Physical Activity and Academic Achievement in Students With Disabilities

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PHYSICAL ACTIVITY AND ACADEMIC ACHIEVEMENT IN STUDENTS WITH DISABILITIES

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Abstract

This literature review examines studies that investigated and evaluated the relationship between physical activity and academic achievement in students with disabilities. Research was found and reviewed that used school-aged participants, exercise or physically movement interventions, and standardized tests to measure academic achievement. Several brain regions are involved in both cognitive and motor tasks, which has sparked interest in this area of study. The studies reviewed showed that there is a positive relationship between being more physically active and having improved cognitive abilities. Student participants of the studies showed increased scores on standardized academic tests after participating in a physical exercise intervention. A regular, moderately paced aerobic exercise routine is suggested to be the most beneficial, both health and academically. Incorporating more physical activity in the classroom, outside of standard physical education classes twice per week, is highly recommended. Aerobic physical activity break before beginning academic tasks was found to increase students' ability to sustain attention and focus on the task, as well as show improved academic performance

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CHAPTER I: INTRODUCTION

Emerging Area of Study

Academic achievement has been the main focus of schools in recent years, supporting and preparing students to perform higher. With such a strong focus on academics, other areas, such as the arts and physical activity, have been all but removed from the curriculum. Students have become more sedentary as they sit in class, as well as at home with electronic entertainment. With less time spent and importance placed on physical activity, today's students face the risk of more inactive lifestyles, which are associated with increased health concerns and shorter life spans (Hillman, 2014). An emerging area of study has focused on the relationship between physical activity and academic achievement. These studies investigate any relationship between students' physical ability and how that correlates with their cognitive abilities, or academic performance, using brain imaging and standardized measures.

The first studies investigating the relationship between exercise and intelligence were conducted in the 1960s. Researchers used the Weschler Intelligence Scale for Children (WISC) to evaluate boys,' ages 12-16, cognitive abilities after 20 days of physical fitness training. Results showed that students in the exercise group had improvements in their full scale IQ and verbal scores, compared to those in the non-exercise control group (Tomporowski, Davis, Miller and Naglieri, 2008; Corder 1966). Since then, other studies have continued to look at relationships between physically fit individuals and their academic achievement, compared to those who are categorized as not physically fit. More modern studies are beginning to use brain imaging techniques to look at the relationships between different types of physical activity, frequency of physical activity, and specific components of cognitive functioning that can be improved by physical activity.

In these studies, there are several frequently used terms to understand. Physical activity is a broad term that encompasses several different types of movement, including team and individual sports, aerobic and cardiovascular activity that increases the heart rate, and muscle strength training and conditioning. Coordination of gross motor skills (i.e. whole body movements such as walking, running, jumping and throwing) and fine motor skills (i.e. smaller movements such as grasping and holding) are developed through physical activity (Geertsen et al., 2016). Academic achievement is typically defined as the student's score on standardized assessments, such as Minnesota Comprehensive Assessment (MCA) or the Woodcock-Johnson Tests of Achievement (WJ-IV). Cognition, also referred to as executive function, is defined as the thought processes associated with ability to guide behavior and decisions. In the studies reviewed, researchers looked at certain aspects of cognition, such as attention, response inhibition, task-switching, working memory, and information manipulation (Chaddock-Heyman, Hillman, Cohen & Kramer, 2014). The development of the brain structures where these cognitive processes take place is important to understand when looking to help improve cognitive functioning.

Brain Structures Involved in Cognitive Functioning

The brain is important to understand and study in relation to children's development due to the brain's plasticity and ability to reorganize and create new neurons throughout the lifespan (Moreau, 2016; Erickson, Hillman & Kramer, 2015). Physical activity during childhood development is thought to take advantage of the developing brain and plasticity, or ability to change, and enhance cognitive functioning (Erickson et al., 2015). While physical activity and brain imaging studies are very new, studies have shown more grey and white brain matter in the hippocampus area of the brain in higher-fit children (Erickson et al.2015). Grey and white matter are found throughout the entire structure of the brain. Grey matter is made up of cell bodies and unmyelinated axons, meaning they are short and not covered in a protective protein layer, that process signals from sensory organs and brain structures. White matter is made up of long myelinated axons and surrounds the grey matter. With their myelin, or protein layer, they are insulated and the ability to transmit signals to the grey matter is improved (Robertson, 2014). More grey and white matter means there are more and stronger signals being sent throughout the brain, allowing for faster processing time and improved cognition.

Researchers have looked at the brain and different structures in animals, children, and adults to study how physical activity impacts the brain and cognition. From these studies, it is suggested that both cognitive and motor functions activate the same brain structures, specifically the prefrontal cortex, basal ganglia, and cerebellum (Diamond, 2000). The prefrontal cortex of the brain is implicated in many executive functions, such as attention, response inhibition, and working memory. Connected to the prefrontal cortex is the basal ganglia, which is involved in cognitive control, motor control, response selection, and learned behaviors (Heyman-Chaddock et al., 2014). Brain imaging studies have shown that neurons in the cerebellum activate during both cognitive tasks (e.g. reciting as many words as possible beginning with a certain letter, or sorting items by category) and motor tasks (e.g. reflexes; Diamond, 2000).

Benefits of Physical Activity

Being active has many physical and mental health benefits, such as reducing health risks of obesity, diabetes, and depression (Heyman-Chaddock et al., 2014; CDC, 2017). There are underlying benefits of physical activity, especially for children, which may help improve their cognitive abilities. During childhood, the brain is most plastic as it develops. Physical activity during childhood development has shown to increase more neurons that may enhance cognition, both in typically developing children and those with disabilities (Moreau, 2016). Physical activity and exercise have also been shown to increase gray matter and neurotrophins, both of which are areas where new neurons develop (Tomporowski et al., 2008). Being more physically active provides more blood flow and oxygen to the brain to help form these new neurons and connections, improving the neurons' chance of survival and improving cognitive functioning (Tomporowski et al., 2008).

Students with disabilities are often less physically active than their typically developing peers and have lower levels of cardiorespiratory fitness, endurance, as well as high obesity rates. Students with disabilities also miss out on the social and mental benefits of participating with and being part of a team, which include social skills, peer relationships, self-esteem and greater independence in life skills (Murphy & Carbone, 2008). Physical inactivity has been linked to lower self-esteem and social acceptance for students with disabilities. Murphy and Carbone (2008) state that participating in sports or other physical activity enhances the psychological well-being, as well as physical well-being, for individuals with disabilities by providing opportunities to form friendships, experience acceptance, and learn life skills to increase their independence.

Students with Disabilities

Emerging from this area of research is investigating how physical/motor activity can help improve academic achievement, or cognitive functioning, in students with different types of disabilities. Students with disabilities often perform below grade level academically and have deficits in their cognitive and motor functioning, among other areas of functioning. Understanding how physical activity and developing their motor skills could help their cognitive abilities is important for professionals and teachers to help students succeed, both in school and later in life.

Guiding questions for this literature review are: Can improving gross motor skills/physical activity help improve cognitive abilities in students? Can improving gross motor skills/physical activity also help improve other areas of functioning? Are certain types of physical activity more beneficial than others? And, how can physical activity be incorporated into the classroom?

CHAPTER II: LITERATURE REVIEW

To locate literature for this thesis, searches of Academic Search Premier, Bethel University Digital Library, EBSCO MegaFILE, ERIC, Expanded Academic ASAP, and ProQuest Education Journals were conducted from publications from 1980 to 2017. This list was narrowed by only reviewing empirical studies and peer-reviewed journals and publications that focused on academic achievement, cognitive functioning, physical activity, and students with intellectual disabilities. Keywords that were used in these searches were "academic achievement and physical activity," "cognitive functioning and physical activity," "physical activity and intellectual disabilities." The structure of this chapter is to review the literature on physical activity and cognitive functioning of students with disabilities in four sections in this order: Physical Activity and Academic Achievement, Physical Activity and Disabilities, Benefits of Physical Movement, Incorporating Physical Movement into the Classroom.

Physical Activity and Academic Achievement

In schools today, less importance is placed on physical fitness and activity in exchange for supporting students' academic achievement. In addition to the health benefits of physical activity, researchers in the past few decades have focused on the relationship of physical activity and how it can help improve academic achievement. Of studies using typically developing students, many have found a positive relationship between physical activity and academic performance. Castelli, Hillman, Buck and Erwin (2007) studied typically developing grade school students to investigate any relationship between their physical fitness and academic achievement on state standardized tests. Their motivation and reasoning for their studied stemmed from federal mandates at the time of the study (i.e. No Child Left Behind) that placed more pressure on schools producing students of all economic levels with higher academic achievement scores than addressing public health issues. Their study looked specifically for any relationship between components of physical fitness and academic achievement in schools with multiple socioeconomic variables. They hypothesized that students who were more physically fit would have higher academic achievement on standardized tests. They also hypothesized that of certain components of physical activity (i.e. aerobic capacity, muscle fitness, and body composition), aerobic fitness would have a closer association with students' academic achievement.

Participants in this study were third thru five grade students, selected from four schools in the same school district in Illinois. The four schools were specifically selected due to their academic performance, poverty index, and neighborhood crime rate index to compile a balanced socioeconomic and academic performing sample. Two schools were ranked as 76.3% of students meeting or exceeding standards in math and 86.4% in reading. The other two schools were ranked as having only 46.2% of students meeting or exceeding the standards in math and 40.4% in reading. The researchers also looked at the percentages of students on free/reduced lunch. Two schools had 24.3% of students receiving free/reduced meals and two other schools had 66%. Despite the socio-economic differences between the schools, all schools were chosen because they all have similar amounts of physical activity (i.e. recess time, physical education classes) within the school day. A total of 259 students participated in the study; 132 male, 127 female. Of the total number of participants, 78% were Caucasian, 12% African American, 5% Asian, 3% Hispanic, and 2% other. About 50% of the sample, 130 participants, received free/reduced lunches. Students with individual education plans were not included in this study.

To measure fitness, the researchers used The Fitnessgram battery of assessments to identify aerobic capacity, muscle fitness and body composition. All testing was completed in the students' regularly scheduled physical education classes. Aerobic capacity was measured by a Progressive Aerobic Cardiovascular Endurance Run (PACER), in which students completed a 20-meter shuttle run that progressively increased in difficulty. Muscle fitness was measured by push-ups, curl-ups, and sit and reach tests. Body composition was measured by obtaining height and weight measurements to convert into body mass index (BMI) scores. According to the Fitnessgram assessment, student scores in the different assessment areas would fall into different categories within the "Healthy Fitness Zone" criteria. Academic achievement was measured using the Illinois Standards Achievement Test (ISAT), which is a state standardized test all third through eighth grade students complete in all Illinois public schools. These tests are used to identify school effectiveness, as well as monitor student progress and performance. Reading and mathematics were assessed in the ISAT, looking at specific standards of comprehension, vocabulary, computation, and problem solving. Participants completed the tests over a five-day period. Test questions included both multiple choice and extended response items. The math test also included test questions that required problem solving with and without computation. The reading test included passage comprehension and vocabulary identification. Each test was scored on a 200-point scale, which the researchers combined for a total of a 400-point scale for each participant to use in their analysis.

When analyzing their data, the researchers used three dependent variables: total academic achievement, mathematics achievement, and reading achievement. The dependent variables were analyzed with individual scores from the different Fitnessgram scores (PACER, push-ups, curl-ups, sit and reach, BMI) to see if there was any correlation. Results showed a positive correlation between the three areas of academic achievement and Fitnessgram scores. A significant association was found between total fitness and academic achievement, indicating that higher academic achievement was associated with higher total fitness. There was also a significant correlation between BMI and PACER scores and academic scores. This showed that lower BMI and higher aerobic fitness is positively related to reading and math achievement. Muscle strength and flexibility were found to be unrelated to academic achievement. Data on the socioeconomic and sociocultural variables of the participants, such as age, gender, school effectiveness, and poverty index, was also used during the analyses. The researchers found that these variables did not effect the results; all children who participated and had higher levels of physical fitness were more likely to have higher scores on the math and reading tests.

The main finding of this study that physical fitness is positively related to academic achievement supports previous research, as well as supporting the thought that more physically fit children are more likely to perform higher on standardized assessments. The current study's result that lower BMI and higher aerobic fitness was more positively related to higher academic achievement also added to the support from other previous studies as well. These findings are useful for schools and administrators to have when making decisions about programming and policies, especially those that involve reducing physical education classes in order to meet the stress and importance placed on student academic achievement. Other studies supporting the importance of physical activity on achievement have focused on specific motor skills and academic areas have found similar results.

Based on the success of studies finding associations between aerobic fitness and academic achievement, Geertsen et al (2016) wanted to investigate any associations between motor skills, exercise capacity and cognitive functioning. Their study aimed to evaluate how these areas correlate to the students' academic performance, specifically in math and reading comprehension. The researchers hypothesized that they would find positive relationships between fine and gross motor skills and cognitive domains, including academic performance. They also hypothesized that they would find evidence to confirm previous research that exercise capacity is positively related to cognitive domains and academic performance. Standardized, objective assessments were used to test the hypotheses.

Four hundred and twenty three Danish 3rd grade students, 209 girls and 214 boys, participated in this study. Participants ranged in age from eight to ten years old and were from seven different Danish municipal schools. Four of those schools were located in the Danish capital, Copenhagen, while the other three were from a nearby suburb. Testing took place on four separate days, in which the children participated in motor skills, exercise capacity, and body composition tests. They also took standardized cognitive and academic performance, specifically mathematics and reading comprehension, tests. The students all had a physical examination and interview with a medical doctor to detail their lifestyle, participation in organized sports, All testing took place during the third thru sixth week of the school year.

Fine motor skills were assessed using the Visuomotor Accuracy Tracking (VAT) task. The VAT was chosen because it requires very accurate hand-eye coordination. This task involved the children using a computer and mouse to track and trace a curser along a path on the screen. Students used their preferred hand to control the mouse and completed ten trials of the task. A score from 0-100 was given on each trial based on the error, or distance, from the target; score of 100 meaning no error. The average of the scores from all ten trials was used for analysis. Gross motor skills were assessed using a coordination wall. There were three tasks to the coordination wall, which was a 9 x 8 grid on the wall with numbers 1 thru 10 distributed throughout the grid. Half of the numbers were blue and the other half were red. The grid was also divided into an upper and lower section by a black line. Students had a red dot on their right hand and foot, and a blue dot on their left hand and foot. They were instructed to touch the numbers corresponding to their colors in order with their hand above the line and foot if the number was below the line. Each child was given three attempts during each of the three tasks. The shortest completion time for each of the three tasks was recorded and summed for their gross motor skills score. Exercise capacity was assessed using the Yo-Yo intermittent recovery level 1 children's test (YYIR1C). This assessment is a 16 meter shuttle run that increases in speed and difficulty, similar to the PACER of the previous study examined. The researchers also participated in the test to demonstrate how to set a pace, as well as to help motivate the students to run as much as they could. The numbers of meters successfully completed was recorded.

Cognitive functions were assessed looking at the specific domains of reaction time, sustained attention, spatial working memory, paired associate learning and free-recall word memory. The study used tests from the Cambridge Neuropsychological Test Automated Battery (CANTAB), as well as using a supplemental free-recall memory test. Reaction time was assessed by the average time students reacted to a target yellow dot on a computer screen. When they saw the dot, they had to let go of a button and touch the screen where they saw the dot. The students participated in 15 trials and the average reaction time between the target and the student letting go of the button, measured in milliseconds, was recorded. Sustained attention was assessed by the Rapid Visual Processing test. Students watched a screen that presented the numbers two thru nine at a rate of 100 digits per minute, in a pseudo random order. Students had to detect the target sequence of 3-5-7 by pressing on their press-pad button. The number of missed target sequences was recorded. Spatial working memory was assessed by having students search for a target blue dot hidden inside colored boxes on a screen. Students would touch the different boxes looking for the target. The test started with three boxes and increased to eight. The total number of errors made (i.e. touching a box that was already found to be empty) was recorded. Paired associates learning was assessed by presenting boxes on a screen that contained a pattern. The boxes were opened one at a time before the student was presented with a pattern and had to touch the now closed box where they first saw the pattern. The total number of errors made was recorded. Free-recall word memory was assessed with a 20-item word list. The words were presented one at a time on a computer screen for five seconds each. Students had two minutes after viewing all of the words to close their eyes in a consolidation period before they were given two minutes to write down all the words they were able to remember.

Academic performance was assessed by standardized tests of mathematics and reading comprehension. Mathematics proficiency was measured using a Danish standardized test for third grade level math skills, involving addition, subtraction, multiplication, geometry and probability. The math test was taken on a computer and consisted of 50 problems. Students were instructed to complete the problems to the best of their abilities and could take as much time as they needed to complete the test. The total number of correct answers was recorded for analysis. Reading comprehension was measured by a Danish standardized test for 2^{nd} thru 5^{th} grade students. Students were presented with a total of 27 drawings of a situation and presented with four statements, for a total of 108 test problems. For each sentence, students had to indicate whether the statement matched the drawing by checking a true or false box next to the sentence. The total number of correctly evaluated statements was recorded.

The researchers found that both fine and gross motor skills were positively associated with better performance in all areas of cognitive functioning tested. They found clear associations between fine and gross motor skills and the cognitive domains of spatial working memory, wordlist memory, sustained attention, reaction time, and learned pair associates. Both motor skills and exercise capacity were also positively associated with higher academic performance. For example, better fine motor performance on the visual tracking task was associated with better academic performance; better and quicker completion time on the gross motor coordination wall was associated with better scores on the math and reading tests. Statistical results showed that for every 100 meters run in the PACER-like test, there were higher scores in both the math and reading tests. Their results also showed an association between overall physical activity levels (i.e. those who also participated in organized sports) and the cognitive domains of free-recall and word memory performance. The current study also found that aerobic fitness is positively associated with academic performance and the cognitive domains of spatial working memory and sustained attention. Like the previous study, body composition was found to be unrelated to performance on any of the cognitive tests. The researchers' hypothesis that both fine gross motor skills would be positively related to academic performance was confirmed. Their results showed that shorter time completing the gross motor assessment, as well as higher accuracy on the fine motor assessment were positively associated with academic performance. The researchers suggest that the motor skill practice also engages cognitive processes, such as processing speed, sustained attention and decision-making, which also affect academic performance that engage the same cognitive processes. These results add to those of previous studies that suggest the development of motor and cognitive functions are related, and not separate like they have previously been viewed.

Findings from this study support previous research and are important for schools to understand. The correlation between higher physical fitness, especially aerobic fitness, and improved cognition function and academic achievement have many implications for ways schools can help their students meet academic standards as well as improve their physical activity. The role that both fine and gross motor skills play related to academic performance is also important to understand, as developing those skills may be just as important as aerobic activities. It also has implications for helping students with deficits in cognitive and motor function, such as students with disabilities.

Physical Activity and Disabilities

Previous research focusing on physical activity have found that aerobic exercise tends to be the most effective in improving cognitive functioning, especially for individuals with disabilities. Along with its health benefits, starting an aerobic exercise routine early on in life can also positively affect individual's social, mental and cognitive development. Based on the previous research on benefits of aerobic exercise, Pastula and colleagues (2012) designed a study to investigate the effect moderate-intensity aerobic exercise on the cognitive function in young adults with intellectual disabilities. By definition, intellectual disabilities are characterized by significant limitations in cognitive, physical, and adaptive functioning. With these deficits, individuals with intellectual disabilities are more likely to be less physically active and less physically fit. Pastula et al (2012) hypothesized that they would see a significant improvement in both cardiovascular fitness and cognitive function in those participating in a moderate dose aerobic exercise routine.

There were 16 participants in this study, nine men and five women, ages 18-20 years old. All participants attended a school for individuals with intellectual disabilities in North Central Florida. There were a variety of intellectual disabilities represented in the small sample, including Down syndrome, Prader-Willi syndrome, autism spectrum disorders, and mild cerebral palsy. All participants were able to communicate, verbally or through sign language. They were also all physically capable of performing the exercises. For the study, the participants were tested before and after the eight-week exercise intervention. The researchers used a combination of resistance training and aerobic exercise designed to increase and maintain a heart rate within the moderate-intensity level. They chose this level based on previous research indicating that moderate-intensity heart rate level had been shown to improve cognitive function.

Cognitive function was measured using specific subtests the Woodcock-Johnson III Test of Cognitive Abilities (WJ-III COG) both before and after the exercise intervention. The three subtests used included visual matching, decision speed, and pair cancellation. Visual matching was chosen as a measure of perceptual speed and cognitive fluency as the participant discriminates between the given symbols and task. The decision speed subtest was chosen as a measure of cognitive efficiency as it assessed the processing speed of simple concepts. The pair cancellation was chosen to measure executive processing, sustained attention, and inference control. Each participant had 3 minutes to complete each subtest. Testing accommodations appropriate to the participants' needs and abilities were made, such as pointing to answers instead of circling.

Before the intervention period, aerobic fitness was assessed using the YMCA step test. Participants used a 12-inch tall platform to step up on with both feet, then step down at a quick pace for three minutes. After the three minutes, the participants sat down and their pulse was counted and recorded as their recovery heart rate. The exercise intervention consisted of moderate-intensity aerobic activities three times a week for eight weeks. Each session occurred at the same time of day and lasted 40-60 minutes. Trained exercise facilitators led and supervised each session. The first 20 minutes of exercise consisted of four circuits, each consisting of four exercise moves. The first circuit focused on lower body, the second on upper body with a focus on "push" movements, the third on core, and the fourth circuit on upper body with a focus on "pull" movements. Each exercise of the circuits was performed for one minute, with a one minute rest period between each circuit. Participants' heart rate was monitored throughout the circuits to make sure their heart rate stayed within the moderate-intensity range. The monitors worn by the participants would sound an alarm if their heart rate increased out of range. The circuit exercises were changed every two weeks, as was the increase in intensity of the exercises. Both verbal and visual cues were used to teach the new exercises, as well as the facilitators modeling the exercises with the participants. If certain movements were too difficult for participants to perform, alternative movements were substituted in that engaged similar muscle groups. The next 30-45 minutes of exercise was an aerobic sport activity. During these activities, the participants were constantly moving or performing exercises so that their heart rate would stay in the targeted range. Activities included, but were not limited to, noodle soccer, relay races, volleyball, lunges across a basketball court, martial arts, basketball games, and Special Olympics training, such as practicing dashes, throws and broad jumps. To help keep their heart rates in the targeted range, the sport activities were organized in stations so that the participants were constantly moving and would not have to wait in line to participate in any of the activities.

Two participants were excluded from the study during the intervention due to behavior problems at school. Pre- and post-test data was collected and analyzed from the remaining 14 who completed the intervention. All participants performed in the targeted heart rate range during the intervention. An increase of 17.5% in aerobic fitness was observed between pre- and post-testing. A significant improvement in all three cognitive tests was also observed, especially processing speed. Standard scores for processing speed in the cognitive tests increased by 103%. Intelligence quotient was not measured in this study, but their findings of improved cognitive function supports previous research that did include IQ testing. A possible explanation for the relationship between exercise and cognition can be found in neuron connections of the brain. Previous studies have found that exercise helps facilitate neuron connections in the brain, most often helping to improve learning and memory formation. A specific brain protein and growth factor called brain-derived neurotrophic factor (BDNF) is viewed as being a key factor in improving cognition and more of it is released during moderate intensity exercise (Cotman & Berchtold, 2002). Previous research also supported the current study's use of moderate intensity exercise as being more beneficial than high intensity exercise. During high intensity exercise lasting for longer periods of time, cortisol is released in the brain that may restrict the release of BDNF (Cotman & Berchtold, 2002).

The researchers highlight the importance of their findings and their connection to the implementation of their intervention. Individuals are more likely to adopt and maintain physical activity habits when they are introduced at a low to moderate intensity. A big challenge is finding physical activity that is engaging for students with intellectual disabilities to participate in. The researchers found that moderate-intensity whole-body movements and group exercise interventions were enjoyable for the participants, who participated in every activity given the choice to participate or stay in class. The researchers observed a 100% attendance rate from the 14 participants who completed the study. This study provides important information for intellectual disabilities that schools can use to help students improve their abilities and be more successful.

Exercise-based Intervention for Children with Reading Disabilities

Researchers Reynolds, Nicolson, and Hambly (2003) were interested in investigating an exercise-based treatment as an early intervention approach for young children with or at-risk of reading difficulties, specifically dyslexia and dyspraxia. There were two theories that guided the study and help the researchers form their hypotheses: the Cerebellar Theory (CDT), which centers on the belief that the cerebellum has a role in both skill acquisition and skill execution, and the Cerebellar Treatment Hypothesis (CTH), which states that because the cerebellum's plasticity during childhood, it would be possible to retrain the cerebellum of young individuals with dyslexia to become more "normal." Using a previously developed exercise-based treatment called the Dyslexia Dyspraxia Attention Treatment (DDAT), the researchers' purpose was to provide a wide-range evaluation of the treatment intervention.

The study had four hypotheses for their research. The first hypothesis was that a high percentage of children with dyslexia, dyspraxia, or attention deficit disorders will show cerebellar or vestibular, specifically overall balance, problems in the initial testing. The second hypothesis was that the DDAT exercise intervention would lead to improving the participants' cerebellar and vestibular abilities. The third hypothesis was that the DDAT exercise intervention would improve fundamental cognitive skills, such as phonology, working memory and speed of processing. The fourth hypothesis was that the treatment would lead to at least normal acquisition of literacy skills, and that progress would continue to occur even after the exercise treatment ended.

The participants of the study were from an elementary school in Warwickshire, England. The Dyslexia Screening Test (DST) was used to identify students most at risk of reading difficulties. Thirty-five students were identified and divided into intervention and control groups. The intervention group consisted of ten male and eight female students with a mean age of nine years old. This group had a mean reading delay of 10.6 months and a mean initial DST score of 0.74. The control group consisted of nine male and eight female students with a mean age of nine years old. This group had a mean reading delay of 4.4 months and a mean initial DST score of .72. Of the total number of participants, six participants had an outside diagnosis of dyslexia (four in the intervention group, two in the control group); two had an outside diagnosis of dyspraxia (one in each group); and one with an outside diagnosis of ADHD (in control group). Twelve participants were withdrawn from two lessons per week for small group support.

There were several tests used to assess the participants' vestibular, visual and literacy skills both initially and six months into the study. A series Dynamic Posturography tests, including Sensory Organization Test, Motor Control Test, and Adaptation Test, were used to assess participants'' abilities to make effective use of visual, vestibular and proprioceptive information; suppress disruptive information; and modify reflexive motor reactions. Each of these tests was scored out of 100, with a low score indicating poor vestibular functioning. Electronystagmography tests using specialized equipment were used to plot and track eye movement while the participant watched a moving target. These tests assessed the participants' abilities of saccade latency and accuracy, or their ability to accurately move their eyes and follow the moving target. The Dyslexic Screening Test to assess skills that are typically lower in individuals with reading difficulties.

The DST is comprised of eleven subtests divided into five sections, which are literacy skills, phonological awareness and verbal memory, motor skill and balance, and memory retrieval fluency. The Literacy Skills section had four subtests. The first subtest is a one minute reading test, in which the participant to read as many words as they can from a list of words that increase with difficulty in one minute. The nonsense passage reading test has the participant read a passage with mixed real and nonsense words. The two-minute spelling test subtest has participants spell as many words as they can, given to them verbally, in two minutes. The one-minute writing subtest has the participant transcribe as many words as they can in one minute, assessing their writing speed. The Phonological Awareness and verbal working memory section had two subtests. The phonemic segmentation test assessed the participants' ability to understand individual letter sounds in a word when specific phonemes were deleted. The backwards digit span subtest was a line of digits presented to the participant, who then had to repeat the digits back in reverse order. This subtest started with two digits presented to the participant and increased up to eight digits. The Motor Skill and Balance section had two subtests. The bead-threading test assessed the participants manual dexterity by how many beads they could thread on a string in 30 seconds. The postural stability subtest assessed balance by how much the participant wobbled when gently pushed by a pre-calibrated stability tester. The Memory Retrieval

Fluency section had three subtests. The rapid automatized naming test assessed the amount of time taken to name pictures on a page of common objects. The verbal fluency test assessed the participants' ability to name as many things that started with the letter 's' as they could in one minute. The semantic fluency test assessed their ability to retrieve information from long-term memory by asking them to name as many animals as they could in one minute. The norms for the DST are based on a national sample of over 1000 children in the United Kingdom. Local standardized tests of academic achievement were also used to assess academic skills and progress for the participants. Three standardized attainment tests (SATS) were used, including writing, comprehension, and math. A National Foundation for Educational Research (NFER, 2018) reading test was also used.

The Dyslexia Dyspraxia Attention Treatment (DDAT) approach is an extensive program that integrates sensory stimulation, visuomotor skills, and balance therapy. It combines groups of exercises and spreads them out over several months in way that best avoids habituation and over stimulation. Key elements include using a balance board, throwing and catching bean bags – including throwing from hand to hand while tracking the bean bag with eye, practice of dual tasking, and a range of stretching and coordination exercises. The DDAT exercise intervention is done on a daily basis for ten minutes twice a day. Only the intervention group participated in the DDAT exercise program at home during the course of the study. Participants were tested every six weeks and given a new sequence of exercises for the next time period (Reynolds & Nicolson,

2007) The control group did nothing different. Students receiving support in school in both groups continued with their normal support services during the study.

The results of the study showed many significant interactions for the intervention group. Tests were administered initially at the beginning of the school year when the study began, again at six months in, and then used information from national standardized assessments the participants took at the end of the school year. Six months into the study, the intervention group showed significant improvement on the posturography, visual tracing, and visual tracking tests. The control group did not show any significant improvements in these areas. When given the DST again, there was a significant change in their at risk scores. The intervention group decreased from a mean of 0.74 to 0.39. The control group decreased from 0.72 to 0.44. The intervention group showed significant improvements for reading, semantic fluency, phonemic segmentation, bead threading and postural stability ($p < 0.05$ or better), slight significance for nonsense passage reading ($p < 0.10$), and near significance for rapid naming ($p = 0.12$). The control group only showed significant improvement for nonsense passage reading and slight significance for phonemic segmentation and backwards span. The researchers decided to run a comparison over time to determine if there were any significant difference between the groups between initial and post testing. There were significant interactions found in reading, bead threading and semantic fluency.

Information from the standardized school measures showed that there was more improvement in the year including the DDAT intervention than in the previous year. Effect sizes were calculated and reported as ratios to show progress of post-intervention to pre-intervention. The intervention group, who participated in the exercise treatment, showed substantial growth on the comprehension SATS with a score ratio of 4.75 to 1 and the writing SATS with a score ratio of 17.05 to 1. There was a smaller score ratio for the math SATS of 1.3 to 1, possibly implying that math skills are not effected as strongly as literacy. The NFER assessment also showed an improvement for the intervention group. Previous NFER scores showed an improvement of six months to children's reading age. After the treatment, the intervention group showed an improvement of 19 months, a ratio of 3.30 to 1.

Also after six months of the DDAT exercise program, the intervention group showed expected improvements in visual tracking and balance. The interventions vestibular score initially was a mean score of 38 and improved to a mean score of 67, which is considered above what is normally expected for a group of students in the age group used. Visual tracing improved for the intervention group from a mean score of 35 to 49, and saccadic, or visual tracking, control and accuracy improved from a mean score of 49 to 61. In contrast, the control group showed only small and non-significant changes in these measures.

In their discussion, the researchers answer their hypotheses. Their first hypothesis that a high percentage of students with reading disorders or difficulties would show cerebellar or vestibular problems was unable to be confirmed, as norms for a couple of their testing instruments were unavailable. Their second hypothesis that DDAT exercise intervention would improve cerebellar and vestibular abilities was supported by their findings. There were many significant improvements in the intervention group's balance, postural stability, visual tracking, and bead threading. The control group did not have as significant results, leading the researchers to conclude that specific intervention like the DDAT exercise treatment is an effective way to improve cerebellar, motor, and visual skills for students with dyslexia and other reading difficulties. The third hypothesis that the intervention would immediately improve fundamental cognitive skills involved in reading was not supported by the results. The improvement on fundamental skills, such as semantic fluency and phonological skills, were small for both the control and intervention group. The fourth hypothesis that the treatment would lead to at least normal acquisition of literacy skills after treatment had ended was supported by the results. The intervention group had significantly higher improvements in their overall reading progress than the control group. Their incidence of difficulty percentages dropped from 78% to 56% in reading, 61% to 56% for spelling, 17% to 6% for writing and 75% to 50% for nonsense passage reading. The intervention group also made a gain of 19 months on their reading age, according to the results of the NFER reading assessment. Their scores on the SATS taken at the end of the school year also showed significant improvement in literacy skills. The researchers ran a Pearson correlation to compare the groups' improvements at the six-month in mark and with the standardized test scores at the end of the school year, after the intervention had ended. Visual tracking, working memory, dexterity, and semantic fluency remained as the most significant improvements.

The DDAT exercise intervention group showed significantly improved balance, dexterity, visual tracking, and literacy skills that remained and students progressed upon through the end of the school year after the intervention had ended. After the study, when the participants were assessed again using the DST, the intervention group's strong risk of dyslexia had reduced from 33% to 11%. Their reading level and skills had improved to a level that was closer to that of their peers. The researchers noted that this was a small study with a limited number of participants and that future research should focus on a larger population to confirm their preliminary findings on exercise and it's impact on improving cognitive and literacy abilities.

The initial study was met with some criticism of their results, in which the critics proposed alternative hypotheses to explain the study's results. Reynolds and Nicolson (2007) conducted a follow-up study 18 months after their initial study had ended to investigate the critic's hypotheses. They also incorporated the Cerebellar Treatment Hypothesis (CTH) from their initial research, which states that the plasticity of the brain during childhood allows for more retention of learned skills, to provide an explanation for their results. Arguments from critics centered on whether or not the significant gains made by the intervention group were artificial or due to outside effects. Reynolds and Nicolson (2007) formed four alternative hypotheses, and corresponding CTH explanations, for their major findings.

Participants of the follow-up study included most of the same participants of the original study. Only six of the original 35 were excluded from analysis, due to moving on to secondary school or moving out of the district. The researchers looked at Dyslexic Screening Test (DST) scores from pre- and post-study and school administered tests before, during, and after the study. The original study began in September 2001 and test scores from SATs that took place in June 2001, June 2002, and June 2003 were evaluated in the follow-up study. Some scores on the SATs from June 2000 were also available to the researchers. Data was collected at four different time points: first from September 2001, pre-treatment start; second from March 2002, post-study and start of treatment for control group; third from September 2002; fourth from September 2003. No exercise intervention was used during the follow-up study. The researchers noted that the original control group was offered the exercise treatment after their original study had ended, and all participants in that group had taken it. By the time of the follow-up study, all original participants had received six to twelve months of the exercise program.

The first alternative hypothesis from critics was that the original control group would make little progress because the improvement of the original intervention group were due to their initially low starting point. Reynolds and Nicolson (2007) offered their CTH explanation that both groups would make equivalent progress due to the improved learning performance of both groups.

After analyzing test results from each time point, large effect sizes in improvement for both groups were found, however they were not considered to be statistically significant. Due to no statistical significance of the results, the researchers concluded that the first alternative hypothesis was falsified and their CTH explanation was supported. Between the first and fourth data collection points, both groups had large effect sizes for their improvement from the exercise intervention.

The second alternative hypothesis proposed by critics stated that the results were due to a Hawthorne effect, meaning results are due to the positive feelings of being associated with a certain group, and their improved performance would dissipate without the intervention. Through their data analysis, Reynolds and Nicolson (2007) found that improvement in performance on DST subtests had remained consistent after the intervention had ended, which disproves the second alternative hypothesis. The CTH is again supported because improvement was continued after the initial intervention. The researchers also highlight that the participants did not know that they would be tested again after the original study had ended, which discredits the Hawthorne effect. They also highlight that there was great care taken in the original study to make the exercise intervention completely independent from school, as well as teachers not being aware of which groups their students were in.

The third alternative hypothesis stated that the initial improvement would fade and drop back to where they were before pre-intervention. Reynolds and Nicolson (2007) offered the CTH based prediction that the performance would be maintained due to the repaired underlying learning processes. The alternative hypothesis was also falsified due to the data showing the participants' had continued improvement in their working memory, phonological skills, and semantic fluency. They did have an interesting finding that the participants' overall improvement in reading was small. Looking more into the scores of the NFER reading test, the researchers credited the small improvement to the subtests relating to speed and accuracy, rather than fluency.

The fourth alternative hypothesis stated that only non-dyslexic participants would maintain their improved performance levels post-intervention, Reynolds and Nicolson (2007) predicted that improvement and maintenance would conversely be higher for participants with dyslexia. To investigate this hypothesis, the participants were re-divided into two new groups: a group of participants with a prior diagnosis of dyslexia or dyspraxia and a group of participants without a formal diagnosis, but identified by the school as having special educational needs. The data showed that the group of participants with a formal diagnosis did perform more poorly than the other group, but the pattern of improvement made was almost identical between the groups, thereby falsifying the critic's hypothesis according to the researchers.

In their discussion of their follow-up results, Reynolds and Nicolson (2007) highlight the finding that exercise-based treatment interventions are indeed associated with significant and long lasting improvements for the participants. The initial study results showed the improvements in a range of both cognitive and literacy skills. The follow-up study supported these results, showing that the improvements had remained over a long period of time. Reynolds and Nicolson (2007) describe three very encouraging outcomes from their studies: first that the positive effect of the exercise intervention continued beyond the treatment period; second that effects of the intervention were at least as favorable for the participants with a dyslexia diagnosis as they were for ones without a diagnosis; and third that the positive performance of those treated were comparable to national SATs improvement expectations.

Overall, there appears to be a clear link between the exercise intervention and long-lasting performance improvements for those with and without formal diagnoses of dyslexia and related disorders. This research issue was highlighted as an important area to investigate further, which may lead to more significant understandings of relationships between cognition, physical activity, and teaching strategies and best practices. More research on these relationships will also benefit students with intellectual disabilities and how schools can help them improve their physical, cognitive and academic skills as well.

Incorporating Physical Movement in the Classroom

Schools have been viewed as an integral place to improve students' physical activity because of how much time they spend at school. Research supporting that physical activity also improves academic achievement has led to more studies researching how to increase physical activity inside schools. A Swedish study designed a nine-year intervention study to examine any effects of a daily physical education intervention would have on the motor skills and academic achievement in the students involved (Ericsson & Karlsson, 2012). The researchers hypothesized that extended daily physical education classes during compulsory (i.e. elementary and middle) school years would show improvement in the students' motor skills, improve the number of those who qualify for upper secondary school, and correlate with grades in Swedish, English, and mathematics.

Participants in the study were in first thru third grades from one Swedish school, and were between the ages of 7-9 years old when the study started. They were followed until they were 16 years old and left compulsory school. A total of 251 students were included in this study and were divided into two groups, a control group and intervention group. The control group participated in standard physical education lessons twice a week for 45 minutes each, for a total of 90 minutes of physical per week. The intervention group participated in a school day that was extended by 45 minutes and physical activity incorporated into 45 minute daily lessons in their classrooms, for a total of 225 minutes of physical activity per week. Those with motor deficits also participated, as needed, in an extra 60 minute lesson once a week to help with adapted motor training. All students were followed until they finished 9th grade. Both groups were taught by the same teachers and followed the same school curriculums, apart from the intervention group's increased physical activity. Students were assessed at the beginning of 1st, 2nd, and 3rd grade at the beginning of the study, as well as at the end of 2nd, 3rd, and 9th grades. Over the course of the nine-year intervention study, 31 participants had either moved or dropped out of the study. Data was collected and analyzed for the remaining 220 participants (119 boys and 101 girls).

Motor skills were assessed using the Motor Skills Development as Ground for Learning (MUGI) method. The MUGI is a checklist that looks at basic motor areas, separated into two components: balance ability/bilateral coordination and eye-hand coordination. Participants were evaluated using the checklist in the fall of grades one and two before the intervention began. Participants were evaluated again in the spring of grades two, three, and nine. Items were rated using scores of 0, 1, or 2. Total scores in the 0-2 range were categorized as good motor skills, 3-9 categorized as small deficits, and 10-32 categorized as major motor deficits. Academic achievement was assessed by collecting grades in Swedish, English, and mathematics from the 9th grade year. These grades were chosen because they need to reach a certain score to pass and qualify for upper secondary school. Grades, or scores, are rated at four different levels: Fail (0 points), Pass (10 points), Pass with Distinction (15 points), and Pass with Special Distinction (20 points).

Results of this study show a significant improvement only in the intervention group, who received daily physical activity lessons. Grades for students in 9th grade at the end of the study were higher in all areas assessed for those in the intervention group, especially for boys. The intervention group had 8% more participants with scores qualifying them for upper secondary school. Adapted motor skill training also had a significant, positive effect on the grades in each academic area for boys. For motor skills, there were no measurable improvements in the control group who participated in the standard physical education classes twice per week. Daily physical activity lessons did show improvement in the motor skills of the intervention group. The results of this study support previous studies that have also found a relationship between physical activity and academic achievement. The improvement of grades and motor skills of the intervention group suggest that daily physical activity has a significant impact on improving cognitive functioning and academics. The researchers indicate that their findings support that schools' standard lessons of physical education classes only two times a week are not enough to help improve motor or academic skills, especially for those with motor deficits. For those with motor deficits, such as students with disabilities, future research should focus on early interventions aimed to improve motor skill development, which would also help their academic achievement.

With increased physical activity improving children's overall health and linked to improving academic achievement, some research has focused on the amount of physical activity and when it takes place for students with intellectual disabilities. Everhart, Dimon, Stone, Desmond, and Casilio (2012) designed a study to investigate any relationship for elementary students with intellectual disabilities when regular structured physical activity is added to their daily schedule, specifically before students engage in math and language arts tasks.

Participants in this study included seven primary grade (grades K-2nd) students and six intermediate grade (grades 3rd-5th) students with intellectual disabilities. Students participated in a daily physical activity lesson in their special education classroom, in addition to their school physical education class offered twice within a six-day rotation. For primary aged students, the physical activity was an aerobic dance session using a DVD. For intermediate aged students, the physical activity was a Taebo DVD. Each grade level participated in their physical activity lesson for ten minutes, with the intention of increasing and maintaining the students' heart rates for the duration of the activity. The physical activity was followed by a five-minute rest period before the students engaged in their academic tasks. The structured physical activity began after a five-day baseline of academic tasks. The physical activity intervention combined with academic tasks lasted sixteen days, followed by four days without the physical activity. The physical activity was brought back after the four days for another three days to determine any influence it had on academic progress. The total timeline of the study, including baseline, intervention, withdrawal, and reintroduction was 30 days.

Students worked one-on-one with a familiar adult on the academic tasks. Mathematics tasks came from a math program called Math Speed Drills. Primary students completed tasks of writing and recognizing numbers. Intermediate students completed tasks of simple addition and subtraction speed drills. Each group of students had two minutes to complete their tasks. Sight word lists were used in language arts tasks. Students in both primary and intermediate grades practiced with lists of ten words, seven of which were familiar and three were unknown. As they practiced the lists and learned the words, three known words were removed and three new words were added; always working with lists of ten words. Both the primary and intermediate teachers were also asked to document any patterns or significant events they observed of their students during the study.

Results of the study showed that the intermediate age group of students showed improved academic performance immediately after performing the physical activity. Both teachers noted that their students' attention and focus on their academic tasks improved following the physical activity intervention. However, the data did not show any clear association between primary age students' academic performance following the physical activity, so no associations or relationships could be concluded. The researchers speculate that only the intermediate students showed progress because they have more developed motor control and skill to be able to reproduce the skills and patterns viewed in their physical activity DVDs. Primary age students' motor skills may be too premature and therefore they are not able reproduce the movements and patterns viewed in their physical activity intervention accurately enough to improve their abilities. Both teachers involved in the current study noted that student attention and focus was improved following the physical activity. This finding is supported by previous research that kinesthetic movement is a brain strengthening activity that helps improve both cognitive and motor functions (Schunck, 2008; Shuell, 1986).

This study has important implications for schools and students with intellectual disabilities. The current study suggests schools increase time spent in structured physical activity, using developmentally appropriate activities in the students' least restrictive environment. With the structured physical activity providing students opportunity for aerobic exercise, they will also have the opportunity to increase their focus on academic tasks, leading to improved cognition and academic performance.

CHAPTER III: CONCLUSION

Summary

Research investigating the relationship between physical activity and academic achievement began in the 1960s and has continued through to present day. Modern day studies are using brain-imaging techniques to view changes in the brain's functioning, as well as neuron structure and volume, when participants engage in physical activity. These studies have found that when participants are more physically active, more neurons form and connect, which help improve cognitive functioning. Children have been of particular interest in these types of studies because their brains are more plastic and still developing, making the neural changes and improvements more likely to be permanent as the children grow. Students with disabilities have been another area of interest due to their gap in both physical activity and academic achievement compared to their peers.

Castelli, Hillman, Buck, and Erwin (2007) hypothesized that students who were more physically fit would have higher academic achievement on standardized tests. They also hypothesized that aerobic fitness would have a closer association with academic achievement, opposed to other components of physical fitness measured, including muscle strength, body composition, and flexibility. The hypotheses of this study were both supported by the results. The students categorized as being more physically fit and having higher aerobic fitness capabilities also had higher scores on the standardized test.

Geertsen and colleagues (2016) investigated the associations between motor skills, cognitive functioning and academic performance in third grade students, specifically looking for any correlation with their math and reading comprehension abilities. This study also found that aerobic fitness was positively associated with academic performance and the cognitive domains of spatial working memory and sustained attention. Fine and gross motor skills were also positively associated with higher academic performance. The relationship between motor skills and cognitive functioning was of particular interest because previous research has suggested that they are separate. This study suggests that motor skill development and cognitive functions are closely related because motor skill practice engages the same cognitive processes that affect academic performance, such as processing speed, sustained attention, and decision-making.

Reynolds, Nicolson, and Hambly (2003) conducted a study to evaluate the Dyslexia Dyspraxia Attention Treatment (DDAT) with elementary school-aged children at-risk of or with diagnosed reading disabilities. DDAT is an at home exercise-based intervention targeting cerebellar, vestibular, dexterity, visual tracking, and literacy skills. They hypothesized that the exercise intervention would help participants improve their cognitive and balance abilities; fundamental cognitive skills involved in reading; and improve their reading abilities to more closely match their peers. Using the Dyslexic Screening Test (DST) and school-based standardized academic achievement tests, the participants were assessed at the beginning of the school year before the intervention started, six months into the intervention, and lastly at the end of the school year after the intervention had ended. The researchers found that the intervention group showed significant improvement in almost all of the areas assessed at the end of the school year, while the control group showed no significant results. This suggests that the exercise-based intervention was successful in improving the participants' academic, as well as some motor, abilities.

Critics of their original study had offered alternative hypotheses to explain the original results, so Reynolds and Nicolson (2007) conducted a follow-up study to investigate the criticisms. Critics had suggested that the improvements seen were due to the participants' low starting scores; improvements were based on the Hawthorne effect, that participants improved because of their feelings of being in a special group; that the improvements would fade away after the intervention ended; and that only non-dyslexic participants would maintain their improvements. They used the same participants of the original study and assessed their scores on school-based standardized assessments from the year of the original study, as well as assessments from the following two years between the original and follow-up study. Based on the scores analyzed, Reynolds and Nicolson (2007) disproved all four of the critics' hypotheses and found that all participants had comparative improvement that was maintained after the initial intervention.

Given the evidence for exercise and physical activity helping to improve cognitive functioning and academic achievement in typically developing individuals and individuals with reading disabilities, Pastula, Stopka, Delisle and Hass (2012) designed a study that investigated the benefits of exercise on individuals with intellectual disabilities. They hypothesized that a routine of moderate aerobic exercise would be positively associated with improvements in both cardiovascular fitness and cognitive function. The results of their study confirmed their hypothesis with all participants showing significant improvement in cognitive assessments after the intervention. This study highlighted a challenge for individuals with intellectual disabilities, which is the types of exercise or activities that they are able to participate in and stay engaged with. The researchers found that when doing whole-body movements and group exercise interventions of moderate intensity, they had 100% participation and engagement by all participants.

Other studies also highlighted the importance of a regular routine of physical activity. Ericsson and Karlsson (2012) designed a 9-year study that extended daily physical education classes in schools. For students with motor deficits, the intervention group included an extra 60-minute lesson once a week of adapted motor skills training. The results showed that only the intervention group had significant improvements in their academic and motor skills. The significant difference in achievement between the intervention and control groups emphasizes that the standard physical education classes of 45-minute classes twice a week was not enough to improve motor skills, especially for those with deficits.

Growing research and evidence supports that increased physical activity is beneficial in helping improve cognitive functioning in students, especially in students with intellectual disabilities. Everhart and colleagues (2012) designed a study that looked at the effects of using physical activity in the classroom before completing an academic task. The results showed that students did show academic improvement immediately after completing an aerobic activity. Their teachers also noted that the students' attention and focus were also improved following the physical activity intervention. The study also found a more significant improvement for intermediate grade students than primary. This study made an important suggestion that an increased amount of time spent in structured, developmentally appropriate, physical activity would greatly benefit attention and academic achievement for students with intellectual disabilities.

Research Questions Answered

Can improving gross motor skills/physical activity help improve cognitive abilities in students? Research has shown that physical activity is positively correlated to students' academic achievement (Castelli et al, 2007; Geertsen et al, 2016; Pastula et al, 2012; Reynolds, Nicolson & Hambly, 2003; Reynolds & Nicolson, 2007; Ericsson & Karlsson, 2012; Everhart et al, 2012). Physical activity activates and engages some of the same brain regions and structures that are used in cognitive functioning. Increasing physical activity and strengthening the related brain structures, cognitive functioning is also improved, leading to improved academic achievement.

Can improving gross motor skills/physical activity also help improve other areas of functioning? For students with disabilities, increasing their physical activity can help improve their health well-being, as well as help them to develop skills to function more independently. Physical activity helps to improve their motor abilities, problem-solving, regulation, social skills, independence, and self-esteem (Castelli et al, 2007; Pastula et al, 2012; Everhart et al, 2012).

Are certain types of physical activity more beneficial than others? The research shows that aerobic activity is the most beneficial in improving both physical activity/fitness and cognitive functioning (Castelli et al, 2007; Geertsen et al, 2016; Reynolds, Nicolson & Hambly, 2003; Reynolds & Nicolson, 2007; Everhart et al, 2012). A regular, moderate paced aerobic exercise or activity can help improve cognitive functioning.

How can physical activity be incorporated into the classroom? Physical activity can be used in the classroom as brain breaks. Studies reviewed showed that physical activity directly before an academic task helped to improve students' attention and ability to complete their work (Ericsson & Karlsson, 2012; Everhart et al, 2016).

Limitations of the Research

Every study has limitations in their design or measures. The limitations in the studies reviewed included limited populations, small sample sizes, non-random samples, anecdotal evidence, and standardized measures that were not able to assess every area of interest. While looking for articles to review, there were not many that included the specific population of elementary age students with disabilities. The research was also very limited in how physical activity could be incorporated more into the classroom and in learning. Most of the research focused on using physical activity in the classroom as brain breaks before or after academic tasks. I was hoping to find some articles that focused on incorporating activity into academic lessons, especially for students who have motor deficits.

Implications for Future Research

Further research should focus on how physical activity can be increased during the school day for young students, especially students with disabilities. Most schools now have students in physical education classes once a week, and students with disabilities who qualify for one extra adaptive physical education class per week. More research is needed on how schools can budget to increase physical education. Research should focus on more types of activity, including aerobic and whole-body movement, as well as how the activity can be incorporated with academic tasks. Multi-sensory approaches could also be explored. Future research should also follow or focus on young students and the effect of early physical interventions on their development and academic achievement as they grow up. It would be interesting to see how early exercise and other physical activity interventions affect young children with disabilities, and contribute to improving their cognitive functioning.

Professional Application

The research has many important implications for schools and teachers to use with their students. Students with intellectual disabilities were of personal interest in this literature review. Students with intellectual disabilities tend to have a larger gap in cognitive functioning, as well as motor skills compared to other students with disabilities and typically developing peers. Increasing their physical activity could help these students increase their motor skills and cognitive functioning to become more independent in their daily life and social interactions. Physical activity on a consistent, daily basis was found to be the most effective in the research, and is something to try and implement in the classroom. It could be that a warm-up activity or a break between learning tasks includes some type of cardio or other physical activity to get students moving and ready to learn.

During the research for this literature review, some articles were found that reviewed specific physical education curricula and the incorporation of regular physical education in the classroom. These articles were not included in the literature review because they were not peer-reviewed studies, and only reviews of curriculum. One such curriculum is SPARK PE. This curriculum uses highly structured lessons that focus on fitness activities as well as developing specific skills. The lessons can be integrated into the classroom as well as with activities students can do at home with family members. SPARK focuses on the increased physical fitness of students, but also helps to develop students' social skills in the areas of teamwork, relationships, self-confidence and self-image (McKenzie, Willistion, & Rosengard, 2013). These skills are important for all students to develop and have. The structure and consistency of the 30-minute daily lesson in this curriculum could be very beneficial for students with disabilities as well, however, the curriculum does not include specific adaptations or modifications to use with students with disabilities. Special education teachers and other staff could look at SPARK PE as a reference or a guide and incorporate activities that are the most appropriate for their students.

Another physical activity curriculum that was found was Project SKIP. Project Skip was founded by Ohio State University professors and piloted in one of their programs for preschoolers identified as being at risk for developmental delays (Goodman & Robinson, 2006). Project SKIP focuses on developing fundamental motor skills, such as walking, running, jumping, throwing, catching, kicking, ball bouncing etc., by incorporating physical activity into daily routines or play inside the classroom. They have found the program to be successful in the early childhood environment, and starting early can help lessen the gap for students with motor deficits.

Conclusion

The research surrounding physical activity and academic achievement in students with disabilities shows strong support that increasing physical activity increases cognitive functioning. This finding is very beneficial for individuals with disabilities, as well as family and school staff. Physically engaging activities can help students to lessen the academic gap between them and typically developing peers. Physical activity can also help them to gain the skills they need to become more independent, competent, and functioning individuals, which is every parent’s and teacher’s goal for students.

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