

The Effects of Physical Activity on Engagement in Young Children With Autism

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The Effects of Indoor Movement Activities on Engagement in Young Children with
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Benefits of physical activity

Regular physical activity is an important part of children's overall health, growth, and development (USDHSS, 2008). Government agencies and national organizations have put forth information describing the positive outcomes resulting from regular exercise for children, along with standards for appropriate amounts of physical activity for this population. For instance, the Center for Disease Control and Prevention has proposed a set of exercise guidelines for youth aged six to nineteen years in an effort to help improve their academic success and prevent overall cases of obesity (CDC, 2011). Additional documented benefits of regular movement for children include the growth and maintenance of healthy bones and muscles, reduced risk of developing chronic disease, and reduced rates of depression and anxiety (USDHSS, 2008).

Physical activity has been shown to have specific positive effects on children's cognitive and adaptive abilities as well, such as on-task behavior and academic performance. In one such study, Castelli et al., (2007) tested the fitness and academic achievement levels of 259 third- and fifth-grade students. Their analyses found that physical fitness was positively associated with academic performance in this population. Jarrett and his colleagues (1998) investigated this as well and found that fourth-grade children worked more in class and were less fidgety on days that they had outdoor recess time.

In order to reap these benefits, children and adolescents between 6 and 17 years of age are recommended by the United States Department of Health and Human Services to do at least one hour of physical activity everyday, with most of it being of moderate to vigorous intensity. Moderate to vigorous physical activity (MVPA) is an intensity of movement that causes

increases in heart rate, breathing, and perspiration for sustained periods of time (Bagby & Adams, 2007). Examples of moderate activity include bike riding and play on playground equipment, while vigorous activity incorporates running and jumping rope. Unfortunately, these same agencies have not published specific MVPA guidelines for children under the age of six, but more broad suggestions for movement for these young children can be found elsewhere. The National Association for Sport and Physical Education recommends that children aged three to five years engage in at least 60 minutes of structured physical activity and from one to several hours of unstructured physical activity every day (NASPE, 2009). Furthermore, preschoolers (typically aged three to six years) are suggested to avoid sedentary activity for more than one hour at a time, except when sleeping. Accountability for promoting physical activity for young children is set upon caretakers and teachers. Adults that are responsible for kids in early childhood settings are expected to provide ample indoor and outdoor space for large muscle movements and facilitation of physical skills so that children can meet their movement needs (NASPE, 2009).

Current levels of physical activity

The reality is that children in early childhood environments are not meeting the recommended amounts of physical activity and they are exceeding the general standards for amount of time spent in sedentary activities. McIver et al., (2008) found that children in preschool classes were engaged in sedentary activities for more than 80% of their time at school. Observations were conducted for 493 children in this study, across twenty-four different preschools. Researchers found that these children were only engaged in moderate to vigorous physical activities for approximately 3% of the time, far below the recommendations set forth for older children by the USDHHS. Brown et al., (2009) found similar trends of low physical

activity when directly observing 476 preschool children during their school day. Preschoolers' activity was described as largely sedentary in nature with 89% of their time spent in activities that involved sitting, lying down, and standing. Again, only 3% of their day was spent in MVPA. The implications of these results are troubling. As discussed earlier, low levels of activity can put children at an increased risk for developing obesity as well as a host of health-related issues later in life. Unfortunately, such conditions have notably increased in children in the United States over the past five years (McIver et al., 2008; Ogden et al., 2006).

Unfortunately, large-sample studies such as these that intend to target standard levels of movement in young children (Brown et al, 2009; McIver et al., 2008; McIver et al, 2009) have not explicitly included children with disabilities among their participants. However, similarities in outcomes related to health may be assumed to apply to students in early childhood settings exhibiting a wide range of ability. Research seeking to obtain overall levels of movement in children with autism and many other disabilities has yet to be added to the current base of literature. In spite of this, researchers have sought to investigate on a smaller scale how physical activity levels among children with autism differ from those of their typically-developing peers, as well as what additional benefits exercise can provide for children with ASD.

Physical activity in youth with autism

Autism spectrum disorder (ASD) refers to a range of neurodevelopment disorders that is increasing in prevalence, with more individuals receiving a diagnosis each year (NRC, 2001). Approximately 1 in 88 children are currently affected by autism spectrum disorder, and this number has grown substantially in recent decades (CDC, 2012). Individuals affected by ASD are characterized as experiencing varying degrees of difficulty with social interactions, delays and deficits in communication skills, and repetitive or restrictive patterns of behavior (APA, 2000).

With this increase in prevalence among children, schools are challenged to serve a generation of students that exhibit increasingly complex educational needs as compared to their typically developing peers. Among these, students with autism have been found to experience greater challenges attending to group instruction and engaging in appropriate classroom behaviors (e.g., Nicholson et al., 2011; Petrus et al., 2007; Lang et al., 2010). In light of this, classroom teachers have been challenged to come up with various strategies and tools to help address these individual behaviors while also managing the classroom as a group.

In addition to the aforementioned characteristics, children with autism engage in significantly less physical activity than their same-age peers. Pan (2008) found that children with autism spectrum disorder (ASD) between 7 and 12 years of age spend more time in sedentary behaviors during lunch and recess breaks at school than even their typically developing peers, with less overall time spent in moderate to vigorous physical activity. More specifically, early primary students with ASD spent less time in MVPA than both late primary students with ASD and early primary students without ASD. This tells us that children with autism are meeting even greater challenges with obtaining the recommended amounts of physical activity than their typically-developing peers, a population that has already been shown to struggle with this (i.e., Brown et al., 2009). Decreased levels of movement in older youth with autism have been confirmed in other studies as well. Using accelerometer data, Pan and Fray (2006) determined that youth with ASD aged 10 to 19 years were found to be less active than previously reported levels in peers without disabilities. Although they were afforded the same or similar opportunities to engage in physical play, young people with autism did not join the activities. Unfortunately, physical activity levels among young children with autism in early childhood

settings have not received much attention in the existing educational literature. Little is known of the amount of physical activity they engage in as compared to their typically developing peers.

Environmental factors affecting physical activity

Studies have shown that children aged three to six years engage in lower levels of MVPA when they are indoors and participate in the highest levels of physical activity when involved in play outside (Brown et al., 2009). When observing children in the home, McIver et al., (2009) also found that youth spent more time in MVPA when spending time outdoors as compared to indoor activities. These findings may present a challenge for early childhood educators that don't have regular access to an outdoor area, whether due to challenges with the regional climate, children's safety, or available financial resources. Outdoor areas may also be limited in nature, depending on the center. In light of these setbacks, it is worth considering what changes educators can make to their indoor classroom routines to increase the amount of daily movement that children engage in. Brown et al., (2009) found that when teachers led children in movement and music games, physical activity was relatively high. Unfortunately, they also found that such teacher-led activities were rare and did not occur often throughout the school day.

Interventions to increase physical activity

Despite the comparatively low levels of physical activity demonstrated in children with and without disabilities, exercise interventions have been found to offer them a variety of substantial benefits. In 2009, Hillman et al., concluded that physical activity improved children's cognitive performance and cognitive control. Twenty children with an average age of nine years engaged in twenty minutes of rest and twenty minutes of aerobic exercise on alternate days. Following the exercise bout, children had overall enhanced performance on an academic achievement test of reading and in response accuracy on a cognitive inhibition task. Physical

activity has also been found to benefit children in kindergarten through fourth-grade, as evidenced by an intervention conducted by Mahar and his colleagues (2006). Two hundred and forty-three students participated in a multiple-baseline study to compare subsequent on-task behavior during an academic activity. During intervention, the children engaged in a ten-minute classroom-based program and were then directly observed to score for on-task behavior. Students were found to demonstrate increases in on-task behavior following the physical activity program.

Additionally, children with ASD show positive outcomes after exercise interventions. Two characteristics that are commonly observed to decrease in these children after engaging in physical activity include stereotypy and off-task behavior. In a review of seven studies, Petrus et al., (2008) examined the relationship between exercise and stereotypy in young people with autism aged 4 to 15 years. Stereotypic behaviors generally include rocking, spinning objects or self, vocal/oral sounds, and gazing at lights. The authors reported an overall decrease in self-stimulatory behavior after exercise in all seven of the studies. Nicholson et al., (2011) also used an exercise intervention to measure the affect of physical activity on observed academic engagement in four third-grade boys diagnosed with autism. “Engagement” included behaviors such as answering questions, reading out loud, looking at the teacher during instruction, and reading silently. Physical activity was conducted in the gymnasium and was immediately followed by an academic activity in the classroom during which time engagement was observed and measured. Results from this study show that across the participants there was an overall increase in academic engagement after participating in the exercise intervention. Researchers in this study theorized that physical activity played a positive role in engagement because jogging improved the integrated functioning of the students’ brain hemispheres. However, the actual

causal relationship between physical activity and increased engagement in individuals with autism has yet to be determined in the literature.

Trends exist in the form of activity that is used in physical intervention studies. Jogging, especially either in a school gymnasium or on a treadmill, is a common form of physical activity used (Petrus et al., 2008; Hillman et al., 2009; Kern et al., 1982; Lang et al., 2010). Other exercise interventions include hydrotherapy (Petrus et al., 2008), walking (Hillman et al., 2009), and water based activities such as swimming and water aerobics (Lang et al., 2010). The intensity of physical activity has been found to relate to the dependent variable in these studies as well. Higher intensity movement, such as that which would induce MVPA, produced more positive outcomes in adaptive and cognitive measures. More intense forms of physical activity (i.e., jogging) have been found to correspond to greater decreases in stereotypy when compared to less aerobically intense exercise (i.e., walking) (Petrus et al., 2008). In a review, Lang et al., (2010) found that jogging was more effective at reducing stereotypy than mild activity (i.e., ball play) and less intense forms of exercise sometimes had no effect on student behavior. Furthermore, students' level of engagement has been correlated with the achieved intensity level of physical activity (Nicholson et al., 2011). Students that spent more time in MVPA had increased engagement behaviors compared to those that participated in more mild forms of movement activities.

Although antecedent physical activity may produce immediate benefits for students, there also appears to be a point at which the effects experienced after exercise diminish (Lang et al., 2010). Jogging decreased stereotypy in three eleven-year-old students, but the stereotypic behaviors returned again ninety minutes after exercise. Jogging also decreased stereotypy in one five-year-old boy and maintained these effects for up to forty minutes after physical activity.

Rationale

In summary, research has shown that engaging in regular physical activity supports academic performance, adaptive functioning, and general health for youth of varying levels of need and ability. Given the documented benefits discussed earlier for both typically developing children as well as those with autism (i.e., increased engagement, improved academic achievement scores, and decreases in stereotypy), providing more opportunities for children in early childhood settings to participate in moderate to vigorous physical activity is significant to their physical health and academic success. Yet, children are not achieving the recommended amount of movement needed to obtain these benefits as proposed by health standards. What can teachers and caretakers do to help improve children's daily physical activity levels? With the increase in autism occurring in our communities and in our classrooms, teachers need access to solutions to help youth with ASD be more engaged in classroom activities and consequently receive greater benefits from their education. Common interventions in the literature include jogging, exercise on a treadmill, and water activities, though these forms of physical activity may not be accessible in many school or center-based settings and may not be easily embedded into the classroom routine.

As discussed, most investigations have been done with older, school-aged children. Little research has been conducted specifically in early childhood settings (i.e., preschool and kindergarten classrooms) to determine the amount and intensity of physical activity that young children both with and without disabilities engage in. Similarly, there is insufficient research to determine what effect movement may have on student levels of engagement during classroom activities for this population or how long these effects may last. Despite observations of increased physical movement in outdoor settings, the current literature does not address

appropriate indoor activities that teachers can add to their daily classroom routines to help these young children increase physical activity. In light of these discrepancies, this study aims to address the following questions:

1. Do physical movement activities embedded into the classroom routine increase engagement for children with autism in early childhood settings?
2. In the case that physical activity level does affect engagement, for how long does this effect last?

Methods

Participants

Three kindergarten students with an autism diagnosis participated in this study. Participant one, Michael, was a Caucasian male student aged five years and six months. Data collected from the Vineland Adaptive Behavior Scales II, the Gilliam Autism Rating Scale, and the Developmental Assessment of Young Children place his daily living skills in the 19th percentile, his socialization scores in the 1st percentile, his cognitive skills in the 19th percentile, and with an overall average probability of autism. Participant two, Lucas, was a Caucasian male student that was six years and four months old. Assessment results from the Vineland II, the Preschool and Kindergarten Behavior Scales-2, and parent input classify his overall adaptive behavior as moderately low, with strengths in communication and motor skills. The domain of socialization was moderately low and the maladaptive behavior index was elevated. Problem behavior was at a moderate to high risk level. Participant three, Anna, was a Caucasian female aged six years and seven months. Evaluation results from the Battelle Developmental Inventory-II, Bayley's Scale of Infant Development, the Preschool Language Scale – 4, and clinical

observations show her as experiencing significant deficits in sensory processing, moderate delays in the areas of expressive and receptive language and social/emotional, and mild delays in cognitive skills. Motor skills were within normal limits. All reported ages were recorded at the beginning of the data collection period. Lucas and Anna were in one kindergarten classroom together and Michael was in the second classroom. The school's kindergarten teachers suggested appropriate subjects and then parent consent forms were sent home to obtain permission for the children's participation in the study. Appropriate subjects were determined to be students in the kindergarten classroom that had a diagnosis of autism. Subjects were chosen among children in the classroom that did not already have significant supports or behavior intervention plans in place that may interfere with study methods and results. Additionally, subjects were identified by the teachers as students that were mildly to moderately impacted by ASD and exhibited challenges with engaging in on-task behavior in various activities throughout the day.

Each child was a student in one of two full-day, integrated kindergarten classrooms. Both classrooms were located in an early childhood education center providing services to children from birth through kindergarten, located on the periphery of a major university campus. The two kindergarten classrooms met from 8:45am to 2:45pm Monday through Thursday and 8:45am to 12:30pm on Friday. They shared the same schedule, consisting of the following activities Monday through Thursday, in order: welcome circle, journal, snack, circle, reading, playcourt, math, lunch, playcourt, music/science/gym, freechoice, snack, playcourt, and shared reading/departure. Their Friday schedule included welcome circle, journal, snack, circle, buddy day activities, playcourt, free choice, lunch, and playcourt/departure. The intervention occurred Monday through Thursday during the second circle of the day. Each classroom had eighteen students with approximately three to four teachers in the room at a given time. Classrooms were

arranged into centers, including an area for book reading, large group activities, snack/work tables, and a writing center.

Two kindergarten head teachers, two assistant teachers, and several classroom aides and volunteers also took part in this study. The head teacher or assistant teacher led the embedded movement activities each day, while the other joined the classroom aides and volunteers in ensuring that the students were participating in the activities. The two head teachers and two assistant teachers participated further by completing social validity surveys at the completion of both intervention conditions. The two head teachers each held an M.Ed. in Early Childhood Special Education from a local University and the two assistant teachers were both working towards the same degree. After providing consent, these four teachers participated further by completing social validity surveys at the end of both intervention conditions.

Experimental design

This study examined the effects of physical activity using a reversal design in an ABAB pattern. The initial baseline phase was followed by intervention, a reversal to baseline, and a second intervention phase. Each intervention phase included an addition of the independent variable, embedded physical activity. The dependent variable, classroom engagement, was measured in each condition of the experiment including all baseline and intervention phases. Each condition was carried out for approximately four to seven consecutive days and varied slightly for each student. Movement interventions occurred in the first two to three minutes of the second circle time of the kindergarten morning schedule and measurement of engagement occurred during the latter part of circle as well as during the subsequent reading activity.

Procedure

Permission from the University of Washington Human Subjects Institutional Review Board was received prior to beginning this study.

Baseline. Baseline consisted of “business as usual” and students proceeded with their usual morning kindergarten schedule of circle time, journal, snack, a second circle time, and reading. The second circle time generally included a “sit down” song in which the children sang and did light movements (e.g., hand movement or swaying) while sitting on their carpet squares, as well as a group book reading, light yoga, and/or a group discussion related to the day’s planned lessons. Either the head teacher or the assistant teacher led all activities in the classroom while the aides provided additional support to the children and the environment. After the circle, the students were dismissed to “small group time” in which all eighteen students in the classroom were placed into small groups and rotated through academic activities. For example, six students went to a math small group, six students went to reading, and six students went to writing. These groups were rotated every ten to fifteen minutes.

Intervention. After four to five consecutive days of baseline, the intervention was introduced. At the beginning of the second circle time, teachers led students in two to three minutes of physical movement while the children remained in the general area of their circle mats. This movement activity was embedded in the students’ typical circle routine and consisted of a “stand-up” song that incorporated dancing and other gross motor movements. Including movement songs at circle time was a familiar practice for both of these classrooms. Songs included student favorites such as “Freeze,” “I’m Gonna Catch You, You Better Run,” and “Wishy Washy Washer Man”. These songs were chosen because they prompted students to be more active than “sit down” songs, they did not occur in the circle routine on a regular basis, and they were easy and appropriate for teachers to embed into circle time indoors. During

intervention, if a target student was observed to not engage in the physical movements for a period of five seconds or more, the supporting teacher or aide prompted the student to do so. At the end of the two to three minute movement activity, students were instructed to sit down and teachers continued with their usual circle time activities for the remainder of circle time, such as group book reading or a group discussion. Intervention songs were not repeated within sessions.

In accordance with the design of the study, intervention was followed by subsequent baseline and intervention conditions, which proceeded in a similar manner.

Measures

Dependent variable. The dependent variable of engagement was observed and recorded for each of the three target students. Engagement was defined as attending to the activity appropriately and independently. For all three students, “engagement” during circle was defined as the following: remaining on their carpet square, looking at the teacher or the relevant action, and following group and individual directions. Non-examples of engagement included out of seat behavior, looking elsewhere in the classroom (looking away from the action related to the activity), and doing something other than what was directed (i.e., standing when students were instructed to sit down).

For Lucas and Anna, their behavior was recorded as engaged during seatwork when they exhibited the following behaviors: looking at the book, journal worksheet, or close-ended activity they were assigned, appropriately interacting with materials (writing, reading, or holding a book with correct orientation), sitting in their seat, and following group and individual directions. Non-examples of engagement included looking elsewhere in the classroom (staring into space or looking away from the action related to their task), engaging in a task that was not specifically assigned (e.g., reading a book or cutting paper during a writing task), not responding

to group or individual directions, exhibiting out of seat behavior, and interacting with task materials inappropriately (e.g., repeatedly hitting a pencil on the table). Students' behavior was also scored as disengaged if they required prompting from a teacher to remain engaged with the task and/or re-engage with the task.

Engagement was defined differently for Michael than it was for Lucas and Anna during seatwork. When collecting pre-baseline data, it was observed that Michael was able to sit and attend to his worksheet with minimal teacher prompting. However, after examination of his worksheets and discussions with his teacher, it was determined that Michael needed more refinement in regards to defining engagement and disengagement for him. In many cases, he was observed to be engaged with his work when in actuality he was writing numbers and letters inappropriately on his materials (i.e., in the margins, on the back of the sheet, on a nearby folder, or even on the table). Therefore, Michael was scored as being engaged with the seatwork task when exhibiting the behaviors listed for the other two students in addition to writing the appropriate characters in the appropriate places on his worksheet (i.e., writing his name at the designated area at the top of the paper). Non-examples of engagement were similar to those outlined for Anna and Lucas, with the addition of writing inappropriate characters in inappropriate areas of his worksheet (i.e., writing numbers in the margins of his worksheet). Changing the definition of engagement in this way provided more clarity and accuracy regarding whether or not Michael was appropriately engaged with his materials.

Data collection. Data were collected for ten minutes during circle time. Ten minutes of observational data was collected again during the independent seatwork portion of the classroom reading activity. This second data collection period began approximately twenty to thirty minutes after the beginning of their circle time, depending on the student. During intervention, data were

collected for the ten minutes of circle time immediately following their physical movement activity. This time period was approximately the same time as it was collected during baseline. Another ten minutes of observational data was collected during the students' independent seatwork activity in the same manner that it was for baseline.

The students' daily reading activity in the classroom consisted of three different stations including independent seatwork, manipulatives practice, and phonetic practice. Students remained in each station for approximately ten minutes before transitioning to the next station. At the independent seatwork station, children retrieved their journal and completed the age-appropriate worksheets inside. When they were finished with their worksheet, a teacher would review it, give them a sticker, and instruct them to use the rest of their time in this station to read a book, complete a close-ended activity, or write in their personal journal. Independent seatwork was chosen for data collection as it involved the students in an independent academic task and it occurred approximately twenty to thirty minutes after the intervention. This variation in time between intervention and independent seatwork was dependent on the order in which the target students were scheduled to do their reading stations on a regular basis. Each of the three students participated in this portion of the reading activity as part of their second or third station.

Data were collected using momentary time sampling during each of the two observation periods. Each period lasted for ten minutes, resulting in twenty minutes of data collection per session. Behavior was observed and recorded by researchers at ten second intervals. Observers were alerted every ten seconds by a vibrating MotivAider at which time they looked at the target student for one second (the length of the vibration) and recorded if the student's behavior was "engaged" as per the operational definition already described. The research assistants continued to observe and record students' behavior every ten seconds for the duration of the ten-minute

observation period during circle time. This process was then replicated for the second ten-minute observation period during the students' independent seatwork reading activity.

MVPA. Data were also collected to determine the level of movement the three target students obtained during their circle time. During baseline and intervention conditions, ActiGraph GT3X accelerometers were used to accurately measure their intensity of movement at fifteen-second intervals. Accelerometers are small instruments, found to be tolerable for children with autism aged 5 to 12 years (Rosser & Frey, 2005). The accelerometers were attached to elastic belts that the researchers put on the target students' clothing for each session before circle time. The belts were arranged in an attempt to place the accelerometer at the student's right hip, as recommended by the company. The devices were then removed from the students' clothing after completing the reading activity. Data from the accelerometer were programmed to be collected for the period of an entire hour though was only analyzed for a fourteen-minute course of circle time.

Data analysis. Data were analyzed visually in graphic form to determine trends in the intensity of movement the target students engaged in as well as the percentage of intervals they exhibited engagement behaviors.

Reliability. Prior to the start of data collection, interobserver reliability was obtained between the primary researcher and all research assistants. Research assistants were trained on the definition of engagement and examples of non-engagement by the primary researcher and practiced by watching video that illustrated these behaviors. To establish reliability, data were coded by two individuals while watching a video and scoring for engagement at 10-second intervals. Coding continued until each set of two individuals reached 80% agreement or higher. Reliability data continued to be collected for the target engagement and non-engagement

behaviors during both circle time and independent seatwork throughout the course of data collection. This was either conducted with two observers independently coding live data or by one coder conducting live observation and the other coder watching video of the target students during both of the targeted activities. Data from the observers were compared for agreements and disagreements for each interval for the occurrence of engagement or disengagement. The percentage of agreement was calculated by dividing the number of agreements by the total number of intervals. Reliability data was collected in each condition for a total of 25% of sessions for each target student.

Social validity assessment. Adult participants completed a social validity assessment at the conclusion of the first intervention phase and again at the close of the second intervention phase. The two head teachers and two assistant teachers were asked to complete a brief survey, reporting their opinions regarding the appropriateness of the intervention for the target students, their perceived outcomes of the intervention, their enjoyment of the intervention, and the applicability of the interventions to the target students' behaviors. Results were collected and analyzed by the primary researcher.

Results

Data were analyzed to determine levels of engagement during target activities and levels of physical activity during circle. Results of these data were compared among the three target students. Results of interobserver reliability data and social validity surveys will also be discussed.

Analysis of Accelerometer data

Accelerometer data was collected in 15-second epochs over a fourteen-minute period of circle time. This fourteen-minute time was based on approximate beginning and ending times for circle and was applied uniformly to each student's data. Therefore, each student was analyzed for fifty-six epochs of movement. Accelerometer data will be expressed to reflect moderate-vigorous physical activity (MVPA) as well as light-moderate-vigorous physical activity (LMVPA). LMVPA illustrates any movement made by the target students exclusive of sedentary behavior. Measures for the intensity of movement were based on counts determined by Sirard (2005) for the average five-year-old child when using the ActiGraph GT3X accelerometer and are outlined in Table 1.

| Activity/Age | Intensity Category | Counts Per 15 seconds |
|-----------------|--------------------|-----------------------|
| Sit, Sit & Play | Sedentary | |
| 5 y old | | 0-398 |
| SLOW WALK | Light | |
| 5 y old | | 399-890 |
| FAST WALK | Moderate | |
| 5 y old | | 891-1254 |
| JOG | Vigorous | |
| 5 y old | | ≥1255 |

Table 1. Accelerometer counts

Michael

During the initial baseline phase, Michael was observed to exhibit engagement behaviors an average of 61% of intervals (range 57 – 68%) during circle time and 48% of intervals (range 34 – 57%) during seatwork. In the first intervention condition, his average engagement level increased to 74% of intervals during circle time (range 50 – 91%) and 70% of intervals (range 32 – 92%) during seatwork. During the return to baseline, he was observed to be engaged an average of 42% of intervals (range 16 – 66%) during circle time and 38% of intervals (range 22 – 58%) during seatwork. When the intervention was reintroduced, he exhibited engagement

behaviors an average of 80% of intervals (range 71 – 93%) during circle time and 71% of intervals (60 – 79%) during seatwork.

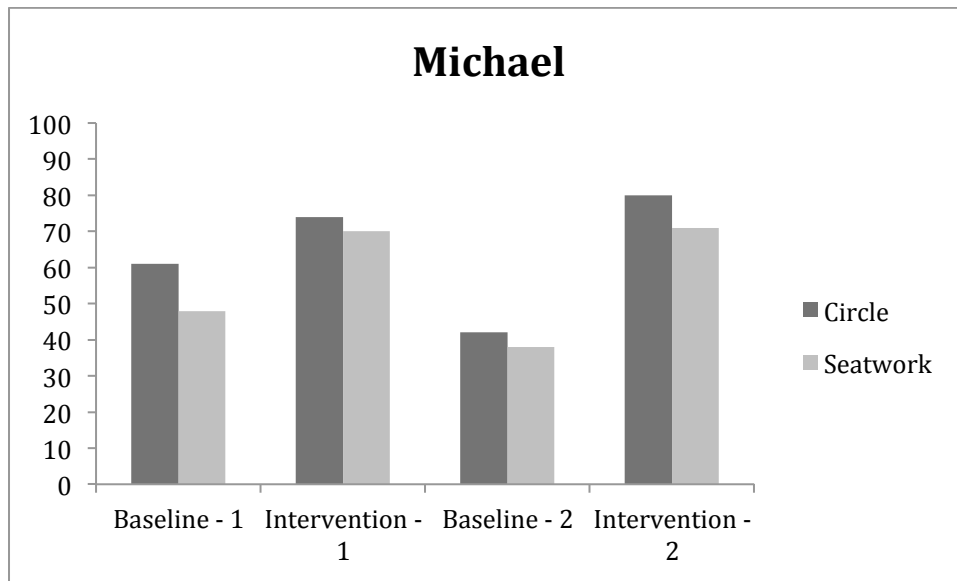


Figure 1. Average engagement levels for Michael (represented in percentages).

Accelerometer data for Michael shows corresponding patterns. During initial baseline, MVPA was recorded an average of 0% of intervals (range 0 – 2%) with LMVPA recorded for 9% of intervals (range 4 – 13%). During the initial intervention phase, MVPA was recorded for an average of 5% of intervals (range 0 – 20%) with LMVPA recorded for 24% of intervals (range 15 – 41%). With the return to baseline, MVPA was recorded an average of 1% of intervals (range 0 – 4%) with LMVPA recorded for 11% of intervals (range 5 – 15%). During the second intervention phase, MVPA was recorded for an average of 13% of intervals (range 11 – 14%) with LMVPA recorded for 26% of intervals (range 21 – 30%). Michael’s physical activity data is listed in Table 2. Engagement and accelerometer data is graphically displayed in Figure 2.

| Session | Baseline 1 | Intervention 1 | Baseline 2 | Intervention 2 |
|-------------|------------|----------------|------------|----------------|
| MVPA mean | 0 | 3 | 1 | 7 |
| MVPA range | 0 to 2 | 0 to 9 | 0 to 4 | 6 to 8 |
| LMVPA mean | 8 | 20 | 8 | 21 |
| LMVPA range | 4 to 13 | 15 to 25 | 4 to 14 | 15 to 24 |

Table 2. Amount of circle time spend in MVPA and LMVPA (represented in percentages)

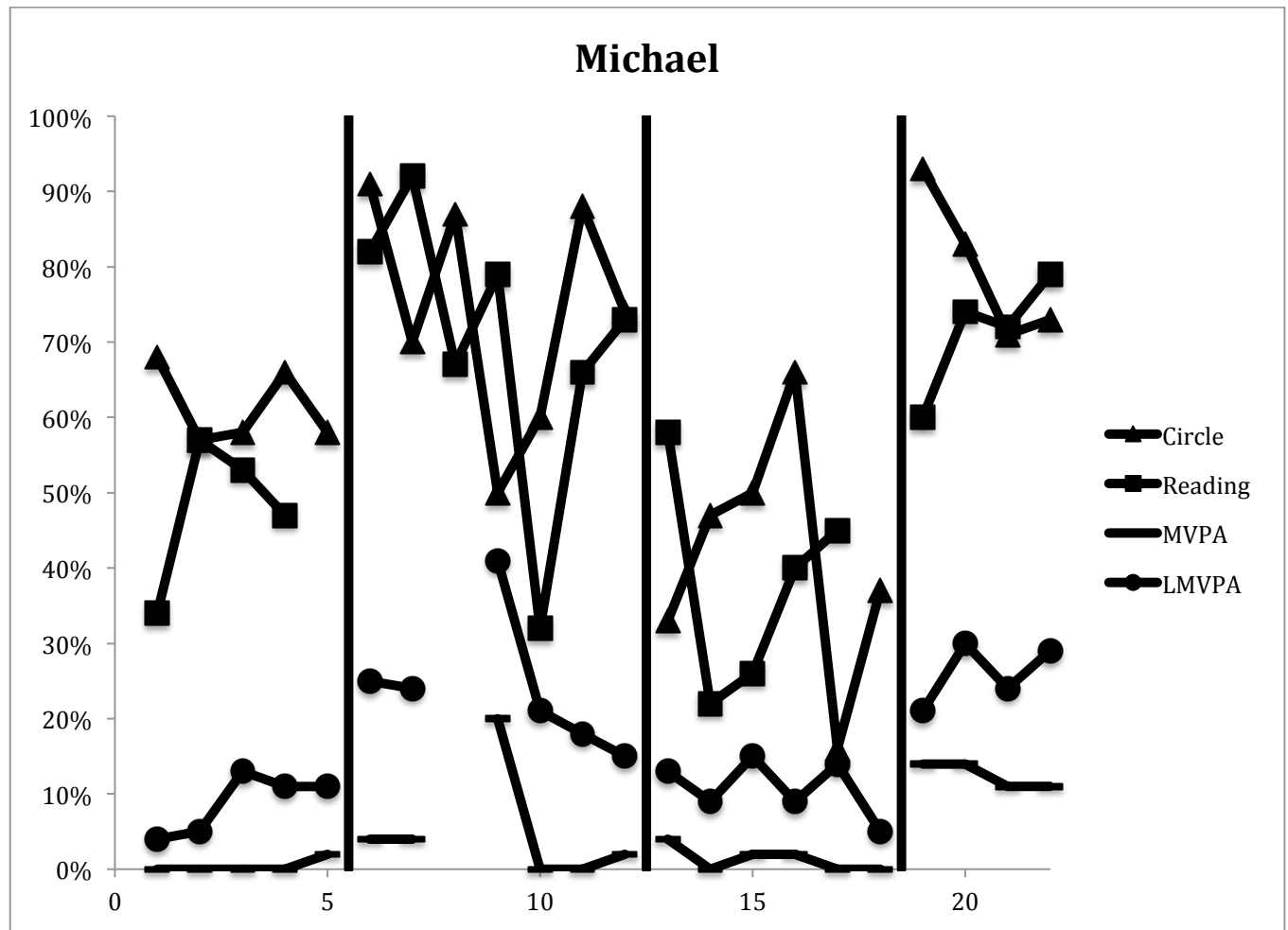


Figure 2. Engagement and accelerometer data for Michael

Lucas

Lucas’ engagement data during the initial baseline phase was an average of 40% of intervals (range 28 – 50%) during circle time and 34% of intervals (range 22 – 53%) during seatwork. In the first intervention condition, his average engagement level was 69% of intervals during circle time (range 56 – 81%) and 64% of intervals (range 48 – 77%) during seatwork. During the return to baseline, he was observed to be engaged an average of 48% of intervals (range 35 – 65%) during circle time and 40% of intervals (range 18 – 56%) during seatwork. When the intervention was reintroduced, he exhibited engagement behaviors for an average of

75% of intervals (range 68 – 82%) during circle time and 63% of intervals (47 – 80%) during seatwork.

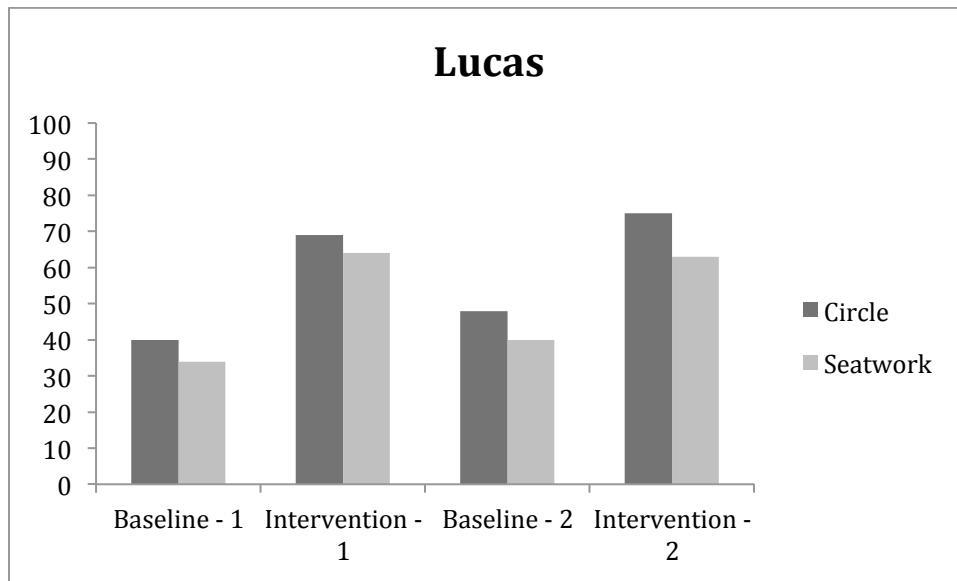


Figure 3. Average engagement levels for Luca (represented in percentages).

Accelerometer data for Lucas shows movement patterns that correlate to engagement levels. During initial baseline, MVPA was recorded an average of 0% of intervals (range 0 – 2%) with LMVPA recorded for 9% of intervals (range 4 – 20%). During the initial intervention phase, MVPA was recorded for an average of 7% of intervals (range 0 – 23%) with LMVPA recorded for an average of 29% of intervals (range 25 – 36%). With the return to baseline, MVPA was recorded an average of 1% of intervals (range 0 – 2%) with LMVPA recorded for 12% of intervals (range 5 – 18%). During the second intervention phase, MVPA was recorded for an average of 4% of intervals (range 2 – 14%) with LMVPA recorded for an average of 26% of intervals (range 23 – 30%). Lucas’s physical activity data is listed in Table 3.

| Session | Baseline 1 | Intervention 1 | Baseline 2 | Intervention 2 |
|-------------|------------|----------------|------------|----------------|
| MVPA mean | 0 | 7 | 1 | 4 |
| MVPA range | 0 to 2 | 0 to 23 | 0 to 2 | 2 to 14 |
| LMVPA mean | 9 | 29 | 12 | 26 |
| LMVPA range | 4 to 20 | 25 to 36 | 5 to 18 | 25 to 30 |

Table 3. Amount of circle time spend in MVPA and LMVPA (represented in percentages).

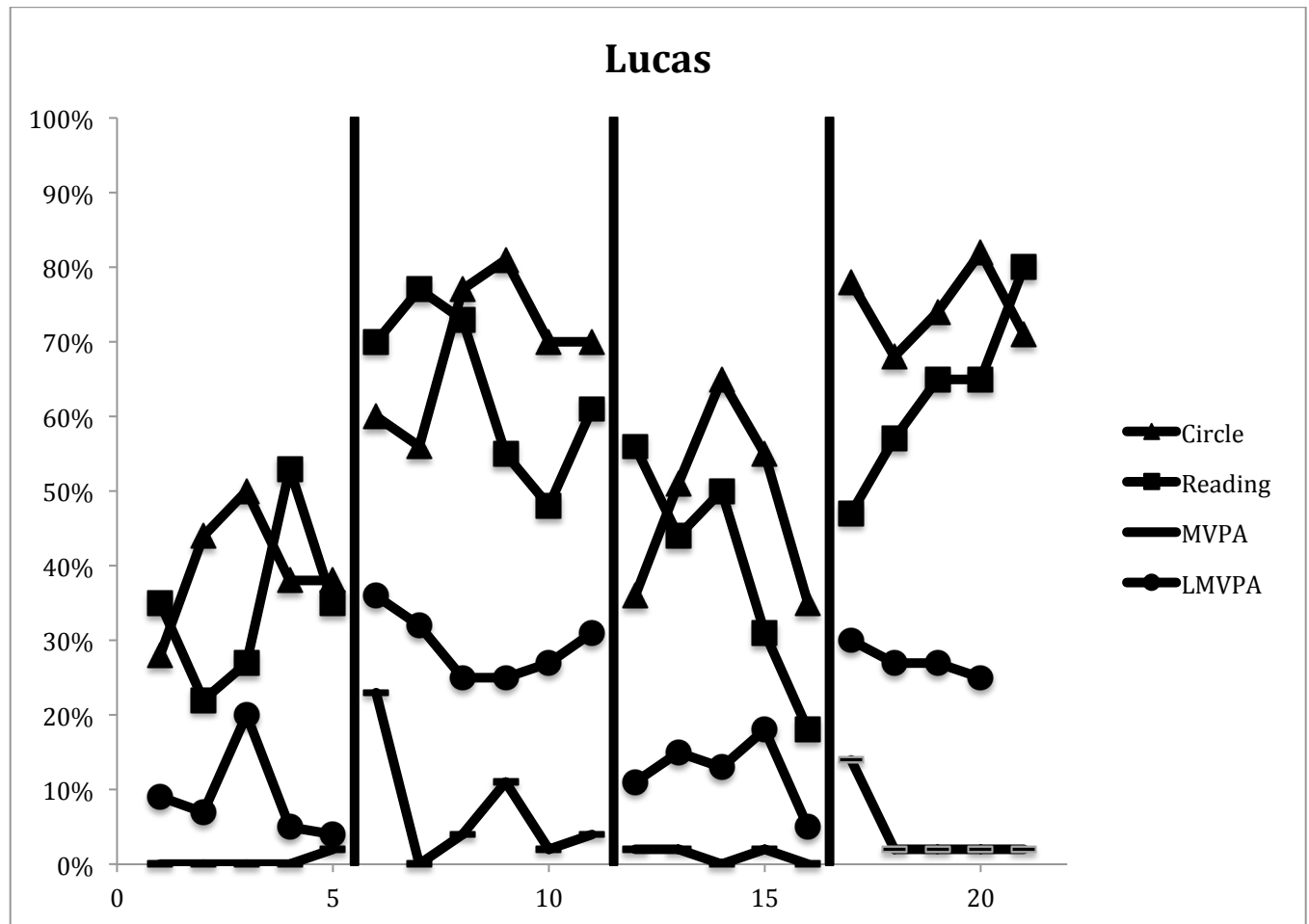


Figure 4. Engagement and accelerometer data for Lucas

Anna

During the initial baseline phase, Anna’s engagement data ranged from 30%-60% (mean 41%) during circle time and ranged 28% - 53% (mean 37% of intervals) during seatwork. In the first intervention condition, her average engagement level was 44% of intervals during circle time (range 5 – 68%) and 56% of intervals (range 33 – 85%) during seatwork. During the return to baseline, she was observed to be engaged an average of 53% of intervals (range 37 – 67%) during circle time and 45% of intervals (range 15 – 66%) during seatwork. When the

intervention was reintroduced, she exhibited engagement behaviors for an average of 58% of intervals (range 41 – 90%) during circle time and 47% of intervals (33 – 57%) during seatwork.

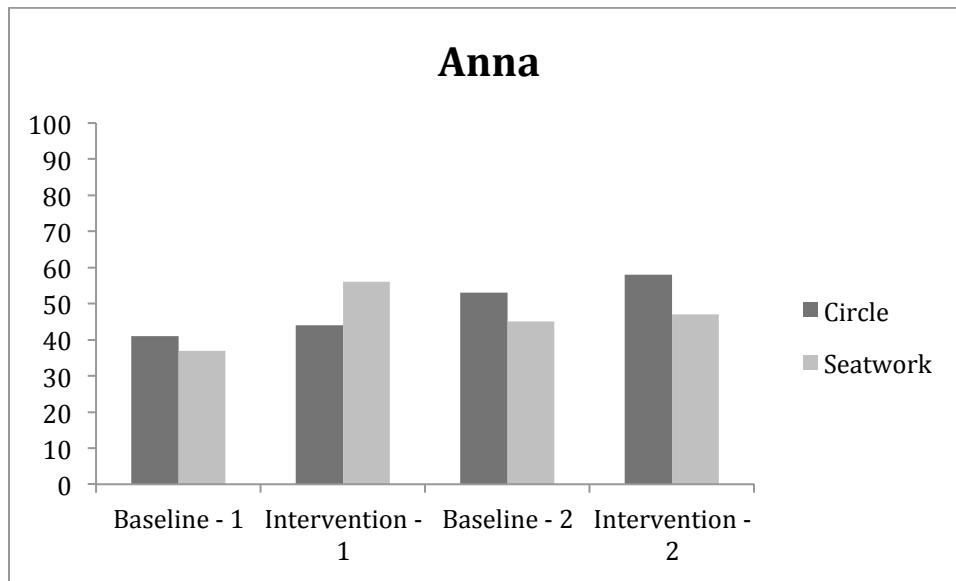


Figure 5. Average engagement levels for Anna (represented in percentages).

Accelerometer data for Anna is variable. Two points were removed from the accelerometer data collected for her for days on which she was observed to be playing with the device. Therefore, it is unknown if she was engaging in this behavior during other sessions unnoticed. During initial baseline, MVPA was recorded an average of 1% of intervals (range 0 – 2%) with LMVPA recorded for 14% of intervals (range 7 – 27%). During the initial intervention phase, MVPA was recorded for an average of 2% of intervals (range 0 – 9%) with LMVPA recorded for an average of 22% of intervals (range 11 – 36%). With the return to baseline, MVPA was recorded in 0% of intervals with LMVPA recorded for 14% of intervals (range 7 – 18%). During the second intervention phase, MVPA was recorded for an average of 3% of intervals (range 0 – 5%) with LMVPA recorded for an average of 25% of intervals (range 16 – 43%). Anna’s physical activity data is listed in Table 4. Engagement and accelerometer data is graphically displayed in Figure 6.

| Session | Baseline 1 | Intervention 1 | Baseline 2 | Intervention 2 |
|-------------|------------|----------------|------------|----------------|
| MVPA mean | 1 | 2 | 0 | 2 |
| MVPA range | 0 to 2 | 0 to 7 | 0 | 0 to 4 |
| LMVPA mean | 10 | 18 | 8 | 16 |
| LMVPA range | 7 to 18 | 9 to 31 | 5 to 11 | 4 to 31 |

Table 4. Amount of circle time spend in MVPA and LMVPA (represented in percentages).

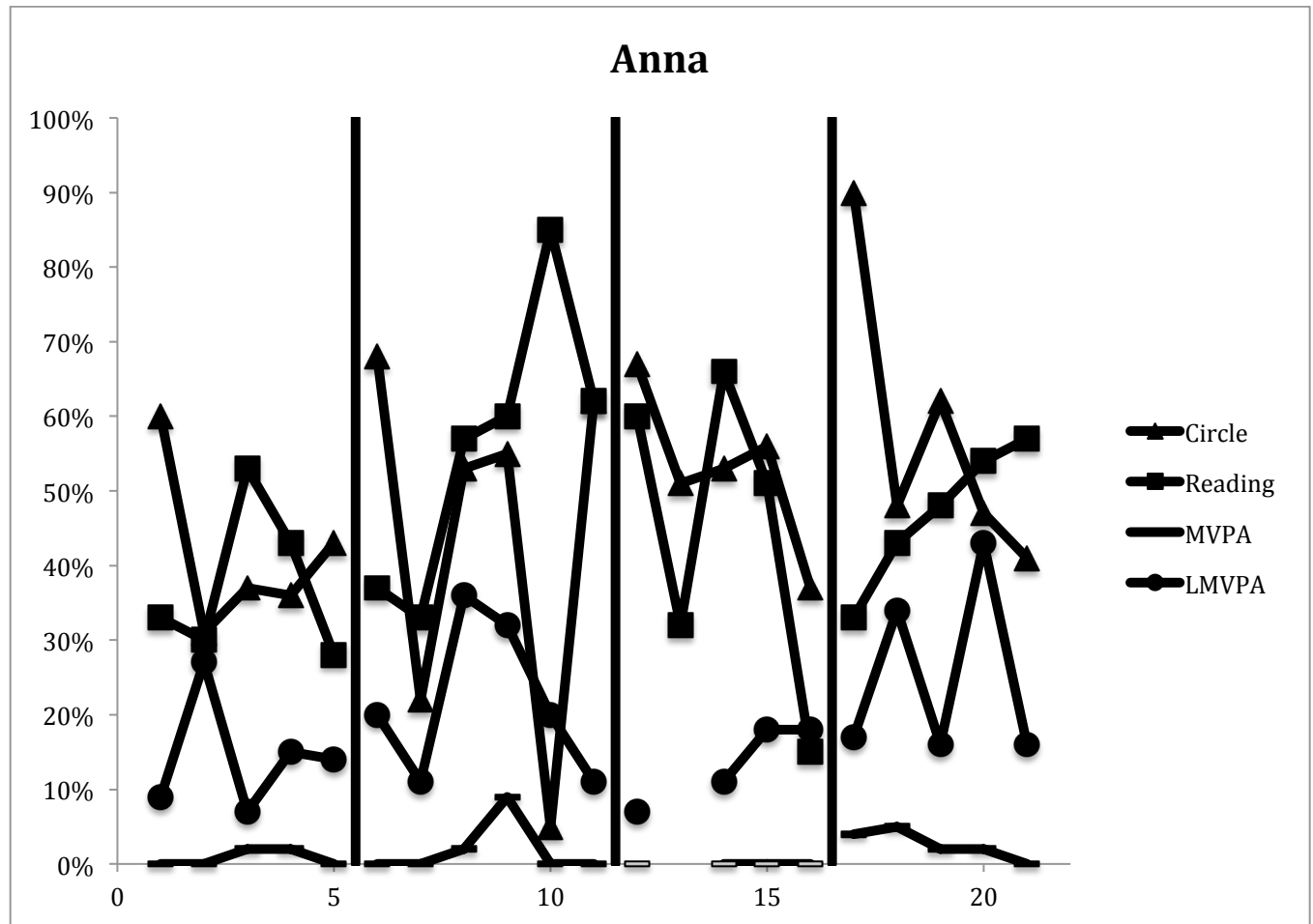


Figure 6. Engagement and accelerometer data for Anna

Comparisons between students

Data was analyzed and visually represented to illustrate the average levels of engagement among the three target students during both circle and seatwork. These levels are expressed for circle is Figure 7 and for seatwork in Figure 8. All three target students show mild to moderate

variances in average engagement levels during seatwork. During circle, only Michael and Lucas show consistent shifts in average engagement levels that correspond to the condition.

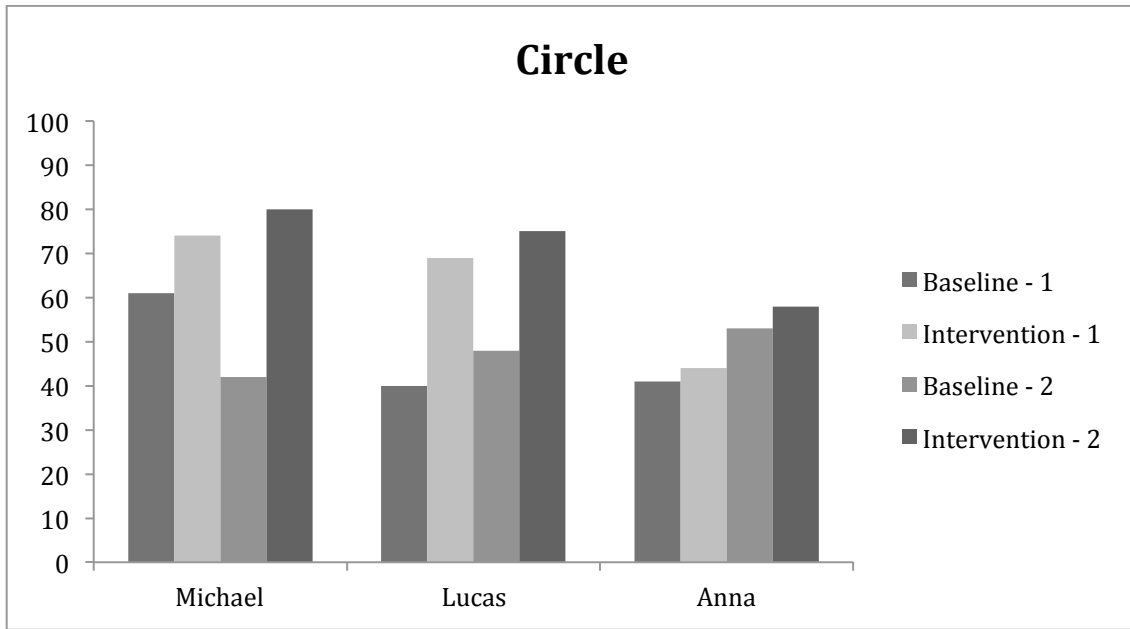


Figure 7. Engagement levels at circle (represented in percentages)

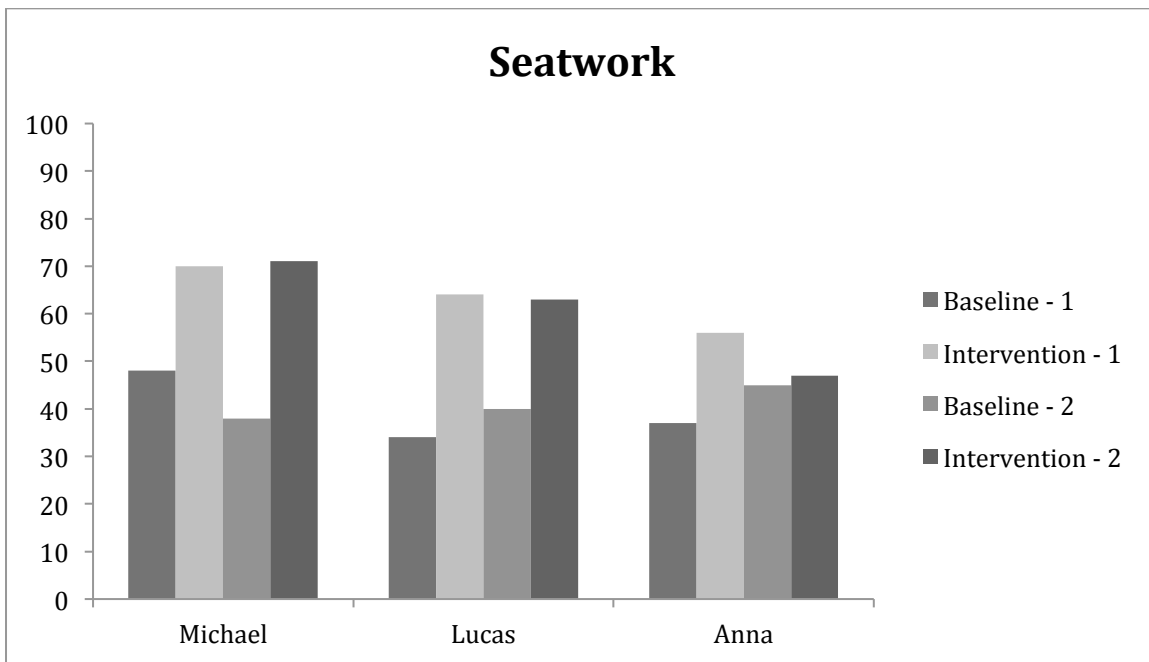


Figure 8. Engagement levels at seatwork (represented in percentages)

Comparisons among target activities

Data was further analyzed to compare average levels of engagement between the two target activities of circle and seatwork. In almost all conditions, engagement was found to be higher for the three target students during circle (range 4 – 14%) with the reverse true only for Anna in the first intervention phase. Her engagement during seatwork was an average of 12% higher in this condition.

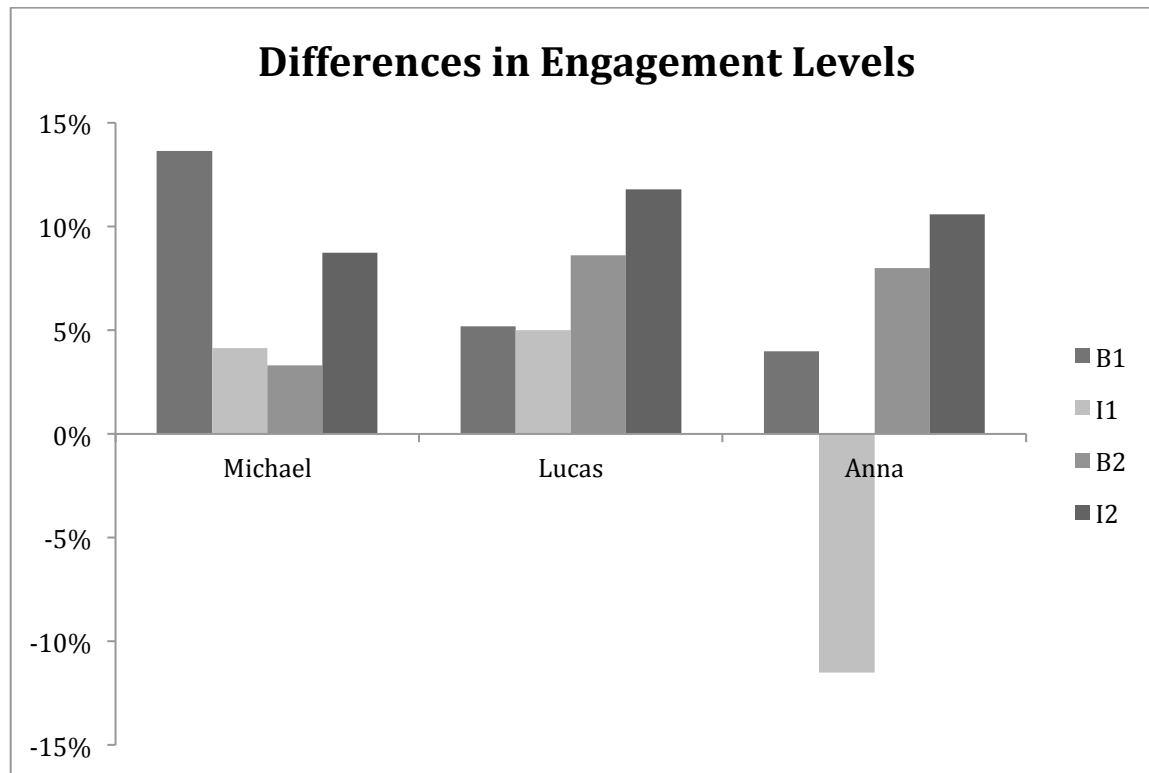


Figure 9. Difference in average engagement levels between circle and seatwork for each student

Interobserver agreement

Reliability data was collected for each target student in each condition. Agreement for Michael's engagement data was M=90% for circle (range 86 – 95%) and M=96% for seatwork (range 93 – 100%). Agreement for Anna's engagement data was M=91% for circle (range 85 – 98%) and M=88% for seatwork (range 73 – 93%). Finally, agreement for Lucas's engagement data was found to be M=92% for circle (range 87 – 96%) and M=87% for seatwork (range 67 – 97%).

Social validity

The two head teachers and two assistant teachers were asked to fill out a brief social validity survey at the end of each intervention phase. Four teachers completed and returned the survey after both phases of intervention. Therefore, eight responses were tallied for each prompt in the survey. Totals are found in table 5.

| Item | 1 | 2 | 3 | 4 | 5 | 6 |
|--|---------------------------|---|-----------------|-----------------|-----------------|--------------------------------------|
| This is an acceptable treatment for the child's behavior | 1 Strongly Disagree | 2 | 3 | 4 (3) 38% | 5 (4) 50% | 6 Strongly Agree (1) 13% |
| The treatment should be effective in changing the child's behavior | 1 Strongly Disagree | 2 | 3 (2) 25% | 4 (6) 75% | 5 | 6 Strongly Agree |
| The child's behavior is severe enough to justify the use of this treatment | 1 Strongly Disagree | 2 | 3 | 4 (2) 25% | 5 (5) 63% | 6 Strongly Agree (1) 13% |
| This treatment would not have bad side effects for the child | 1 Strongly Disagree | 2 | 3 | 4 (1) 13% | 5 (2) 25% | 6 Strongly Agree (5) 63% |
| I like this treatment | 1 Strongly Disagree | 2 | 3 | 4 (4) 50% | 5 (4) 50% | 6 Strongly Agree |
| The treatment was a good way to handle the child's problem | 1 Strongly Disagree | 2 | 3 (4) 50% | 4 (3) 38% | 5 (1) 13% | 6 Strongly Agree |
| Overall, the treatment would help the child | 1 Strongly Disagree | 2 | 3 (2) 25% | 4 (4) 50% | 5 (2) 25% | 6 Strongly Agree |
| | | | | | | |

Table 5. Combined teacher responses after both intervention phases

Overall, teachers were divided about whether or not they believed the treatment was a good way to solve the child's problem. Yet, the majority of teacher responses indicate that they generally agreed the treatment would help the child, that it was acceptable for the child's behavior, that the child's behavior was severe enough to justify the use of this treatment, that it would be effective in changing the child's behavior, and that they liked the treatment. The majority of teacher responses convey that they believed the treatment would not have bad side effects for the child.

Discussion

This study aimed to assess multiple factors related to the effects of embedded physical activities on students with autism in early childhood settings. Among these was the interest in increasing movement in young children. In addition, we examined the collateral effects of physical activity on engagement.

A primary question of interest in this study regarded the documented relationship between increases in physical activity and corresponding improvements in engagement during school activities (Castelli et al, 2007; Hillman et al, 2009; Mahar et al., 2006; Nicholson et al., 2011; Petrus et al., 2007). Overall, results from the three target students showed an increase in engagement during a group circle time activity and an independent seatwork task after participating in a two to three minute embedded physical activity. Directly observed levels of engagement increased for each of the three students in each intervention condition compared to baseline levels during their seatwork activity. Increases were more dramatic for Michael and Lucas, with only slight increases in the second intervention phase for Anna. During circle, similar increases in levels of engagement when the intervention was in place were observed in

both Michael and Lucas. While we did not see rates of engagement for Anna increase as we did with Michael or Lucas, if we take combined averages of Anna's engagement across circle and seatwork, it appears that her levels slightly increase during intervention compared to baseline. However, analyzing accelerometer data showed that Anna exhibited lower levels of movement during the intervention phases than Michael and Lucas. It is possible that her levels of MVPA and LMVPA were not significant enough to effectively benefit her engagement during circle time. If we look at engagement levels during circle and independent seatwork, we see Anna's engagement appears to progressively increase for circle throughout the course of the study. Although she showed her lowest level of engagement in the first baseline condition and her highest levels in the second intervention condition, they did not increase significantly with the first intervention or decrease in the second baseline phase. However, during the independent seatwork activity, Anna's engagement levels were observed to increase when the intervention was in place as compared to baseline.

Anna's engagement levels were observed to be influenced by other factors as well. For instance, her lowest level of engagement data corresponded with a day that a teacher was absent and the classroom was short-staffed. No one was present to prompt her to re-engage with circle time, as they usually would have. During the course of the study, classroom staff were observed to regularly prompt individual students in the class to remain engaged with or re-engage with the activity at hand. Having fewer teachers and aides present resulted in less overall opportunities for teacher prompts. Furthermore, it was observed that she was occasionally offered a small toy or object to fidget with during circle. This was more common near the beginning of data collection and may have contributed to a decrease in her engagement during circle when she had access to the fidget toy.

One variable that appeared to decrease Michael's engagement during seatwork related to the difficulty of the assigned worksheet. Although the students were to be given worksheets reflecting their level of academic ability in the usual fashion, it was noted on a couple of occasions that Michael was mistakenly assigned worksheets above his reading level. Teachers noted that this might have influenced his engagement during this activity.

As demonstrated in other studies evaluating children with and without disabilities (Brown et al, 2009; Hillman et al, 2009; Mahar et al, 2006; Nicholson et al, 2011; Petrus et al, 2007), researchers became interested in whether or not target students were participating in the classroom wide physical activity intervention. Michael and Lucas were both found to participate in the intervention, based on increases in their accelerometer counts during this condition. These two students willingly engaged in higher levels of both MVPA and LMVPA when the teachers incorporated "stand-up" songs into the circle time routine. Anna shows similar patterns, but to a lesser extent and never reaching the same levels of PA as the other two students. Additionally, Anna was informally observed by researchers and teachers to require higher levels of physical prompting during the intervention songs in order to remain active and moving.

Before beginning the intervention, Michael's teachers were already incorporating "sensory breaks" into his routine on days that he exhibited higher levels of agitation, such as inappropriately interacting with materials, not following directions, and throwing materials. Sensory breaks consisted of going outside to bounce and throw a ball or going on a brisk walk around the building. It is important for us to note that his teachers did give him a sensory break on one day during the initial baseline, which may have affected his later levels of engagement. This break occurred within an hour before researchers began collecting engagement data during

the students' circle time that morning. No other sensory breaks were noted during the course of data collection.

The two target activities illustrated the students' engagement levels immediately after physical activity as well as twenty to thirty minutes after. Researchers hypothesized that the length of time between physical activity and the seatwork activity may impact students' engagement levels such that they would be lower compared to levels observed immediately after the intervention song, during circle. It appears that the students' engagement decreased during seatwork compared to circle, though this occurred in all conditions of the study except for Anna's data in the first intervention phase. Therefore, we can conclude that the physical activity intervention continued to benefit the students' engagement twenty to thirty minutes later despite the observation that the students' engagement was lower during this activity as compared to circle, overall.

Limitations

This study faced limitations in the course of implementation. Many environmental factors come into play when doing research in a classroom environment that are difficult to control. It was the goal of researchers to conduct the study in such a way as to obtain accurate data on the relationship between physical activity and engagement while applying minimal changes to the classroom environment. Examples of this include some of the variables already discussed, such as the intermittent use of toys and props during circle activities, teacher attendance, difficulty of seatwork, and variability of circle time activities.

The accelerometer data that was collected for the students was limited in that it was not focused on only the two to three minutes during circle that the students were participating in the intervention at circle. Exact start and ending times for the intervention songs were not recorded

for each classroom and were therefore not formally tracked. Instead, approximate start times for circle were noted and a time frame was determined from which to extract accelerometer data.

Future Research

This study only measured the effect of physical activity on engagement for children with autism. Future research in the early childhood population should examine the effects of other activities that may influence students' levels of engagement such as teacher prompting behavior, student interest and participation (a book read-aloud vs. an interactive lesson), and fidget toys. Each of these factors may have affected engagement levels for the students in this study in addition to the physical activity intervention that was put in place. Research isolating these elements could provide greater insight regarding what supports young children need to remain more engaged during large group and independent activities.

Additionally, future research could do a similar study but focus more on the length of time that physical activity benefits engagement. This could be done by taking data across two activities that are more similar to one another and demand similar criteria for engagement. Data could be collected at greater time intervals, such as immediately after intervention, thirty minutes after, and again at an hour after the intervention. Such information could provide teachers with guidelines regarding how often to introduce physical activity in the schedule in order to positively influence engagement.

In summary, this study found that brief, embedded physical activity generally improved engagement levels during both a large-group activity and an independent academic task for three kindergarten students with ASD. This supports research including students with and without disabilities demonstrating that physical activity contributes to positive outcomes for students in the areas of academic performance, engagement, repetitive behaviors (stereotypy), and physical

health (Brown et al, 2009; Castelli et al, 2007; Hillman et al, 2009; Mahar et al., 2006; Nicholson et al., 2011; Petrus et al., 2007;). Procedures from this study show that opportunities for physical activity can be provided to young children easily and effectively in an indoor classroom environment. Combined with other essential elements in an early childhood classroom such as effective instruction, age-appropriate activities, and positive supports, regularly implementing bouts of physical activity can help teachers enjoy a more engaged and focused group of young students.

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