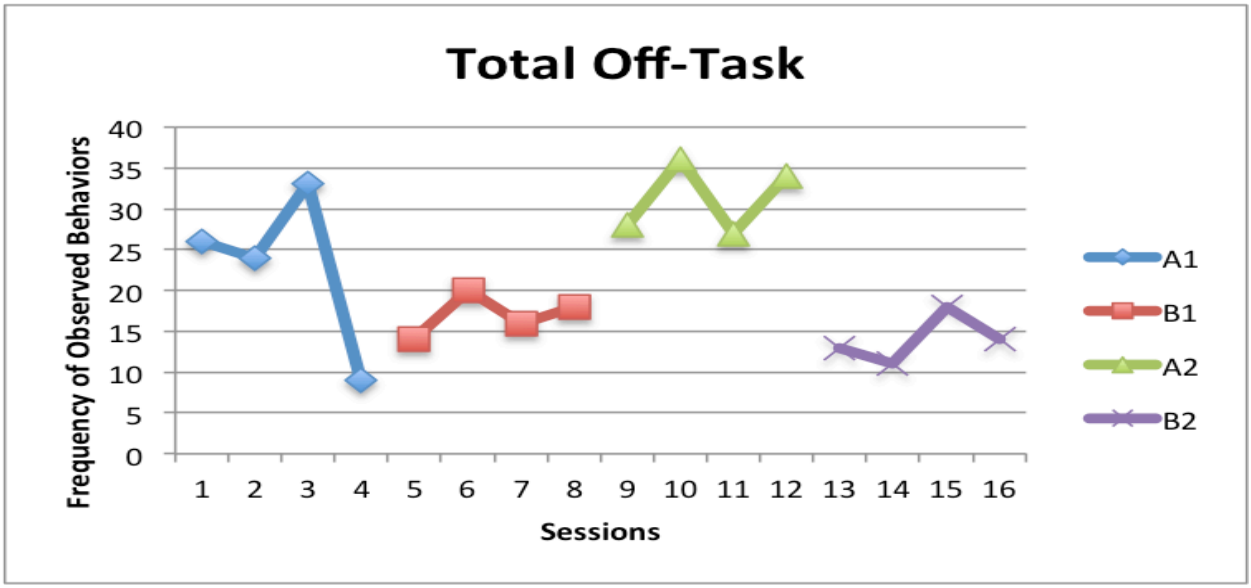

Figure 2.4. Frequency of total off-task behaviors observed during all phases.

Visual Analysis A1 vs. B1 Total Off-Task. Figure 4 displays the frequency of observed off-task behaviors during A1 and B1. Figure 4 indicates that during A1 and B1 there was some variability of the number of problematic behaviors observed. The level (mean) of A1 is *M* = 23. There was a decrease of behaviors observed during the final day of A1. Interestingly, there was an increase in problematic behaviors observed in the intercept gap (last day of baseline [4] and

first day of intervention [5]) of A1 and B1 (9 behaviors to 14 behaviors). The level (mean) of B1 is *M* = 17 and the trend (slope) is stable.

Visual Analysis A2 vs. B2 Total Off-Task. Figure 4 displays the frequency of observed off-task motor behaviors during A2 and B2. Figure 1 indicates that during A2 there was some variability of the number of problematic behaviors observed. The level (mean) of A2 is *M* = 31.25. There was an immediate and significant decrease in problematic behaviors observed in the intercept gap (last day of baseline [12] and first day of intervention [13]) of A2 and B2 (34 behaviors to 13 behaviors). The level (mean) of B2 is *M* = 14 and the trend (slope) is relatively stable.

Visual Analysis A1 B1 A2 B2 Total Off-Task. Figure 4 displays the frequency of observed off-task motor behaviors during A1 A2 and B1 B2. Figure 1 indicates that during baseline (A1 and A2) there was some variability of the number of problematic behaviors observed. The level (mean) of A1 and A2 is *M* = 27.13. During intervention (B1 and B2) there was more stability in the overall trend of the data. The level of B2 and B2 is *M* =15.5.

Improvement Rate Difference A1 vs. B1 Total Off-Task. The sample size (number of days observed) of A1 vs. B1 was n = 8, SD = 7.54 and a margin of error of 5.23. There were no overlapping data points between A1 and B1 but IRD removed one data point as an outlier [9]. The percent of non-overlapping data was computed using the online calculator. IRD is .75 (95% CI [.70, .80]) between these two phases. The IRD of 75% indicates a large effect.

Improvement Rate Difference A2 vs. B2 Total Off-Task. The sample size (number of days observed) of A2 vs. B2 was n = 8, SD = 9.86 and a margin of error of 6.83. There were no overlapping data points between A2 and B2 and no points were removed as outliers. Thus, the

percent of non-overlapping data was computed using the online calculator. IRD is 1.0 (95% CI [.93, 1.07]) between these two phases. The IRD of 100% indicates a very large effect.

Improvement Rate Difference A1 B1 A2 B2 Total Off-Task. The sample size (number of days observed) of A1 A2 vs. B1 B2 was n = 16, SD = 8.58 and a margin of error of 4.21. One data point was removed [9] as an outlier. The percent of non-overlapping data was computed using the online calculator. IRD is .88 (95% CI [.83, .92]) between these two phases. The IRD of 88% indicates a large effect.

3.5 DISCUSSION

The purpose of this study was to determine the extent at which modifying classroom lighting by lowering color temperature affects commonly observed behaviors of a student diagnosed with EMD in a general education classroom. Prior to the study, the general education science teacher and the special education resource teacher of record for Student 2 completed the BASC-3 TRS. This assessment provided the researcher with information regarding typical problematic behaviors for Student 2. The general education teacher noted occurrence of clinically significant problematic behaviors in the areas of hyperactivity, aggression, and conduct problems (motor and verbal behaviors) in addition to attention and learning problems (passive) and atypicality. In comparison, the special education teacher identified attention and learning problems as clinically significant but aggression and withdrawl as at-risk. This contrast may be attributed to the number of students in each classroom environment and the accommodations and modifications that are made in a smaller resource setting. Visual analyses of the data gathered by tracking indicated the changes observed. Results of this study suggest that students with EMD and ADHD may benefit from a reduction in overhead lighting color and brightness.

According to the literature, lighting environments can foster attitudes or feelings about school subjects and may boost achievement (Chan, 1996). More recently, researchers (Mott et. al, 2012) found a significant positive effect on oral reading as well as socially appropriate behaviors when a teacher was able to control the color and intensity of the overhead lights in the classroom.

Overall findings from this investigation lend initial support to the use of modified lighting in classrooms. Visual analysis and IRD of collected data identify modified lighting appears to reduce off-task motor behaviors observed in a student with EMD and ADHD. However, a very small reduction of negative verbal and passive behaviors was evident therefore the lighting change was less successful as an intervention.

Limitations

This study suggests that modifying classroom lighting can impact negative or problematic behaviors observed in a student with EMD and ADHD. However, future research should incorporate experimental designs that optimize external validity for a larger sample and population. The results of this study may only be generalizable to the single individual studied, which affects external validity. The researcher intends to replicate the study and determine generalizability in later research. Additionally, there were differences or levels of behavior displayed by the student that could not be controlled. For example, the classroom behavior management style of the classroom teacher could have had an affect on observed behaviors and internal validity. For example, the school did not utilize Functional Behavior Assessment information or implement a Behavior Plan for commonly observed behaviors in Student 2. Student 2 was often disciplined in front of other children, and there were no rules for group participation when it was required for an assignment so her often did not participate. Students were not assigned seats in the classroom, and task avoidance was frequently overlooked.

Future Research

Because single intervention study evidence is not sufficient enough to identify the intervention as effective (Thompson, 2006), the researcher recommends performing multiple replications of the study to solidify the external validity and generalizability of the original

experiment involving an individual student with EMD and ADHD. Once multiple replications occur, it is advised that a meta-analysis be conducted to identify the common effect size and confidence interval of the combined research studies.

In addition to a meta-analysis, there is potential benefit from the addition of a qualitative component. Qualitative inquiry through interview or field notes could possibly support and explain the findings of the quantitative IRD data.

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CHAPTER IV:

MODIFYING STUDENT BEHAVIORS BY MODIFYING THE CLASSROOM ENVIRONMENT AND LIGHTING DESIGN

4.1 INTRODUCTION

Previous research identifies concerns regarding how school design and learning environment affect academic and behavioral achievement of students (Chan, 1996; Tanner, 2008; Asiyai, 2014). Anekwe and Ifeakor (2006) discuss how the contents of a learning environment characterize the setting in which students are expected to learn. They explain the components of the learning environment are color, light, social interaction, space, and furniture (Anekwe & Ifeakor, 2006). Obong, Okey, and Okaba (2010) add equipment, instructional materials, laboratories, libraries, and play grounds as part of the learning environment. Asiyai (2014) states "conducive classroom environment is an agent of intellectual stimulation and an important factor in strengthening the child's educational development" (p. 717). Goodlard (1984) notes "the nature of the classroom environment has a powerful influence on how well students achieve". He discusses how the environment's physical, emotional, and aesthetic characteristics can enhance student attitude. For students to learn effectively and meaningfully, their overall perception about classroom physical condition should be positive (Asiyai, 2014; Goodlard, 1984).

The amount of light used in classrooms is a fundamental aspect of school building design. In the early 1900s, daylight was the primary source of light in classrooms (Baker, 2012). Time and innovation have led to alternative methods of illuminating classrooms. Enlargement of windows, artificial fluorescent lighting, LED lighting, and variable lighting (Baker, 2012; Castaldi, 1969; Mott, Robinson, Walden, Burnette, & Rutherford, 2012; Mott, Robinson,

Williams-Black, & McClelland, 2014) are examples of recent advances in lighting design and use. Recently, a team of researchers investigated how changing the color of lighting used in classrooms affected students oral reading fluency and behaviors (Mott, et. al, 2012; Mott, et. al, 2014). The results suggest that academic performance varies based on lighting in the classroom. Asiyai (2014) conducted an investigation of the perception students had of their physical learning environments. The results suggest the classroom physical learning environment in most public schools is not desirable and effective learning cannot take place if the environment is not pleasing to the student. The study noted that an inadequate lighting condition contributes to ineffective learning of students.

Learning Spaces

Researchers have investigated the relationship between student behavior, academic focus, and classroom environment (Visser, 2001). In fact, many researchers (Bullard, 2010; Guardino & Fullerton, 2010; Visser, 2001; Weinstein, 1979) acknowledge how a well-organized classroom offers more positive engagement opportunities between teachers and children, reducing the likelihood of problematic behaviors. Although environmental modifications are essential to classroom management, many teachers are unaware of the process to appropriately implement these modifications (Guardino & Fullerton, 2010). Furthermore, although well-designed classrooms have proven benefits there is more research to be done on the impact environmental modifications have on specific behaviors and subject area knowledge acquisition (Schilling & Schwartz, 2004). Gonzales and Young (2015) identify instructional learning space as one of the key elements that can help students flourish and achieve their potential.

Lighting Spaces

Although many types of modification exist and are supported by research, overhead lighting modifications have been proven effective and minimally intrusive (Mott, 2012; Simpson, 2016). Lighting modification is not yet an evidence-based practice. However, results suggest the frequency of disruptive and problematic behaviors can be reduced by lowering the brightness of overhead lights in a classroom (Simpson, 2016).

4.2 CASE STUDY

As a first year teacher I struggled daily to teach academics, control classroom behavior, and differentiate learning experiences for students in my inclusive classroom during group learning time. Several students in my class received special education services based on qualification of behavior-based disabilities. One evening I recalled a trick a former professor used to get attention after group activities in a college classroom, simply turn the lights on and off. On Monday morning I began class with a discussion about the new "light rule" and then practiced a few times with the class. I explained to the class that when the lights were off during instruction time, the students should be quiet and listen. When the lights were on during center time, the students should keep an inside voice and work in groups. The class responded well during practice. I began the lesson for the morning and soon it was time to transition. I reached for the light, flipped the switch to off. The students get quiet. Eureka! I gave instruction for transition to centers and groups and flipped the switch to on. The students moved and began to work. Time passed and it was time to switch to another center. I flipped the switch to off. The students got quiet and looked up at me. Progress! I reinforced the behavior by giving the class a round of applause and then gave instructions for the next task. The students moved as directed and I praised the class again. One day, I was distracted and forgot to turn the lights back to on (after all, it's not dark...there are two windows in the room and the blinds were open. Once I realized what I had done I quietly observed the students. They were all working and calm but I flipped the light switch to on anyway. A child mumbled and complained. He said, "Awwweee,

can't we keep the lights off? I'm working better like this." Other children chimed in, "Yeah, can't the lights stay off? We promise we'll be good. Pllllleeeeaaaassseeeee?" I thought to myself, "Well...why not give it a whirl? After all, what would it hurt to let the sunshine come in through the windows?" I thought to myself, "Those fluorescent lights give me a headache by the end of the day anyway." I left the lights off for the rest of the lesson and then flipped the switch to on before the class left for lunch. I noticed that while the class was still calm as they transitioned, they seem to lack energy completely. I wondered, "Could this be a result of the lights being off for too long?". I thought to myself the on/off "light rule" needed some work, but I wasn't sure how to proceed.

4.3 EVIDENCE FOR EFFECTIVENESS

Classroom Environment. Guardino and Fullerton (2010) researched how environmental modifications could be used as a tool to potentially decrease chronic behavior problems or prevent behavior problems from ever occurring. The research study took place in one elementary school classroom with teacher reports of high-levels of problematic behavior. Baseline data was gathered to determine overall engagement and overall disruptive behaviors across all students. Before intervention, the researchers discussed potentially helpful modifications for the classroom. These included: adding organizational materials, motivational posters, creating clear pathways, changing the seating arrangement, and creating a group space. Their results suggested that after the environmental changes were made overall student engagement rose and disruptive behaviors decreased.

Gonzales and Young (2015) studied the learning environment of a classroom by collecting data on student performance and engagement. The researchers evaluated ten different design parameters, including light, sound, and color of the room. They found that classroom design could be attributed to a twenty five percent impact on student progress over the course of an academic year.

Classroom Lighting. Light bulbs are available in a variety of colors and brightness. Rating scales for lighting sources are measured through Correlated Color Temperature (CCT). CCT values provide information regarding the color appearance of the bulb used. Additionally, the Kelvin Scale is a unit of measurement used to describe the color of a specific light source. At

the time of this study, no documented required CCT or Kelvin bulb required for use in classrooms was found. However, research suggests classrooms with a "warm-red color tone" could create a more calming atmosphere for students and teachers (Mott, 2012). Simpson (2016) sought to determine to what extent the use of lighting with low color temperature and low level of illuminance affected commonly observed behaviors of a student diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and a student with Emotional Disturbance (EMD) in a general education classroom.

Prior to the study, the teachers of record for the students identified frequently occurring problematic behaviors. Data was collected on off-task motor, off-task verbal, and off-task passive behaviors. Off-task motor behaviors include: fidgeting in seat, playing with an object in hands, chewing an object obsessively, flipping book pages aimlessly, drawing or doodling. Students may demonstrate off-task verbal behaviors by: whistling, humming, talking to another student at an inappropriate time, or calling out before being called on. Off-task passive behaviors may include: sitting quietly but unengaged, looking around the room, staring out the window or at a wall. Single case research design was used to determine the behavioral impact of modified lighting. Data was gathered using a frequency tracking application called the Behavior Observation of Students in Schools (BOSS) on the researcher's iPad (Shapiro, 2013).

The modification of the twenty classroom light bulbs used in this study cost approximately seventy-five dollars. Districts often have specific vendors that are used as selling agents for large quantities of building supplies. It is advised to discuss the cost and feasibility or approval of light replacement with school administration prior to purchasing.

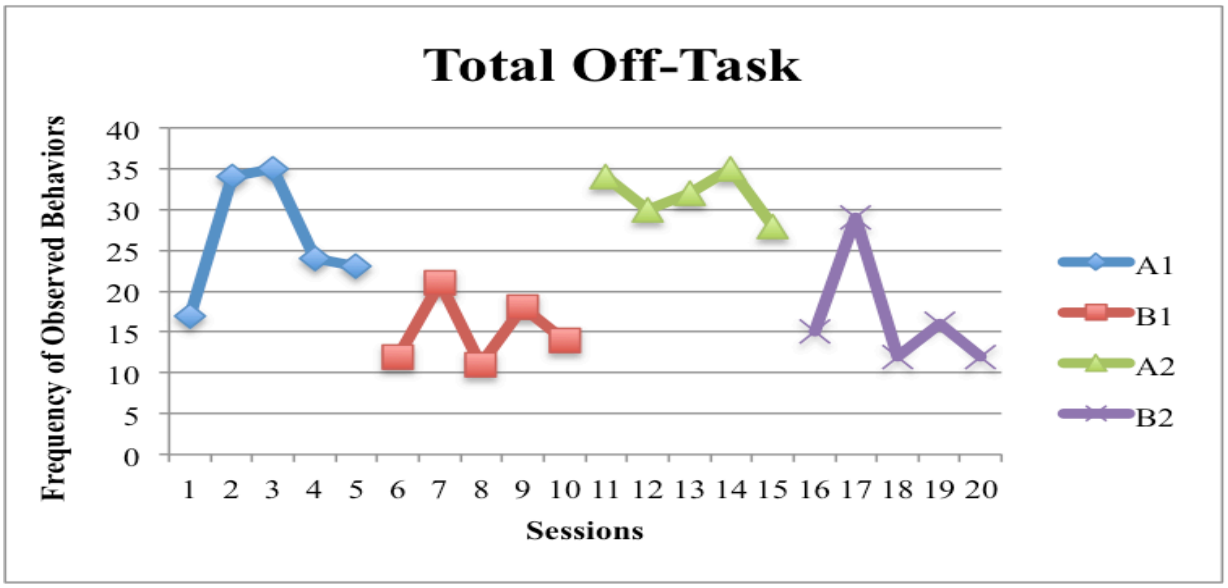

Figure 3.1. Frequency of problematic behaviors observed in a student with ADHD.

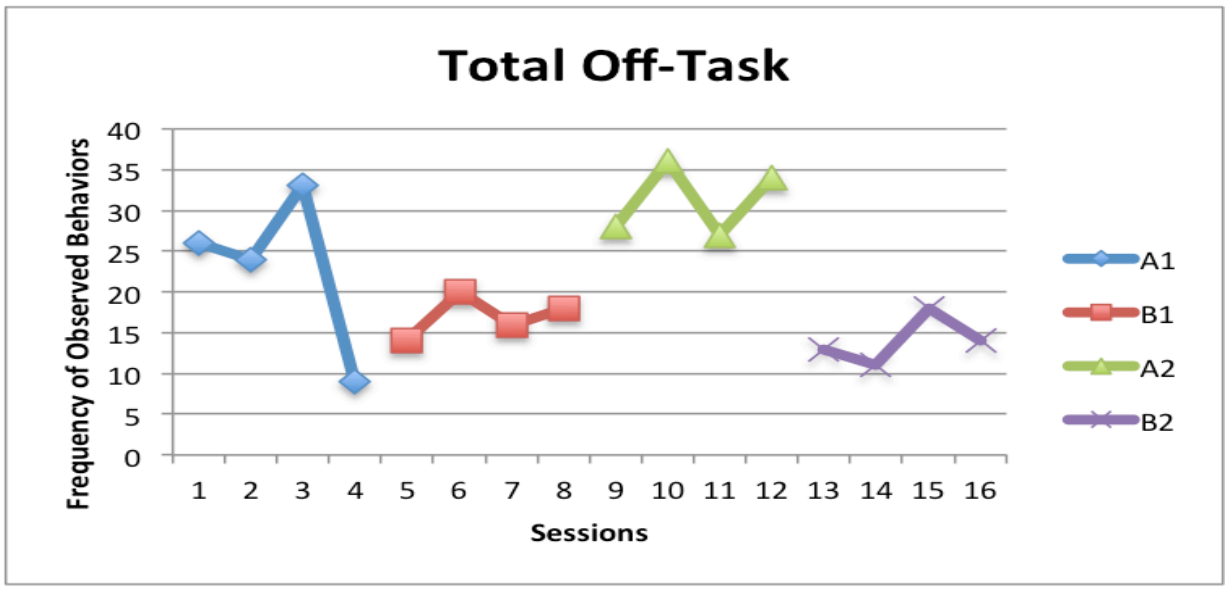

Figure 3.2. Frequency of problematic behaviors observed in a student with EMD.

Figures 1 and 2 show the baseline and intervention data for the study. Prior to intervention, baseline data was collected (A1). Intervention occurred (B1) and the study was repeated (A2 and B2). Overall reduction of problematic behaviors occurred during intervention phases (B1 and B2). The average number of off-task behaviors observed in a student with ADHD (*Figure 1*) reduced from 26.6 in A1 to 15.2 in B1 and from 31.8 in A2 to 16.8 in B2. The

average number of off-task behaviors observed in a student with EMD (*Figure 2*) reduced from 23 in A1 to 17 in B1 and 31.25 in A2 to 14 in B2. This single case research suggests behavioral concerns can potentially decrease by modifying the lighting of a learning environment. However, it should be noted that future studies should include a greater number of classrooms and students identified with behavior concerns.

Figure 3.3. Classroom light bulbs before and after modification (6500K baseline A1 and A2 to 3000K intervention B1 and B2).

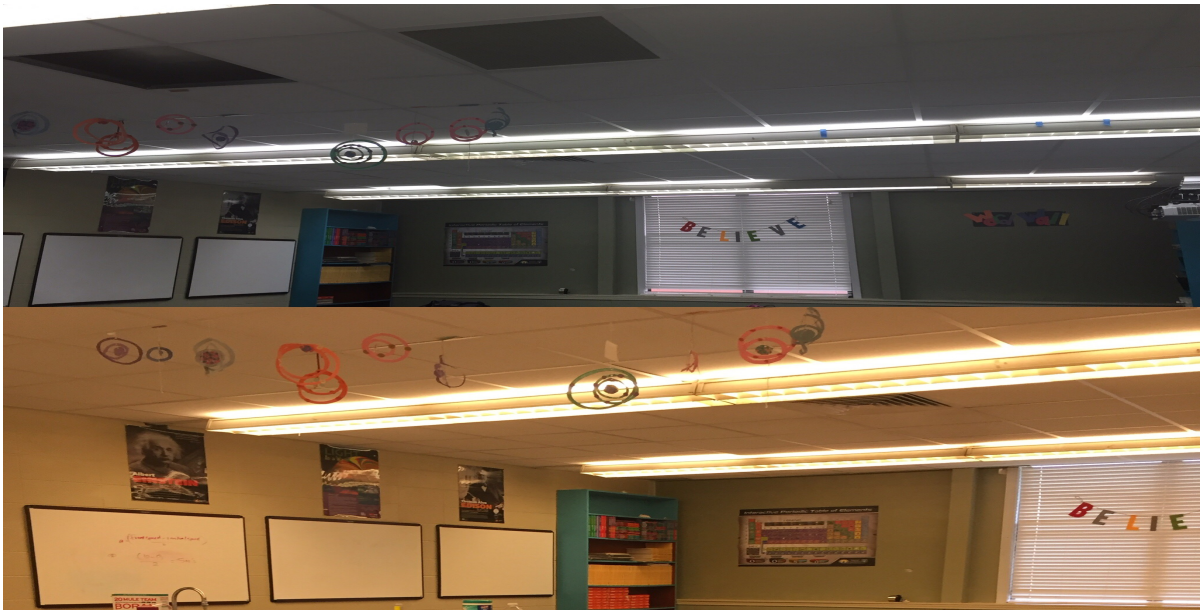

Figure 3.4. Classroom lighting before and after lighting modification (6500K baseline A1 and A2 to 3000K intervention B1 and B2).

4.4 IMPLICATIONS FOR SCHOOL DISTRICTS AND TEACHERS

When designing the learning environment it is important to complete a comprehensive evaluation of the current environment. Rikhye, Gothelf, and Appell (1989) recommend the use of their "Classroom Environment Checklist". Although this checklist was originally created to evaluate environments suited for children with dual-sensory impairments, it is the belief of this researcher that it can be used for all classrooms inclusive of children with special needs. The checklist contains twenty simple yes/no questions that reflect on a variety of classroom considerations including safety, equipment availability, environmental characteristics, and ambiance. Guardino and Fullerton (2010) discuss the struggle many teachers face with disruptive behavior in their classrooms. They suggest "finding classroom management strategies that are proactive, preventative, and relatively easy to implement, and which provide minimal disruption to the classroom" (p. 8). They acknowledge the importance of observation of the current environment, modifications as needed, and reflective follow-up to monitor effectiveness of the change.

Regarding lighting, the researchers recommend evaluating lighting illumination levels and adjustability of the lighting system currently in the classroom in order to optimize vision while acknowledging light sensitivity (Rikhye, Gothelf, & Appell, 1989). When choosing the type of lighting system originally placed in a school, specifically classrooms, district administrators must consider not only cost, but also how the lighting system and the level of

illumination (brightness) could facilitate or hinder learning and behavior within the environment (McGuiness, 2007).

Emerging research promotes the need of modified lighting. Therefore, educational leaders should find ways to address the cost and benefit of moving away from artificial fluorescent lighting (Ott, 1976) to full spectrum lighting (Martel, n.d.) or the use of daylight through windows (Baker, 2012). Few school leaders consider themselves experts in lighting; therefore, those seeking to make modifications to classrooms with the goals of positive academic and behavioral impact on students may ask questions regarding current research, funding options, and continual measurement of success of the modifications to systems currently in learning environments (Simpson, et.al, 2015).

4.5 CONCLUSION

Research clearly documents that learning environments affect student behavior and achievement (Chan, 1996; Tanner, 2008; Asiyai, 2014). Therefore, it is critical that school personnel address classroom environmental concerns. In recent research related to classroom lighting, multiple studies provide methods to measure the success of moving to full spectrum lighting options (Mott et. al, 2012, Simpson, 2016). However, districts must be aware of the cost associated with modification of existing learning spaces. This is important because funds allocated to school districts by the state and federal government are often designated for specific projects or materials and may not be used in other ways (O'Donovan, 2009).

Additionally, teachers must become aware of environmental distractions and how to rearrange or modify the classrooms so students are less likely to become distracted during important educational opportunities. In order to do this, teachers must define learning areas, improve accessibility of materials, utilize appropriate lighting, and organize effectively (Guardino, & Fullerton, 2010).

Finally, administrators must understand the costs associated with modification of current classroom environments; therefore, they should seek out design and lighting experts to assist in estimating the total cost of purchasing and maintaining updated lighting systems in all classrooms. Budgeting for replacement costs and retrofitting costs may require school leaders to seek out alternate funding opportunities.

In conclusion, providing specific frameworks for environmental modification should enable teachers and districts to modify the learning environment to encourage academic engagement and discourage disruptive or problematic behaviors. Ultimately, teachers have the freedom to design their classrooms, with respect to building codes and rules. However, frameworks should be utilized in order to ensure evidence-based practices are in place and reflective assessment of usefulness of the modification is continual.

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Obong, L. B., Okey, S., & Okaba, L. A. (2010). Strategies for school environment management in Nigerian secondary schools: A case study of Calabar, Nigeria. *International Education Studies, 3*(1), 196-205.

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CHAPTER V:

CONCLUSION TO THE DISSERTATION

Final Thoughts

The purpose of this dissertation was to present evidence for the effectiveness and appropriate use of modified lighting in classrooms. For the two single case research studies conducted, Simpson (2016) evaluated two students with disabilities. One student participant is diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and another student participant is diagnosed with Emotional Disturbance and ADHD. Visual analysis and statistical analysis were used to evaluate effectiveness. Three types of behaviors were considered and observed; off-task motor behaviors, off-task verbal behaviors, and off-task passive behaviors. Results indicate that modified lighting is an appropriate tool to use when attempting to reduce these behaviors. Visual analysis and statistical analysis through Improvement Rate Difference (IRD) indicate that modifying the classroom lighting to a lower temperature and level of illuminance is most appropriate and statistically significant when off-task motor behaviors are problematic.

VITA

JESSICA FOSHEE SIMPSON
Department of Teacher Education
School of Education
The University of Mississippi
303 Guyton Hall – P.O. Box 1848
University, MS 38677
jlfoshe1@olemiss.edu

EDUCATION

Ph.D.	2016	The University of Mississippi	Special Education
		Dissertation: The Calming Effects of Modified Lighting	
M.Ed.	2004	The University of Mississippi	Special Education
B.A.	2003	The University of Mississippi	Special Education Cum Laude

PROFESSIONAL EXPERIENCE

HIGHER EDUCATION

2012 – Present **Graduate Instructor**, Department of Teacher Education
The University of Mississippi – Oxford, MS

- Designed and taught 8 undergraduate courses - including multiple sections
- Created and designed the technology component of all courses for accessibility to the online system Blackboard
- Supervised practicum and student teaching field experiences, advising on skills, methods, and techniques to assist the transfer of knowledge
- Delivered a range of teaching and assessment activities, including tutorials directed towards the delivery of all special education content at undergraduate level
- Applied departmental processes related to the academic discipline process/dispositions
- Supported faculty research projects
- Involved in the development of new material for program courses insuring the embedding of diversity and equity
- Contributed to the development of appropriate teaching materials to ensure content and methods of delivery meet learning objectives, activities, and evaluations
- Participated in the assessment process, using a variety of methods and techniques and provide effective, timely, and appropriate feedback to students to support their learning
- Helped with ongoing development and design of the curriculum, in a manner supporting a research-led and scholarly approach to student learning
- Pursued professional development to remain current and ensure application of recent advances in knowledge to teaching

K-12 EDUCATION

2007 – 2012 **Special Education Teacher**, Crosswind Elementary School
Reading and Math Resource, Language Arts and Math Co-Teaching
Shelby County School District – Collierville, TN

2004 – 2007 **Special Education Teacher**, Southwind Middle School
Math and Science Resource
Shelby County School District – Memphis, TN

LICENSURE

Tennessee Department of Education Professional License
Endorsements in SPED Modified K-12 and SPED Comprehensive K-12
Highly Qualified in All Subject Areas K-8
Eligible for Gifted Endorsement

HONORS AND AWARDS

2016 Outstanding Doctoral Student, Special Education
This award is based on GPA, course completion, writing and research skills, leadership ability, service to university and service to the profession. One award is given each year.

2016 Graduate Student Achievement Award for Teacher Education
This award is based on GPA, course completion, writing and research skills, service learning, leadership potential, and professional organization participation. One award is given to a University of Mississippi School of Education graduate student each year.

2015 Cutting Edge Graduate Student, Teacher Education
My teaching background and dissertation research were featured in the University of Mississippi School of Education Fall 2015 Annual Report "Education Edge".

2014 Graduate Student Achievement Award for Teacher Education
This award is based on GPA, course completion, writing and research skills, service learning, leadership potential, and professional organization participation. One award is given to a University of Mississippi School of Education graduate student each year.

2014 Ole Miss Alumni Review, Feature Story
My interest and research in neuroscience education were highlighted in the feature story of the Winter 2014 *Alumni Review* publication distributed to all active alumni of the University of Mississippi.

2014 Joan Gilbert Smith Scholarship Recipient, The University of Mississippi
This financial award is based on scholastic ability, leadership potential, and experience working with children.

2013 Lamar Memorial Scholarship Recipient, The University of Mississippi
This financial award is based on scholastic ability, leadership potential, and experience working with children.

2011 Students' Choice Teacher of the Year, Crosswind Elementary

2009 Tennessee Teacher of the Year Nominee, Crosswind Elementary

2009 Rotary Teacher of the Month, Crosswind Elementary

2008 Crosswind Elementary Special Education Teacher of the Year

2004 Outstanding Master's Student in Special Education, University of Mississippi
This award is based on GPA, writing and research skills, service learning, leadership, potential, and professional organization participation.

HIGHER EDUCATION TEACHING EXPERIENCE

The University of Mississippi

EDSP 308 - Introduction to Special Education: Introduction and overview of the various exceptionalities receiving special education services. An inclusive approach is presented with strategies for accommodating students with disabilities in regular education settings. An emphasis is placed on the role of technology and its uses with students with learning and behavioral problems.
Fall 2012, 2013, 2014; Spring 2013, 2014, Winter 2014 :
Teaching Evaluation Overall Mean – 4.70/5.00

EDSP 327 - Nature and Needs of Students with Mild to Moderate Disabilities:
Introduction to the education of students with mild/moderate disabilities. Emphasis on the characteristics and assessment of students with mild/moderate disabilities as related to instruction.
Fall 2012, 2014, 2015 : Teaching Evaluation Overall Mean – 4.65/5.00

EDSP 329 - Nature and Needs of Students with Severe Disabilities: Introduction to the education of students with severe disabilities. Emphasis on the characteristics and assessment of students with severe disabilities.
Spring 2012 - This course was exempt from evaluation due to student enrollment (4 enrolled).

EDSP 402 - Organization and Administration of Special Education: The referral to placement process. Federal, state, and local laws, policies, and procedures. Financial bases, community resources, service delivery systems, program development, and models of instructional implementation.
Spring 2012 (2 sections) : Teaching Evaluation Overall Mean – 4.4/5.00

EDSP 405 - Instructional Strategies for Students with Mild to Moderate Disabilities: Strategies for instruction of students with mild/moderate disabilities.
Fall 2012 : Teaching Evaluation Overall Mean – 4.5/5.00

EDSP 407 - Survey of Special Education Students: An overview of the legal bases for special education services, school law, the referral-to-placement process (federal, state, and local policies and procedures) including Response to Intervention and the Tier Process, research-based interventions for students at risk for a disability.
Spring 2014 : Teaching Evaluation Overall Mean – 4.6/5.00

EDLE 417 - Senior Practicum Supervision: Field experience designed to support elementary methods courses.
Fall 2013 : Teaching Evaluation Overall Mean – 5.00/5.00

EDLE 464 - Student Teaching Supervision: Full-time, full-semester student teaching; preparation of portfolio of teaching and interview materials; staff development activities at PDS sites.
Spring 2013 - This course was exempt from evaluation due to student enrollment (4 enrolled).

RESEARCH

PUBLICATIONS

Simpson, J. F., Mott, M. S., Moore, V. J., McClelland, S. S., & Thomas, L. (in press). Light technology for promoting learning in schools: A review of the educational research. *Journal of Contemporary Research in Education.*

Simpson, J. F., Thurston, R. J., & James, L. E. (2014). Exploring personality differences of teachers for co-teaching. *Journal of Instructional Psychology, 41* (1-4). 100-105.

FUTURE PUBLICATIONS

Simpson, J. F., & Soares, D. A. (in preparation). Closing the RTI gap for pre-service teachers.

Simpson, J. F., & Thurston, R. J. (in preparation). Exploring the effect of stress on children and learning.

CONFERENCE PRESENTATIONS

Simpson, J. F., & Soares, D. A. (2015). Exploring the Use of Dynamic Lighting to Influence Student Behavior. Poster Presentation at The Council for Exceptional Children with Behavioral Disorders International Conference. Atlanta, GA.

Simpson, J. F., Parker, M. A., Naron, K. Y., Stapp, A., & Alef, E. C. (2014). Reading, Writing, and the Common Core…Thinking Outside of the Box. Mississippi Reading Association Conference. Biloxi, MS.

CONFERENCE ATTENDANCE

2015 Neuroscience and Learning: Healing the Injured Brain. Oxford, MS Conference Attendee

2013 Mississippi Association of Educators Student Program Advisors Conference. Jackson, MS. Conference Attendee

INVITED PRESENTATIONS

Simpson, J.F. (2016). What to know about working with at-risk student athletes. Presentation to University of Mississippi FedEx Athletic support center staff and tutors. Oxford, MS

Simpson, J. F. (2015). Modified lighting and the impact on students with disabilities. Dissertation and Prospectus Defense was presented to EDEL 700 Doctoral Seminar. Oxford, MS.

Simpson, J. F. (2014). How building structure and lighting systems can affect healing in hospitals. Presentation to EDSP 674 Seminar in Special Education. Oxford, MS.

Simpson, J. F. (2013). Classroom management and behavioral assessment. Presentation to EDCI 419 Effective Classroom Management and Assessment Practices. Oxford, MS.

Simpson, J. F., & Platt, S. A. (2013). Representation of disabilities in feature films and documentaries. Presentation to EDSP 543 The Learning Brain. Oxford, MS.

Simpson, J.F. (2012). Teacher Education Awards and Scholarships. Presentation to the Teacher Education Department. Oxford, MS

Simpson, J. F. (2012). Response to Intervention procedures and differentiated instruction. Presentation to EDCI 352 Education, Society and the K-12 Learner. Oxford, MS.

Simpson, J. F. (2012). Response to Intervention procedures and differentiated instruction. Presentation to EDSE 400 Principals of Education. Oxford, MS.

Simpson, J. F. (2009). Differentiation in the inclusive classroom. Presentation to Shelby County School District Special Education Department. Memphis, TN.

Simpson, J. F. (2005). "Love and Logic" for classroom management. Faculty Meeting Presentation at Southwind Middle School. Memphis, TN.

SERVICE

ACADEMIC SERVICE

The University of Mississippi

2014-2015 NCATE/CAEP Accreditation Participant. I participated in vertical and horizontal alignment of special education undergraduate program courses to ensure full coverage of CEC Standards for NCATE/CAEP Accreditation.

2014-2015 Undergraduate SPED Program Review. I researched and compared higher education undergraduate special education programs from across the nation with the goal of improving the current undergraduate special education program at the University of Mississippi. The program coordinator utilized my research to determine appropriate program revisions.

2014-2015 Course Design. I developed a draft course syllabus combining two current courses. The two courses (EDSP 308 and 327) were very similar in nature and our program coordinator wanted to combine the two into EDSP 308 so EDSP 327 could become more focused on classroom management and behavior assessment. The draft was accepted and the course change will take place in 2016.

2013-2014 CCSS Service Learning Project. I coordinated the development and donation of over one hundred and fifty Common Core State Standard Activity Centers to local school districts. The centers, which focused on reading and mathematic skill development and enrichment, were developed by undergraduate education majors enrolled in EDSP 327 and donated to local schools.

2013-2016 Teacher Education Awards and Scholarships Coordinator. I coordinated a review of all past and present scholarship and award opportunities offered in the Teacher Education Department of the School of Education. I continue to communicate with faculty each spring semester to ensure proper procedures are followed for nomination.

PROFESSIONAL SERVICE

The University of Mississippi

2015 Search Committee Member for Assistant Dean and Director of Assessment for the School of Education, University of MS

2015 M.Ed. Comprehensive Exam Symposium Project Evaluator, University of MS

2015 Autism Speaks U Faculty Advisor, University of MS

2015 Center for Excellence in Literacy Instruction Tutor, University of MS

2015 Search Committee Member for Graduate Activities Assistant, University of MS

2015 MS Charter School Authorizer Board Discussion Group, Invited Attendee

2014-Present University of Mississippi School of Education Alumni Board of Directors

2013-2016 Teacher Education Awards and Scholarships Committee, University of MS

Local School Districts

2014 Water Valley School District Open House Welcome Committee

2009-2012 Fast Math/Fraction Nation Coordinator, Crosswind Elementary

2009 Compass Odyssey Implementation Coordinator, Crosswind Elementary

2008 Professional Learning Community Co-Chair, Crosswind Elementary

2007-2012 Specialist Committee Chair, Crosswind Elementary

2007-2012 Student Support Team Member, Crosswind Elementary

2007-2012 School Improvement Plan Committee Chair, Crosswind Elementary

2007-2012 Discovery Assessment Coordinator for SPED, Crosswind Elementary

2007-2009 TN Department of Education TCAP-Alt MAAS Development Committee

2004-2007 ThinkLinkLearn Assessment Coordinator for SPED, Southwind Middle

2004-2007 Student Support Team Member, Southwind Middle School

2004-2007 Principal's Advisory Committee Member, Southwind Middle School

ACADEMIC AND PROFESSIONAL MEMBERSHIPS

2015 – Present	Council for Exceptional Children
2012 – Present	Phi Kappa Phi Honor Society
2012 – Present	Phi Delta Kappa Honor Society
2012 – Present	Kappa Delta Pi Honor Society
2014 – Present	Mississippi Reading Association
2004-2012	National Education Association
2004-2012	Tennessee Education Association
2004-2012	Shelby County Education Association
2004-2011	Crisis Prevention Institute Certification
2004-2011	Professional Crisis Management Certification
2003-2004	Mississippi Education Association
1999-2004	Lambda Sigma Honor Society