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Evaluation of Preference for Exergames Among Elementary Students

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by

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Abstract

Obesity in children is a nationwide problem. Physical activity is one way to help children stay fit and prevent obesity. Unfortunately, access to technology involving sedentary behavior is easier than ever. Fortunately, for this generation of students there is a way to combine physical activity and technology through exergaming. In order to encourage students to participate in exergaming, the students should be able to play games they prefer. The purpose of this study was to apply a paired choice preference assessment, rank order card sort, and social validity surveys to determine the preference order of six exergames for six elementary students and measure heart rates as the children played the six exergames. The results of this study show that children had different preferences as evident by the rank order card sort, social validity survey, and paired choice preference assessment. The pre-rank order card sort was significantly correlated with the paired choice assessment. On the other hand, the pre-social validity survey was not significantly correlated with the paired choice assessment.

Introduction

Childhood obesity is a growing epidemic in the United States. A survey completed in 2007-2008 found that 16.9% of children and adolescents ages 2 to 19 were classified as obese (Ogden & Carroll, 2010). In March 2011, the American Heart Association reported that a third of American children and adolescents were overweight or obese; a threefold increase over the numbers reported in 1963 (Overweight in children, 2011). According to the World Health Organization, individuals are classified as overweight if they have a body mass index (BMI) of 25 to 29.99 and obese if they have a BMI greater than 30 (BMI Classification, 2004).

There are many risks associated with childhood obesity and overweight (Medical consequences of being overweight or obese in childhood, 2004). Some medical risks include asthma, type 2 diabetes, high blood pressure, and sleep apnea. One very concerning risk involves the growth of children's bones. If there is excess weight on the growing bones, the bones may not develop normally, leading to orthopedic complications in adulthood. There are not only physical risks but there are also psychological risks that can accompany obesity. A few involve low self-esteem, depression, negative self-image, deficits in logical thinking, and social withdrawal. Unfortunately, some of these psychological factors can start as early as kindergarten (Medical consequences of being overweight or obese in childhood, 2004).

Although genetics may play a role in childhood obesity (Why are children becoming obese?, 2004), the main explanation for weight gain in children is that

overweight children consume more calories than they burn through physical activity (Ferry, 2007). This situation can be changed in two different ways (Behavior Modification for weight control in children, 2004). One way is to control the eating habits of children to reduce calorie intake and increase the consumption of healthy food. The other way is to increase physical activity in children.

Physical activity plays a major part in keeping children's, and adults', weight in check. The American Heart Association recommends that every child and adolescent gets 60 min of moderate to vigorous physical activity every day (Physical activity in children, 2011). Physical activity is important for many reasons such as controlling weight, reducing blood pressure, and raising good cholesterol, to list a few. In order for children to engage in physical activity more often, the American Heart Association lists a few things that can be done (Physical activity in children, 2011). Physical activity should be fun for the child. Parents should be good role models. Most importantly, in order for increases in physical activity to be more likely, competing sedentary behavior needs to be reduced.

Technology has been a major factor that has led to increases in sedentary behavior. As of 2009 (Henry J. Kaiser Family Foundation, 2010), children ages 8 to 18 years of age spend an average of 7.5 hours a day in front of various screens. One of the most common screens that children use is TV which is where kids spend about 4.5 hours a day. The two second most used screens a day are the computer (1.5 hours) and video games (just over 1 hour). The screen that is used the least is movies (.5 hours). With all of these screens taking up so much time, there is less time for physical activity.

In a nationwide survey conducted by the Department of Health and Human Services Center for Disease Control and Prevention in 2010, participants were asked about the amount of time in a week they spend engaging in physical activity and how much time in a week they spend engaging in sedentary activities. Based on the results, younger children were more likely to engage in physical activity at least 60 min per day on all seven days than were older children. However, the percentage of younger children nationwide that engaged in the recommended amount of physical activity was only 21.3%. The results also showed that younger children were more likely to spend three or more hours per day watching television, playing video games, or using a computer for something other than school. Although the increase in "screen time" for children (TV, video games, and computer use) is leading to more sedentary behavior, recent research shows that screen time can be incorporated into physical activity through exergaming.

Exergaming is defined as "video games that provide physical activity or exercise through interactive play" (Mears & Hansen, 2009, p. 2). There are many different types of exergames. Most require the player to move his or her whole body to participate (National Association for Sports and Physical Education, 2009). Considering that many video games played in the home are sedentary games, exergaming might be an option to get people of all ages up and engaging in more physical activity.

Researchers have evaluated the effectiveness of exergaming for increasing physical activity (Fogel, Miltenberger, Graves, & Koehler, 2010; Graf, Pratt, Hester, & Short, 2009; Graves, Stratton, Ridges, & Cable, 2007; Lanningham-Foster et al., 2009; Lanningham-Foster et al., 2006; Mellecker & McManus, 2008; Ni Mhurchu et al., 2008; Read & Shortell, 2011; Shayne, Fogel, Miltenberger, & Koehler, in press). In most of

these studies the children participated in exergames in classroom and lab settings. Graf et al. (2009) compared watching TV, walking, and exergaming and found that there were significant elevations in energy expenditure for walking and exergaming over watching TV. Similar results were found for Lanningham-Foster et al. (2006) and Mellecker and McManus (2008). Lanningham-Foster et al. (2009) also found that the children seemed to enjoy participating in exergaming in this study.

Ni Mhurchu et al. (2008) compared two groups of children ages 10 to 14 where one received an upgrade to their PS2 console and the other group did not. The researchers wanted to see the effects of exergaming over a 12-week period using a device (an accelerometer) that recorded the activity of each participant. Ni Mhurchu et al. found that physical activity was higher in the treatment group than in the control group. The result was that children who were assigned to the upgrade engaged in more physical activity, played fewer video games, and decreased their waist circumferences when compared to the control group.

The research conducted to date suggests that the use of exergames can increase physical activity in children. This is an important finding as it suggests that making exergames more widely available may be a strategy to promote more exercise in children. However, although children increased physical activity when using exergames in these studies, the studies did not investigate whether the children would chose exergames over other forms of physical activity or which exergames would be more preferred than others. During the creation of the games, designers need to keep the player in mind and consider what is going to be preferred for the player. More preferred games might be played more often, resulting in higher levels of physical activity. In order to know what the

participants are going to choose and what they are not going to choose, preference assessments need to be completed.

Many types of preference assessments have been used to identify stimuli that are preferred so the stimuli can be used to potentially reinforce desirable behavior. The main assessments are single stimulus, multiple-stimulus (with and without replacement), and paired choice assessments (Daly, Wells, Carr, Kunz, & Taylor, 2009; DeLeon et al., 2001; DeLeon & Iwata, 1996; Fisher, Piazza, Bowman, Hagopian, & Slevin, 1992; Pace, Ivancic, Edwards, Iwata, & Page, 1985). The assessment that was used in this study was a paired choice assessment. In a paired choice assessment, the researcher presents two options to the participant and the participant chooses one of them. All of the options that the researcher is interested in are paired with each other and then presented to the participant. The results of paired choice assessment put the options in a rank order from most preferred (most chosen) to least preferred (least chosen). Preference assessments typically have been used to assess food, tangible, or activity reinforcers (Bojak & Carr, 1999; Daly et al., 2009; DeLeon et al., 2001; Fisher et al., 1992; Hanley, Piazza, Fisher, & Maglieri, 2005; Mithaug & Hanawalt, 1978; Mithaug & Mar, 1980; Parsons, Reid, Reynolds, & Bumgarner, 1990). The value of conducting a preference assessment is that it results in objective data on the participant's choice of items or activities.

To date, no studies have examined exergames using preference assessments to determine if some exergames may be more preferred than others. Although two studies found that exergaming produced more physical activity than regular PE class, suggesting it is more reinforcing than regular PE (Fogel et al., 2010; Shayne et al., in press), no studies have evaluated the relative preference among exergames. Once it is known which

games are more preferred by individuals, the information can be used to make those games available and promote the most physical activity. The purpose of this study was to apply a paired choice preference assessment, rank order card sort, and social validity surveys to determine the preference order of six exergames for six elementary students. Heart rates were also recorded to determine if one game had a greater effect on the children's heart rate than others and to determine if there was a relationship between heart rate and selection.

Method

Participants and Setting

Participants were 6 elementary students, ages 9 and 10, with no mental, physical, or medical limitations. Farrah was a 10 year old female who was 4 ft. 7 in tall, weighed 97 lbs., and had a BMI of 22.5. Wendy was a 9 year old female who was 4 ft. 10 in tall, weighed 143 lbs., and had a BMI of 29.9 (she was classified as overweight but on the verge of obese). Thomas was a 9 year old male who was 4 ft. 1 in tall, weighed 82 lbs., and had a BMI of 24. Ken was a 10 year old male who was 4 ft. 5 in tall, weighed 77 lbs., and had a BMI of 19.3. Stephen was a 10 year old male who was 4 ft. 9 in tall, weighed 116 lbs., and had a BMI of 25.1 (he was classified as overweight). Allison was a 10 year old female who was 5 ft. 1 in tall, weighed 103 lbs., and had a BMI of 19.5.

Before beginning the study, the parents of the participants signed a Parental Consent form and completed a Verification of Physical Health form to ensure that the participant had no mental, physical or medical limitations that would preclude physical activity. Participants were recruited by distributing flyers to the after school program at a local elementary school. The principal of the school was contacted to get permission to pass out the flyers.

The study was conducted after regular school hours during the children's after school program in the Active Gaming Lab located in the School of Physical Education and Exercise Science on the campus of the local university. The after school program was normally held on the campus of the elementary school. For this study, a worker from

the school escorted the students to the lab and escorted them back to school when the session was over. The investigator was given permission to use the Active Gaming Lab for this research study. The Active Gaming Lab was a 1,800 sq. ft. room with ten different exergames arranged around the perimeter of the room.

Equipment

Preference for six exergames was evaluated in this study. Most exergames have a variety of games within the exergame console for the player to choose. Because the purpose of this study was to evaluate the exergame equipment not the games within the exergame, participants were limited to no more than two choices within each exergame. Two researchers played each of the exergames to determine which games would be best for the participants to play. Two games were selected for each exergame based on ease of use, amount of exertion, potential enjoyment, skill level required, and difficulty to learn. For Lightspace, we took the potential height of the children into account since the top of the game could have been out of the reach of a shorter child. However, for the Kanomi Dance Dance Revolution™ (DDR) with Sony Play Station ™, participants were able to choose the song and difficulty level for themselves. For Microsoft Kinect, the participants were allowed to choose from a range of games from a group of games called Kinect Adventures. Below is a description for each of the six exergames that were utilized in this study.

Kanomi Dance Dance Revolution™ (DDR ™) with Sony Play Station. This game consists of a dance pad on which a player moves his or her feet to a set pattern that matches the general rhythm or beat of a song shown in front of the

player on a TV screen. The songs that were chosen for this game are as stated above.

Gamercize™ Stepper with Xbox. This exergame utilizes a stair stepper machine which interfaces with a video game's console. Motion from the stepper provides a signal to the interface module. The interface allows interaction between the game controller and game's console only when the signal is present. The games that were selected for Stepper were Connect 4 and Bop it. These were two games from a collection of games called Family Fun Night 2.

Cateye Virtual Bike™ with Sony Play Station. This exergame is a form of virtual bike that resembles a traditional bike that allows children to control all on-screen actions, including steering, speed, turns, and other strategies. The faster the player pedals, the faster the objects on the screen move. There was only one option for Bike. This option was a game called ATV Off Road Fury

Microsoft Kinect™. This gaming system utilizes a controller-free, webcam, sensor technology, and responds to how the player moves. This system enables users to control and interact with the sensor through a natural user interface using gestures and spoken commands. This system can track up to six players, however there can only be two active gamers playing at any given time. The players can stand between six and eight feet from the sensor while playing. There was a range of games that the participant could choose from a group of games called Kinect Adventures.

Light Space Play™. This exergame includes an interactive wall surface comprised of programmable LED lit and pressure sensitive tiles. Each tile

consists of pixels that can display any color, pattern, or image. The surface is able to detect location, movement, and density of players to give a realistic gaming experience. Reactions to player movements are displayed on the surface and are accompanied by sound effects. The games that the participants could choose from were Reaction and Color Crazy.

Xavix™. The XaviXPORT® System provides interactive ways for players to maintain or improve fitness levels. With Xavix™, players can participate in sports and other fitness activities such as boxing, tennis, and Jackie Chan running games. The game that was used for this study was Xavix Boxing.

Assessments

The dependent variables assessed in this study included a) rank order of preference for exergames, b) social validity survey of exergames, c) choice of exergames, and d) heart rate while playing each exergame.

Rank order card sort. To assess verbal preference for the 6 exergames, participants were presented with six cards, each with a picture of one of the exergames. The rank order card sort was administered during Phase 2 and Phase 4 of the study (see procedures). Each participant met with the researcher individually just outside the Active Gaming Lab. During the rank order card sort, participants were told to put the six cards in order of their least favorite to most favorite exergame (1 as least preferred and 6 as most preferred). Following the rank order card sort, the researcher asked each participant two questions. The first question was, "Why did you put (least preferred) exergame as least preferred?" The second question was, "Why did you put (most preferred) exergame as most preferred?" After the participant answered these questions, he/she was thanked

for speaking with the researcher. The duration of time that the participant took to complete the rankings was recorded. This information was used in assessing the participant's strength of preference for the exergames (it was hypothesized that the quicker the participants ordered the cards the stronger the preference).

Social validity survey. The social validity survey included a Likert scale indicating strong agreement to strong disagreement with 10 statements designed to assess the participants' opinions of each of the exergames (see Appendix A). The social validity survey was administered during Phase 1 and Phase 4 of the study. Participants filled out the paper survey after completing each exergame. The researcher provided instructions for filling out the survey by providing examples for how to rate the statements on the survey.

Paired choice preference assessment. During Phase 3, participants were directed to a location away from the other participants so as to not influence the other participant's decision and were then given a choice between two exergames. The participant was then allowed to participate in the activity of his or her choice for a specified amount of time (5 min).

Heart rate. During Phase 1 and 2, a Polar RS400 heart rate monitor was put on at the beginning of the session to record the participant's resting heart rate and to ensure adequate resting time during Phase 3 and 4. A researcher showed each participant how to put on the monitor and then ensured that the monitor was on correctly. During these two phases, heart rate was recorded after the child had a 5 min resting period to account for any physical activity that they may have engaged in prior to entering the lab. The 5 min resting period was used between exergames in Phase 1 as well. The heart rate monitors

were also used during Phase 3 to ensure that the participant's heart rate returned to resting before being presented the next pair. During Phase 4, a heart rate monitor was worn by each participant to obtain a measurement of heart rate for each exergame and to determine when the participant had reached his/her baseline heart rate while resting before engaging in the next exergame. Data from the heart rate monitor were collected after each exergame.

The participants may have experienced a transient increase in heart rate, respiration, and blood pressure associated with physical exertion. They understood that they could stop participation at any time. The principal investigator (PI) was monitoring the participant's heart rate during the study. The PI had been trained to use heart rate monitors and had previously used heart rate monitors in research in the active gaming lab. The Co-Investigator and the research assistants also understood how to operate the heart rate monitors. The individuals that were present while the participants were engaging in the activities were the PI, the Co-Investigator, and the research assistants. The heart rate monitor for Ken was not tight enough due to the fact that monitor did not tighten enough and kept falling down. Every once in a while he had to stop what he was doing and either fix it himself or have a researcher fix it.

Interobserver Agreement

Interobserver agreement data were taken for the preference assessment, heart rate, and rank order card sort both pre and post-paired choice preference assessment. For the paired choice assessment, the researcher identified two machines for the participant to choose. Two researchers were present and recorded the selection of the participant. The researchers had similar data sheets to record the choice (see Appendix B) and recorded

the choice with their backs to each other. Interobserver agreement on choice was calculated by adding the agreements on choice between the researchers, dividing by the total number of opportunities to choose, and multiplying by 100 percent. The interobserver agreement for the paired choice assessment was 100% for all participants.

Interobserver agreement on heart rate was conducted by having the two researchers look at the heart rate monitor at the same time 10 seconds after the participant was done with his or her time on each exergame. Percentage of agreement on heart rate was calculated by dividing the smaller recorded heart rate by the larger recorded heart rate and dividing by 100. The interobserver agreement for the heart rate was 100% for 5 of the 6 participants. For Allison, the IOA for her heart rate was 99.8%. Interobserver agreement for both the pre- and post-rank order card sort was conducted by having two researchers record the order of the cards at different times. Percentage of agreement on rank order was calculated by dividing agreements between the two researchers for each card by total opportunities (6 opportunities/games). The interobserver agreement for both the pre- and post-rank order card sort were 100% for all participants.

Procedures

Once the parents of the participants reviewed and signed the consent form and the participants had given their verbal consent to participate, the participants were taken through the four phases of this study. In Phase 1, the participants were exposed to and engaged in all 6 exergames then completed a social validity survey. In Phase 2, the participants completed the rank order card sort. In Phase 3, the participants participated in the paired choice preference assessment for the exergames. In Phase 4, the participants participated in the post-exposure to the exergames while their heart rates were monitored.

In addition, participants were given the second administration of the rank order card sort and social validity survey.

Phase 1: Exposure to exergames and social validity survey. Before the study began, the height and weight of each participant was recorded. During this phase, the participants were taught how to operate each piece of equipment. Each participant was given instructions and modeling for all six exergames. Following the instructions and modeling of each exergame, the participants were given 10 min to play the exergame before receiving instructions and modeling for the next exergame. Between exergames, the participants received a minimum of 5 min of rest time or until his/her heart rate returned to resting (resting heart rates were taken before the session using the heart rate monitor) at which point he or she completed the social validity survey for the exergame just completed.

Phase 2: Ranking. During Phase 2, the participants completed the rank order card sort. The heart rate monitors were also worn from the beginning of this phase and the results were averaged with the heart rate from Phase 1 to determine the resting heart rate.

Phase 3: Paired choice preference assessment. In this phase, every exergame was paired once with each other exergame for a total of 15 comparisons. If the same game was presented more than three times in eight trials then it was replaced with another pair to prevent satiation. During Phase 3, participants were pulled aside and given a choice between two exergames as determined by the schedule of pairings for each participant. The researcher said, "You can either play (name of exergame) or (name of exergame), which would you like to play?" Once the participant made his/her choice, the

researcher said, “Okay, you can go play.” The choice was recorded by each researcher on a data sheet. The pairings of exergames were already on the data sheet. The trial number was left blank to be able to switch around the trials. This allowed the researchers to ensure that the participants were not given the same exergame more than 3 times in a row. The participant then had the opportunity to play the exergame for 5 min. Five min was chosen because it was equivalent to a short game or a song on DDR. Five min was used across all participants to ensure that everyone was given the same amount of time. While the participants were playing, if they stopped engaging in the exergame, they were encouraged to keep playing. They were given single line statements that they were doing a good job (examples: “You’re doing a great job”, “Keep it up”, and “Way to go”). This was to ensure that the participants kept playing for the full 5 min. This was done for every participant for every game to ensure that the encouragement did not affect the participant’s preference. After the participant stopped playing the exergame, the participant received a minimum of 5 min of rest time or until his/her heart rate returned to resting (resting heart rate was determined using the average heart rate found in Phase 1 and 2). Following the break, the participant was presented with a second pair of exergames and was given the opportunity to play the chosen exergame. This process was repeated until all of the pairs had been presented. The participants were presented each piece of equipment five times.

Phase 4: Post paired choice assessments–heart rate, rank order card sort, and social validity survey. In this phase, the activities of Phase 1 and 2 were repeated. There was only one difference, the initial instruction and modeling in Phase 1 were not repeated and the participants were only allowed 10 min of playing time with a minimum

of 5 min of resting time. The participants wore the heart rate monitors while playing each exergame and their heart rates were recorded to determine if there was a difference in the heart rate between the exergames.

Results

These results show that all participants exhibited different preferences for the different exergames. Pearson r correlations showed few positive correlations among the assessment procedures.

The results for the paired choice preference assessment for all of the participants are displayed in Figure 1. The exergame that was chosen most often was the Bike (Farrah, Wendy, Thomas, Ken, and Stephen), followed by Xavix (Thomas), DDR (Stephen), Microsoft Kinect (Allison), and Light space (Allison). Overall, the Bike was chosen 87% of the time. The next most chosen exergames were Microsoft Kinect (63%) and DDR (60%). The game that was chosen the least often was Gamercize Stepper which was only chosen 13% of the total opportunities. There was no observed relationship between the children that were overweight and their preference. Figure 2 displays the overall average percentage of selection for all participants.

Table 1 displays the heart rate data from each phase. The baseline heart rate for each participant was collected in Phase 1 and 2 and is reported in the first column. During baseline, the average resting heart rate across participants was 93.9 beats per min (range 86-98). The heart rate collected in Phase 4 was taken 10 s after completing a 10 min exposure session to each game. The exergames that resulted in the highest heart rate was Gamercise Stepper (142.3 beats per min, chosen 13% of the total opportunities). It should also be noted that the exergame that produced the second highest heart rate was Bike which was the exergame that was the most preferred (142.0 beats per min, chosen

87% of the total opportunities). The exergame that produced the lowest heart rate was Microsoft Kinect (117 beats per min, chosen 63% of the total opportunities). The rates for the rest of the exergames were 137.8 (DDR), 142 (Bike), 138.7 (Lightspace), and 127.5 (Xavix). A one way ANOVA was conducted and showed a significant difference in heart rate among exergames, $F(5, 35) = 3.8$, p=.008. A Tukey's standardized range test was used to analyze differences among the exergames. There was a significant difference between Microsoft Kinect and Gamercize Stepper (p=.017) and between Microsoft Kinect and Bike (p=.019).

Table 2 and 3 show the results from all of the assessments. Two participants' least preferred exergame was the exergame that resulted in the highest heart rate (Farrah-Xavix and Wendy-Stepper). Thomas was the only participant who's most preferred exergame was the game that resulted in the highest heart rate (Bike). Allison's most preferred exergame was the game that led to her lowest heart rate (Microsoft Kinect). Farrah was the only participant that had the lowest preferred exergame and the lowest heart rate match (Lightspace). A Pearson r correlation was used to determine if there was a correlation between heart rate and preference based on the results from the paired choice preference assessment for each. The correlation was not significant, r(34)=.06, p=.7. A Pearson r correlation was also conducted to determine if there was a correlation between heart rate and the pre-rank order assessment and it also was not significant, r(34)= -0.4, p=.8. A third Pearson r correlation was calculated to determine the correlation between heart rate and the pre-social validity survey. This correlation was not significant, r(34)=.2, p=.2 as well.

All of the assessments of preference (paired choice preference assessment, pre- and post-rank order card sort, and pre- and post-social validity survey) were included in Tables 2 and 3 for comparison purposes. All pre-assessments were conducted in Phases 1 and 2 prior to the paired choice preference assessment. All post-assessments were conducted in Phase 4 after the paired choice preference assessment. The order for the rank order card sort was as follows: 1=least preferred to 6=most preferred. Duration was recorded as the time it took each participant to complete the ranking. The duration is included in Table 2 and 3.

There were some differences between the pre- and post- assessments. For many of the participants, their rankings from pre- to post- for the rank order were within one spot. All participants except for Stephen had the same exergame ranked the most preferred in the pre-assessment as they did in the post-assessment (Farrah-DDR, Wendy, and Allison-Microsoft Kinect, Thomas and Ken-Bike). Three participants (Wendy, Stephen and Allison-Stepper) had the same exergame ranked as the least preferred in both the pre- and post-assessments. A Pearson r correlation was run to see if there was a correlation between the pre- and post-rank order card sort assessment. The correlation was highly significant, $r(34)=.581$, $p=.0002$.

The duration data were collected to see if the rankings were completed more quickly in the post assessment after more exposure to the exergames. A quicker ranking may have indicated the participants were more certain in their rankings. However, there was no consistent pattern in the duration data with some participants decreasing duration from pre to post and some increasing duration from pre to post.

The answers to the 10 questions on the social validity survey were averaged for each exergame and reported in Table 2 and 3. A Likert scale was used with the following values: Strongly Agree=5, Agree=4, Neutral=3, Disagree=2, and Strongly Disagree=1. Four participants had the same rating for the pre- and post-assessments. A Pearson r correlation showed that the pre- and post-assessments were significantly correlated, $r(34)=.382$, $p=.02$.

The relationships between the paired choice preference assessment and the pre-rank order card sort as well as between the paired choice preference assessment and the pre-social validity survey were evaluated. The pre-assessments were used rather than the post-assessments to determine if a rank order card sort or a social validity survey would be a valid method to evaluate preference before substantial exposure to the games and the potential confounding of the paired choice preference assessment. If a rank order card sort and/or a social validity survey are a valid assessment of preference, then utilizing one of these assessments would be quicker than conducting a complete paired choice assessment.

There were mixed results when comparing the paired choice assessment and the pre-rank order card sort. Farrah and Wendy had the Stepper as the least preferred in the rank order and selected the least in the paired choice. Thomas and Ken had the Bike as most preferred in both assessments. Stephen and Allison were the only participants that had their least and most match for both assessments. A Pearson r correlation between the pre-rank order card sort and the paired choice preference assessment for all of the participants was significant, $r(34)=.395$, $p=.02$. Even though the overall findings were significant, the correlation was significant for only 2 of the 6 participants; $r(4)=.813$,

p=.05 for Stephen as well as Allison. The correlation was not significant for 4 of the 6 participants; r(4)=.543, p=.266 for Ken, r(4)=-0.116, p=.8 for Thomas, r(4)=.039, p=.9 for Wendy, and r(4)=.151, p=.8 for Farrah.

When evaluating the relationship between the paired choice assessment and the pre-social validity survey, there was no consistency. A Pearson r correlation was conducted between paired choice assessments and their pre-social validity survey for all participants and it was not significant, r(34)= -0.0057, p=.97. Furthermore, the correlation was not significant for any individual participant: r(4)= -0.081, p=.9 for Farrah; r(4)= -0.055, p=.9 for Wendy; r(4)= -0.029, p=.957 for Thomas; r(4)= -0.131, p=.8 for Ken; r(4)=.528, p=.3 for Stephen; r(4)= -0.461, p=.4 for Allison.

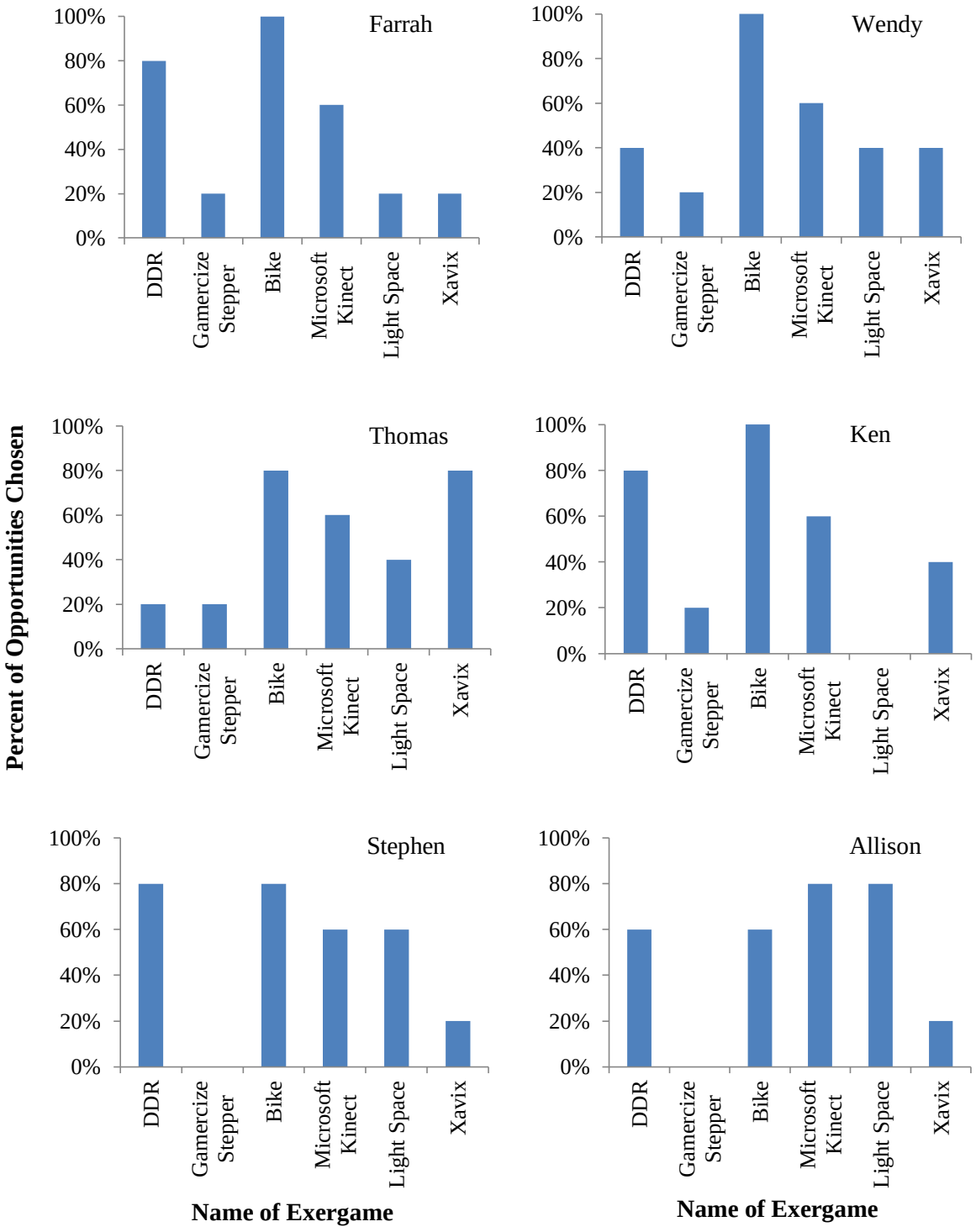

Figure 1: Results for the paired choice preference assessment for all participants.

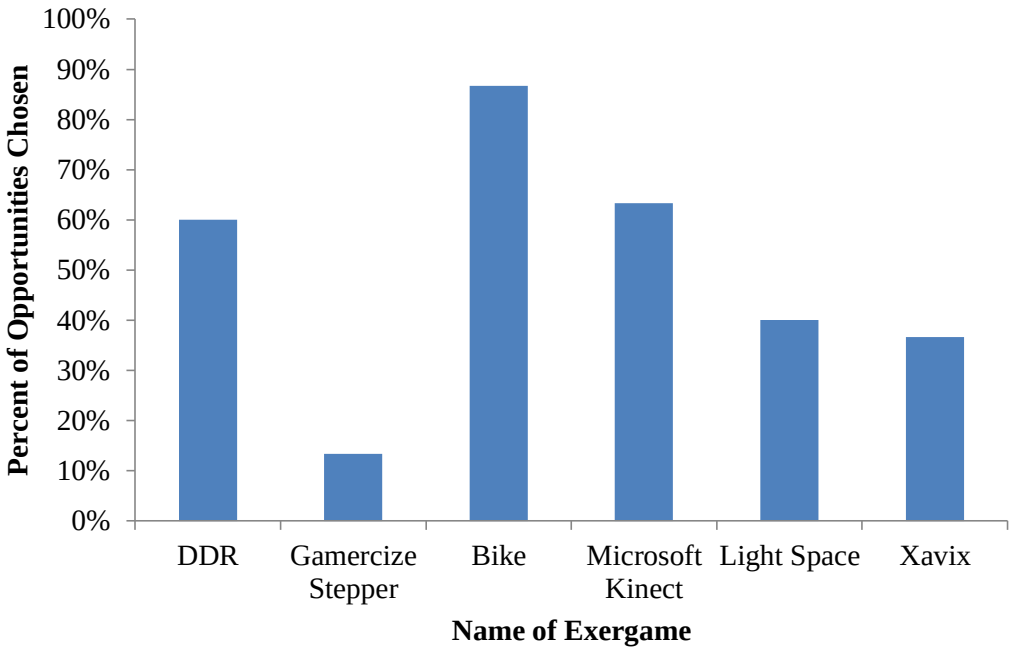

Figure 2: Overall selection of each exergame for all participants.

Table 1: *Heart rate measurements for each participant taken in Phase 1 and 2 (baseline) and in Phase 4 (following each exergame).*

Name	Phase 1 & 2	Phase 4					
	Baseline	DDR	Gamercize Stepper	Bike	Microsoft Kinect	Light Space	Xavix
Farrah	93	145	141	146	125	117	149
Wendy	94	131	149	138	113	120	116
Thomas	86	115	135	140	112	131	121
Ken	94.5	148	138	141	122	145	126
Stephen	98	154	142	136	107	178	123
Allison	98	134	149	151	123	141	130
Mean for Exergame		**137.83**	**142.33**	**142.00**	**117.00**	**138.67**	**127.50**

Table 2: *Results for the height, weight, paired choice preference assessments, rank order card sort (pre and post), social validity (pre and post), and heart rate for participants 1-3.*

Name Height/Weight	Name of Exergame	Paired Choice Assessment %	Rank Order (Pre)	Rank Order (Post)	Social Validity (Pre)	Social Validity (Post)
Farrah (M) 55in/97lbs	DDR	80%	6	6	5	4.4
	Gamercize Stepper	20%	1	1	4.6	3.4
	Bike	100%	2	5	4.3	4.2
	Microsoft Kinect	60%	4	3	4.2	4.2
	Light Space	20%	5	4	4.5	4
	Xavix	20%	3	2	4.6	2.7
			Duration:23.4s	Duration:19s		
Wendy (F) 58.25in/143lbs	DDR	40%	4	4	5	4.1
	Gamercize Stepper	20%	1	1	4.3	2.2
	Bike	100%	2	5	4	3.8
	Microsoft Kinect	60%	6	6	4.2	3.4
	Light Space	40%	5	3	3.8	4.2
	Xavix	40%	3	2	3	3.4
			Duration:93s	Duration:39s		
Thomas (M) 52.5in/82lbs	DDR	20%	3	3	3.6	4.4
	Gamercize Stepper	20%	5	1	5	3.9
	Bike	80%	6	6	5	5
	Microsoft Kinect	60%	1	5	3.7	4.7
	Light Space	40%	4	2	4.8	4
	Xavix	80%	2	4	2.7	4.1
			Duration:39.6s	Duration:47s		

Table 3: *Results for the height, weight, paired choice preference assessments, rank order card sort (pre and post), social validity (pre and post), and heart rate for participants 4-6.*

Name Height/Weight	**Name of Exergame**	**Paired Choice Assessment %**	**Rank Order (Pre)**	**Rank Order (Post)**	**Social Validity (Pre)**	**Social Validity (Post)**
Ken (M) 53.75in/77lbs	DDR	80%	3	2	5	5
	Gamercize Stepper	20%	1	4	5	4.6
	Bike	100%	6	6	5	5
	Microsoft Kinect	60%	5	5	4.6	4.6
	Light Space	0%	4	3	5	4.7
	Xavix	40%	2	1	5	4.6
			Duration:43s	Duration:44s		
Stephen (M) 57in/116lbs	DDR	80%	6	4	3.8	1.8
	Gamercize Stepper	0%	1	1	3	3
	Bike	80%	3	3	4.3	2.7
	Microsoft Kinect	60%	4	5	4	2.2
	Light Space	60%	5	6	4	4.2
	Xavix	20%	2	2	4.35	1.3
			Duration:37s	Duration:13s		
Allison (F) 61.25in/103lbs	DDR	60%	4	5	3.7	3.9
	Gamercize Stepper	0%	1	1	4.2	2.4
	Bike	60%	2	3	3.5	3
	Microsoft Kinect	80%	6	6	3.6	3.8
	Light Space	80%	5	4	3	3.2
	Xavix	20%	3	2	3.1	2.1
			Duration:23s	Duration:40s		

Discussion

The purpose of this study was to use a paired choice preference assessment, rank order card sort, and social validity survey to determine preference for exergames. The results of these assessments showed that all participants had different preferences for the six different exergames, although there were some correlations among these measures of preference. Overall, Bike was the most chosen exergame and Stepper was the least chosen. One potential explanation for the bike being chosen the least preferred might be the fact that the motions involved in playing the game are disconnected from what the player is doing on the screen. Future research should assess whether playing exergames that require the same movements that the character in the game is engaging in are more preferred. The heart rates of the participants were taken to assess differences in the different exergames and to assess whether heart rate was correlated with the participants' exergame selection. Although there were differences in heart rate among the exergames, there was no correlation between heart rate and preference. The comparison of the pre-rank order card sort and the paired choice assessment showed there was a correlation whereas the comparison between the pre-social validity survey and the paired choice assessment showed that there was no correlation.

There are a number of implications of the results of the current study. One major implication has to do with the connection between the different assessments. If it was found that a quicker assessment such as a rank order card sort or a social validity survey was highly correlated with the actual behavior of selecting (paired choice assessment)

then the quicker assessment could be used instead to save time. Unfortunately, there was no correlation between the social validity survey and the paired choice assessment which means that the social validity survey is not as valid as the paired choice assessment and would not be a good predictor of the behavior of selecting or a good indication of preference. The results of the social validity survey were similar to the results that can be found in a single stimulus preference assessment (Pace, Ivancic, Edwards, Iwata, & Page, 1985). In a single stimulus preference assessment, all of the options can be chosen 100% of the time. For the social validity survey that was given to the participants, all of the questions for each exergame could receive the highest rating. The opportunity to use the same rating for every game can lead to outcomes such as participants expressing that they like everything equally. This outcome can be seen in Pace et al. (1985) when they assessed preference for reinforcers for individuals with disabilities. Pace at al. found that when the individuals were presented with each of the 16 stimuli across trials many of the participants approached (chose) many of the items each time the items were presented. As a result, the single stimulus assessment, much the same as the social validity survey in the present study, did not result in a measure of relative preference.

On the other hand, the rank order card sort was correlated with the paired choice assessment. This correlation indicates that the rank order card sort might be a valid assessment of preference however caution should be taken since there were only six participants involved in this study. This finding is valuable because the rank order card sort is quicker and easier to administer than a paired choice assessment. If the rank order card sort is to be used in future research or practiced as a measure of preference, researchers will need to identify how much exposure to the stimuli the individual should

have before the rank order card sort is utilized and for the results to be a valid measure of preference. In this study, the participant had 10 min of exposure to each exergame before completing the card sort procedure to rank order the exergames. Future research should test to see if less exposure would produce the same significant correlation with the paired choice assessment results.

Conducting the self-report assessments (rank order card sort and social validity survey) prior to the paired choice assessments (pre-paired choice) was important for the comparisons stated above. The same self-report assessments were also conducted after the paired choice assessments (post-paired choice). The main purpose for conducting the post-paired choice assessments was to compare the findings to the pre-paired choice assessments. If it was found that the results of pre- and post-assessments were highly correlated then not only would the pre-paired choice assessment be valid and save time in the beginning, but the post-assessments would also be a valid assessment and could be conducted at a later time to determine if those items are still preferred. Preference might change over time so participants might choose something that was not preferred in an earlier assessment. Using the rank order card sort at multiple times might be a quick way to observe any changes in preferences that may occur over time.

The findings from this study and others (e. g., Fogel et al., 2010; Shayne et al., in press) may help promote greater exercise in children in a couple of ways. If children who play sedentary video games play exergames instead, it might help increase their heart rate. The heart rate data reported in this study can also be used to determine a good starting point for exercising. For example, if a child is obese and very strenuous activity is not recommended, the child may start playing a game that results in the lowest average

heart rate increase such as Microsoft Kinect. Once results are seen with a game such as Kinect and the child has clearance to move to an exercise that is more strenuous, the child could move to an exergame that requires more movement such as DDR. Eventually the child could use the most physically demanding exergame like Xavix and/or physical exercise such as basketball or soccer in the natural environment. Considering the importance of elevating heart rate during physical activity for burning calories and attaining the best metabolic effect, future studies should continue to evaluate the relationship between heart rate and preference with exergames.

Because exergames can be expensive, cost has to be taken into account when thinking about the type of exergame to purchase. Some of these games, such as Microsoft Kinect, Xbox 360 (used with the stepper), or a Play Station, can be purchased at a reasonable price by families. Other games, such as Light Space, may be too costly for most families to install in their homes. Schools or corporations, on the other hand, have a better chance of being able to purchase this type of equipment. The information in this study may be useful to gaming companies while they are trying to develop new exergames or improve the ones that they have. If they know which games are more preferred than others they might be able to find a way to make that game affordable to not only schools and corporations but also to families who would like to have it in their homes. The inverse is that if an exergame is not preferred then development time and money does not have to be wasted and these resources can be used on the games that are preferred. It can also help schools potentially include exergames in their physical education classes. Schools could use these findings as well as the findings in Fogel et al. (2010) that showed that exergames were preferred over regular physcial education, to

increase the physical activity of their students.

A pilot study, completed prior to this study, used college students rather than elementary aged children (Cacioppo, Miltenberger, Whitherspoon, Fogel, & Sanders, 2012). The procedures were the same however the findings were somewhat different. The paired choice preference assessment also showed that everyone has different preferences. When the paired choice assessment was compared to heart rate, unlike this study, the two were significantly correlated. When comparing the pre-rank order card sort and the pre-social validity survey to the paired choice preference assessment, both were significantly correlated. It is not clear why similar strong correlations were not found among the various assessments of preference in the current study. Perhaps children's preferences are still developing and thus more variable than those of adults. Or, perhaps the adults were better able to deal with the more abstract aspects of the social validity survey where preference was based on questions rather than pictures or actual choice of activity.

There are a few limitations that should be pointed out in the current study. The first has to do with the number of participants. This study only used six participants. The small number of participants might be the reason the social validity survey and the heart rate correlations were not significant. A greater number of participants might lead to more significant correlations between the assessments. Also, if more individuals participate, patterns might arise in the paired choice assessment. A second limitation might be the fact that the researchers selected the games for the participants. Selection of games chosen by the researchers might have affected the pattern of preference for the exergames. If the participants would have been allowed to select their own games on the

exergame, the participants might have had a different selection order of the exergames. This issue might be something to consider for future research. A third limitation has to do with the heart rate monitors. All of the participants had issues in the beginning while attempting to ensure the heart rate monitors were working. Some of the participants did not put enough water on the band and some did not have their straps tight enough so the monitor kept slipping. One participant (Ken) was not able to keep his heart rate monitor on due to the fact that it could not be tightened enough. This problem was temporarily fixed using a paperclip and a hairband. The last limitation involves the researchers' contact with the participants during Phase 3. Because the researchers encouraged the participants to keep playing until they completed 10 min on the game, this requirement might have affected their preference for the game itself.

Future research should be conducted to build on this study. Future research may start by looking at the rank order card sort. If the rank order card sort is going to be used instead of a paired choice preference assessment, a question that might be investigated is how much exposure to the exergames is required for the rank order card sort to still be a valid assessment of preference. The participants in this study spent 10 min on each piece of equipment before they participated in the rank ordering. Research might investigate whether less than 10 min of exposure to the exergames might be sufficient to produce rank ordering that correlates highly with the results of the paired choice assessment. The type of exposure might also play a part in the validity of the rank ordering procedure. Different exposures could include pictures, videos, or a vocal description. Studies can compare the different exposure types or the duration of exposures.

Preference assessments that include actively choosing one exergame over others

(paired choice assessment) should continue to be conducted in this area. More studies that evaluate paired choice assessments with exergames can add to these results to help determine if there is an overall pattern in children's preference. Another study might compare selection of a high preferred exergame verses a low preferred exergame condition to selection of a low preferred exergame. These results might show that the low preferred game is chosen when it is the only option as opposed to the high preferred exergame being chosen the most when selecting between a low and high preferred exergame. Data should also be collected on different age groups. Results from the pilot study with college aged students found there to be a difference in preferences between the age groups. Studies should be replicated with young children and conducted with junior high and high school students to see if the assessments would produce similar results. If these procedures are conducted with junior high and high school groups, it might be found at which age the self-report assessments (rank ordering and social validity measures) correlate highly with the paired choice measures.

Correlations should continue to be evaluated between paired choice assessments and heart rate. As stated earlier, if it is known which exergames produce certain levels of heart rate then that information can be incorporated into different fitness programs. Research could also be done to determine which games within the exergames produce different heart rates.

Another research question might investigate how the participants interact with the exergame as well as how they interact with others around them. When it comes to interacting with the exergame, preference assessments should be conducted not only between exergaming equipment but also between the games within the exergame.

Individuals might have a different preference if they are allowed to select the game that they play. Another area for researchers is to evaluate children's preference while others are watching them play or while they are competing with others, either people they do or do not know.

A last suggestion for future research has to do with the type of preference assessment that was used. This study and the pilot study utilized a paired choice assessment. Future research can evaluate preference for exergames using either a single stimulus or a multiple stimulus (with or without replacement) assessment. Additionally, future research might compare the results of these three forms of preference assessment. DeLeon and Iwata (1996) compared three assessments (multiple stimuli with and without replacement and paired choice) and found that for 4 of the 7 participants, all of the assessments identified the same highly preferred item. It is not known whether similar results might be found for exergames. Further research is definitely needed in the area of exergames and preference assessments so that game developers can work on games children prefer and parents, schools, and fitness centers can acquire games most likely to be utilized by children.

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Appendices

Appendix A- Social Validity Survey

Participant: _____ Pre/Post: _____

Social Validity Survey

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I like playing DDR.					
2. I would play DDR again.					
3. I would play DDR at home.					
4. I would recommend DDR to a friend.					
5. I could feel my heart rate change while playing DDR.					
6. DDR was difficult to play.					
7. While playing DDR, I was completely focused on what I was doing.					
8. I felt like I was working hard while playing DDR.					
9. It was hard for me to breath/I was out of breath while playing DDR.					
10. I felt tired after playing DDR.					

Participant: _____ Pre/Post: _____

Social Validity Survey

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I like playing the Bike.					
2. I would play the Bike again.					
3. I would play the Bike at home.					
4. I would recommend the Bike to a friend.					
5. I could feel my heart rate change while playing the Bike.					
6. The Bike was difficult to play.					
7. While playing the Bike, I was completely focused on what I was doing.					
8. I felt like I was working hard while playing the Bike.					
9. It was hard for me to breath/I was out of breath while playing the Bike.					
10. I felt tired after playing the Bike.					

Participant: _____ Pre/Post: _____

Social Validity Survey

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I like playing Microsoft Kinetic.					
2. I would play Microsoft Kinetic again.					
3. I would play Microsoft Kinetic at home.					
4. I would recommend Microsoft Kinetic to a friend.					
5. I could feel my heart rate change while playing Microsoft Kinetic.					
6. Microsoft Kinetic was difficult to play.					
7. While playing Microsoft Kinetic, I was completely focused on what I was doing.					
8. I felt like I was working hard while playing Microsoft Kinetic.					
9. It was hard for me to breath/I was out of breath while playing Microsoft Kinetic.					
10. I felt tired after playing Microsoft Kinetic.					

Participant: _____ Pre/Post: _____

Social Validity Survey

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I like playing Light Space.					
2. I would play Light Space again.					
3. I would play Light Space at home.					
4. I would recommend Light Space to a friend.					
5. I could feel my heart rate change while playing Light Space.					
6. Light Space was difficult to play.					
7. While playing Light Space, I was completely focused on what I was doing.					
8. I felt like I was working hard while playing Light Space.					
9. It was hard for me to breath/I was out of breath while playing Light Space.					
10. I felt tired after playing Light Space.					

Participant: _____ Pre/Post: _____

Social Validity Survey

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I like playing Gamercise Stepper.					
2. I would play Gamercise Stepper again.					
3. I would play Gamercise Stepper at home.					
4. I would recommend Gamercise Stepper to a friend.					
5. I could feel my heart rate change while playing Gamercise Stepper.					
6. Gamercise Stepper was difficult to play.					
7. While playing Gamercise Stepper, I was completely focused on what I was doing.					
8. I felt like I was working hard while playing Gamercise Stepper.					
9. It was hard for me to breath/I was out of breath while playing Gamercise Stepper.					
10. I felt tired after playing Gamercise Stepper.					

Participant: _____ Pre/Post: _____

Social Validity Survey

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I like playing Xavix.					
2. I would play Xavix again.					
3. I would play Xavix at home.					
4. I would recommend Xavix to a friend.					
5. I could feel my heart rate change while playing Xavix.					
6. Xavix was difficult to play.					
7. While playing Xavix, I was completely focused on what I was doing.					
8. I felt like I was working hard while playing Xavix.					
9. It was hard for me to breath/I was out of breath while playing Xavix.					
10. I felt tired after playing Xavix.					

Appendix B- Preference Assessment for Researcher

Participant:_____

Preference Assessment Selection

Trial	Choose between:			
_____	DDR	☐	Light Space	☐
_____	Kinetic	☐	Xavix	☐
_____	Gamercize	☐	Xavix	☐
_____	Bike	☐	Gamercize	☐
_____	DDR	☐	Bike	☐
_____	DDR	☐	Gamercize	☐
_____	Light Space	☐	Xavix	☐
_____	Bike	☐	Kinetic	☐
_____	Light Space	☐	Gamercize	☐
_____	Bike	☐	Xavix	☐
_____	Kinetic	☐	Gamercize	☐
_____	DDR	☐	Xavix	☐
_____	Bike	☐	Light Space	☐
_____	Kinetic	☐	Light Space	☐
_____	DDR	☐	Kinetic	☐