PHYSICAL ACTIVITY LEVEL COMPARISONS OF INDIVIDUALS WITH AUTISM SPECTRUM DISORDER WHILE PLAYING ACTIVE VIDEO GAMES

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PHYSICAL ACTIVITY LEVEL COMPARISONS OF INDIVIDUALS WITH AUTISM SPECTRUM DISORDER WHILE PLAYING ACTIVE VIDEO GAMES

By Joseph Evans

We recommend acceptance of this thesis in partial fulfillment of the candidate’s requirements for the degree of Master of Science in Exercise and Sport Science: Physical Education Teaching-Adapted Physical Education Emphasis.

The candidate has completed the oral defense of the thesis.

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ABSTRACT

Evans, J.P. Physical activity level comparisons of individuals with autism spectrum disorders while playing active video games. MS in Exercise and Sport Science-Physical Education Teaching, Adapted Physical Education Emphasis, August 2014, 76pp. (E. Felix)

Many students with Autism Spectrum Disorders (ASD) receive adapted or specially designed physical education. Active video games (AVGs) are tools adapted physical education (APE) teachers use to promote physical activity (PA) in students with disabilities. However, little research exists on what game consoles are effective. The purpose of this study was to compare XBOX Kinect and Nintendo Wii active video game (AVG) consoles to see if either console elicited more physical activity (PA). Participants (N=15) included 12-21 year old youth with ASD who were tested in a counter balanced order once on XBOX Kinect and once on Nintendo Wii while playing Boxing. Each testing session started with a collection of anthropometric measures. Two wrist worn and two hip worn Actigraph GT3X+ accelerometers and a waist worn OMRON HJ-720IT pedometer were used to monitor participant’s physical activity (PA) levels. Participants played boxing on each console for 6-minutes with a 4-minute break between activity sessions. A repeated measures analysis of variance (RMANOVA) found there were no significant differences in moderate to vigorous physical activity (MVPA) levels between consoles. Also, a paired t-test showed no significant differences in steps between consoles. Study findings indicated both consoles elicited similar MVPA and similar step counts.
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INTRODUCTION

The National Center for Health Statistics reports as many as one in 50 children currently have Autism Spectrum Disorder (ASD) (Blumberg et al., 2013). Since many students with ASD are educated in both inclusive and segregated educational settings, an understanding of ASD is important for all educators. Autism Spectrum Disorder is characterized by persistent deficits in social communication, social interaction, and restricted, repetitive behaviors, interests, or activities (American Psychiatric Association, 2013). Deficits in these areas can create challenges for educators who teach students with disabilities, including physical education (PE) teachers.

As a result, the Individuals with Disabilities Education Improvement Act (IDEA) of 2004, an important piece of special education legislation that defines what services must be provided to children with disabilities, includes physical education. Physical Education (PE) must be made available equally to children with disabilities and children without disabilities. The IDEA defines PE to include the development of physical and motor fitness, fundamental motor skills and patterns, and skills in aquatics, dance, individual and group games, and sports. This law implies PE teachers should be appropriately prepared to teach students with disabilities, including students with ASD. Adapted physical education (APE) can be provided from 3-21 years old to address the motor needs of students with disabilities in public schools. Adapted physical education teachers must have knowledge of evidence-based practices to effectively teach students with ASD.
Adapted PE teachers must understand the unique barriers individuals with ASD possess so they can provide instruction and exposure to activities to help overcome these barriers. Physical activity (PA) is important for all populations to maintain health and wellness. Individuals with ASD are often limited in PA choices and as a result are largely sedentary due to a lack of access to facilities, low levels of functional motor movement, and a shortage of staff that are knowledgeable to work with children with disabilities (Rowland & Rimmer, 2012).

Active video games (AVGs) are an emerging technology that may be one opportunity for children with ASD to become more active. Commercially manufactured AVGs, such as the XBOX 360 Kinect (Microsoft, Redmond, WA) and Nintendo Wii (Nintendo, Redmond, WA), are readily available for home use. In-home use can address a lack of access to community facilities. It can also provide a social and emotional safe zone for individuals who may have difficulty interacting in a social environment.

Anderson-Hanley, Tureck, and Schneiderman (2011) conducted a preliminary study utilizing Dance Dance Revolution (DDR) and cyber cycling to examine the effects of AVG play on repetitive behaviors and cognition. Their findings were encouraging and provided support for using AVGs to manage behavioral disturbances and increase cognitive control in youth with ASD. Repetitive behaviors, as identified by the author's observations significantly decreased while performances on the Digit Span Backward, Stroop C, and Color Trails improved (Anderson-Hanley et al., 2011). This indicates a combination of exercise and technology can have positive benefits for youth with ASD.

A study by Pan (2008) indicated children with ASD are more likely to achieve moderate to vigorous physical activity (MVPA) in a structured environment as opposed
to a non-structured environment. Active video games can provide structured PA with regimented time, specific movements, auditory and visual prompting, and motivation through auditory and visual stimulation. Pan concluded students with ASD might need less unstructured playtime and more structured playtime during the school day to promote daily attainment of MVPA. One solution might be to use AVG play as a part of recess.

The use of AVGs as a controlled exercise session might be a type of technology-aided intervention to contribute to daily MVPA. Evidence-based practices indicate controlled exercise sessions can reduce maladaptive and stereotypical behaviors exhibited by individuals with ASD (Wong et al. 2014). Exercise sessions should include a warm-up, cardiovascular activity, strength training, and/or flexibility development in addition to a cool-down. Wong et al. indicated exercise is an evidence-based practice to address social behavior, school readiness, academic, and motor skills in youth with ASD. The same report indicated technology aided instruction and intervention was effective for youth with ASD to increase or maintain recreation/leisure capabilities. Technology can be used in psychomotor, cognitive, and affective contexts and is shown to be an effective motivational tool to increase PA levels.

Contradictory findings in research by Duncan and Staples (2010) and Duncan, Birch, Woodfield, and Hankey (2011) indicate typically developing children may or may not experience PA levels similar to traditional play while participating in AVGs. This study was designed to determine if the type of AVG console influenced the attainment of MVPA levels in individuals with ASD. There are two AVG consoles compared in this study, XBOX Kinect and Nintendo Wii. These two consoles were selected for two reasons; both consoles are available for home use, and both consoles offer Boxing
As shown in previous research, Boxing is an AVG that can elicit MVPA levels greater than sedentary gaming (Sween et al., 2013). Study findings will contribute to program considerations in PE programs and out of class PA.

The purpose of this study was to compare the MVPA levels and step counts of 12-21 year old individuals with ASD while playing two types of AVG consoles. The independent variables were the type of AVG console used by the participant and accelerometer locations. The dependent variables were MVPA percentages and step counts.

**Research Hypotheses**

Hₐ1: Youth with ASD will have a significantly greater percent of time spent in MVPA while playing XBOX Kinect than while playing Nintendo Wii.

Hₐ2: Youth with ASD will have a significant difference in percent of time spent in MVPA between wrist and hip worn accelerometers.

Hₐ3: Youth with ASD will have a significantly greater step count while playing XBOX Kinect than while playing Nintendo Wii.

**Assumptions**

1. Accelerometer data is valid and reliable to measure MVPA in youth with ASD while playing AVGs.

2. Pedometer data is valid and reliable to measure step counts in youth with ASD while playing AVGs.

3. Participants understood the directions given to them to complete the task expected of them.
4. Participants played the games to the best of their ability.

5. The participant information form was a valid and reliable summary of the participant’s ASD characteristics.

**Delimitations**

1. The sample was delimited to La Crosse County, WI.

2. The individuals had to participate in the study with verbal prompting and directions.
   
   Participants were expected to play AVGs with minimal assistance. At a minimum, the participants had to play independently once the game was initialized.

3. Participants had to follow the research protocol.

4. Participants could not exhibit maladaptive behaviors at rest that would confound results.

**Limitations**

1. The study did not control for any amount of prior experience subjects may have had with Wii Boxing or Kinect Boxing.

2. A variety of intellectual and social abilities were contained in the sample.

3. Co-occurring conditions were not controlled for in this study.

**Operational Definitions**

For this study, an AVG was defined as an experiential activity involving any video game that requires physical exertion or movements that are more than sedentary video games including strength, balance, and flexibility activities (Oh & Yang, 2010).

Autism Spectrum Disorder is defined as persistent deficits in social communication and social interaction across multiple contexts with restricted, repetitive patterns of behavior, interests, or activities. Symptoms must be present in the early
developmental period and cause clinically significant impairment in social, occupational, or other important areas of current functioning (American Psychiatric Association, 2013).

Wii Boxing is an AVG requiring a Wii Remote and Nunchuck. The Nunchuck is a device tethered to the Wii Remote. Both the Nunchuck and Wii Remote contain bi-axial accelerometers to detect motion. The player can manipulate the Wii Remote and Nunchuck to punch, block, or shift position. Each boxing match is three, 1-minute rounds. The player wins by knocking out their opponent, technical knock out (knocking down their opponent three times), or earning a judge’s decision. The player can manipulate the Wii Remote and Nunchuck to punch, block, or shift position.

Kinect Boxing is an AVG that does not require a remote control device. An infrared motion sensor detects body movements to manipulate an on-screen avatar. The player moves their body to punch high and low, block high and low, and “power punch.” Each boxing match is three, 1-minute rounds. The player wins by knocking out their opponent, technical knock out (knocking down their opponent three times), or earning a judge’s decision.

An avatar is an on-screen character. The player manipulates the avatar to interact with the in-game virtual environment. In this study the avatar was the boxer on the screen that reacted to the participants movements.
METHOD

Participants

The 15 participants were male youth ranging in age from 12.0 to 21.3 years ($M = 16.9$, $SD = 3.1$). The participants ranged in height from 52.0 to 74.0 inches ($M = 65.5$, $SD = 6.5$). The participants ranged in weight from 58.8 to 294.6 pounds ($M = 170.7$, $SD = 65.1$). The participants ranged in BMI from 15.3 to 46.8 ($M = 27.6$, $SD = 9.5$). Table 1 presents the participants’ physical characteristics. All participants resided in La Crosse County, Wisconsin. Additionally, all 15 participants had a parent reported ASD diagnosis. The participants’ ASD characteristics are described in Tables 2 and 3, as per DSM-V diagnostic criteria (APA, 2013). Table 4, describes the participants’ PE placements. A total of six participants had parent reported secondary or tertiary disabilities including apraxia, intellectual disability, seizure disorder, attention deficit hyperactivity disorder, chronic static encephalopathy, specific learning disability-reading and writing, Asperger’s disorder, and oppositional defiant disorder.
Participant data indicated only four participants (27%) were at a healthy weight.

The majority of participants were overweight, obese, and extremely obese (60%). This sample had higher percentages of overweight and obese individuals than recent CDC reports, which indicate 22% of 2-17 year old children with disabilities are overweight or obese and 36% of adults with disabilities are overweight and obese (Bandini et al., 2005).
Table 2. Frequency and Percent of Social Communication Deficits

<table>
<thead>
<tr>
<th>Task</th>
<th>ND</th>
<th>SoD</th>
<th>SuD</th>
<th>VSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back and forth conversation</td>
<td>5 (33%)</td>
<td>5 (33%)</td>
<td>3 (20%)</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>Sharing interests, emotions, or feelings</td>
<td>3 (20%)</td>
<td>5 (33%)</td>
<td>4 (27%)</td>
<td>3 (20%)</td>
</tr>
<tr>
<td>Initiating or responding to social interactions</td>
<td>0 (0%)</td>
<td>7 (47%)</td>
<td>7 (47%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>Using nonverbal communication in social interaction</td>
<td>1 (7%)</td>
<td>6 (40%)</td>
<td>8 (53%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Using eye contact</td>
<td>1 (7%)</td>
<td>9 (60%)</td>
<td>4 (27%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>Using body language</td>
<td>3 (20%)</td>
<td>6 (40%)</td>
<td>6 (40%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Understanding use of gestures</td>
<td>2 (13%)</td>
<td>5 (33%)</td>
<td>8 (53%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Using facial expressions and nonverbal communication</td>
<td>3 (20%)</td>
<td>5 (33%)</td>
<td>7 (47%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Developing, maintaining, and understanding relationships</td>
<td>3 (20%)</td>
<td>6 (40%)</td>
<td>4 (27%)</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>Adjusting behavior to social context</td>
<td>4 (27%)</td>
<td>6 (40%)</td>
<td>5 (33%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Participating in imaginative play</td>
<td>4 (27%)</td>
<td>5 (33%)</td>
<td>5 (33%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>Making friends</td>
<td>3 (20%)</td>
<td>4 (27%)</td>
<td>5 (33%)</td>
<td>3 (20%)</td>
</tr>
<tr>
<td>Showing interest in peers</td>
<td>2 (13%)</td>
<td>7 (47%)</td>
<td>5 (33%)</td>
<td>1 (7%)</td>
</tr>
</tbody>
</table>

Note: ND = No Difficulty, SoD = Some Difficulty, SuD = Substantial Difficulty, VSD = Very Substantial Difficulty

Table 2 indicates the majority of participants had some difficulty to substantial difficulty with social communication. The majority of participants were able to understand spoken English. Some participants needed verbal cues, hand gestures, physical manipulation, and physical demonstrations to complete the tasks. No participants had communication difficulties that prevented them from participating.
Table 3. Frequency and Percent of Maladaptive Behaviors, Interests, or Activities

<table>
<thead>
<tr>
<th>Behavior</th>
<th>NP</th>
<th>SP</th>
<th>UP</th>
<th>AP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive movements, use of objects, or</td>
<td>2 (13%)</td>
<td>8 (53%)</td>
<td>3 (20%)</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>speech</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insistence on sameness, inflexible adherence</td>
<td>2 (13%)</td>
<td>9 (60%)</td>
<td>2 (13%)</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>to routines, ritualized patterns of nonverbal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>behavior</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly restricted and fixated interests that</td>
<td>5 (33%)</td>
<td>4 (27%)</td>
<td>6 (40%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>are abnormal in intensity or focus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: NP = Never Present, SP = Sometimes Present, UP = Usually Present, AP = Always Present

Table 3 indicates the majority of participants had maladaptive behaviors that were sometimes present to usually present. Some maladaptive behaviors observed during testing were echolalia, nail biting, fidgeting with accelerometer wristbands during breaks, and sidestepping in place. Participants did not display any behaviors that hindered their completion of the task. Research notes were checked against accelerometer and pedometer data. Stereotypical behaviors did not confound any data.

Table 4. Frequency and Percent of Physical Education Placement

<table>
<thead>
<tr>
<th>Placement</th>
<th>f (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduated</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>Full-time general physical education (GPE)</td>
<td>4 (27%)</td>
</tr>
<tr>
<td>Full-time GPE with Support</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>Part-time GPE and APE</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>Full-time APE</td>
<td>5 (33%)</td>
</tr>
<tr>
<td>Not Sure</td>
<td>1 (7%)</td>
</tr>
</tbody>
</table>

Table 4 indicates the participants' physical education placements. According to the participants' placements, the sample possessed a wide variety of skills. This indicates the sample had various levels of independence and physical skill while in PE, which might indicate their levels of independence while participating in PA.
Participants were recruited primarily with phone calls to parents or guardians, word of mouth, and flyers (see Appendix A) from university and public school PA programs for youth with disabilities. Upon contact and voluntary informed consent to participate, a testing date and time was established. Before each participant partook in the study, his parent or guardian signed an Institutional Review Board (IRB) approved informed consent form (Appendix B) and completed a participant information form (Appendix C). The University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects approved this study.

**Instruments**

**Accelerometers**

The participants’ MVPA levels were monitored using GT3X+ accelerometers (ActiGraph, Pensacola, FL) worn on the left hip, right hip, left wrist, and right wrist. Actigraph GT3X+ accelerometers have established reliability and validity in healthy children, adolescents, and adults (Sasaki, John, & Freedson, 2011; Robusto & Trost, 2012).

The accelerometer used in this study was a piezoelectric tri-axial accelerometer. A piezoelectric crystal detected acceleration, transmitted the information to an electrical transmitter, and then stored the data for download. The GT3X+ was about the size of a wristwatch. They were attached to the participants’ wrists with plastic bands. They were attached to the participants’ waists with an elastic belt. Accelerometers validated against indirect calorimetry showed a strong positive correlation (typically greater than >.70) as a measure of PA (Loprinzi, & Cardinal, 2011).
**Pedometers**

An HJ-720IT pedometer was worn on the right hip (OMRON Healthcare, Bannockburn, IL). The HJ-720IT pedometers have established step count reliability and validity for walking and stepping activities in healthy and overweight individuals (Holbrook, Barreira, & Kang, 2009).

The pedometers used in this study were also piezoelectric type. Loprinzi, & Cardinal (2011) suggest that because of their objectivity and evidence of reliability and validity, pedometers are well suited for measuring PA in youth. When compared to accelerometers ($r > .87$), oxygen uptake ($r = .81$), and heart rate ($r = .62$) pedometers have demonstrated their validity as a PA measure in youth (Loprinzi, & Cardinal, 2011). The difference in steps accrued in each game session was recorded manually from the device display by using a research note form (Appendix D).

**Weight scale**

A 500KL digital weight scale and stadiometer measured height and weight (Pelstar, McCook, IL). The 500KL had a digital readout that displayed weight to the nearest tenth of a pound. It had a manually operated ruler to measure height to the nearest half inch.

**Pilot Study**

A pilot study was conducted on two evenings with four participants. The goals of the pilot study were to understand how the individuals with ASD would react to wearing the data collection devices, determine how to instruct the participants to complete their tasks, establish test-retest reliability of the testing sessions, have parents critique informed consent forms, and have parents critique the participant information form. All
four pilot participants had ASD. The participants completed a test protocol that involved seven phases.

The phases included, One: a discussion with the participant’s guardian with what the research protocol consisted of, what paperwork the guardian needed to complete, the collection of the participant’s anthropometrics, and the fitting of the data collection devices. Two: participant familiarization with the XBOX Kinect and Nintendo Wii gaming consoles. Phase Two utilized a side view video model, scripted verbal directions, a physical demonstration, and an in-game tutorial to teach the youth how to play the games. The side view video model, scripted verbal directions, and physical demonstration were ineffective methods to teach the youth how to play the games. The in-game tutorial was an effective method to teach the youth how to play the games. Phase Three was a 6-minute bout of AVG play. The participants played on each console in a counter balanced order with odd participants playing XBOX Kinect Boxing first and even participants playing Nintendo Wii Boxing first. Phase Four was another bout of AVG play on the console they did not play on in phase three. Phase Five was a break from game play. The participants played either an iPad golf app or iPad soccer app based on their personal preference or viewed a dinosaur app for 4-minutes. Phase Six was a 6-minute bout of AVG play on the console they played on in phase three. Phase Seven was a 6-minute bout of AVG play on the console they played on in phase four.

The in game tutorials were the best methods for teaching the games to the participants. This conclusion was based on the participant’s demonstration of their boxing form and their response to the question, “Do you understand how to play?” A purple mat was placed on the floor to indicate the zone where the participants must stand for the
game consoles to detect the participant’s motion. The test protocol was shortened from four bouts of activity to two as the data indicated a fatigue effect and a familiarization phase was added before testing to minimize a learning effect. The iPad apps were restricted to Golf Putt 3D (Neon Play Ltd, 2012) and Flick Kick Football (PikPok, 2012) because Era of Dino HD Lite (AlphaWeb Plus LLP, 2011) appeared to be a special area of interest for some participants and became an unwanted distraction. Redirecting the participants back to the AVGs after they viewed the dinosaur app was difficult. Lastly, the participant information form was revised to include secondary and tertiary disabilities to better describe the sample. Based on the results of the pilot study, the research methods were finalized.

Procedure

The research protocol was administered to participants individually in an empty university classroom on evenings and weekends between March and May 2014. Sessions were scheduled based on the researcher’s available time slots and at the parent’s convenience. During the session, parents were instructed to wait in a neighboring office or they were welcome to watch their youth participate.

The protocol consisted of five phases. Phase one involved a discussion with the participant’s guardian about the research protocol, what paperwork the guardian needed to complete, the collection of the participant’s anthropometrics, and the fitting of the data collection devices. Phase two was a familiarization with the XBOX Kinect and Nintendo Wii gaming consoles. Participants played one match (6-minutes) or until they earned a knockout (KO) on each console. Phase three was a 6-minute bout of AVG play. The participants played on each console in a counter balanced order with odd participants
playing XBOX Kinect Boxing first and even participants playing Nintendo Wii Boxing first. Phase four was a short break from game play. The participants played either Golf Putt 3D or Flick Kick Football on the iPad based on their personal preference for 4-minutes (Neon Play Ltd, 2012; PikPok, 2012). Phase five was a 6-minute bout of AVG play on the console they did not play on in phase three.

Each console’s version of Boxing is unique and as a result, game settings were adjusted to make the gaming experience as equal as possible to truly understand the differences in the console’s technology. The researcher initialized the XBOX Kinect to utilize a guest avatar. The participants played against a beginner computer opponent, the easiest opponent possible. The introductory movie was turned off. The animated tutorial was turned on for phase two but off for phases three and five. In the case of a KO, the participants were instructed to “play again.” Participants played consecutive games for 6-minutes.

The researcher initialized the Nintendo Wii was also set up to utilize a guest avatar. The participants also played against a beginner computer opponent, the easiest opponent possible. An animated tutorial automatically played for the participant’s use in Phase two. After the first use, the tutorial automatically shut off so it was not displayed in phases three and five. In the case of a KO, the participants were instructed to “play again.” Participants played consecutive games for 6 minutes.

**Statistical Analysis**

All data, including MVP percentage for left hip, right hip, left wrist, right wrist, as well as steps accumulated, were recorded into SPSS statistical software (IBM, 2012). The statistical procedures employed in this study were a RMANOVA and one-tailed
paired samples t-test. The RMANOVA was used to compare MVPA percentage between the two AVG consoles and within the four accelerometer locations. The one-tailed paired samples t-test was used to compare mean step counts between the two AVG consoles.

Data were downloaded in 1-second epochs with biometrics, lux, and inclinometer toggled on, into ActiLife 6. Time filters were applied to analyze wear time during AVG play. Two MVPA prediction models were used during data analysis because Bandini et al. (2012) recommended using specific MVPA prediction equations for specific age groups. Evenson Children (Evenson, et al., 2008) was used for 12 year-old participants. Freedson Adult VM3 (Sasaki, John, & Freedson, 2011) was used for 13-21 year-old participants. Accelerometer data were examined to confirm assumptions had been met for a repeated measures analysis of variance (RMANOVA). The dependent variable, percent of time in MVPA, was continuous and normally distributed. The independent variables, AVG console and accelerometer locations were nominal. Each participant was independently observed and played each AVG console in a counterbalanced order. This study met the assumption of sample size with 15 participants. The repeated measures failed Mauchly’s Test of Sphericity ($p = .00$). However, a lack of sphericity did not impact the conclusions of this study, as there were no significant differences detected in MVPA percent between consoles.

Pedometer data were examined to meet assumptions of a one-tailed paired samples t-test. The dependent variable, step count, was continuous and normally distributed. The independent variable, AVG console, was nominal. Lastly, each participant was independently observed and played each AVG console in a counterbalanced order.
Of the 15 participants observed in this study, all provided complete data sets and were retained for analysis. The dependent variable, percent of time spent in MVPA, was calculated by summing the total amount of time spent in MVPA, and then dividing the sum by 6-minutes. The dependent variable, step count, was calculated by subtracting the ending step count from the beginning step count directly from the pedometer display. Alpha was set at .05. Data are reported as percentages and step counts.
RESULTS

A repeated measures analysis of variance (RMANOVA) was performed to compare percent of time spent in MVPA on each console and to compare PA differences between the hips and wrists. There was no significant difference in time spent in MVPA between game consoles. There was a significant difference within accelerometer locations ($p < .01$). Bonferroni multiple comparisons revealed a significant difference between wrist worn accelerometers and hip worn accelerometers ($p < .01$) with wrist worn accelerometers achieving higher MVPA ($M_{difference} = 41.6$). There was no significant difference between locations left to right. There was no significant interaction effect within accelerometers and game consoles. Table 5 presents the raw accelerometer data. Figure 1 illustrates this relationship between accelerometer locations and differences between consoles.
Table 5. XBOX Kinect Boxing and Nintendo Wii Boxing Percent of Time in MVPA

<table>
<thead>
<tr>
<th>Participant</th>
<th>Left Hip (%)</th>
<th>Right Hip (%)</th>
<th>Left Wrist (%)</th>
<th>Right Wrist (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kinect</td>
<td>Wii</td>
<td>Kinect</td>
<td>Wii</td>
</tr>
<tr>
<td>1</td>
<td>3.3</td>
<td>6.9</td>
<td>2.6</td>
<td>11.2</td>
</tr>
<tr>
<td>2</td>
<td>13.1</td>
<td>12.0</td>
<td>12.4</td>
<td>10.4</td>
</tr>
<tr>
<td>3</td>
<td>18.9</td>
<td>6.7</td>
<td>16.4</td>
<td>6.2</td>
</tr>
<tr>
<td>4</td>
<td>10.5</td>
<td>46.0</td>
<td>10.5</td>
<td>42.1</td>
</tr>
<tr>
<td>5</td>
<td>38.5</td>
<td>37.6</td>
<td>37.1</td>
<td>38.8</td>
</tr>
<tr>
<td>6</td>
<td>43.3</td>
<td>41.0</td>
<td>52.6</td>
<td>42.9</td>
</tr>
<tr>
<td>7</td>
<td>40.7</td>
<td>59.8</td>
<td>38.6</td>
<td>57.6</td>
</tr>
<tr>
<td>8</td>
<td>16.4</td>
<td>7.9</td>
<td>20.5</td>
<td>8.3</td>
</tr>
<tr>
<td>9</td>
<td>45.5</td>
<td>51.2</td>
<td>44.8</td>
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<td>10</td>
<td>48.8</td>
<td>54.5</td>
<td>44.8</td>
<td>50.0</td>
</tr>
<tr>
<td>11</td>
<td>17.6</td>
<td>1.9</td>
<td>28.1</td>
<td>7.5</td>
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<td>12</td>
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<td>13</td>
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<td>14</td>
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<td>15</td>
<td>8.0</td>
<td>3.60</td>
<td>8.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Mean</td>
<td>23.3</td>
<td>28.6</td>
<td>23.8</td>
<td>27.7</td>
</tr>
<tr>
<td>SD</td>
<td>16.4</td>
<td>20.9</td>
<td>16.5</td>
<td>19.6</td>
</tr>
</tbody>
</table>

Figure 1. XBOX Kinect Boxing and Nintendo Wii Boxing Percent of Time in MVPA
A one-tailed paired t-test was performed to compare steps attained between AVG consoles. The mean step count while playing XBOX Kinect Boxing was 296 (SD = 142). The mean step count while playing Nintendo Wii Boxing was 300 (SD = 140). Results indicate there was no significant difference in step count between consoles. The participants' step counts were calculated directly off the pedometers. The differences between steps after AVG play and steps before AVG play were calculated before and after each trial. Raw data is presented in Table 6. Figure 2 illustrates the mean difference between consoles.

Table 6. XBOX Kinect Boxing and Nintendo Wii Boxing Step Count

<table>
<thead>
<tr>
<th>Participant</th>
<th>XBOX Kinect (steps)</th>
<th>Nintendo Wii (steps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>317</td>
<td>314</td>
</tr>
<tr>
<td>2</td>
<td>471</td>
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<td>3</td>
<td>228</td>
<td>396</td>
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<td>4</td>
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<td>6</td>
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<td>10</td>
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<td>11</td>
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<td>12</td>
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<td>Mean</td>
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<td>300</td>
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<tr>
<td>SD</td>
<td>142</td>
<td>140</td>
</tr>
</tbody>
</table>
Figure 2. XBOX Kinect Boxing and Nintendo Wii Boxing Step Count
DISCUSSION

The purpose of this study was to compare the PA levels of 12-21 year old individuals with ASD while playing two types of AVG consoles. The research question was which AVG console, XBOX Kinect or Nintendo Wii, would elicit more MVPA in youth with ASD? Three hypotheses were formed to answer this question.

The primary research hypothesis, youth with ASD will have a significantly greater percent of time spent in MVPA while playing XBOX Kinect, was rejected. No significant difference in time spent in MVPA was detected between consoles. This outcome was not anticipated. Previous literature suggested that games with less controller manipulation would increase energy expenditure (O’Donovan & Hussey, 2012; O’Donovan et al., 2012). O’Donovan et al. (2012) examined healthy young adults during their studies. Additionally, they utilized different AVGs from this study. These differences in methodology might explain why the expected outcome was not achieved.

This study featured individuals with ASD. Autism Spectrum Disorder is a diverse condition. The participants in this study had a variety of cognitive abilities, behaviors, and motivational levels. A limitation of this study is that it might have been underpowered to account for the individual difference amongst individuals with ASD.

The secondary research hypothesis, youth with ASD will have a significant difference in percent of time spent in MVPA between wrist and hip worn accelerometers, was accepted. A significant difference was detected between time spent in MVPA at the hips and at the wrists. This result was anticipated. The game chosen, Boxing, is primarily
an upper body activity. Previous research by O’Donovan et al. (2012) suggested Boxing was a light intensity activity. O’Donovan utilized oxygen consumption and heart rate monitoring to analyze energy expenditure. This study used accelerometers because of the unique sensory concerns of individuals with ASD. Participants achieved MVPA playing both the XBOX Kinect and Nintendo Wii. Differences in instrumentation may account for differences in observed intensity. However, it is unlikely. Accelerometers have been shown to correlate with oxygen uptake (Loprinzi, & Cardinal, 2011). A limitation of both of these studies is cardiorespiratory fitness was not assessed in either group. However, body measures were assessed and the ASD group had a mean BMI of 27.6 whereas the healthy adult group had a mean BMI of 23.2. This suggests the ASD group had lower physical fitness than the healthy adult group.

The tertiary hypothesis, youth with ASD will have a significantly greater step count while playing XBOX Kinect, was rejected. There was no significant difference in step counts between consoles. No previous research has used pedometers as an objective measure of PA. However, it was anticipated that since the Kinect captures total body motion that participants would be more inclined to utilize their lower bodies while playing Boxing. Pedometers may be better suited for use with AVGs featuring lower body activities.

It is important to note participants 7, 8, and 11 did have differences in their step counts and accelerometry between consoles. Participants 7 and 11 were high functioning individuals with no previous experience playing either console. Participant 8 was a low functioning individual. The apparent differences in step counts and accelerometry might be attributed to the technique used for each console. While playing the Kinect,
participants 7 and 11 exhibited realistic punches whereas participant 8 exhibited long windmill-like punches. While using the Wii, all three participants used more of a drumming motion. Participant 7 had more forceful movements while playing the Wii, which would increase accelerometer and pedometer counts. Participants 8 and 11 had more forceful movements while playing the Kinect. Individual technique might contribute to MVPA expenditure. Participants were allowed to participate with whatever technique they chose. The technique used while playing one console versus the other might have attributed to individual differences.

Determining which AVG console is more effective at eliciting MVPA is important for APE teachers and parents with youth with ASD. Generally, participants enjoyed playing both consoles. Each participant that used verbal communication was asked three questions, “Which game was more fun,” “which game was more realistic,” and “did you like playing?” One participant thought the Wii was more sensitive. While another participant indicated they were frustrated with how the Wii Nunchucks had a lag in time or “didn’t count” the punches. While playing the Kinect, one participant thought it was “cool how the hand on the screen moves.” Another participant said, “If I had to choose, I would pick the XBOX.”

**Practical Implications for PE Teachers**

While PA attainment was relatively equal on both consoles, APE teachers and parents must consider a number of factors when choosing AVGs. First, based on informal observations of participant’s interactions with the consoles, the Kinect might be a better option for individuals with ASD who are higher functioning where as the Wii might be a better option for individuals with ASD who are lower functioning.
The Kinect utilizes infrared motion capture technology. Interacting with the Kinect necessitates the user understanding a cause and effect relationship between the player and the game. The higher functioning participants seemed to understand the concept that when the player’s body moves, the avatar moves. The participants who were lower functioning were easily frustrated if the game did not precisely react to their motion. Additionally, the Kinect has several motivational features to encourage the participants to play. They include cheering fans, introductory videos, highlight reels, and photos of the participant while they are playing.

Conversely, the Wii utilizes bi-axial accelerometers to capture motion. The Wii Remote and Nunchuck are concrete objects for the player to manipulate. For some players it was easier for them to understand that moving the controller moved the avatar on the screen. The participants who were higher functioning sometimes realized that the controllers did not capture all of their motion. As a result they sometimes became frustrated. However, a strength of the Wii is it is more easily adaptable for a variety of skill levels. There are several practice challenges, which the Kinect lacks, that make the Wii suitable for lower skilled and non-competitive players.

In addition to the technology, the types of games available for each console differ slightly. The Kinect has more game titles available because the manufacturer has updated over time. The Wii has had the same game titles for years. Moreover, not all games for the Kinect and Wii are games that elicit MVP. Both consoles have games such as Bowling, Darts, and Baseball that only elicit light PA. Lastly, the social and emotional capacity of the player must be taken into consideration. Some youth with ASD might not handle competition, failure, or violence. Therefore, the APE teacher or parent should
consider all factors, not just MVPA promotion when selecting games. Boxing on either console appears to be an appropriate game for male youth with ASD over the age of 12.

This study added to the body of literature on AVG research as a form of PA for individuals with disabilities, but several limitations must be addressed. First, this study featured data on only male participants with ASD. Future studies should attempt to recruit female participants with ASD to understand if their physical activity levels are similar to those of male participants while playing AVGs. Second, the sample size of 15 participants with a moderate to large effect size expected resulted in a moderately powered study. A sample size of approximately double the amount of participants would result in a high-powered study. Third, the games were set at a beginner level on both consoles for all participants. This resulted in several participants earning knockouts. After each knockout both games would display replays and video clips. The XBOX Kinect has a slightly longer replay segment than the Nintendo Wii. This may have resulted in a lower percent of time spent in game play on the XBOX Kinect than on the Nintendo Wii. Lastly, 6 of 15 participants had tertiary and secondary disabilities that could not be controlled for in this study. Participant recruitment focused on enrolling as many individuals with ASD as possible. As a result, secondary and tertiary disabilities were not taken into account, as exclusion of individuals with additional disabilities would result in low participant numbers. Co-occurring conditions may have affected the results.

Conclusion

These results indicate AVGs can be used for MVPA attainment amongst male students with ASD and specifically XBOX Kinect and Nintendo Wii can make contributions to MVPA attainment. There were no significant PA attainment differences
between XBOX Kinect and Nintendo Wii. Both consoles are good options to promote PA in youth with ASD. All players achieved MVPA while playing Boxing. The game was more of an upper body activity as opposed to a lower body activity.

Future research should investigate longitudinal MVPA attainment. This study included novel experiences for many of the participants with mean prior experience of .08 years with XBOX Kinect Boxing and 1.1 years with Nintendo Wii Boxing. Future research should investigate if AVG technology can contribute to fitness development or fitness maintenance in individuals with ASD by investigating the effects of other AVGs. Additionally, future research should analyze what contribution AVG play can make to daily MVPA attainment. Future research questions could be, “Can AVGs be used as a form of exercise over a 12 week period to improve physical fitness,” “can other AVG game titles elicit MVPA,” and “what percentage of AVG play contributes to daily MVPA?”

Research that answers these questions will contribute to meaningful PA opportunities for individuals with ASD. This research is important because many PE teachers are starting to use AVG technology in PE. Many parents have AVG game consoles at home. Also, many individuals with ASD play sedentary videogames at home (Foran & Cermak, 2013). Physical education teachers and parents need to know what games to use to promote fitness and parents need to know of alternatives to sedentary video games. This study indicates both the Nintendo Wii and XBOX Kinect technology provide appropriate PA opportunities when active games are chosen for youth with ASD. As such, APE teachers and parents should utilize the appropriate console and active games based on the individual youth’s needs.
REFERENCES


APPENDIX A

PARTICIPANT RECRUITMENT FLYER
The Center on Disability Health and Adapted Physical Activity seeks contact with parents of 12-21 year old individuals with autism.

<table>
<thead>
<tr>
<th>WHO</th>
<th>WHEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals 12-21yrs old with ASD are being recruited to play active video games.</td>
<td>February-May 2014</td>
</tr>
</tbody>
</table>
| **WHAT** | Monday-Thursdays 3:15-3:45pm  
Fridays 3:15-7pm  
Sundays 12-4pm |
| The researcher will measure physical activity levels of individuals with ASD while playing active video games. Participants will play XBOX Kinect Boxing and Nintendo Wii Boxing.Parents are asked to bring their son/daughter to a one-time session that will last 30-45min. | (Set-up a 35min single testing session at your convenience during any of these times.) |
| **BENEFITS** | WHERE |
| The information gained from this study will enhance the physical activity opportunities for individuals with autism. Upon request, practical information on how active video games can be used to promote physical activity at home will be provided to the parents and guardians of study participants. | UW-La Crosse  
Mitchell Hall Rm 109  
(Across from the Dance Studio) |

**HOW**

Contact  
Joe Evans  
Office: (608) 785-8695  
evans.jose@uwlaex.edu  

Project under direction of  
Dr. Manny Felix  
(608) 785-8691  
efelix@uwlaex.edu
APPENDIX B

INFORMED CONSENT FORM
Informed Consent Form

Title of Study: Physical Activity Level Comparisons of Individuals with Autism Spectrum Disorders Playing Active Video Games

Researcher: Mr. Joseph Evans, Department of Exercise and Sport Science, Adapted Physical Education Graduate Fellow, University of Wisconsin-La Crosse

PLEASE READ THE FOLLOWING INFORMATION TO BE SURE YOU ARE INFORMED ABOUT THE RESEARCH STUDY. SIGN THE FORM IF YOU AGREE TO HAVE YOUR CHILD PARTICIPATE. YOUR SIGNATURE ON THE FORM CONFIRMS THAT WE HAVE INFORMED YOU OF THE PURPOSE OF THE STUDY, NATURE AND RISKS OF PARTICIPATION, POTENTIAL BENEFITS, AND THAT YOU HAVE MADE YOUR DECISION VOLUNTARILY.

Why is the study being done?
This study will compare the physical activity levels in youth with autism spectrum disorder (ASD) while playing X-Box Kinect Boxing versus Nintendo Wii Boxing.

How many people will take part in the study?
Approximately 20 participants, ages 12-21 years, with ASD, and the ability to exercise will participate in this study.

Why are you and your son/daughter being asked to take part in this research study?
Your son/daughter is being invited to take part in this study because he or she was identified as having ASD and is between 12-21 years old.

What will happen in this study?
In this study your son/daughter will wear one accelerometer on each wrist. Accelerometers are similar in size to a wristwatch. They record body movements. Height, weight, age, and gender will be recorded to calibrate the accelerometers to correctly measure the participant’s activity level. The participant will complete 6 minutes of Wii Boxing and 6 minutes of Kinect Boxing in Mitchell Hall Rm 109 (across from the Dance Studio). Parents/guardians will complete a participant information form to provide background information on the participant.

How long will my adolescent be involved in the study?
This study will last approximately 4 months. However, your adolescent will be involved in one session at UW-L for 30 minutes.

Are there reasons that my adolescent and I might leave the study early?
Your decision to have your adolescent participate in this study is completely voluntary. You or your adolescent may decide to stop participation at any time without penalty.
What are the risks of the study?
No risks are anticipated. However, there is a minimal possibility that muscle soreness and fatigue from physical activity can occur. Participants may experience emotional distress (sadness or frustration) as a result of playing competitive games. Risks will be minimized by supervision of all physical activity. The activity area will be free from obstruction. The researcher is CPR, AED, and First Aid certified.

Are there benefits to taking part in this research study?
We do not anticipate any direct benefits to the subjects as a result of participation in this study. A broader objective, however, is to observe the physical activity levels attained on two different gaming systems of individuals with ASD to determine which type of active video game console best promotes physical activity in persons with ASD.

Will there be any cost for participation in the study?
There will be no cost associated with this study. Parents/guardians must transport their son/daughter to and from the test site. PARENTS/GUARDIANS MUST WAIT WITH THEIR SON/DAUGHTER WHILE THEY ARE BEING TESTED.

What happens if my adolescent is injured while in this research study?
In the unlikely event that any injury or illness occurs as a result of this research, the Board of Regents of the University of Wisconsin System, and the University of Wisconsin-La Crosse, their officers, agents and employees, do not automatically provide reimbursement for medical care or other compensation. You or your third-party payer, such as your health insurer or Medicare, must provide payment for treatment of any injury or illness. If any injury or illness occurs in the course of research, or for more information, please notify the investigator in charge. I have been informed that I am not waiving any rights that I may have for injury resulting from negligence of any person or the institution.

For information about policies, the conduct of the study, or the rights of research participants, please contact the University of Wisconsin-La Crosse Institutional Review Board (IRB) for the Protection of Human Subjects at (608-785-6892 or irb@uwlax.edu). The IRB is a group of people who review the research to protect the rights of research participants.

What are my rights of my adolescent if he/she takes part in this research study?
Taking part in this research does not take away any other rights or benefits that you or your adolescent might have if they did not take part in this study. Taking part in this study does not give you or your adolescent special privileges. You and your adolescent will not be penalized in any way if you decide to stop or withdraw your adolescent after the start of the study. As the parent/guardian, you will be told of new important findings or any changes in the study or procedures that may affect your willingness to have your adolescent in the study. Data may be published upon study completion.
What about confidentiality?
Information from this study may be published or presented at professional meetings. However, your adolescent’s name and other identifying information will not be used without your written permission. Any personal demographic data or information collected will be kept confidential.

Who can answer my questions?
You may talk with Mr. Joseph Evans (716-270-3569) or Dr. Manny Felix (608-498-9710) 7am-4pm to talk about questions you have regarding the study.

I HAVE READ ALL OF THE ABOVE, ASKED QUESTIONS, RECEIVED ANSWERS CONCERNING MY QUESTIONS, AND I WILLINGLY GIVE MY CONSENT TO HAVE MY CHILD PARTICIPATE IN THIS STUDY. UPON SIGNING THIS FORM, I WILL RECEIVE A COPY.

(Date) (Signature of Parent/Guardian)

(Date) (Signature of Individual Obtaining Consent)
APPENDIX C

PARTICIPANT INFORMATION FORM
Physical Activity Level Comparisons of Individuals with ASD Playing Active Video Games

Participant Information Form

**Name:** ___________________________  **Date of Testing** (YYYY/MM/DD): _______ ______ ______

(Please circle one):  
- Male  
- Female

**Parent Name:** ___________________________  **School District:** ___________________________

**Phone Number:** ___________________________

What is your son/daughter's Physical Education (PE) placement? (Please circle one):

- Full-time general PE  
- Full-time general PE with support  
- Part-time general PE and adapted PE  
- Full-time adapted PE  
- Not Sure

Does your son/daughter have any additional disabilities? Secondary ______ Tertiary ______

**Social Communication**

Place an X on the level that best describes your son/daughter based on the following criteria:

- 0 = No Difficulty  
- 1 = Some Difficulty  
- 2 = Substantial Difficulty  
- 3 = Very Substantial Difficulty

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<th>2</th>
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<tbody>
<tr>
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<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Initiating or responding to social interactions</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Using nonverbal communication in social interaction</td>
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<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Using eye contact</td>
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<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Using body language</td>
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<td>2</td>
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<td>2</td>
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<td>Adjusting behavior to social context (Example: adjusting behavior to school, home, play)</td>
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</tr>
<tr>
<td>Participating in imaginative play (Example: using imagination)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Making friends</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Showing interest in peers</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Behavior, Interests, or Activities**

Place an X on the level that best describes your son/daughter based on the following criteria:

- 0 = Never present  
- 1 = Sometimes present  
- 2 = Usually present  
- 3 = Always present

<table>
<thead>
<tr>
<th>Repetitive movements, use of objects, or speech</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insistence on sameness, inflexible adherence to routines, ritualized patterns of nonverbal behavior</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Highly restricted and fixated interests that are abnormal in intensity or focus</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Over or under-reactive to sensory input from environment</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Has your son/daughter ever played Kinect Boxing? 
(Please circle one):

- No  
- <1/2yr  
- 1yr  
- 2yrs  
- 3yrs  
- 4yrs  
- 5yrs  
- 6yrs  
- >6yrs  
- Not Sure

Has your son/daughter ever played Wii Boxing? 
(Please circle one):

- No  
- <1/2yr  
- 1yr  
- 2yrs  
- 3yrs  
- 4yrs  
- 5yrs  
- 6yrs  
- >6yrs  
- Not Sure

**Code Number:** ______
APPENDIX D

RESEARCH NOTES FORM
Physical Activity Level Comparisons of Individuals with ASD Playing Active Video Games

Name: ______________________

Weight (lbs) Height (in) Age (yrs) Gender

Game Console
(Odd participants X-Box 1st; even participants Wii 1st)

<table>
<thead>
<tr>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
</table>

Step Count

<table>
<thead>
<tr>
<th>Starting Count</th>
<th>Ending Count</th>
</tr>
</thead>
</table>

Accelerometer Locations

Front

Note Observations Below (stereotyped behaviors, movement patterns, time off-task, etc.)

__________________________________________
__________________________________________
__________________________________________
__________________________________________
__________________________________________
__________________________________________
__________________________________________
__________________________________________

Code Number: ___
APPENDIX E

LITERATURE REVIEW
Introduction

Physical educators and health professionals often view screen time, which is time spent in front of televisions, computers, and tablets, as a negative influence on the health of adolescents (O’Donovan & Hussey, 2012). In response, innovative physical therapists and physical educators began using active gaming, a combination of video games and physical activity (PA), as a means to enhance PA levels in adolescents (O’Donovan & Hussey, 2012). Promoting moderate to vigorous physical activity (MVPA) levels in youth is a major priority as 16% of 2-17 year-olds without disabilities are overweight and 22% of 2-17 year-olds with disabilities are overweight (CDC, 2012). The active virtual gaming experience may provide a motivating and exciting way to capture an otherwise sedentary audience.

In addition to typically developing young adults, children with disabilities may benefit from active video gaming (AVG) experiences. This population is sometimes limited in PA choices and as a result is largely sedentary due to a lack of access to facilities, a lack of functional movement, and a lack of educated staff to work with children with disabilities (Rowland & Rimmer, 2012). Active video games provide an active experience for these children. Examples of popular commercial AVG platforms include Nintendo Wii, X-Box Kinect, and Playstation. These are three choices physical educators can use to get children moving with video games (Howcroft et al., 2012; Rowland & Rimmer, 2012).

Each gaming platform requires a variety of movements from stepping in place to punching, throwing, and running. Varying amounts of energy expenditure are required for each motion. Research must be conducted to better understand which AVG consoles
promote PA best. This literature review examines five areas of published research in relation to AVGs for children with Autism Spectrum Disorder (ASD). Review subtopics are PA in youth with ASD, the physiological benefits of AVG, school based AVG PE interventions, AVG research involving individuals with disabilities, and AVG PA preferences.

**Physical Activity in Youth with Autism Spectrum Disorder**

Memari et al. (2012) investigated age, gender, and the time spent in PA of 80 7-14 year old youths with ASD so that they could better understand factors affecting PA participation. The authors recruited participants from specialty schools with ASD diagnoses confirmed by psychiatrists utilizing the DSM-IV diagnostic criteria. They delimited the study to participants with an IQ > 70 and no additional orthopedic or behavioral disabilities. Participants wore Actigraph GT3X activity monitors over 7 days. Participant’s parents reported demographic information, sedentary pursuits, and completed an activity log for the week. The purpose of this research was to understand the factors affecting PA attainment in order to create programming to promote PA.

The participant’s ages were stratified into four age groups. Results indicated overall physical activity counts decreased as age increased. Counts of PA were lower on weekends than weekdays. Counts of PA were lowest during school hours and significantly decreased as age increased. Children from single parent families attained significantly lower PA counts than children from two parent families. Additionally, children reported as being obese attained significantly less physical activity counts than children reported as being a normal weight.
The researchers concluded the determinants they investigated should be considered when creating PA programming for youth with ASD. This information can be used to target interventions to minimize or modify determinants related to decreased PA. One possible solution is to infuse AVG play into schools or homes to increase PA levels.

A study by Bandini et al. (2012) compared PA levels between 111 3-11 year old children with and without ASD so that they could better understand if differences in PA exist and if so, what they are. The study was delimited to children without additional diseases or disorders and who did not take appetite-inhibiting drugs. The participants’ ASD diagnosis was confirmed by utilizing objective measures. An Actical accelerometer was used to measure PA. The participants wore the accelerometer for at least 10 hours per day for 7 days. Additionally, parents completed a PA questionnaire, which indicated what activities their child participated in, in the past year and for approximately how many hours. The purpose of this research was to compare children with ASD’s PA levels to children without ASD in order to understand any potential differences between the two populations.

The results indicated parents of children with ASD reported their children partook in fewer activities for less time than children without disabilities. Accelerometer data and questionnaire results indicated time spent in PA did not differ by ASD status. Additionally, BMI was not related to time spent in PA for either group.

This study found conflicting evidence on children with ASD’s PA. Accelerometer data did not indicate any significant differences between children’s overall PA with and without ASD. Based on accelerometer data, children with ASD experienced less weekday MVPA. The researchers speculated that fewer after school activity choices might explain...
this result. According to parents, children with ASD participated in fewer activities for less time than children without ASD. The researchers could not explain why parent reported PA did not align with measured PA. However, they speculated that children with ASD might engage in repetitive and self-stimulatory behaviors, which may increase accelerometer PA counts, but may not be recognized, as PA by parents. The authors recognized limitations of this study including the MVPA prediction equation used, the lack of a standardized method for estimating annual hours of PA, and the inability to account for differences in PA during the school year and during summer vacation.

This study is important because it had a large sample size. Many studies with children with ASD have small sample sizes (<15 participants). Additionally, it indicated 3-11 year old children with ASD have similar PA levels to children without ASD. Future studies should utilize cross sectional data to determine when PA levels begin to significantly decline. Physical activity may decline in the adolescent years. Given the parent reported limited number of PAs and low PA levels, AVGs may be one solution to help children with ASD become more physically active at home.

Lastly, a study by Pan (2008) compared MVPA levels of students with ASD and students without disabilities during inclusive PE classes and recess so that the contribution of PA during PE and recess to weekly total PE and recess time available, health-related guidelines, and daily total school time MVPA among students with and without ASD could be assessed. Trained medical professionals confirmed participants’ ASD diagnoses. Participants with secondary disabilities and behavioral concerns were excluded from the study. A total of 24 students with ASD in grades 1-6 and 24 students without disabilities 7-12 years old participated in the study. Students were matched based
on gender and age in the same classrooms to account for opportunities for PA. The participants’ PA was assessed using GT1M ActiGraph accelerometers. The accelerometer was worn for 5 consecutive days during school hours. Trained research assistants kept activity logs for each participant. The purpose of this study was to compare children with ASD and children without disabilities in order to understand differences in PA attainment during PE and recess.

The results of this study indicated students with and without ASD had equal amounts of daily recess time available and equal amounts of PE time available. Students with and without ASD appeared to engage in similar percentages of time spent in MVPA during PE, however they spent significantly different amounts of time in MVPA during recess. Students without disabilities were 9% more active during recess than students with ASD. For both groups there was a significant difference between time spent in MVPA during PE and recess with no significant interaction effect between groups. Recess accounts for a large amount of daily school time MVPA. However, students with and without ASD engaged in PA for less than 50% of the time allotted.

This study has a number of important implications. Researchers found all students spent a greater proportion of time spent in MVPA during PE than recess. However, a greater total amount of time was spent in MVPA during recess. This could be attributed to the fact that the students with ASD in this study responded better to the structured PE environment. Another implication is that the PE teachers came close to achieving 50% of class time spent in MVPA and with some lesson modifications, they could achieve > 50% of time spent in MVPA. These findings support the idea that PE and recess can significantly contribute to daily MVPA attainment. Additionally, the researchers
suggested future research should identify other sources of PA attainment outside of PE during the school day and ways to structure activity during recess so that children with ASD become more active. One option would be to investigate how AVGs could contribute to structured recess sessions.

Based on this literature, students with ASD receive a significant amount of daily MVPA during the school day in some instances. Differences in results might be attributable to different educational systems. The studies in this review were conducted in multiple countries including Iran, Taiwan, and the United States. However, it is clear that more research must be done to understand the determinants and causal variables of PA in children with ASD. As prior research suggested, structured environments could promote MVPA in individuals with ASD (Pan, 2008). One possible solution might be to use AVGs as the structure for students with ASD.

**Physiological Benefits of Active Video Games**

Researchers have recently attempted to understand the physiological demands of participating in AVG play. Mixed results on MVPA attainment, energy expenditure, and heart rate levels necessitate more research involving AVGs. Some studies found AVGs to induce moderate activity levels and in some instances vigorous levels of activity, whereas some studies have found AVG play to only induce light or very light activity. A variety of factors influence activity intensity. This section seeks to better understand research related to the physiological responses to AVG play.

Graves, Ridgers, Atkinson, and Stratton (2010) conducted a study that evaluated the effects of Playstation 2 (PS2) jOG on the PA levels of 8-10 year-old children from low socioeconomic status groups and assessed the effects on habitual PA, participant’s
activity behavior preferences, and participant's body composition. PS2 jOG is a device that allows for normally sedentary video games to be played by taking steps.

The children in the study were 58 low socioeconomic boys and girls from the UK. Data were collected from 13 males and 9 females in the jOG group and 19 males and 10 females in the control group (Graves et al., 2010).

A 12-week intervention program was designed as a randomized control trial. Participants were randomly assigned to a control group or an experimental jOG group. A behavior preference survey was given at 0-weeks, 6-weeks, and 12-weeks to each group. Researchers utilized self-reports of sedentary video gaming, active video gaming, TV viewing, computer usage, reading, and doing homework (Graves et al., 2010). Recordings were made in three time frames; waking to lunch, lunch to dinner, and dinner to bedtime. Habitual PA was analyzed over 1-week periods with data recorded in 5-second epochs by an ActiGraph GT1M accelerometer. The devices had to be worn at least 9-hours per day on 3 out of every 7 days for data to be utilized (Graves et al., 2010). Anthropometry was assessed using a Leicester Height Measure to check the children’s height and a Seca scale was used to check the children’s weight. Estimating years from attainment of peak height assessed maturity to predict maturation offset. Body fat was assessed using x-ray absorptiometry.

Graves et al. (2010) concluded, "No positive effect on PA or sedentary time was observed in any intervention." There were no significant differences between the two research groups for TV use, reading, doing homework, or working on a computer. There were no significant effects on body mass index. On a whole, an increase in time spent in leisure behaviors such as video gaming (VG), TV use and computer use was found. AVG
was more popular on week-6 but decreased on week-12. This trend suggests the device was initially interesting, but that interest later wore off (Graves et al., 2010).

Achieving an optimal balance between physical input and immersion may be important if AVGs are to be enjoyed and become a preferred choice over sedentary equivalents. Video games are seen as immersive. If the PA is too distracting for the participant, then they might not become immersed in the game. As a result, players will find the game less enjoyable and ultimately choose sedentary options.

Sanders, Santo, Peacock, Williamson, Von Carlowitz, and Barkley (2012) analyzed the physiological differences between playing a sedentary VG and an active version of the same game. The purpose of their study was to compare the physiologic responses (heart rate and VO₂), enjoyment of a popular video game (i.e., Madden NFL 2011) for the Wii versus the same game played on a sedentary video game system (i.e., Sony Playstation 2), and the relative reinforcing value (RRV). The RRV is a measure of the participant’s persistence to game. Physiological responses of Wii Madden, were compared to Wii Sports Boxing.

Research participants totaled 24 college-aged adults with no contraindications to exercise. The participants were 13 males and 11 females recruited from flyers around their college campus.

The participants followed specific protocol at each clinical test session. First, baseline data were collected during a 10-min rest period. The participants then played randomized trials of Wii Boxing for 10-min, Wii Madden for 10-min, and PS2 Madden for 10-min. Madden was chosen to allow for a comparison between a Wii game that was not shown to be active, and one that was. The participants always rested first, then the
three experimental conditions were always randomized. Heart rate and VO₂ were recorded via indirect calorimetry in each condition. The RRV was assessed at the end of all conditions (Sanders et al. 2012).

The resting condition recorded the lowest energy expenditure (EE), which was similar to the non-active PS2 Madden. The active Wii Madden significantly increased EE and Wii Boxing was significantly greater than Wii Madden. RRV values showed there was no significant difference between PS2 Madden and Wii Madden indicating the individuals were equally likely to participate in each game (Sanders et al. 2012).

Playing AVG equivalents of traditional sedentary VG may have positive benefits over time. Not all AVGs induce MVPA, including Wii Madden. However some games are able to promote moderate PA levels such as Wii Boxing. For children who currently play exclusively sedentary VGs, playing active versions of the same games will increase caloric expenditure and lead to some positive health benefits over time.

Snyder, Anderson-Hanley, and Arciero (2012) conducted a study to compare the impact on exercise intensity of a virtual versus live competitor while riding a virtual reality-enhanced stationary bike. The authors hypothesized that compared with less competitive individuals, more competitive individuals would expend greater amounts of energy when in the presence of a live competitor as opposed to a virtual competitor.

The participants were 23 female college students between the ages of 17 and 22. There were 18 Caucasians, four African-Americans, and one Hispanic. Researchers chose one gender to eliminate potential gender differences.

First, Competitiveness, and PA were assessed for each individual. The Competitiveness Index was used to assess competitiveness levels (CI; Smither & Houston,
The index ranged from 0-20. Individuals were split into two groups based on the mean score overall. Those above the mean were classified as more competitive, whereas those below the mean were classified as less competitive. A PA questionnaire, the Aerobics Center Longitudinal Study Physical Activity Questionnaire, was used to assess baseline daily PA (ACLS-PAQ; Kohl, Blair, Paffenbarger, Macera, & Kronenfeld, 1988). Participants exercised under three conditions: solo training, virtual competitor, and live competitor. While exercising, the cycles calculated Watts, the primary measure of exercise intensity as well as heart rate and miles per hour.

There is an effect caused by social facilitation from the presence of a competitor (Snyder et al., 2012). Highly competitive individuals exerted the greatest amounts of energy when in the presence of a live competitor as opposed to a virtual competitor. Less competitive individuals exerted near equal amounts of energy in the presence of the virtual and the live competitor.

The results of this study indicate personality should be taken into account when considering exercise interventions. Virtual versus live competitors have different effects based on the exerciser's personality. Therefore, an exercise partner may motivate some individuals, but may have little effect on others.

Van Biljon and Longhurst (2012) researched whether and how AVG play can drive overweight and obese children to function more effectively in everyday life activities through the use of a Wii intervention. This studied attempted to determine if the Wii could help overweight and obese children acquire motor skill.

Researchers recruited a total of 30 overweight and obese boys and girls ages 9-12 years-old within 20-km of the University of Zululand, South Africa. Overweight children
were children with a BMI in the 85th percentile and obese children had a BMI in the 90th percentile. Two control groups based on the participant’s location of residence and one experimental group were formed.

The experiment was a 6-week program requiring a minimum participation in the Wii intervention of three days per week for 30-minutes per session. Players created Miis, which are on-screen avatars the player manipulates with gross motor movements. Participants played Wii Boxing for 15-minutes and Wii Hoola Hoops for 15-minutes without stopping (Van Biljon et al., 2012). The Bruininks Oseretsky Test of Motor Proficiency short form was used as an assessment of agility, speed, balance, reaction time, and coordination before and after intervention (Van Biljon et al., 2012).

After 6-weeks, improvements were shown in both control groups and in the experimental group. Researchers concluded this was likely due to maturation. However, the most improvement in functional fitness occurred in the experimental group. Significant gains in speed, agility, balance, reaction time, and coordination occurred (Van Biljon et al., 2012).

This study demonstrates a 6-week AVG intervention can be used to improve functional fitness at a greater rate than traditional games. It can also promote PA levels in children. However, AVG play should be used as part of a fitness improvement plan, and not as an exclusive intervention method.

O’Donovan et al. (2012) suggested that energy expenditure may increase while playing AVGs with the XBOX Kinect or while playing multiplayer modes. A total of 13 healthy 18-30 year old university students participated in the study. Resting EE was recorded for 10-minutes prior to game play. The participants then played Reflex Ridge on
the Kinect for 10 minutes in both single and multiplayer modes and Wii Boxing for 10-
minutes in single and multiplayer modes. If players completed a level within 10-minutes,
then they were instructed to immediately begin the next level. A 5-minute rest period was
taken between each gaming condition. Single player games were played against a
computer opponent or a timer. Multiplayer modes were played against a human
opponent. Each condition was randomized. The purpose of this study was to analyze EE
during single and multiplayer game modes on two different AVG consoles in order to
understand the effects of game modes and console type on healthy adult participants.

The results indicated there was a significant effect of the console on heart rate and
METs. Additionally, gaming mode had a significant effect on measures of heart rate,
oxygen uptake, EE, and METs. The results indicate the XBOX Kinect elicited overall
greater EE than the Wii. However, neither console elicited MVPA during game play.
Activity was light in intensity and is recommended for individuals who primarily play
sedentary video games to become more active.

This study has two important implications. One implication is that it investigated
the physiological effects of AVG play on the XBOX Kinect. Research on the Kinect is
limited. Another implication is that the Kinect game, Reflex Ridge, required full body
movements such as jumping, ducking, sidestepping, and reaching whereas the Wii only
required punching. The XBOX Kinect might encourage the player to perform more full
body movements whereas the Wii encourages more adaptive behavior. More research
needs to be conducted on the XBOX Kinect to better understand how the motion capture
technology affects EE as opposed to Wii biaxial accelerometer technology.
Based on this literature, AVG play can increase PA in sedentary populations. Exercising with a partner may promote greater exercise intensities. However, AVG play may not have any lasting effects on PA habits. This suggests that several factors must be taken into account when designing an exercise intervention. Personal motivation to play AVGs and adhere to an exercise program is influenced by the mode of PA, how the PA is incorporated into game play, the intensity of PA, and whether or not the PA will be performed alone, against in game components, or with a partner. There does not appear to be one method that works best for AVG play, but rather a combination of variables contributes to the success of an intervention.

**Active Videogame Uses in School Settings**

Active video games are seen as novel ways to increase PA in children. They are being incorporated into recess, after school programs, and PE. Several consoles allow for a selection of games and types of interaction. Some games are designed as skilled-based activities and some games are designed as health related activities. This section seeks to better understand research-based, in-school, AVG interventions.

Duncan and Staples (2010) assessed PA levels during AVG play over time and compared this to “free play” associated with recess activity in a sample of British primary school children over a 6-week period. The primary objective of this study was to see if AVG play could maintain PA levels over an extended period of time.

A total of 12 boys and 18 girls ranging from 10-11 years old participated in AVG and free play trials. The participants were split into two groups. The experimental group, with six boys and nine girls, played Wii Sports Tennis, Sonic & Mario at the Olympics, and Celebrity Sports Showdown. Game titles were rotated regularly to reduce the chance
of boredom. The control group, with six boys and nine girls, participated in playground ‘free play.’ Both groups had equal amounts of recess time (Duncan & Staples, 2010).

Steps per minute were initially greater for the AVG group than the ‘free play’ group. However, by the end of the intervention the AVG group took fewer steps than the control group at the mid-point assessment and at the final assessment.

Duncan and Staples (2010) concluded there are acute effects on PA because of AVG play, however there are not sustained PA benefits. Some games may not elicit MVPA. Also, practice using the Wii remote may decrease PA levels as success in the games increases. As participant’s experience increases, their movements become more efficient.

Duncan, Birch, Woodfield, and Hankey (2011) assessed PA levels during AVG play and compared it to ‘free play’ associated with recess activity in a sample of British primary school children over a 6-week period. The primary goal of the study was to better understand if AVG play could elicit more activity than ‘free play’ on a playground.

A total of 20 boys and 20 girls, ages 10 to 11 years old, from two primary schools in England participated in the study. Twenty children were in the control group and 20 children were in the experimental group with boys and girls distributed equally.

The primary intervention tool was a Gamercize Power Stepper, a stepping machine used in conjunction with a gaming console to power the gaming controller (Duncan et al., 2011). Participants had to step at a minimum cadence of 30 steps-per-minute. Twenty boys and girls played XBOX 360 games with a Gamercize Power Stepper while 20 boys and girls were in a “free play” control group. Both groups played for equal amounts of time during their recess periods.
Steps per minute were initially higher for the AVG group than the playground group. However, by the end of the intervention the control group took more steps than the AVG group. The number of steps taken by AVG group participants remained consistent throughout the study (Duncan et al., 2011). While the control group took a higher mean number of steps than the AVG group, there was a greater standard deviation from the mean in the control group than the AVG group. This suggests that there is greater individual variance in ‘free play’ than in AVG play. That fact could be caused by a consistent step count minimum for AVG play (Duncan et al., 2011). The Gamercize Power Stepper is different from some AVGs where the player’s gross motor movements control an avatar. The Gamercize Power Stepper uses positive reinforcement for the number of steps taken (i.e. as long as the step count is above 30 steps-per-minute, the game stays on.) The individual’s movement does not relate to any in-game action.

The Gamercize Power Stepper is one potential alternative for children’s physical activity in school recess (Duncan et al., 2011). It elicited a similar step count to “free play” and demonstrated more consistent activity levels than “free play.”

The research of Duncan et al. suggests AVG play has limitations in a school setting. AVG play may not be the best method for promoting MVPA levels. However, AVGs seem to be played at a more consistent level. Child play tends to be very sporadic with short bursts of activity followed by a period of rest. AVG play may be a more effective mode of exercise for older individuals who exercise at a consistent level for longer periods of time.
Active Video Game Research Involving Individuals with Disabilities

For several years the main body of literature for AVG research included participants without disabilities. Recently, several studies involving individuals with physical disabilities and involving individuals with intellectual disabilities were conducted. Many of these studies yielded results with positive physical and cognitive implications for individuals with disabilities.

Anderson-Hanley, Tureck, and Schneiderman (2011) assessed the effects of an acute bout of AVG play on the repetitive behaviors and cognitive performance of children with ASD. This group attempted to better understand if AVGs could reduce repetitive behaviors as observed during play activities. They also administered assessments of executive function including the Digit Span Forward and Backward (Lezak et al. 2004), Color Trails Test (D’Elia, Satz, Uchiyama, & White, 1996), and the Stroop task form (van der Elst, van Boxtel, van Breukelen, & Jolles, 2006). These tests required the participants to recall numbers in the reverse order from which they heard, connect color coded numbers in a specific sequence, and name the color of blocks and words and colors of blocks with words printed in contrasting colors.

A total of 12 youth with ASD participated in the study. These children possessed some language function. The severity of their diagnosis was verified using the Gilliam Autism Rating Scale, 2nd edition (Gilliam, 2006). The participants’ parents completed the scale and returned it to the researchers (Anderson-Hanley et al., 2011).

Three research groups were created. A control group was videotaped for 5-minutes while playing with Play-Doh, administered an executive functioning assessment, watched a 20-minute video of their school’s talent review, videotaped for another 5-
minutes while playing with the Play-Doh, and performed a second executive functioning test. Pilot group 1 came in 1-week later and followed the same procedure except the participants played DDR. Pilot group 2 played Dragon Chase (cybercycling).

The researchers observed fewer repetitive behaviors and greater cognitive functioning after exercise bouts in the pilot groups. They also concluded, “Aerobic activity can decrease self-stimulatory behaviors in children with autism... this demonstrates the feasibility of using exergames for children with autism” (Anderson-Hanley et al., 2011).

Active video games helped decrease repetitive behavior and increased executive functioning, whereas sedentary activity was shown to do the opposite. This study demonstrated cognitive benefits of AVG play for children with ASD. Active video games appear to be a feasible source of PA and a possible method to decrease maladaptive behaviors in individuals with ASD.

Foran and Cermak (2013) described ownership trends, assessed video game (VG) play patterns, determined the relationship between AVG and sedentary video game play, and determined the parent’s satisfaction with their child’s current PA level in children with ASD. The authors used the information to analyze ownership trends and play patterns in this population. This information is useful because youth with disabilities have limited access to organized sports or other opportunities. Active video game play could provide an option for PA.

A 10-item survey was sent to 900 families in the Los Angeles Unified School District (LAUSD) and approximately 2,000 through the Interactive Autism Network...
A total of 215 parents of youth with autism returned questionnaires (Foran & Cermak, 2013). This study has a limitation in that only 7% of the sample responded. Respondents were predominately boys (86%) and 81% of all respondents had ASD alone. Nearly 84% of respondents played sedentary VGs for at least 30-minutes per day. Overall, 52% played AVG at least 30-minutes per day. Only 34% of youths with an additional physical or cognitive disability reported playing AVGs. There was a positive correlation between age and VG play. Active video games were often played with a partner, whereas sedentary VGs were often played alone. More support was needed for AVG play than sedentary VG play (Foran & Cermak, 2013). Researchers concluded VG ownership is similar to typically developing youth.

With the availability of AVG consoles, in home intervention using AVGs is realistic. Some support may be required, but AVG play is often done with a partner, so the partner may often provide the support. Active video game play is often more social than sedentary video game play. As a result, AVG play may provide affective benefits in addition to physical benefits.

Yuen et al. (2013) investigated the process associated with the motivation for playing Wii Fit among sedentary patients with systemic lupus erythematosus. Participants totaled 14 sedentary African American women with systemic lupus erythematosus between the ages of 25 and 67 years-old.

Researchers analyzed responses from telephone interviews at the end of a 10-week Wii Fit program. Interview questions were all open-ended responses. The order in which questions were asked was always maintained unless probing responses and
requests for clarification were made. Results were coded and categorized to tease out patterns in activity and exercise preferences (Yuen et al., 2013).

The participants listed enjoyment, health benefits, a sense of accomplishment, convenience, and personalized activities as reasons for liking the Wii. Complicated movements and limited activity choices were negatives of the Wii. Researchers concluded games should be tailored to meet the needs of the patient.

This study is unique because it involved a commercial gaming platform for PA use in a population with disabilities. The responses these women presented provide insight into what a Wii based exercise program should be able to do for individuals with disabilities who would like to use AVGs as a primary mode of exercise. Suggestions derived from this study may be used to develop future in-home AVG exercise programs.

**Physical Activity Preferences**

Mellecker, Lanningham-Foster, Levine, and McManus (2012) examined children’s choices when given the option to play VGs seated or the same VG ambulatory. While a variety of AVG choices exist, they are quite limited in comparison to traditional VGs. The researchers investigated if the choice of a variety of VGs would be preferable even if activity while gaming was not associated with game success. The participants were given the choice to play while seated or to walk on a treadmill and play. Participants included a total of 20 boys and 10 girls ranging in age from 9-13 years old who were from high SES families.

Children played X-Box 360 games of their choice either seated or walking on a treadmill in a secluded cubicle. The treadmill walking was not related to game
performance. The children were given the option to play a normally seated game while walking on the treadmill.

Seventeen children spent 100% of sessions 1, 2, and 3 seated. In session 4, 18 of the children spent 100% of the time seated. A total of 7, 4, 3, and 5 children spent 100% of the time ambulatory during the sessions (Mellecker et al., 2012).

According to the authors, children would rather spend their time seated as opposed to ambulatory when given the choice during VG play. The researchers postulated the extra activity might be distracting when it does not directly relate to success in the VG. When activity correlates to success in the VG, children are more likely to sustain activity.

O'Loughlin, E., Dugas, Sabiston, and O'Loughlin, J. (2012) investigated potential sociodemographic, lifestyle, psychosocial, weight-related, and mental health correlates of AVG play. They also described the type, timing, and intensity of AVG play in a group of adolescents.

Data was derived from the AdoQuest study, a survey on the natural occurrence of health compromising behaviors in children. Participants were 14-19 year-old students in the Montreal area. A total of 1,241 questionnaires were completed.

A total of 284 participants reported AVG play. Active video gamers played 2 days per week for a mean of 50.5-min per bout. Respondents reported 27% of their activity was light intensity, 57% was moderate intensity, 16% was vigorous intensity, and 8% did not respond to the question. The most popular games were: Wii Sports 68%, DDR 40%, Wii Fit Yoga 34%, and Boxing Punchout 15%. Wii Sports (26%) and DDR (29%) were
the most popular games played at a friend’s house. Less than 1% of active video gamers played at school.

A total of 23% of respondents played AVG. Of that group, 73% were able to exercise at a moderate intensity level for 50-min. Therefore; they nearly met PA guidelines for 2 days per week. Girls were more likely to play AVG than boys. Social interaction may be a motivator to play. Active video gamers were more likely to be stressed about their weight. They were also more likely to engage in sedentary activities.

One important finding from this study was that children are playing AVGs at home, but not in school. Physical education teachers should consider infusing AVG play into PE to make a connection between home and school PAs. Physical education teachers might be able to teach students how to become even more active while playing AVGs.

Sun (2012) examined students’ in class PA levels, situational interest motivation, and motivation change over time in an AVG unit in comparison with those in a traditional fitness-education unit in elementary school PE. A combination of technology and activity along with social interaction appear to make AVG play a promising form of PA in physical education.

Participants in this study were 9-12 year-olds and included 34 boys and 40 girls in 4th grade physical education. These students were going to experience a fitness-education unit for the first time in their scholastic experience. The population of this study was very diverse with 60.8% of participants African American, 20.3% Latino, 9.5% Caucasian, 2.7% Asian, 1.4% Native American, and 5.4% multiracial American.

Students participated in whole body AVG and a cardiovascular (CV) fitness unit. Caloric expenditure due to in class PA was assessed using RT3 accelerometers.
Situational interest was assessed using the Situational Interest Scale-Elementary School (Sun et al. 2008). Initial interest was assessed based on their first interaction with the unit. Retained interest was assessed based on interest throughout the entire unit. Comparing differences in initial and retained interest assessed situational interest change (Sun, 2012).

The cardiovascular unit met criteria for moderate PA; however the AVG unit did not meet criteria for moderate PA levels. Active video games were motivating because of the challenge they presented, exploration opportunities, and instant enjoyment. Students perceived more interest in the AVG unit than in the CV fitness unit (Sun, 2012).

Active video games provide a source of situational interest motivation. They can be used to enhance the curriculum as a novel experience. However, they should not replace a traditional PE curriculum. Active gaming could be used to spark an interest in a particular topic, but traditional activities should be used if MVPA is to be attained.

Summary, Conclusions, and Recommendations

The body of research reviewed above provides an overview of literature with direct implications for children with disabilities. While children with autism have unique needs, results and conclusions from studies with typically developing individuals and individuals with other disabilities can be beneficial when designing appropriate exercise opportunities. Overall, AVG play is one activity among many different options. Active gaming should be used in conjunction with a variety of activities to achieve PA recommendations. The initial interest provided by active gaming wears off over time (Sun, 2012). Boredom is one reason why individuals may not adhere to exercise. As a result, a combination of activities is necessary to best promote exercise adherence (Duncan et al., 2011).
Several active game titles were shown to induce moderate physical activity levels. Based on heart rate and EE, activities such as Wii Boxing, jOG, Gamercize, and Cybercycling appear to be strong choices for attaining MVPA levels (Anderson-Hanley et al., 2011; Duncan et al., 2011; Snyder et al., 2012). Selecting appropriate games, creating the right exercise environment, providing the correct amount of support, and providing the right amount of social facilitation all contribute to success (attainment of MVPA) in an AVG session (O’Loughlin, et al., 2012). Silva Salmeron (2013) advocates the development of AVG games that are created with eliciting maximum activity intensities. He suggests creating games that can estimate the participant’s exertion level and adjust game play accordingly.

Games created in this manner may be beneficial for use in schools. With limited PA time, PE teachers must be able to justify the use of active games. Games designed with the purpose of inducing MVPA in participants could be used in a variety of ways. The main limitation of AVG play is that there is no current research that shows active games can promote and sustain activity levels more than or equal to traditional activities. Active games may be novel, but their effects wear off over time (Duncan et al., 2010, 2011). Games designed with greater specificity and purpose could be useful in the education environment.

The findings of Foran and Cermak (2013) indicate AVG use is not very prevalent amongst children with autism in the scholastic setting (< 1%). However, respondents collectively reported playing VG for a total of 1.73-hour and AVG for .39-hour at home. Children may need more education on how to choose appropriate or more active games. The availability of VGs in the homes of children with ASD was very high amongst
respondents (95%) with 82% owning AVG consoles in this study. The opportunities for PA are available at home, but children will need more education on appropriate choices for leisure time activities.

In addition to the physical benefits, AVG play has been shown to enhance behavioral tendencies and cognitive functioning of children with autism (Anderson-Hanley et al., 2011). Autism is a social disorder. Therefore activities that improve behavioral tendencies can have significant positive implications for children with autism.

Limited research exists in the area of children with disabilities and the effects of AVG play on their cognition. Anderson-Hanley et al. conducted a unique study that would benefit from replication to confirm the study's results. The aerobic AVGs, DDR, and Cybercycling, may not be the only aerobic activities that benefit children with autism's behavioral and cognitive functioning.

Areas of needed research include physiology related to individuals with disabilities, uses in special education school settings, and the PA preferences of children with ASD. Several research questions can be derived from these areas of study. For example, in the area of AVG physiology, do AVG elicit similar physiological responses in children with autism as they do in typically developing peers?

In the school environment, what is the prevalence of AVG use in PE or classroom settings for individuals with ASD? Can AVGs provide sustained engagement over several weeks in a recess setting for individuals with ASD? Can AVG interventions serve as effective behavior management plans for youths with ASD?

To better understand preferences, many people such as parents, educators, and the children themselves can be surveyed to better understand the PA preferences of
individuals with ASD. Also, studies could be created to determine if children with ASD prefer AVG activities to real life activities. Additionally, do children with ASD prefer playing AVG with a partner or playing alone?

Little is known about the PA preferences and modes of exercise for individuals with ASD. A variety of activities could be researched including AVG games, stationary exercise, and dynamic exercises.

Possible research questions for a study of this type could be do children with ASD prefer stationary or dynamic exercises? Do children with ASD prefer AVGs to traditional exercise modes? Can AVGs facilitate more social interaction than traditional exercise? Do children with ASD prefer social PA environments or secluded PA environments?
REFERENCES


