The purpose of this study was to examine the effects of vigorous bouts of physical activity on elementary students with and without a diagnosis of ADHD. To test these relationships, a series of assessments were administered to 10 elementary school students with and without diagnoses of ADHD following bouts of either physical activity or sedentary activity. Results of statistical analyses indicated that over the 4 week period of the study, students with and without a diagnosis of ADHD who engaged in the physical activity condition exhibited a greater increase in their weekly attention scores over the four week period compared to their peers who engaged in sedentary activities.
EFFECTS OF VIGOROUS BOUTS OF PHYSICAL ACTIVITY IN ELEMENTARY STUDENTS WITH AND WITHOUT A DIAGNOSIS OF ATTENTION DEFICIT DISORDER: AN EXAMINATION OF HOW PHYSICAL ACTIVITY INFLUENCES THE ATTENTION AND CONCENTRATION OF STUDENTS IN THE SCHOOL ENVIRONMENT

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CHAPTER I
INTRODUCTION

Research Question

The research question for this study is: Does the attention and concentration of students with Attention Deficit Disorder improve or increase following bouts of aerobic physical activity? More specifically, the purpose of this study was to examine if physical activity may increase the concentration of students and as a result, benefit their cognitive functioning as seen in aspects such as attention, concentration, and over-all behavior. Similarly, this study seeks to understand the relationship between attention and physical activity in children.

Approximately 3-7% of school-age children are diagnosed with Attention Deficit Disorder (Amen & Carmichael, 1997; Vereb & DiPerna, 2004). Attention Deficit Disorder is characterized by the symptoms of inattention, hyperactivity, and impulsivity (DSM-IV-TR-TR) and these symptoms are most typically alleviated by medications such as Ritalin (Cross & Abernethy, 1999). Recently, researchers have noted that the long term effects of these medication is unknown (Panksepp, 1998) and may be hindering the necessary play and activity needed for normal growth during childhood critical growth periods (Panskepp, 1998). Similarly, at one time, ADHD was found in only 1% of the population where as up to 8 million children are now diagnosed with the condition (Panskepp, 1998). The question becomes then, did researchers and medical not have enough information and knowledge of ADHD to correctly diagnose the condition, or is something else contributing to the growing numbers of children identified with the disorder? Panskepp (1998) and Eaton et al (2001) noted that rather than actual neurological dysfunction, ADHD may actually be a diagnosis resulting from societal factors or normative symptoms. In fact, recent research indicated that 15% of children ages 6-19 years between the years of 1999-2000 are overweight and at risk for serious health related ailments later in life (Lavizzo-Mourey & McGinnis, 2003). One component of weight management is a consistent opportunity or practice of movement and physical activity. However, recent surveys in the United States indicated that inactivity is prevalent due to a pre-occupation with computers, video games, television, a lack of safe areas to play outdoors, and large cities limiting space for play (Lavizzo-
Mourey & McGinnis, 2003). In addition, curriculum changes in the classroom both in the United States and England limit opportunities for physical activity in the regular school day (Buttress, 2002).

The purpose of this study is to determine if various bouts of physical activity or exertion increase the concentration and/or attention of school age children both diagnosed and undiagnosed with Attention Deficit/Hyperactivity Disorder. The participants will include both male and female students with and without a diagnosis of Attention Deficit/Hyperactivity Disorder in the fourth grade from a small Midwestern elementary school. The students will be placed in one of two groups: aerobic or sedentary. The aerobic group will participate for 20 minutes in a tae-bo activity and the sedentary group will participate for 20 minutes in a guided reading activity. Each separate group will participate in their designated activities for a period of 4 weeks, 2 times a week. Following each activity, the participants will take one of 4 assessment pieces specifically targeting attention and concentration tasks. Prior to and directly following the 4 week period, the students will individually take a 20 minute assessment of executive functioning skills as an additional pre-and post-test measure, making the total time of the study span over a 6 week period.

Prior to the study, the principals, teachers, and parents will be contacted for permission to work with students during a designated period of the school day. More specifically, a letter of explanation concerning the study will be sent to each student, parent, teacher, and principal to inform them of the issues regarding this study. Following the collection of data, the results of the pre-post executive assessments gathered over weeks 1 and 6 and the attention tasks gathered over weeks 2 through 5 will be statistically analyzed using SPSS and the raw data will be visually/graphically presented in graphs using Microsoft Excel.

The benefits of conducting such a study include the possibility of encouraging the importance of physical activity during the regular school day in a time when standardized testing and rigorous curriculum requirements leave little time for a change of tasks, particularly for younger students who have short attention spans (Panskepp, 1998; Panskepp, 2003; Pelligrini & Bjorklund, 1997; Pelligrini & Smith, 1998; . In addition, the study may suggest to researchers that AD/HD can potentially be treated using other
and/or additional means beyond behavioral modification and medication, which may prompt neurologists to further investigate the idea that the increase in endorphins during exercise may mimic the dopamine that is important in attention and concentration. As a result, using short sessions of physical activity throughout the school day may increase student learning and productivity. Also, increased physical activity may improve the health and quality of life of younger students. Teaching them early that physical activity is important and engaging them in that activity at age appropriate levels, may potentially instill the value of healthy living beyond the bounds of academia. In this way, the schools can take a step toward encouraging the development of the entire student, rather than simply their academic and social knowledge. To provide a basis for the proposed research project, the research and theory in the areas of Attention Deficit Disorder, Physical Activity, and the effects of play in the classroom environment are reviewed in the next chapter.
CHAPTER TWO
REVIEW OF LITERATURE

While several forms of intervention exist for the treatment of children diagnosed with Attention Deficit/Hyperactivity Disorder, the study of the benefits of locomotor-related play is a topic of both physical and mental concern as it relates to this particular population of students. Through the pages that follow, the reader will gain an understanding of the impact age-appropriate physical activity can have on student performance, particularly those with characteristics of AD/HD, in the classroom environment. First, the specific characteristics of AD/HD from both behavioral and neurological perspectives will be defined. Second, a discussion of current intervention strategies for the treatment of attention disorders will follow. Third, there will be a discussion of the physical benefits of play and exercise for children with and without AD/HD and the risks of physical inactivity.

Attention Deficit/Hyperactivity Disorder

Children and adolescents diagnosed with Attention Deficit/Hyperactivity Disorder comprise one group of particular interest in both the fields of education and neuropsychology. The main symptoms of AD/HD include hyperactivity, inattention, and impulsivity (DSM-IV-TR, Teicher et al, 2000). These symptoms can then include a whole host of other characteristics such as mood swings, depression, anger, and anxiety as manifestations of the hyperactivity, inattention, and impulsivity. AD/HD can additionally be characterized as combined, predominantly inattentive, predominantly hyperactive-impulsive, and not otherwise specified (DSM-IV-TR). Children exhibiting these characteristics are typically referred to be assessed for Attention Deficit/Hyperactivity Disorder by teachers (Vereb & DiPerna, 2004). While the diagnosis for AD/HD is often vague and consists of multiple symptoms, approximately 3-7% (Amen & Carmichael, 1997; Vereb & DiPerna, 2004) of school-age children are diagnosed with AD/HD. Because the symptoms of AD/HD encompass symptoms such as hyperactivity and inattention, these symptoms may be alleviated by opportunities for regular exercise and physical activity.
AD/HD and Executive Functioning

According to Smith (2002), “AD/HD is a developmental disorder that is usually inherited, and is a result of impaired functioning of certain neurotransmitter networks in the brain, resulting in impaired executive functions” (slide 3). Executive functions include the ability to use interrelated skills to reach a goal in a particular activity by paying attention for relatively extensive periods of time. The components of executive function include planning, monitoring, goal setting, and anticipation (Guy, 2005). Smith (2002) described the executive function system as the following:

Visualize executive function as the conductor of a symphony orchestra, who does not play a musical instrument in the orchestra but does play a critical role by enabling the orchestra to produce complex music. The conductor organizes, activates, focuses, integrates, and directs the musicians as they play. The brain’s executive functions, in like fashion, organize, activate, focus, integrate, and direct, allowing the brain to perform both routine and creative work (slide 16).

The executive functional impairments of AD/HD can mimic learning disorders, when a disorder does not exist. In particular, while learning disorders and AD/HD can occur as comorbid situations, impairments of executive functioning can have a significant impact on the learning process (Smith, 2002).

Understanding the neurological components of AD/HD

In current practice, fMRIs or Functional Magnetic Resonance Imaging-T2 Relaxometry screenings, are being used to better understand the physiology behind the resulting behaviors of AD/HD (Amen & Carmichael, 1997; Teicher et al., 2000). These fMRIs are able to screen for particular neuropeptides by looking at blood volume in the striatum, specifically in the caudate and Putamen. Using fMRIs, Teicher et al (2000) found that boys with AD/HD had higher T-2 Relaxometry time measures in the Putamen “bilaterally” than those who were not diagnosed with AD/HD. In applicable terminology, this higher T-2 score in boys with AD/HD strongly correlated with the individual’s ability to sit still and his accuracy at completing a computer task. Treatment with Ritalin, medically termed methylphenidate or dextroamphetamine, changed the T-2 time measure in the left Putamen. Similar changes took place in the right Putamen, but with no significant results. Additionally, the T2 Relaxometry times did not significantly
differ between the boys with AD/HD and the boys without AD/HD. According to Teicher et al (2000), the results of the study suggested that “ADD symptoms may be tied to functional abnormalities in the Putamen which is mainly involved in the regulation of motor behavior” (p. 470).

Another way of studying the physiology of AD/HD is through Brain SPECT (single-photon emission computed tomography) imaging. Brain SPECT imaging, according to Amen & Carmichael (1997), is “a nuclear medicine study which may offer the most widely applicable measure of neuronal behavior…SPECT [specifically] measures cerebral blood flow and, indirectly, brain metabolism” (p.81). Amen and Carmichael’s (1997) work with small samples of clinical patients comparing unmedicated children diagnosed as having AD/HD to unmedicated children not having the diagnosis of AD/HD, resulted in significant differences between Brain SPECT studies of the two groups at rest. More specifically, the children diagnosed as having AD/HD exhibited significantly lower activity levels in the left prefrontal area, the left frontal lobe, and the left temporal lobe. Amen and Carmichael (1997) described these results as the following:

Prefrontal lobe functions include attention span, concentration, judgment, activity level, critical thinking, and impulse control. It is not surprising therefore, to see that in a significant majority of the AD/HD cases (87%), there was prefrontal lobe hypoperfusion with intellectual stress or decreased activity in the prefrontal cortex at rest. (p. 83).

While these findings appear to relate well to Teichler et al (2000), as the Putamen is responsible for coordinating movement and is one of the nerve cell clusters in the basal ganglia, therefore possibly affecting the signals sent to the frontal and temporal lobes of the brain, a few limitations exist concerning the findings. In particular, the sample of children without AD/HD who were compared to the children with AD/HD were receiving patient care at a clinic. Therefore, the “control” sample had their own particular concerns and/or conditions that could have influenced the marked differences between the two samples.

Treatment/Interventions for AD/HD

Interestingly, several studies of AD/HD and other symptoms of clinical conditions suggest that these concerns can be treated effectively with regular physical activity, or
what Pellegrini and Smith (1998) might term as “locomotor play”. Recent AD/HD literature suggested that children are over-diagnosed and over-medicated with stimulant medications and other drugs. According to Wigal et al. (2003),

A leading pathophysiologic hypothesis of ADHD is based on the notion of a catecholamine dysfunction. This hypothesis suggests that the catecholamine (CA) response to environmental stimuli is attenuated in ADHD and is derived primarily from observations that drugs such as methylphenidate and amphetamine—considered to be catecholamine agonists—are effective in treating the symptoms of ADHD (p. 9).

The most popular drug for treating AD/HD is called methylphenidate, better known as Ritalin, and is prescribed to over 90% of the children on medication with AD/HD. Ritalin has been utilized since the 1960s and is used for the release and reuptake of dopamine in the striatum (the location of the Putamen). The stimulant is short-acting and lasts a maximum of 1 to 4 hours and its specific “mechanism of action” is cited as yet to be understood by researchers (Cross & Abernethy, 1999).

According to Panskepp (1998), AD/HD is the “most common psychiatric problem in our society” (p. 95). The “disorder” was first mentioned George Still, a physician, in 1902. At the time, only 1% of the population was suggested to have a diagnosis of AD/HD. Currently, Panskepp (1998) suggests that 5-15% or up to 8 million children are diagnosed with AD/HD. Panskepp noted that rather than an actual neurological dysfunction, AD/HD may actually be a diagnosis resulting from societal factors. Specifically, “…standardized educational expectations along with a growing intolerance of childhood playfulness may, in fact, be leading to more and more children being labeled as AD/HD” (Panskepp, 1998, p. 95). If this is true, the psycho stimulant drugs that are used to moderate the “symptoms” of AD/HD may actually be inhibiting a child’s need to engage in “rough and tumble” play. According to Panskepp (1998), previous studies have documented detrimental effects in young organisms that are provided limited opportunity to engage in play, and suggested that this may be just as true for young children. In short, play appears to be psychobiological need for children.

Currently, interventions including behavior plans, medication, and counseling are often put into place when a child is diagnosed with AD/HD. While physical activity is
suggested as a positive means of dealing with AD/HD, neuropsychologists are only beginning to consider why individuals with AD/HD seemingly can focus their attention and concentration to a greater extent following periods of physical activity (Amen & Carmichael, 1997). Before identifying the specifics, a brief over-view of the importance of playful activity for children in general and in relation to AD/HD will be discussed.

Physical Activity and Play

During the formative years of childhood, play has countless definitions and takes on many forms. One characteristic pervasive in play is activity, usually physical activity. In a review of play characteristics, Pellegrini and Smith (1998) suggested that play falls into the categories of pretend play, social play, and locomotor play. Although all of these are present to some extent throughout childhood, the emphasis differs at various age levels. During middle to late infancy, children engage in “exploration,” in which they gather information about their environment by watching, touching, and observing things around them. Social pretense or fantasy play, in which children take on particular roles such as a nurse or superhero, is predominant during the preschool years. Locomotor play is first seen when children engage in nonsocial locomotor play; they then move toward more socially oriented, unstructured locomotor activities. These activities include what researchers have termed, “chase games”, which fit into a category defined by Piaget as “games with rules” (Bergen, 2000). At first these have one rule (turn-taking: I run, you catch; then switch roles) but they become very elaborated in the elementary years.

The high activity level children demonstrate in most play behavior may be related to the potential value of physical activity for cognitive types of activities. More specifically, one previous study conducted to observe the use of play have shown that depriving children of locomotor play, significantly increased such play following that deprivation. Following the increase in locomotor play, the researchers found the students to be more attentive in the classroom environment. Such results suggest that locomotor play may increase attention. Pelligrini and Smith in a study of recess play (1998) stated that “…nonfocused play activities, such as those found at break time, provided a release from more focused school work” (p. 55).

Similarly, motor progression studies have focused on the growth patterns of organ systems throughout childhood in an attempt to connect movement and cognitive
development. In a study by Pellegrini and Bjorklund (1997), the functions of recess were analyzed because recent patterns in the schools have minimized the time for this particular activity. The study specifically compared Asian schools’ model of recess and their traditional rigorous curriculum against the United States schools’ model of recess and ever-changing curriculum. In Asia, young school-age students generally take recess breaks for approximately ten minutes after every forty to fifty minute activity. Although young children in the Asian schools are in class for more hours of the day than children in the United States and are additionally in school for most of the year, the recurring physical activity periods may have a role in making school more productive. While the curriculum is rigorous, the school days are longer, and summer break is not long, the Asian schools generally thrive and graduate students with knowledge and skills beyond those of their American peers.

Pellegrini and Bjorklund (1997) suggested that this finding may be explained by the Cognitive Immaturity Hypothesis, which notes that attention span is more difficult for students at younger ages but increases with age and maturity. Therefore, they suggest that schools should not only tailor their curriculum to the level of the students’ cognitive development, but also do things to foster young students’ attention such as interspersing recess between curriculum activities (Pellegrini & Bjorklund, 1997). They state that young children need changing tasks that vary significantly from each other. For example, if students work on a math assignment for 20 minutes, they should then take a break and do something such as recess rather than moving on to a science or social studies lesson. They conclude, “Research using a wide range of tasks has shown that children are increasingly able to inhibit task-irrelevant thoughts and to resist interference from task-irrelevant stimuli, and that such skills contribute significantly to overall cognitive functioning” (Pellegrini & Bjorklund, 1997, p. 37).

Recess is an unstructured period of time limiting cognitive interference, and the results of Pellegrini and Bjorklund’s (1997) study concur with both the Asian model of recess and the cognitive immaturity hypothesis, suggesting that longer delays in an unstructured break such as recess resulted in less attentive behaviors in school-age children. More specifically, Pellegrini and Bjorklund (1997) stated that “…children’s social interaction and physical activity at recess were positively and significantly related
to their task attention after recess” (p. 38). These findings merit further investigation as to why and how recess, particularly physical activity, is an important activity in the schools.

While some who focus their study on play suggest that the cognitive immaturity hypothesis accounts for this finding, other theorists focus on neurological (Amen, 1997) and physiological explanations. For example, Gordon’s et al (2003) work with rats suggested that rough and tumble play may help “program” emotions in the higher brain regions. In addition, Panskepp (2003) noted that children diagnosed with AD/HD often exhibit pre-frontal lobe deficits, particularly on the right side of the brain. While psycho stimulant medication is helpful in treating the symptoms, the side effects of the medications are often called into question. Therefore, Panskepp et al (2003) suggested that other modes of therapy or intervention need to be available for children with AD/HD. Based on his work with the play, Panskepp et al (2003) looked at the effects of play therapy in rats and found that this form of therapy reduced hyperactivity or over-active behaviors. Eaton et al. (2001) noted that Movement epitomizes childhood. From the first flutterings in the womb to the preschooler on the move, or the playful child and the adolescent who sleeps until noon, parents, grandparents, and teachers are variously charmed, amazed, and frustrated at the level of movement displayed by their children (p. 205).

Likewise, as Pellegrini (Pelligrini & Smith, 1998; Pelligrini & Bjorklund, 1997) and Panskepp (2003) suggested, recess in elementary school is linked to more on-task behaviors following such movement activities. In fact, the “normal” movement of an 8 year old does not fit well into the school environment where the expectations are to sit quietly and listen or perform activities in one’s seat. Therefore, Eaton et al. (2001) suggested that the diagnoses of AD/HD in the early elementary years may be one of normative symptoms rather than a pathological disorder. Clearly, this concept raises questions as to when and how AD/HD children are identified and treated during the school age years.

Regardless of the implications of play as defined by various areas of research, locomotor play clearly attracts a great deal of study as findings continue to indicate that motor movements can affect individuals on various levels. Physical activity incorporates
locomotor play, however, it ranges from unstructured locomotor play such as a game of tag to structured play such as a baseball game. In addition, physical activity encompasses individual or group activities such as running, biking, rock climbing, and swimming.

Physical Activity Recommendations

Rates of individuals engaging in physical activity on a regular basis vary based on environment. For example, a recent study of patterns of physical activity in the United Kingdom indicated that the majority of young people ages 7-18 years old did not engage in regular physical activity (Buttress, 2002). According to Buttress (2002), of children ages 7-18 in the United Kingdom, “…girls were less active than boys and activity decreased with age…in the oldest age group, the proportions who were inactive rose to 56% of boys and 69% of girls” (p. 288). Similarly, surveys of children in the United States reported that inactivity is prevalent for similar reasons such as television, computers, video games, and a lack of safe areas to play outdoors, particularly in large cities (Buttress, 2002; Lavizzo-Mourey & McGinnis, 2003). In addition, curriculum changes in both areas of the world limit physical activity during the regular school day (Buttress, 2002). As an aside, these findings parallel those reported by Pelligrini and Smith (1998) indicating that locomotor play tends to decrease by the onset of adolescence.

Despite these trends, the United States Surgeon General recommends at least 30 minutes of moderate-to-rigorous physical activity on a daily basis (Lavizzo-Mourey & McGinnis, 2003), which is minimal compared to the UK’s standards for young children suggesting at least 1 hour of moderate to intense activity, with a focus at least 2 days a week on activities that enhance flexibility and muscular strength (Buttress, 2002). The benefits of physical activity and the dangers of physical inactivity continue to become clearer as researchers search out the implications of why exercise is an important component of over-all health and wellness. A wealth of research currently exists regarding the direct physical benefits of exercise. Specifically, data from the years 1999-2000 indicate that 15% of children ages 6-19 years are overweight and at-risk of serious health related ailments later in life (Lavizzo-Mourey & McGinnis, 2003).
Other Effects of Physical Activity

Current research has resulted in findings that indicate a connection between the influence of physical activity and mental health (Kirkcaldy, Shephard, & Siefen, 2002; Paluska & Schwenk, 2000). More specifically, recent studies have shown that individuals diagnosed with conditions such as depression, excessive anxiety, and compulsive disorders respond positively to treatments utilizing physical activity (Paluska & Schwenk, 2000). In fact, Paluska and Schwenk (2000) noted the following:

Many studies with diverse methodologies have demonstrated associations between participation in physical activity and improvement in mental health symptoms among various populations. Indeed, physical activity has been linked to improvements in mood and creativity even after a single session (p. 2).

In regard to depression, several studies indicated that physical activity increases positive mood states and has been shown to be as effective as psychotherapy and/or antidepressants. The type of exercise utilized in these studies included both cardiovascular programs and strength and flexibility programs, suggesting that both elicit positive benefits for individuals who have been diagnosed with depression (Paluska & Schwenk, 2000). Other studies of depression yielded mixed findings, resulting in inconclusive data. Similarly, studies examining trait anxiety and the implementation of physical activity programs have suggested that moderate exercise may assist in alleviating feelings of long term, chronic anxiety (Paluska & Schwenk, 2000). However, other studies have suggested that physical activity can actually increase the likelihood of panic attacks and other forms of chronic fear and worry, citing that those with chronic fears tend to avoid physical activity which “may contribute to its pathophysiology” (p.6).

Studies focusing on adolescent exercise and sport participation have yielded positive correlations with mental health. For example, the results of a study conducted by Kirkcaldy, Shepherd, & Siefen (2002) suggested, “substantial associations between the regular practice of endurance sport and attitudes, personality, scores for physical and psychological well-being and the adoption of a healthy lifestyle” (p. 548). Similarly, Paluska and Schwenk (2000) noted, “the decreasing regular physical activity levels among adolescent populations make this age group particularly important to address with future studies and physical activity interventions” (p. 7).
The Link between Physical Activity and Attention in the Classroom

Several studies suggest the positive effects of children exercising on a regular basis at age-appropriate, moderate levels of intensity. As noted earlier, Pelligrini and Smith (1998), found that depriving children of physical activity led to increased locomotor play following deprivation. Additionally, following locomotor play, the children were observed to exhibit increased attention in the classroom. Other studies in the realm of exercise science and physical activity point to the facilitation of cognitive/behavioral tasks relating to academics following the implementation of various bouts of exercise (Pellegrini & Bjorklund, 1997; Tomprorowski, 2003). A few of these studies even cite the extent to which children exhibited characteristics of increased attention and ability when completing specific school-related/thinking-type tasks. Therefore, studies that continue to search out not only how physical activity can benefit children from an academic stand-point, but also study the mechanisms by which this activity occurs, will further validate the need for interventions and learning activities in the schools involving not only the mind, but the entire body. As stated by Tomporowski (2003) in his review of cognitive and behavioral responses to exercise in youth,

…despite the general consensus among health professionals that aerobic exercise is a health-promoting activity that results in many short-term and long-term favorable benefits, it has not been actively promoted in the vast majority of educational systems. Unfortunately, few states presently mandate physical activity as part of the curriculum for kindergarten, elementary, middle school, and high school. Elucidating the positive relation between acute exercise and children’s attention, cognitive function, and academic performance may provide support for the implementation of structured aerobic-type physical activity programs in schools (p.356).

While educators and researchers have utilized specific theories based on physical activity as tactics to assist students in concentration and consequently, learning, little direct intervention has been implemented that targets the suggested benefits of exercise in relation to concentration (Pelligrini & Smith, 1989; Tomprowski, 2003). Previous research has suggested that children without clinical disorders exhibited facilitation of cognitive and behavioral tasks following gym class, aerobic walking for 15 minutes, relay
activities ranging from 20 to 50 minutes, and paced walking ranging from 20 to 30
minutes in length (Tomprowski, 2003). All of the above activities include a component
of aerobic activity, which involves raising the heart rate for a specific continuous period
of time, thus producing endorphins. Endorphins produced during exercise are suggested
to mimic drugs and/or neurotransmitters that are proposed to result in anything from a
“runner’s high,” to a decrease in sensitivity to pain, to increased attention (Tomporowski,
2003). Therefore, while results of these suggestions remain inconclusive, testing
intervention possibilities must be focused on activities that include moderate to vigorous
exercise in order to produce these endorphins. Possible interventions include daily
sustained age-appropriate aerobic physical activity for periods of 20 to 30 minutes,
depending on the age of the students. Aerobic walking is an activity that most students
can take part in particularly prior to the second half of the school day when student’s
attention begins to wane or before examinations such as standardized test.

Recently, Sibley and Ethier (2003) reviewed research over the last several years
involving the study of possible relationships between exercise and cognitive
enhancement. More specifically, Sibley and Ethier (2003) reviewed 44 studies involving
physical education and its suggested connections to cognitive growth and development.
Although 44 studies were reviewed, only 9 of them used a true-experimental design. Of
particular interest, Sibley and Ethier (2003) found that the results of three out of four of
these studies showed significant improvement in academic performance upon the
implementation of daily physical education classes. In addition, of the 44 studies that
focus on the relationship of physical activity to learning, many yielded mixed results, but
the effect size was larger for children between the ages of 6 and 13 as opposed to the
entire population.

Sibley and Ethier (2003) noted that in 2000, only 8% of elementary and 6% of
middle school children have physical education class on a daily basis. While previous
studies conducted by Pellegrini and his colleges (1996, 1997), indicate that play and
physical movement are key components in a young child’s development, the schools are
currently seeking to eliminate many of the programs and/or time that children can be
engaging in these motor activities. Additionally, Sibley and Ethier (2003) noted that
“According to Piaget, skills and relationships learned during physical activity carry over
to the learning of other relationships and concepts” (p.244), suggesting that movement rather than exertion is a key component in motor activity and the facilitation of cognitive functions such as attention and concentration.

Overview of Proposed Study

Previous research on the effects of physical activity for children diagnosed with attention disorders suggests that bouts of 1, 5, and 10 minutes have minimal facilitation benefits. Vigorous physical activity is recommended for a period of 1 to 2 hours for children with Attention Deficit/Hyperactivity Disorder, but few systematic studies have done this. Studies involving longer and more vigorous periods of exercise may point to the possibility of exercise as an intervention strategy for increased attention not only in children with AD/HD, but in all school age children. In particular, physical activity may increase the concentration of students and as a result, benefit their cognitive functioning as seen in aspects such as attention, concentration, and over-all behavior. This present study seeks to compare the differences in the attention and concentration of 2 groups of students involved in either a sedentary activity or an aerobic activity. Both groups will have a mix of students that are diagnosed and not diagnosed with AD/HD. The following hypotheses will guide the results and discussion of this study:

1. The students in the aerobic condition will show a greater increase in attention span scores as compared to students in the sedentary condition.

2. Students diagnosed with AD/HD in the aerobic condition will show a greater increase in attention span as compared to students in the sedentary condition.

3. Students diagnosed with AD/HD will have lower executive function scores on pre-test measures as compared to their peers.

4. Students in the aerobic condition will exhibit a greater increase in executive function scores as compared to their peers in the sedentary condition.

5. The teachers will report an increase in attention and/or concentration in the students diagnosed with AD/HD from the aerobic condition as compared to the sedentary condition.
CHAPTER 3
METHODOLOGICAL PROCEDURES

The purpose of this study was to determine if various bouts of physical activity or exertion increase the concentration and/or attention of school age children both diagnosed and undiagnosed with Attention Deficit/Hyperactivity Disorder. To fulfill this goal, two groups of students were selected to participate on a voluntary basis in a set of sessions involving 2 different activity conditions: a reading activity and an aerobics activity. The students took a pretest and a post test measuring executive functioning following the conditions of no physical activity and vigorous physical activity and after each session, measuring attention span. This chapter will discuss the methods used to conduct this study.

Study Participants

The participants in this study were two groups of male and female school age children, ages 9-11, from elementary schools in the Mid-Western Region of the United States. Of the students participating, four were diagnosed with Attention Deficit Disorder and six did not have a diagnosis of any disability condition. There were approximately a similar number of males and females, and diagnosed and undiagnosed students in each group. In addition, data was collected on how each student with AD/HD was diagnosed.

Recruitment and Selection of Subjects

Recruitment of participants occurred on a voluntary basis where the principal, teacher, and students were notified of the researcher’s procedures, time needed, and general purposes through a detailed letter (see attached Appendices) and face-to-face contact from the researcher. First, the principal was contacted to ensure that sufficient information regarding the purpose of the study was provided to the teachers, parents, and students, and to gain assistance in identifying classrooms in which children with attention deficit diagnoses are located. Once these classrooms were identified, those teachers were contacted personally by the researcher who verbally explained the purpose of the study and asked for assistance in sending out a letter explaining the purpose of the study to the potential participating students. Letters are in the appendix. In addition, the parents of the students were informed through a detailed letter and provided a permission slip to sign allowing their children to take part in the study. The letter asked if the parents were
willing to disclose to the researcher if their student has been identified with AD/HD and how he/she was diagnosed, with the assurance of confidentiality of the students’ diagnoses. The researcher’s contact information was made available to the principal, teachers, and parents if they needed further explanation or had questions.

Risks and Benefits

As with any ethical study involving human subjects, minimal risks existed. Specifically, the physical and health considerations included the possibility that students engaging in aerobic physical activity may not acclimate to the demands of the exercises. They may feel tired or out of breath. Additionally, academic considerations included the possibility that removing a group of students out of the regular classroom environment may potentially keep that group from learning specific material with the rest of their classmates. Finally, social considerations included the possibility that students in the group may feel left out from the rest of the class and/or those not chosen to participate may feel left out from the group taking part in the study.

In order to minimize these risks, parents signed a waiver indicating that their child did not have any known physical or health conditions that would limit them or put them at risk for participating in the aerobic activities. Additionally, the participants took part in the study at their particular school during the regular school day with adequate supervision in a large area, the gymnasium, which was free from physical barriers and/or other harmful obstacles. Also, the researcher collaborated with the teacher to coordinate an appropriate time, during a free intervention period, where the participating groups missed a minimal amount of class time. Both of the groups taking part in the study and the non-participants were told by the teacher and researcher that a few students are helping out a college student with some work. The students were assured that they were chosen from groups of students whose parents had agreed they could participate, and the activities the students took part in were explained in straight-forward and age-appropriate terminology.

The potential benefits of the study include several possibilities that may impact both students with and without diagnoses of AD/HD. Primarily, students participating in the group receiving weekly reading received increased exposure to modeled reading. This may potentially increase their vocabulary, sharpen their listening skills, and better
prepare them for the reading rigors of the first grade curriculum, a critical time for reading acquisition. Those students who participated in the weekly aerobic group may benefit from increased physical fitness, offering a wealth of health benefits both cardiovascularly and in regard to over-all body fat and muscle tone. Additionally, the students who participated in the active group may improve motor coordination, flexibility, and cognitive abilities. Also, those students who participated in the active group may exhibit increased levels of concentration and/or attention following the aerobic exercise periods.

The benefits of conducting such a study include the possibility of encouraging the importance of physical activity during the regular school day in a time when standardized testing and rigorous curriculum requirements leave little time for a change of tasks, particularly for younger students who have short attention spans. In addition, the study may suggest to researchers that AD/HD can potentially be treated using other and/or additional means beyond behavioral modification and medication, which may prompt neurologists to further investigate the idea that the increase in endorphins during exercise may mimic the dopamine that is important in attention and concentration. As a result, using short sessions of physical activity throughout the school day may increase student learning and productivity. Also, increased physical activity may improve the health and quality of life of younger students. Teaching them early that physical activity is important and engaging them in that activity at age appropriate levels, may potentially instill the value of healthy living beyond the bounds of academia. In this way, the schools can take a step toward encouraging the development of the entire student, rather than simply their academic and social knowledge.

Informed Consent

As previously mentioned, the principal, teacher, students, and parents were contacted by the researcher to obtain permission and documentation of consenting permission for the participants. More specifically, the researcher contacted the principal of the school and explained the study both verbally and offered a detailed written description out-lining the basic purpose and procedures intended during the research process. The researcher provided a similar document to the teacher and requested that additional copies be given to students to obtain parental permission. Attached to the
documents provided to the parents, a permission slip was attached that outlined the potential risks and benefits of the study, an assurance of confidentiality, and the extent to which the study will last both weekly and throughout the total project.

Instrumentation

Activity Conditions

The activity conditions included the following:

Condition 1: 20 minutes of guided reading (little-to-no-physical activity)
Condition 2: 20 minutes of aerobics (vigorous physical activity)

The researcher met with each group of students at separate times for 20 minute sessions. The sessions continued for 4 consecutive weeks with an additional 2 weeks of pre and post testing procedures. During the first and sixth week, the students met individually once with the researcher for a period of 20 minutes to collect pre-and-post-test measures. Then during weeks 2 through 5, the students met 2 times a week in groups that were assigned to either the sedentary or aerobic condition (for a total of 8 sessions over a 4 week period, 10 sessions over the 6 week period). During each session during weeks 2 through 5, the students in the 1st group engaged in a sedentary activity (guided reading) for 20 minute, while the 2nd group engaged in a physical activity (aerobics) for 20 minutes.

Research Location

The location of the research took place at the participating school during the regular school day. The groups of students were located in the school’s gymnasium to assure adequate space away from potentially dangerous obstacles or barriers. A supervising researcher or data collector was present in order to supervise and direct the students in the intended activities of the study.

The data gathering instruments include the following:

The Wechsler Intelligence Scale for Children (WISC-IV); Cancellation and Symbol Search Subtests, and the Woodcock Johnson-R (WJ-R), and the Delis Kaplan Executive Function System (D-KEFS); Card-Sorting Task subtest.

The WISC-IV, authored by Wechsler, is used to measure components of suggested intellectual ability. The administration of the Cancellation and Symbol Search subtests take 2 minutes each to administer and are each normed for children ages 6
through 16.11 years old and is a measure of what the test authors call, “processing speed.” The Cancellation section consists of a set of colored pictures randomly placed on one side and placed in rows on the other side of a sheet of paper. Children are asked to cross out all the pictures of animals on one side of the paper using a pencil. The Symbol Search section is similar to a decoding activity where students are asked to look at a set of numbers or letters that correspond to specific shapes or figures. They are then asked to place the correct shape or figure under sets of numbers or letters for a brief period of time. (http://harcourtassessment.com/haiweb/Cultures/en-US/Products/Product+Detail.htm?CS_ProductID=015-8982-800&CS_Category=CognitionIntelligence&CS_Catalog=TPC-USCatalog.) The reliability coefficient for internal consistency in symbol search and cancellation are .79 and test-retest reliability is .80 for symbol search and .70 for cancellation. The validity of symbol search in relationship to correlations with other measures is .68. The cancellation relationship was not reported (http://harcourtassessment.com/hai/Images/pdf/wisciv/WISCIVTechReport2.pdf).

The Woodcock-Johnson Test of Cognitive Abilities-R subtests measure “Cognitive Efficiency”, similar to the Cancellation and Symbol Search subtests of the WISC-IV. The test is co-normed with the Woodcock Johnson Test of Achievement and is appropriate for individuals ages 2 to 90+ years old and each subtest takes approximately 5 minutes for administration (http://www.riverpub.com/products/clinical/wj3).

The D-KEFS is normed for individuals ages 8 to 89 years old, measuring executive functioning tasks in regard to visual and spatial tasks (http://harcourtassessment.com/haiweb/Cultures/en-US/Products/Product+Detail.htm?CS_ProductID=015-8091-108&CS_Category=Adolescents&CS_Catalog=TPC-USCatalog). The Card Sorting Task is a 20 minute individually administered test.

The instruments measuring attention and concentration were age appropriate forms of the Symbol Search and Cancellation subtests of the WISC-IV and WJ-R. Following the activity, both groups took these timed subtests for a specific amount of time. Group 1 (sedentary group) took the subtest in the same room and Group 2
(physical activity group) took the subtest in the same room. The Symbol Search and Cancellation sections of these standardized and norm-referenced tests have a total of 4 different forms. Therefore, in order to account for practice effects, the subtests were administered in the order of 1,2,3,4 during the first 2 weeks, and 1,2,3,4 during the second 2 weeks, so a period of 2 weeks separated each version of the test. The researcher used the results of the subtests to gauge the student’s speed and accuracy following each exposure to the conditions.

Nature of activities and Timeline

The students were given a pre-test at the beginning of the 6 week period and at the completion of the 6 week period using the Card Sorting Task from the D-KEFS (Delis-Kaplan Executive Functioning Scale). The researcher used the results of the D-KEFS to note any motoric difficulties, initial attention/concentration abilities, and post-measures of related executive functions. Also, the teachers of each participating student were asked to use the BASC-Monitor to record their observations of student attention and/or concentration in class.

In order to ensure the confidentiality of the participants, the researcher used Pseudo-names to represent each individual subject. Due to the nature of the data collection, anonymity was not possible because the researcher must work one on one with each subject for an over-all pre- and post-test period. In addition, the researcher led each group in the activities and followed the activities with an assessment that the group took at the same time. Also, the researcher received direct information from the participating teacher regarding each subject, therefore further making it necessary to use pseudo-names in the reporting of data and results in order to ensure confidentiality. However, the data was recorded with pseudo-names and the code to the real name was kept in a separate locked file.

The subjects were in no way was deceived while participating in the study. Instead, the researcher explained in age appropriate terms that the purpose of the study is to gather information about different activities such as exercise and listening to a story. The information provided was minimal so as to maintain the integrity of the method of data collection; however, the subjects were not deceived in any way throughout the
investigation. After the study data collection was completed, students and teacher were verbally debriefed.

Figure a: Over-View of Student Schedule over a 6 week period

Week 1  **Individual pre-test measures with each student**: 20 minutes

Students meet 2 times a week to do the following:

**Aerobic Group**: Tae-bo for Kids, 20 minutes of activity with 10 minutes for testing and getting organized

**Week 5**  **Sedentary Group**: Guided reading, 20 minutes for activity with 10 minutes for testing and getting organized

Week 6  **Individual post-test measures with each student**: 20 minutes

Figure b: Detailed Out-line of Student Measures

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1:</strong></td>
<td><strong>Day 2:</strong></td>
<td><strong>Day 3:</strong></td>
<td><strong>Day 4:</strong></td>
<td><strong>Day 5:</strong></td>
<td><strong>Day 6:</strong></td>
</tr>
<tr>
<td>Pre-test measures</td>
<td>Aerobic</td>
<td>Aerobic</td>
<td>Aerobic</td>
<td>Aerobic</td>
<td>Post-test measures</td>
</tr>
<tr>
<td>with each individual student using the</td>
<td>Sedentary measures</td>
<td>Sedentary measures</td>
<td>Sedentary measures</td>
<td>Sedentary measures</td>
<td>Sedentary measures</td>
</tr>
<tr>
<td>*Attention</td>
<td>*Attention</td>
<td>*Attention</td>
<td>*Attention</td>
<td>*Attention</td>
<td></td>
</tr>
</tbody>
</table>

Day 7: Aerobic | Sedentary | Sedentary | Sedentary | Sedentary |
*Attention | *Attention | *Attention | *Attention |

Day 8: Aerobic | Sedentary | Sedentary | Sedentary | Sedentary |
*Attention | *Attention | *Attention | *Attention |

Day 9: 20 minutes D-KEFS, measures |

*WJ-III or WISC-IV for students

Plan of Analysis

An analysis of the data was conducted using statistical measures for the individual students and the two groups of sedentary and active groups. Specifically, the results of the over-all pre-and-post test measures were statistically analyzed using SPSS and then
plotted on an Excel graph for each individual student and each group as a whole to observe if any trends or differences existed between individuals and the groups. Similarly, the repeated post-test scores following each activity were statistically analyzed using SPSS and then plotted for each individual student as well as for each group. Also, the scores from the over-all pre-and-post-test measures and repeated post-test measures of the students diagnosed with AD/HD were plotted on a graph as compared to students without a diagnosis of AD/HD. In this way, the individual differences of each student were noted as well as any over-all differences between the sedentary and active groups.
CHAPTER IV
RESULTS

This chapter provides the results of the data that were collected from 10 (N=10) fourth grade students in a small elementary school in Southwest, Ohio. Four students had received diagnoses of ADHD prior to the study while six did not have diagnoses of ADHD. Of the four students classified as ADHD, two were exposed to an exercise condition and two were exposed to a sedentary condition. Similarly, of the six students without an ADHD diagnosis, four participated in the exercise condition and the remaining two were in the sedentary condition.

To determine if any significant differences existed (p=<.05) among the groups, a series of statistical procedures were conducted. In addition, graphs of each of the students’ individual test results were visually analyzed on a case-by-case basis. The results of these statistical and graphical analyses are presented in the rest of this chapter. This chapter begins with a presentation of the descriptive data. In the second section the statistical analyses conducted to test the study hypotheses are presented followed by the case-by-case graphs.

Descriptive Data

The ten children in this study were divided into two treatment groups—an exercise/tae-bo group and a sedentary/reading group. Within each of these treatment groups, some of the children had a diagnosis of ADHD and some did not. As explained in the previous chapter, children’s attention span was measured over a four week span, using two sessions per week. For the statistical analyses of this data, the scores from the two sessions per week were averaged to create one attention span score for each child for each of four weeks. In addition all children were administered the Delis-Kaplan Executive Function instrument at pre and post treatment time points.

During the 4 week period of 2 sessions per week, 1 of the students with a diagnoses of ADHD in the aerobic condition was absent during sessions 2, 4, and 9. In the sedentary condition group, 1 of the students without a diagnosis of ADHD was absent during sessions 3, 1 of the student with a diagnosis of ADHD was absent during sessions 2 and 7, and 1 of the students with a diagnosis of ADHD was absent during sessions 2, 6, and 9. This missing data was accounted for by averaging each child’s scores across the
two sessions per week. This resulted in complete attention data for all children. However, the following group results may be affected by the above missing data.

**Figure A**: Means, Standard Deviation, and Range for Executive Functioning Scores for all Study Participants (N=10)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Treatment</td>
<td>7.80</td>
<td>4.13</td>
<td>2.00 to 15.00</td>
</tr>
<tr>
<td>Post-Treatment</td>
<td>9.40</td>
<td>3.92</td>
<td>4.00 to 18.00</td>
</tr>
</tbody>
</table>

**Figure B**: Means, Standard Deviations, and Range for All Weekly Attention Score for All Study Participants (N=10)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>8.35</td>
<td>2.53</td>
<td>4.00 to 11.50</td>
</tr>
<tr>
<td>Week 2</td>
<td>8.91</td>
<td>3.36</td>
<td>4.50 to 15.80</td>
</tr>
<tr>
<td>Week 3</td>
<td>10.80</td>
<td>3.14</td>
<td>5.00 to 16.00</td>
</tr>
<tr>
<td>Week 4</td>
<td>12.05</td>
<td>4.16</td>
<td>4.20 to 17.50</td>
</tr>
</tbody>
</table>
Figure C: Means and Standard Deviations for all weekly attention scores: Aerobic vs. Sedentary Group Differences for ADHD and non-ADHD groups.

<table>
<thead>
<tr>
<th></th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerobic Group</strong> (N=6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHD (n=2)</td>
<td>7.25 (1.06)</td>
<td>6.70 (2.40)</td>
<td>9.00 (2.12)</td>
<td>10.55 (.49)</td>
</tr>
<tr>
<td>non-ADHD (n=4)</td>
<td>10.63 (.75)</td>
<td>11.43 (2.93)</td>
<td>12.88 (2.66)</td>
<td>15.23 (1.95)</td>
</tr>
<tr>
<td>Total</td>
<td>9.50 (1.90)</td>
<td>9.85 (3.50)</td>
<td>11.58 (3.02)</td>
<td>13.67 (2.86)</td>
</tr>
<tr>
<td><strong>Sedentary Group</strong> (N=4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHD (n=2)</td>
<td>6.50 (2.12)</td>
<td>5.05 (.78)</td>
<td>7.50 (3.54)</td>
<td>5.35 (1.63)</td>
</tr>
<tr>
<td>non-ADHD (n=2)</td>
<td>6.75 (3.89)</td>
<td>9.95 (1.63)</td>
<td>11.75 (1.77)</td>
<td>13.90 (.14)</td>
</tr>
<tr>
<td>Total</td>
<td>6.63 (2.56)</td>
<td>7.50 (3.01)</td>
<td>9.63 (3.35)</td>
<td>9.63 (5.03)</td>
</tr>
</tbody>
</table>

Figure D: Means and Standard Deviations for Executive Functioning Scores: ADHD and non-ADHD Group Differences for Aerobic and Sedentary Groups

<table>
<thead>
<tr>
<th></th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADHD Group (n=4)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerobic (n=2)</td>
<td>7.00 (1.41)</td>
<td>9.00 (1.41)</td>
</tr>
<tr>
<td>Sedentary (n=2)</td>
<td>2.00 (.00)</td>
<td>5.00 (1.41)</td>
</tr>
<tr>
<td>Total</td>
<td>4.50 (3.00)</td>
<td>7.00 (2.58)</td>
</tr>
<tr>
<td><strong>non-ADHD Group (n=6)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerobic (n=4)</td>
<td>10.00 (4.16)</td>
<td>12.50 (4.12)</td>
</tr>
<tr>
<td>Sedentary (n=2)</td>
<td>10.00 (1.41)</td>
<td>8.00 (1.41)</td>
</tr>
<tr>
<td>Total</td>
<td>10.00 (3.29)</td>
<td>11.00 (4.00)</td>
</tr>
</tbody>
</table>

Main Study Analyses

In Chapter 2, four main study hypotheses were identified. To test these hypotheses, a series of statistical group comparisons were used. In addition, due to the small sample
size, graphs were prepared showing the changes that occurred over time for each of the
study participants individually. These statistical and graphical results are presented in the
following sections.

Hypothesis 1: *The students in the aerobic condition will show a greater increase in attention span scores as compared to students in the sedentary condition.* The results (see Graph 1) revealed that over a 4 week period (8 sessions combined over a 4 week period), students in the aerobic condition (blue line in graph) increased an average of 4.17 points between the first and last session scores on individual attention scores while students in the sedentary group (pink line in graph) increased an average of 3.00 points between the first and last session scores. The results also revealed that attention scores in the aerobic condition increased an average of 4.4 points between weeks 1 and 4 of the treatment phase versus an increase of 3.2 points in the sedentary group condition.

Figure 1: Attention Scores by Week (Aerobic = Top, Sedentary = Bottom)

To statistically test this hypothesis, two one-way repeated measures of analyses were run to determine whether the exercise and sedentary groups showed changes in their attention scores over the four weeks. The results of this repeated measures analysis for the sedentary group showed no significant change over the four weeks, $F (1.24, 3.71) = 1.48$, $p < .31$. For the exercise group, however, the main effect for time was significant, $F (3, 15) = 10.59$, $p < .001$. Furthermore, the post hoc polynomial contrast results indicated that the changes were linear in nature (i.e., attention scores for the exercise group increased over the four weeks) (see descriptive data in Table 3). Thus, these results
provide support for the hypothesis in that the exercise group did show significant increases in their weekly attention scores while the sedentary group showed no significant changes over the four weeks.

Hypothesis 2: Students diagnosed with AD/HD in the aerobic condition will show a greater increase in attention span as compared to students in the sedentary condition. To compare the aerobic and sedentary groups in a statistical manner, a series of independent t-tests were conducted to compare students diagnosed with ADHD who participated in the exercise sessions with those children with ADHD who participated in the sedentary activities (see descriptive group data in Table 3). These T-tests results showed that the exercise and sedentary children did not differ in their attention scores at week 1 (t = .45, p < .70), week 2 (t = .92, p < .45), or at week 3 (t = .51, p < .66). By week 4, however, there was a significant difference in attention scores of the exercise (Mean = 10.55, sd = .49) and the sedentary (Mean = 5.35, sd =1.63) groups, t = 4.33, p < .05, with the exercise group showing higher attention scores. In contrast, comparison of children without ADHD indicated no differences between the exercise and sedentary groups throughout any of the 4 weeks of the study.

These results show support for the hypothesis but suggest that the positive effect of the exercise intervention on the attention abilities of children with ADHD may not be evident immediately, but may become significant over time or weeks.

Figure 2: Average Attention Scores for Students with ADHD by Week: aerobic group= top, sedentary group=bottom
Hypothesis 3: *Students diagnosed with AD/HD will have lower executive function scores on pre-test measures as compared to their peers.* As the results in Graph 3 show, students with ADHD had lower executive function scores on pre-test measures with an average of 4.5 compared to an average score of 10 for their peers. An independent t-test confirmed that the scores from the two groups were significantly different $t(8) = -2.68$, $p < .03$. At the post-test, however, the 2 groups did not differ significantly in their executive functioning scores ($t = -1.74$, $p < .12$). As indicated in Table 4, the children with ADHD exhibited a mean score at post-test of 7.00 (sd = 2.58) while the children without ADHD had a mean score of 11.00 (sd = 4.00).

Figure 3: Pre-Test and Post-Test Executive Function Average Scores: Left= Students with ADHD, Right = Peers

Hypothesis 4: *Students in the aerobic condition will exhibit a greater increase in executive function scores as compared to their peers in the sedentary condition.* The results presented in Graph # 4 show that students in the aerobic condition group had an average increase of 2.3 points from pre to post time points, while the students in the sedentary group had an average increase of 0.5 points. Results also revealed that students with ADHD in the aerobic condition experienced an increase in executive functioning scores of 2 points, while those in the sedentary condition with ADHD experienced an increase in executive functioning of 3 points. Those without ADHD in the aerobic group experienced an increase in scores of 2.5 points while those in the sedentary condition...
without ADHD decreased by 2 points on executive functioning scores. Although the graphical results suggest that the exercise group may have shown a greater increase in executive functioning from pre to post time points, the results of the two paired samples t-tests indicated no significance. That is, the exercise group showed no significant change from pre (Mean = 9.00, sd = 3.63) to post (Mean = 11.33, sd = 3.72) time point (t = -1.47, p < .20) and the sedentary group also showed no change (t = -.29, p < .79) from pre (Mean = 6.00, sd = 4.69) to the post (6.50, sd = 2.08) time points. Thus, no support was obtained for this hypothesized change. An independent t-test comparing the exercise (Mean = 9.00, sd = 3.63) and sedentary (Mean = 6.00, sd = 4.69) groups at pre-treatment indicated no significant differences (t = 1.14, p < .29). However, a similar independent t-test conducted at the post time point was significant (t = 2.33, p < .05) indicating that the exercise group (Mean = 11.33, sd = 3.72) scored significantly higher after their intervention than did the sedentary group (Mean = 6.50, sd = 2.08).

Figure 4: Group Averages for Executive Functioning; Pre-/Post-Tests, sessions 1 and 10; Top = Exercise Group, Bottom = Sedentary Group

Although the above results indicate significant group differences, the reader is reminded that the findings may not necessarily be reliable or valid as the sample size was extremely limited by size. To further understand the results, individual case studies were conducted. The results follow in the paragraphs below:
Dori, a ten-year-old female student without a diagnosis of ADHD, reportedly exercises about an hour a day, and was placed in the aerobic group. The results indicated that Dori scored a 5 on the pre-test executive function assessment and scored an 8 on the post-test assessment, increasing a total of 3 points. Progress on the weekly attention assessments indicated that Dori went from an average score of 11 during the first week, 10.2 the second week, 11.5 the third week, to an average of 12.9 on the last week, increasing a total of 1.9 points from week 1 to week 4. Progress on individual attention assessments indicated that Dori went from a score of 9 during the first session to a score of 13 during the last session, increasing a total of 4 points. Dori regularly talked to the researcher about all of her extracurricular sporting activities on the way to the gym and often mentioned how much she enjoyed these after-school activities. During each session, Dori was very enthusiastic about engaging in the tae-bo activity. Of all of the students in the aerobic group, from an observational standpoint, Dori had advanced motor skills and endurance, and she pushed herself to work hard during each session. Following the aerobic activity, she was excited to do the paper task (attention test). She attended every session and often offered to act as a “model” for helping other students master the new moves they were learning with tae-bo. Based on Dori’s results, although she reportedly has at least 1 hour of exercise each day (if not more during her practices), she seemingly benefited from the additional sessions each week, and increased in her executive functioning and attention scores by the end of the 4 week period. Dori is an example of a student who is in good physical condition, is of typical age for her grade, has daily physical activity, is without a diagnosis of ADHD, and seemingly benefited from the addition of physical activity into her regular school week.
Jacob, a ten-year-old male student with a diagnosis of ADHD, is on medication, reportedly exercises about 15 minutes a day, and was placed in the aerobic group. The results indicated that Jacob scored an 8 on the pre-test executive function assessment and scored an 10 on the post-test assessment, increasing a total of 3 points. Progress on the weekly attention assessments indicated that Jacob went from an average score of 6.5 during the first week, 8.2 the second week, 7.5 the third week, to an average of 10.9 on the last week, increasing a total of 4.4 points from week 1 to week 4. Progress on individual attention assessments indicated that Jacob went from a score of 7 during the first session to a score of 11 during the last session, increasing a total of 4 points. Jacob was clearly apprehensive about participating in the aerobic group, but said he would like to try tae-bo. Based on observation, Jacob’s gross motor skills were below that of his peers, but after the first couple of sessions, he began to improve in his ability to follow the movements more accurately that were being portrayed on the TV screen. Following the aerobic activity, Jacob was excited to do the paper task (attention test). He attended every session. Based on Jacob’s results, he seemingly benefited from the additional small group sessions of exercise each week, and increased in his executive functioning and attention scores by the end of the 4 week period. Jacob is an example of a student who does not have well-developed motor skills, is of typical age for his grade, has minimal daily physical activity, has a diagnosis of ADHD, is on medication for his
ADHD, and seemingly benefited from the addition of physical activity into his regular school week.

Figure 6:

Jared, a ten-year-old male student without a diagnosis of ADHD, reportedly exercises about 30 minutes a day, and was placed in the aerobic group. The results indicated that Jared scored an 15 on the pre-test executive function assessment and scored an 12 on the post-test assessment, decreasing a total of 3 points. Progress on the weekly attention assessments indicated that Jared went from an average score of 11.5 during the first week, 15.8 the second week, 16 the third week, to an average of 17.6 on the last week, increasing a total of 6 points from week 1 to week 4. Progress on individual attention assessments indicated that Jared went from a score of 9 during the first session to a score of 16 during the last session, increasing a total of 7 points. Jared was one of two students who really appeared to “lead” the group. He talked with the researcher on the way to the gym about the various activities going on in their classroom and had to often be reminded to “walk” rather than “run” in the hallways. During tae-bo, Jared made an effort to follow the moves on the TV and often allowed the researcher to correct him or assist him in learning a new move. From an observational stand-point, his motor skills appeared to be average, particularly in relationship to his age. He also was very well-spoken and tended to receive the highest scores on attention tests. Jared was always excited to find out which tests we would be doing at the end of the tae-bo sessions. He worked on each test quickly and often asked how well he had done and had to be
reminded that it was not a competition, but just to “do his best work.” Jared’s scores improved on the attention tasks, but his scores decreased on the executive functioning post-test. One reason for the decrease in scores may be the timing of the post-test. Due to time constraints and scheduling conflicts, the post-test was given on the last day of school, and Jared was very excited and the researcher found it difficult to hold his attention. Another reason for his decreased scores may be due to the fact that Jared had almost hit ceiling scores for all of the tests, and had little room to improve on his scores. Despite his executive functioning scores, Jared is an example of a student who seemingly did improve on attention scores over the 4 week period following the implementation of a regular aerobic program.

Figure 7:

Eli, a nine-year-old male student without a diagnosis of ADHD, reportedly exercises more than 2 hours a day, and was placed in the aerobic group. The results indicated that Eli scored an 9 on the pre-test executive function assessment and scored an 18 on the post-test assessment, increasing a total of 9 points. Progress on the weekly attention assessments indicated that Eli went from an average score of 10 during the first week, 9.6 the second week, 10 the third week, to an average of 14.6 on the last week, increasing a total of 4.6 points from week 1 to week 4. Progress on individual attention assessments indicated that Eli went from a score of 7 during the first session to a score of 12 during the last session, increasing a total of 5 points. Eli was close friends with Jared, and the two seemingly “led” the group. Eli was highly competitive and appeared to enjoy
learning the new moves of tae-bo. From an observational stand-point, Eli was very bright for his age and had average motor skill ability. He always asked to know which “activities” we would be doing following the activity, and reported that like many of the others, he enjoyed the “animals” (Cancellation from the WISC) the most. Similar to Jared, he received high scores on most of his tests and often tried to compete with Jared on who could get the most done on each test. Eli is an example of a student who reportedly receives adequate physical activity, does not have a diagnosis of ADHD, is of average age for his grade, and seemingly benefited from weekly sessions of regular physical activity.

Figure 8:

<table>
<thead>
<tr>
<th>Week</th>
<th>Eli’s Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>9.6</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>14.6</td>
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</tbody>
</table>

Danny, a ten-year-old male student with a diagnosis of ADHD, is not on medication, reportedly exercises about one hour a day and was placed in the aerobic group. Danny missed the first session, 3rd session, and 8th session of data collection. The results indicated that Danny scored a 6 on the pre-test executive function assessment and scored an 8 on the post-test assessment, increasing a total of 2 points. Progress on the weekly attention assessments indicated that Danny went from an average score of 8 during the first week, 5 the second week, 10.5 the third week, to an average of 10.2 on the last week, increasing a total of 2.2 points from week 1 to week 4. Progress on individual attention assessments indicated that Danny went from a score of 87 during the second session to a score of 10.2 during the seventh session, increasing a total of 2.2 points. Danny was absent 3 of the tae-bo session days because he needed to meet with
another teacher to work on classroom assignments. When at tae-bo sessions, he joined in with Eli and Jared, and often discussed his participation in an after-school sports team. He also told the researcher that he had tried tae-bo in the past with his mom, because she regularly uses the tapes in their home. Danny often stood at the back of the group and was willing to participate when the moves were “easy” for him, but quickly stopped when the moves were what he termed “difficult”. More specifically, if it was a kick or step that he had not attempted at home on his mom’s tape, or a stretch that he did not do on his after-school sports team, he refused to participate. When the moves changed to ones that did not pose as unfamiliar or as a challenge to him, he willingly participated with the rest of the group. During the attention testing, Danny often had difficulty putting down his pencil when asked by the researcher as he wanted more time to complete the tasks. Danny is an example of a student with ADHD who is not on medication, has regular physical activity, receives help outside of the classroom on his academics, and seemingly benefited from additional time participating in physical activity over a 4 week period both in regard to his attention and executive functioning scores.

Figure 9:

Madison, a ten-year-old female student without a diagnosis of ADHD, reportedly exercises about 30 minutes a day, and was placed in the aerobic group. The results indicated that Madison scored an 11 on the pre-test executive function assessment and scored a 12 on the post-test assessment, increasing a total of 1 point. Progress on the
weekly attention assessments indicated that Madison went from an average score of 10 during the first week, 10.1 the second week, 14 the third week, to an average of 15.9 on the last week, increasing a total of 5.9 points from week 1 to week 4. Progress on individual attention assessments indicated that Madison went from a score of 8 during the first session to a score of 16 during the last session, increasing a total of 8 points. Madison was excited to join the tae-bo group and mentioned that she had never attempted the activity prior to her participation in the study. She was present at every session and worked hard during both the tae-bo and attention-task periods. Based on observation, her motor skills appeared to be slightly below that of her peers and she required frequent assistance in learning new motor moves. With the assistance of the researcher and by watching Dori, she improved and seemed to gain more confidence in her abilities through each session. Based on Madison’s results, she seemingly benefited from the additional small group sessions of exercise each week, and increased in her executive functioning scores and even more so in her attention scores by the end of the 4 week period. Madison is an example of a student who does not have well-developed motor skills, is of typical age for her grade, has average physical activity, does not have a diagnosis of ADHD, and seemingly benefited from the addition of physical activity into her regular school week. Figure 10:

![Madison's Scores by Week](image)

Joy, a nine-year-old female student without a diagnosis of ADHD, reportedly exercises about one hour a day, and was placed in the sedentary group. Joy was absent during the second session. The results indicated that Joy scored an 11 on the pre-test
executive function assessment and scored a 7 on the post-test assessment, decreasing a total of 4 points. Progress on the weekly attention assessments indicated that Joy went from an average score of 4 during the first week, 8.8 the second week, 10.5 the third week, to an average of 13.8 on the last week, increasing a total of 9.8 points from week 1 to week 4. Progress on individual attention assessments indicated that Joy went from a score of 4 during the first session to a score of 15 during the last session, increasing a total of 11 points. Joy regularly talked with the researcher about her day on the way to the spot where the group regularly read the book together. She often expressed that she enjoyed the book and looked forward to her time reading with everyone. Joy sometimes forgot her book and shared with the researcher or her friend Issac. Following the sedentary activity, Joy was excited to do the attention task and like the other students, often asked which task we were going to do on each day. Based on Joy’s results, her attention seemingly increased following each session, but did not impact her executive functioning scores at the conclusion of the 4-week period. Joy is an example of a student who is reportedly in good physical condition, is younger for her grade, has daily physical activity, is without a diagnosis of ADHD, and seemingly benefited from increased attention following each session, while her executive scores did not show improvement. Figure 11:

Isaac, a ten-year-old male student without a diagnosis of ADHD, reportedly exercises 1 hour a day, and was placed in the sedentary group. The results indicated that Isaac scored a 9 on the pre-test executive function assessment and scored a 9 on the post-
test assessment, increasing a total of 0 points. Progress on the weekly attention assessments indicated that Isaac went from an average score of 9.5 during the first week, 11.1 the second week, 13 the third week, to an average of 14 on the last week, increasing a total of 4.5 points from week 1 to week 4. Progress on individual attention assessments indicated that Isaac went from a score of 8 during the first session to a score of 13 during the last session, increasing a total of 5 points. Issac expressed the most excitement in taking part the reading group. He attended and brought his book to every session, and was extremely helpful and compliant through the 4-week period. At one point, Issac expressed to the researcher that he had read ahead in the book, but did not mind re-reading with the rest of the group. Based on Issac’s results, he is reportedly in good physical condition, and seemingly benefited from the group reading sessions, and increased in his attention scores following each session. However, like Joy, his executive functioning scores did not improve over the 4 week period.

Figure 12:

Laura, an eleven-year-old female student with a diagnosis of ADHD, did not report how much time exercised each day, and was placed in the sedentary group. Laura was absent during the first and sixth sessions. The results indicated that Laura scored a 2 on the pre-test executive function assessment and scored a 6 on the post-test assessment, increasing a total of 4 points. Progress on the weekly attention assessments indicated that Laura went from an average score of 5 during the first week, 4.5 the second week, 5 the third week, to an average of 6.5 on the last week, increasing a total of 1.5 points from
week 1 to week 4. Progress on individual attention assessments indicated that Laura went from a score of 5 during the second session to a score of 8 during the last session, increasing a total of 3 points. Laura did not get along well with Larson, and this information was not brought to the researcher’s attention until the third week of the study. Laura also reportedly had other learning concerns in addition to ADHD that required her to receive extra assistance outside of the classroom during the regular school day. During the study, Laura often had difficulty paying attention and following along with the rest of the group. She also lost her book and tried to talk Larson, one of the other group members, into giving her his book. Laura’s individual scores on the attention measures generally remained consistent throughout the study, but her executive function scores showed an increase over the 4 week period.

Figure 13:

Laura’s Scores by Week

Larson, a ten-year-old male student with a diagnosis of ADHD, reportedly exercises 30 minutes a day, and was placed in the sedentary group. Larson was absent the first, fifth, and eighth sessions. The results indicated that Larson scored a 2 on the pre-test executive function assessment and scored a 4 on the post-test assessment, increasing a total of 0 points. Progress on the weekly attention assessments indicated that Larson went from an average score of 8 during the first week, 5.6 the second week, 10 the third week, to an average of 4.2 on the last week, decreasing a total of 3.8 points from week 1 to week 4. Progress on individual attention assessments indicated that Larson went from a score of 8 during the second session to a score of 4.2 during the seventh
session, increasing a total of 3.8 points. Larson was very compliant and pleasant during the first few weeks of the study. However, his teacher mentioned during the 3rd week of the study that he did not get along with Laura and that he had some medical concerns that were impacting his attitude and behavior in the classroom. His parents reported to the teacher that Larson’s doctor was adjusting his medication. During this same day, Larson expressed that he did not want to be near Laura and refused to join the group to read together. The researcher reminded him that he did not have to participate, so he decided to remain in his classroom. Based on Larson’s results, his attention scores were up and down without a steady trend line. However, Larson’s executive functioning scores did improve over the 4 week period.

Figure 14:
CHAPTER V
DISCUSSION

The purpose of this study was to examine if physical activity may increase the concentration of students and as a result, benefit their cognitive functioning as seen in aspects such as attention, concentration, and over-all behavior. The specific areas focused on were the differences in the attention and concentration of 2 groups of students involved in either a sedentary activity or an aerobic activity. This chapter will discuss the results of the analyses.

Characteristics and Physiological Connections of the student with ADHD

The students in this particular study who were diagnosed with ADHD tended to exhibit the characteristics as defined by Teicher et al (2000) and the DSM-IV-TR of one or all of the following: hyperactivity, inattention, and impulsivity. Laura was often inattentive, always moving (hyperactive), and impulsive, David had trouble focusing on the video, L was impulsive, and Jacob exhibited inattention. However, that is not to say that the rest of the students did not exhibit any or all of these characteristics along with their diagnosed peers at one point or another, but the degree of the hyperactivity, inattention, and/or impulsivity was observed to be less intense. More specifically, the students without a diagnosis of ADHD were observed to be more easily redirected when off-task. Along with exhibiting the characteristics of ADHD, the students with ADHD also had significantly lower executive functioning scores at the pre-testing period of the study, adding strength to Smith’s (2002) and Guy’s (2005) work regarding the connection between executive functioning disorders and ADHD. In addition, while this study did not examine fMRIs or Brain SPECT imaging as in Amen and Carmichael’s work (1997) and Teicher’s et. al (2000) suggesting that specific treatments can change the physiology of the brain, the results indicate that for students with ADHD, their attention span may be increased over a 4 week period using vigorous bouts of exercise with or without the addition of Ritalin or other stimulate medications. Therefore, while medication may currently be the most effective option for students with ADHD, the long-term benefits of exercise should be examined in future research as another option that may yield similar stimulate medication results.
Interventions for the Student with ADHD

Previous research suggested that the most accepted and effective method of intervention in treating children with ADHD is Ritalin or other forms of dopamine and stimulate medication (Cross & Abernethy, 1999). Locomotor play, noted by Pelligrini and Smith (1998) is a possible alternative intervention for students with ADHD. Therefore, in this study, based on the literature, the increase in attention of students with ADHD in the aerobic group at the end of the 4 week period adds support to the idea that the use of locomotor play may improve upon attention for students both with and without ADHD and for those both on and off medication.

ADHD: Psychiatric Problem as the Result of Societal Factors

In Panskepp’s (1998) work, he noted that ADHD is the most common psychiatric problem that may actually be the result of societal factors. He specifically targeted the increasing expectations in the classrooms and the lower expectation of playfulness as part of a child’s daily activities in the school. He suggested that this lack of playfulness may be squelching the biological need for children to develop through “rough and tumble play” (Panskepp, 1998). The results of this particular study offer further evidence that allowing children a period of activity and “playfulness” is a positive, if not necessary component of a child’s day. In fact, such playfulness encouraged their attention and concentration, which could in turn carry over into assisting them in the increasingly rigorous tasks in the classroom.

Physical Activity and Play

Previous literature on child development has found that locomotor play is a necessary aspect of child development that has physical, cognitive, and social purposes. Pelligrini and Smith (1998) noted that when children are deprived of play for extended periods of time, it then increases play following that deprivation. If that is the case, then the results of this particular study suggest that the reverse may be true: If children are provided with periods of locomotor play, they are then able to decrease their need for play following that recess or break in the day. This study also sheds light on Pelligrini and Bjorklund’s (1997) study of recess in Asian schools, indicating that there may be a positive association between periodic recess and an increase of on-task behavior in the classroom. In short, the results of this study offer further insight into the research
suggesting that there is a relationship between the opportunities for social interaction and physical activity in a school day and on-task attention (Panskepp, 2003; Pellegrini & Bjorklund, 1997). Along with that, the results of this study further provide support for the findings of Panskepp et al (2003) who noted that play therapy used in rat research reduced hyperactivity and overactive behaviors, suggesting more attentive behaviors in these creatures. The question then becomes, is this true for children as well? If the children in the aerobic group in this study all benefited from the activity by showing a significant increase in attention based on assessment regardless of a diagnosis of ADHD or medication/no medication, could it be then that as suggested in past literature that the diagnoses of ADHD in the early elementary years may be one of normative symptoms rather than a pathological disorder (Eaton et al, 2001)? A discussion of each hypothesis and resulting findings will further shed light on how this particular study relates to the previous literature and research in the area of ADHD and physical activity.

Aerobic v. Sedentary Group Results

Previous literature suggested that physical activity in the regular school day increases attention and on-task work in students, particularly those in the younger ages (Pellegrini & Bjorklund, 1997; Pellegrini & Smith, 1998). The literature also indicated that physical activity is imperative during the school-age years due to growth and development stages physically, mentally, emotionally, and cognitively (Horn, ???verse). With this in mind, the results of the mean scores of attention by week, over a 4 week period, indicated that students who are engaged in periods of moderate to vigorous physical activity score higher on attention tasks at the end of a 4 week period than students engaged in sedentary tasks for the same period of time. When considering individual attention scores by session rather than by week, the mean results indicated that there was little difference in attention on individual tasks. One reason for the difference between scores by week versus scores by session may be accounted for by the acclimation of students to physical activity in the aerobic condition group. Specifically, the differences by session may not have been enough time to actually observe variance in attention between the two groups. Students may have not only needed time to learn the physical rigors of the aerobic activity (such as coordination and steps/movements of tae-bo), but because a 4 week exercise program is a recommended, if not typical time period
for results to be expected physically, several weeks time may also be expected in regard
to the cognitive affects of physical activity. More specifically, just as one would not
expect immediate weight loss, lower blood pressure, increased aerobic capacity, and etc.,
following one session of aerobic activity, but rather the cumulative process of practicing
a consistent aerobic exercise over a period of time, the results of this study suggest that
increased attention span in relation to physical activity is a cumulative process of a
consistent practice as well. Therefore, this study further supports the previous findings
suggesting that physical activity may increase the attention and concentration of children
(Pellegrini & Bjorklund, 1997; Pellegrini & Smith, 1998), particularly those with a
diagnosis of ADHD (Panskepp, 2003).

Aerobic with ADHD v. Sedentary with ADHD Group

Previous literature suggested that physical activity will not only have a positive
effect on all students and should be utilized in the classroom to increase on-task behavior
and attention (Panskepp, 1998 and 2003), but physical activity can increase attention and
concentration in students with a diagnoses of ADHD (Tomprowski, 2001), and may be
utilized in the future as an alternative to current medication that is often over-prescribed,
miss-used, and under-studied for potentially dangerous side-effects (Panskepp, 2003).
With the above in mind, the results of this study suggested that while the students with
ADHD in the sedentary condition experienced an increase in attention, students with
ADHD in the aerobic condition experienced a significant increase in attention at the end
of the four week period. These findings suggest that physical activity may be an effective
intervention in improving attention and concentration in students with ADHD. The
results also suggest that while students with ADHD in the aerobic condition experienced
an increase in attention, students without ADHD also experienced an increase in addition.
Therefore, the above supports that in the academic environment, all students may benefit
from physical activity (Panskepp, 1998 & 2003) and small group activities. In addition,
students with ADHD may experience an increase in attention that may be more
commensurate with that of their peers following from engaging in locomotor activity.

Executive Functioning Scores of Students with and without ADHD

One aspect of executive functioning involves the capability to pay attention for
extended periods of time (Smith, 2002; Guy, 2005). In this study, students with ADHD
scored more than 50% lower than those students without ADHD during pre-testing sessions. However, following 4 weeks of small group activity, students with ADHD in the combined groups of sedentary and aerobic together increased from being at 45% of that of their peers at pre-testing, to 65% of their peer’s scores at pre-testing, and 59% of their peer’s scores at post-test period. Therefore, these results not only support previous research in the area of ADHD and its impact on executive functioning skills, and that small groups of interactive activities, both sedentary and physical, may be effective interventions for improving executive functions. Specifically, the results suggest that executive functioning is able to be improved by all students over a period of time through experiences, particularly for students with ADHD, as they experienced more of an increase in their scores over the 4 week period as compared to their peers without diagnoses of ADHD.

Comparison of Executive Functioning Scores in the Aerobic v. Sedentary Group

The results indicated that the students in the aerobic group experienced a greater increase in executive functioning scores as compared to their peers in the sedentary group. However, the results also indicted that the students without ADHD in the sedentary group had lower executive functioning scores during post-test compared to their pretest scores, while those without ADHD in the aerobic group had higher executive functioning scores during post-test than pre-test scores. Also, while both groups with ADHD experienced an increase in executive functioning scores, those in the sedentary group experienced more of an increase than those in the aerobic group. These findings add to previous literature on executive functioning skills (Guy, 2002) by suggesting that physical activity may improve over-all cognitive functioning and that executive skills are not necessarily physiological skills that are fixed, but may be improved upon through the possibility of various activities and/or practice and experiences.

Limitations

While this study adds to current literature and research in the area of physical activity and Attention Deficit Disorder, several limitations need to be noted. First of all the subjects in this study were limited to one elementary school. The two elementary school classrooms that participated does not provide a representative sample of all elementary schools classrooms across the United States. Additionally, only a small and
A select number of students from the elementary school participated, which is not a representative sample of students. The consequence of using such a limited sample is that the results from this study will not necessarily be generalizable to the population of elementary students with and without a diagnosis of ADHD.

A second limitation to this study is that one of the instruments utilized in this study needed to be changed due to the availability of test materials and protocols. More specifically, the Woodcock Johnson-III was to be used, but the Woodcock Johnson-R, an older version of the test had to be used because of availability issues at the particular university where the researcher had access to materials. The test is normed and standardized just as the new one and the attention task requires concentration and on-task behavior, but utilizes a slightly different format.

A third limitation to this study is time. The researcher originally intended to study the participants’ attention over an 8-week, rather than a 4 week period. However, due to curriculum demands and time constraints in the participating elementary school, a period of 4 weeks with and additional 2 weeks for pre and post testing was used to complete the study.

A fourth limitation to this study is that the teachers were unable to report change in student attention during the school day. The researcher originally asked the teachers to complete a brief attention rating scale for each student each day following the period of aerobic or sedentary activity. However, the teachers expressed to the researcher that their schedules and time did not allow for additional surveys, reports, or measures of attention of their students, therefore limiting the information the researcher could gather to further verify the attention results collected following each group activity. More specifically, the researcher was not able to report if the attention of participating students increased or decreased for more than the period of time following the group activities and carried over into the rest of the regular school day.

A fifth limitation is the diversity of the students. The students in this study were between the ages of 9 and 11, Caucasian, and went to the same school in a small Midwestern town. Because of this limited diversity, an understanding of how other students of different ages, ethnicities, and backgrounds would respond to these activities is unknown.
Recommendations

Although this study provides important findings regarding the implications of physical activity on students with and without a diagnosis of ADHD, additional research in this area is necessary. First, future research should increase the number of participants to better understand the concepts measured in this study. The small size of 10 students represented in this study was located in the same region, school, and grade. Also, only 4 of the students in the study had a diagnosis of ADHD. By extending the study to include an increase in participants from other school districts, a more diverse and representative sample will be obtained to better understand the impact of physical activity on attention and concentration in the classroom.

Another factor to consider for future research should include an examination of the measurement tools for individual attention tasks. While the instruments utilized in this study have been normed and standardized to address the measurement of on-task activities, they were not necessarily designed to specifically measure attention and concentration. In addition, while the attention tasks were rotated, it is unclear as to if practice effects played a role in the increases in scores throughout the 4 week period. By examining other avenues of measuring attention and concentration, and possibly developing other scales or tasks, researchers can gain a better idea of how to monitor the progress of attention and concentration in students.

A third recommendation for future study is to utilize a convenient, yet effective form of measurement or progress monitoring with the teachers and parents who have students participating in the study. In this study, teachers were asked to use the BASC Monitor to indicate student attention following the group tasks, but the teachers indicated to the researcher that they did not have time to fill out this component of the study. Therefore, by examining other avenues for measurement of student progress, researchers can gain more information on the impact of the activities in the classroom environment.

A fourth recommendation for future research is to examine the attention-task scores in students following aerobic activity versus sedentary activity over a more extended period of time. Extending the study may offer insight into how physical activity can impact the attention of students, particularly those with ADHD. More specifically, while the results of this study indicate that over a 4 week period student
scores on attention tasks significantly increased, researchers can gain a better understanding of the implications of physical activity on attention and concentration by extending the study by days per week or months out of the year.

A final recommendation is to examine the effects of other forms of physical activity in relation to attention, rather than only utilizing one aerobic program such as tae-bo. By focusing on other forms of physical activity, the implications of age-appropriate physical activity on attention in the classroom can be better assessed. In addition, an examination of different aerobic activities would help to assess the effects of physical activity on attention in various contexts outside of the school environment.

Summary

According to the results and description of each individual participant, every student seemingly benefited from the small group environment and practice going over weekly attention tasks. More specifically, at the conclusion of the 4 week period, every student experienced an increase in attention scores, executive functioning scores, or even both attention and executive functioning scores. These results suggest that the small group environment may be more beneficial in promoting the attention and concentration of students. The implications of such findings suggest that smaller class sizes and more individual attention may promote a more productive learning environment for all students, including those with a diagnosis of ADHD. In addition, the findings suggest that physical activity is imperative not only to the physical growth and development of students, but may also have positive implications to the cognitive development of children, specifically in the areas of attention and executive functioning skills. The implications of such results suggest that including activities that provide time to engage in motor activities may contribute to encouraging more on-task and attentive behaviors in the classroom for both students with and without a diagnosis of ADHD. Finally, the results of this study suggest that participating in regular physical activity throughout the week may result in increased attention and improve executive functioning in students, particularly those with diagnoses of ADHD.

Lastly, the individual analysis of each student emphasizes the idea that every child is unique and will respond to group activities in a different way. For example, in the aerobic group, Dori, who reportedly had advanced experiences and practice in motor
and physical activities on a daily basis, had fairly similar scores throughout the 4 weeks of the study. In contrast, Madison, who reportedly had little to no experiences and practice in motor and physical activities on a daily basis, did not have similar scores throughout the 4 weeks of the study. Similarly, Dori exhibited advance motor skills and took on the role of “leader” in the aerobic group, while Madison observed the other students and gradually improved on her motor skills in tae-bo as the sessions continued into week four. While amount of physical activity and/or gross motor abilities of each student were not examined closely in this study but rather observed (gross motor) and noted on parent questionnaire’s (amount of physical activity per day), it does emphasize the concept that each participant brought different experiences to the study in addition to their label as a student with or without a diagnoses of ADHD. Such information further emphasizes the need to consider each child’s background, experiences, and strengths both when analyzing the results of a study and in working in the school environment.
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The Wechsler Intelligence Scale for Children (WISC-IV). Accessed on 11/5/05:


Appendix A

Dear Principal and Teachers

Hello. My name is Stacie Packard and I am currently working towards my degree in School Psychology at Miami University. As part of my program, I am to conduct a research project involving some aspect of the educational system. My project is focused on exercise and physical activity in the schools in relation to all students, with a specific focus on those children diagnosed with AD/HD.

I am writing to ask for your permission to allow your students to voluntarily participate in my study. During the spring semester, beginning in January, I would like to work twice a week with students on either reading or exercise activities for approximately 30 minute sessions. These once a week sessions will last approximately 8 weeks. The reading sessions will consist of me reading a story to your child in a group with their peers, while the exercise sessions will consist of 20 minutes of tae-bo activity using Billy Blank’s Tae-bo for Kids tape.

If possible, your students will be completing these sessions within the school building in either the gymnasium or in a classroom during the regular school day. Prior to and following these sessions, your students will be asked to complete test measures. The shortest measure lasts approximately 2 minutes, while the lengthiest measure requires approximately 20 minutes to complete. In addition, I would ask that the teachers complete a brief questionnaire, using a measure called the BASC Monitor, during the weeks of the study. The BASC Monitor takes between 5 and 10 minutes to fill out.

All of yours and your students’ information will be kept completely anonymous and all identifying information will be kept between the teachers and me. Neither your students’ name nor yours would be used in any publication resulting from this study. Data will be stored for 5 years and then destroyed.
Thank you very much in advance for your consideration. If you have any questions or would like to indicate your interest in the study, please contact me at 513-529-8762 or 440-258-6584, or via email at: packarss@muohio.edu.

Thank you again for your time.

Sincerely

Stacie S. Packard
M.S. Sports Studies; M.S. Educational Psychology
Graduate Student
Miami University of Ohio
School Psychology Program
Dear Parents and Students

Hello. My name is Stacie Packard and I am currently working towards my degree in School Psychology at Miami University and will be working at Becker Elementary this semester as a practicum student counselor. As part of my program, I am to conduct a research project involving some aspect of the educational system. My project is focused on exercise and physical activity in the schools in relation to all students, with a specific focus on those children diagnosed with AD/HD.

I am writing to ask for your permission to allow your child to voluntarily participate in my study. During the spring semester, beginning in January, I will be working twice a week with students on either reading or exercise activities for approximately 30 minute sessions. These once a week sessions will last approximately 8 weeks. The reading sessions will consist of me reading a story to your child in a group with their peers, while the exercise sessions will consist of 20 minutes of tae-bo activity using Billy Blank’s Tae-bo for Kids tape.

Your children will be completing these sessions within the school building in either the gymnasium or in a classroom during the regular school day. Prior to and following these sessions, your child will be asked to complete test measures. The shortest measure lasts approximately 2 minutes, while the lengthiest measure requires approximately 20 minutes to complete.

All of your child’s information will be kept completely anonymous and all identifying information will be kept between your child's teacher and me. Neither your child’s name nor yours would be used in any publication resulting from this study. Data will be stored for 5 years and then destroyed.
Thank you very much for your help. If you have any questions about the study, please contact me at 513-529-8762 or the Office of Advancement of Research and Scholarship at 513-529-3734.
I agree to allow my child to participate in the study of exercise and reading activities. I understand my child’s participation is voluntary, and he/she may withdraw from the session at any time or refuse to participate. Also, I understand that my child’s name will not be associated with his/her results on the test measures or the above questions.

Parent’s signature: _________________________________________________

Date: ____________

Student’s signature: ________________________________________________

Date: ____________

Please indicate the following:

Child Height: _____

Child Weight: ____

Date of Birth: ___ / ___ / _______

Level of your child’s average regular physical activity (check one):

__ 0 minutes a day   __15 minutes a day

__30 minutes a day   __1 hour a day   __more than 2 hours a day

If your child was diagnosed with AD/HD:

How was your child diagnosed?

__ a doctor/physician   __ a clinical psychologist   __ through the school/a school psychologist
When was your child diagnosed with AD/HD?

Month: ___  Day:  ____  Year:  _______

OR

Age at diagnosis:  _______

Is your child currently taking medication for his/her AD/HD symptoms?

___ yes   ___ no

If so, what medication is your child taking?  _______________

Is your child medicated during the school day?  _____