THE EFFECT OF PEER INFLUENCE ON THE REINFORCING VALUE
OF PHYSICALLY INTERACTIVE VIDEO GAMES IN CHILDREN

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Relative to sedentary video games (e.g., Playstation 2 (PS2)), playing physically active video games (e.g., Nintendo Wii (Wii)) significantly increases caloric expenditure in children. Studies have demonstrated that the presence of a friend increases physical activity in children. We sought to determine if children would expend more energy and find playing Wii more motivating than PS2 when with a friend.

Seventeen children (6-10 years old) rested, played PS2 and Wii Sports Boxing for 10 minutes each, in two conditions: one in which the children rested/played the games alone (alone condition) and another in which they were with a friend (peer condition). We assessed oxygen consumption (VO₂), and liking (visual analog scale). After three 10-minute resting/gaming conditions, motivation was assessed using a relative reinforcing value task (RRV) in which children performed computer mouse presses to gain additional access for either PS2 or Wii. VO₂ was greater ($p < 0.001$) with Wii compared to rest and PS2. During the peer condition, boys exhibited a greater ($p = 0.02$) increase in VO₂ from rest to Wii. Liking was significantly ($p < 0.001$) greater for Wii and PS2 relative to rest. RRV for Wii significantly decreased ($p = 0.03$) from alone to the peer condition.

Conclusion: The presence of a friend increased VO₂ during Wii play for boys but not girls. Surprisingly, the presence of a friend decreased children’s motivation to play Wii versus PS2.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>II. REVIEW OF THE LITERATURE</td>
<td>5</td>
</tr>
<tr>
<td>Prevalence and Causes</td>
<td>5</td>
</tr>
<tr>
<td>Societal Influences</td>
<td>5</td>
</tr>
<tr>
<td>Square Screen Use</td>
<td>6</td>
</tr>
<tr>
<td>Behavioral Factors</td>
<td>8</td>
</tr>
<tr>
<td>Self Efficacy</td>
<td>8</td>
</tr>
<tr>
<td>Relative Reinforcing Value</td>
<td>9</td>
</tr>
<tr>
<td>Peer influence</td>
<td>10</td>
</tr>
<tr>
<td>Importance of Peer and Parental Influence</td>
<td>10</td>
</tr>
<tr>
<td>Summary</td>
<td>15</td>
</tr>
<tr>
<td>Hypotheses</td>
<td>17</td>
</tr>
<tr>
<td>III. RESEARCH DESIGN AND METHODS</td>
<td>18</td>
</tr>
<tr>
<td>Participants</td>
<td>18</td>
</tr>
<tr>
<td>Design</td>
<td>18</td>
</tr>
<tr>
<td>Procedures</td>
<td>21</td>
</tr>
<tr>
<td>Anthropometrics</td>
<td>24</td>
</tr>
<tr>
<td>VO₂</td>
<td>24</td>
</tr>
<tr>
<td>Liking</td>
<td>25</td>
</tr>
<tr>
<td>RPE</td>
<td>25</td>
</tr>
<tr>
<td>Relative Reinforcing Value</td>
<td>26</td>
</tr>
<tr>
<td>Statistical Analysis</td>
<td>28</td>
</tr>
<tr>
<td>Oₘₐₓ</td>
<td>28</td>
</tr>
<tr>
<td>IV. RESULTS</td>
<td>29</td>
</tr>
<tr>
<td>Physical Characteristics</td>
<td>33</td>
</tr>
<tr>
<td>VO₂</td>
<td>34</td>
</tr>
<tr>
<td>Liking</td>
<td>37</td>
</tr>
<tr>
<td>RPE</td>
<td>38</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. VO$_2$ for social condition by gaming condition by sex</td>
<td>35</td>
</tr>
<tr>
<td>2. VO$_2$ for gaming condition by sex</td>
<td>36</td>
</tr>
<tr>
<td>3. O$_{max}$ for social condition by gaming condition</td>
<td>39</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Study Design for VO₂, Liking, and RPE</td>
<td>19</td>
</tr>
<tr>
<td>2. Study Design for Omax</td>
<td>20</td>
</tr>
<tr>
<td>3. Random Order for Alone Condition First or Peer Condition First</td>
<td>21</td>
</tr>
<tr>
<td>4. Omnibus Table of Means for VO₂, Liking and RPE</td>
<td>30</td>
</tr>
<tr>
<td>5. Kilocalories (kcal) Per Minute</td>
<td>31</td>
</tr>
<tr>
<td>6. Metabolic Equivalents (METS)</td>
<td>32</td>
</tr>
<tr>
<td>7. Physical Characteristics</td>
<td>33</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

The growing problem of childhood obesity in the United States is indicative of social and environmental changes in recent decades. Obesity in children, which is defined as a body mass index (BMI) greater than the 95th percentile (Ogden & Flegal, 2010) has become an epidemic and is a serious public health concern. The result of overweight (defined as a body mass index between the 85th and the 95th percentiles) and obesity in children is a greater risk for cardiometabolic syndrome in the short term and cardiovascular disease later in life (Allcock, Gardner, & Sowers, 2009). A greater body mass index (BMI) in children is related to more severe adult adiposity as well (Freedman et al., 2005; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997).

There is no indication that the obesity rates for children are decreasing (Hedley et al., 2004). 2007 data shows that 13% of youth are obese and 15.8% are overweight in grades 9-12, according to the Center for Disease Control (CDC) (Eaton, Kann, Kinchen, Shanklin, Ross, & Hawkins, 2008). Additionally, the percentage of overweight children and teens continues to grow. In 2002, the percentage of overweight children age 6-19 years in the United States had increased to 16%, nearly triple what it was in 1980 (Ogden & Tabak; CDC, 2005). Severe obesity for children ages 2-19 years of age increased from 1.1% for boys and 1.3% for girls in 1976, to a staggering 5.1% and 4.7% respectively by 2006 (Wang, Gortmaker, & Taveras, 2010).
The causative factors for the burgeoning problem of childhood obesity are complex and include poor diet and decreased physical activity (PA). The effects of poor diet have been well documented. A study by Kranz, Findeis, & Shrestha (2008) showed that the prevalence of childhood obesity decreases as the quality of diet improves. While dietary trends are a reason for concern, physical inactivity is also a main culprit influencing overweight and obesity in children. In fact, children 10-16 years of age rarely take part in vigorous PA (Strauss, Rodzilsky, Burack, & Colin, 2001). Children are becoming more and more sedentary and this is directly affecting adiposity. Rennie et al., (2005) demonstrated a consistent negative correlation between PA level and fat mass.

While many factors contribute to the rise in childhood inactivity, one factor is the increase in sedentary behaviors such as television, video game and computer use. Such “square screen” activity is not only sedentary it is rewarding and as a result, efforts to make physical activity attractive to children often fail (Lanningham-Foster et al., 2006). In the past few years, “square screen” activities have become so alluring and reinforcing that children are becoming more sedentary over time (Sisson et al., 2009). In the U.S., 47% of children age 2-15 years, spend more than 2 hours per day in sedentary leisure activity (Sisson et al., 2009). Leisure activities and square screen use may often be more attractive to children than PA, thus contributing to the increasing BMI of American children.

One study demonstrated this phenomenon by showing that time allocated to “square screen” use is inversely related to PA behavior (Laurson et al., 2008). While
increased “square screen” time decreases PA which increases the likelihood of overweight and obesity, physically-interactive video games (i.e. “exergames”) such as the Nintendo Wii® are becoming more popular and have been shown to increase energy expenditure in children (Penko & Barkley, 2010). Emerging research has demonstrated that playing certain “exergames” elicits caloric expenditures that would constitute light to moderate intensity physical activities in children (Penko & Barkley, 2010; Maddison, Mhurchu, Jull, Jiang, Prapavessis, & Rodgers, 2007; Lanningham-Foster et al., 2009). Therefore, if children would forego their traditional sedentary “square-screen” use and replace it with certain “exergames,” PA behavior may increase.

While playing “exergames” versus traditional sedentary games may result in the desired increase in energy expenditure, children may not always select a physically interactive game. Children may be more likely to be physically active when influenced by others to do so. Peer influence in particular has been examined by a number of researchers and has been found to influence the likelihood and the amount of physical activity a child participates in (Ali, Amialchuk, & Heiland, 2011; Anderssen & Wold, 1992; Beets, Vogel, Forlaw, Pitetti, & Cardinal, 2006; Brustad, 1996; Coppinger, Jeanes, Dabinett, Vogele, & Reeves, 2010; Davison & Jago, 2009; Duncan, Duncan, & Strycker, 2005; Finnerty, Reeves, Dabinette, Jeannes, & Vogele, 2010; Hohepa, Scragg, Schofield, Kolt, & Schaaf, 2007; Horne, Hardman, Lowe, & Rowlands, 2009; Jago, Brockman, Fox, Cartwright, Page, & Thompson, 2009; Keresztes, Piko, Pluhar, & Page, 2008; King, Tergerson, & Wilson, 2008; Macdonald-Wallis, Jago, Page, Brockman, & Thompson, 2011; Rittenhouse, Salvy & Barkley, 2011; Salvy et al., 2008; Salvy et al., 2009;
Schofield, Mummery, Schofield, & Hopkins, 2007; Strauss et al., 2001; Veitch, Salmon, & Ball, 2010; Voorhees et al., 2005; Weiss, McCullagh, Smith, & Berlant, 1998). While peer influence often affects the choices that children make this is the first study we are aware of that has examined the influence of a peer on the choices children make between an “exergame” and a traditional “square screen” activity. The purpose of the present study was to broaden the body of research seeking to find ways to increase physical activity in children. To that end we sought to determine if children would find a physically interactive video game more reinforcing (i.e. motivating) than a sedentary game in the presence of a peer versus playing the games alone.

We hypothesized that relative to playing alone, the presence of a friend would increase children’s motivation to play an “exergame”, Nintendo Wii Sports Boxing® (Wii), versus a traditional, sedentary video game, Playstation II Ready to Rumble® (PS2). Additionally we hypothesized that children would expend a greater amount of energy, as assessed by oxygen consumption (VO$_2$), while playing an “exergame” (Wii) with a friend versus playing the same game alone. We also expected that children would like the “exergame” in the presence of a friend more than in the “alone” condition as evidenced by a higher “liking” score.
CHAPTER II

REVIEW OF THE LITERATURE

Prevalence and Causes

Societal Influences

The decrease in PA over time is clear. According to the National Personal Transportation Survey, American children in 1977 were more likely to walk or bike to school than they are today (Sturm, 2005). At the same time the CDC is recommending daily physical education (PE) in schools, but studies are indicating that the PE is rarely often enough to affect children’s overall PA (Datar & Sturm, 2004). In fact, PE may not result in adequate PA even when it is offered. When compared to a physically interactive video game children show a tendency to play PA video games longer than they do traditional PE activities (Shayne, Fogel, Miltenberger, & Koehler, 2012). While children are receiving less PA in school and in the travel to and from school, the other reasons for physical inactivity in children may have many social and environmental causes.

In societies in which sedentary alternatives and modern conveniences are few, physical activity for children is much greater than that of industrialized societies (Esliger, Tremblay, Copeland, Barnes, Huntington, & Bassett, 2010). Esliger et al. (2010) did a cross-sectional study that gives insight into changes in PA over time by examining Old Order Amish. The Old Order Amish (OOA) lifestyle is reminiscent of the way many modern cultures lived a century or more ago. The Amish study showed a significant
difference in the daily PA habits of modern children compared to those who do not use modern technology or conveniences. The study revealed that OOA accumulated an average of 55 minutes more moderate to vigorous PA every day compared to the children living in a typical modern society. BMI and percent body fat for the OOA were significantly less than their modern counterparts, apparently due to daily PA or non-exercise thermogenesis (NEAT).

While an industrialized, highly technology-dependant society contributes to a sedentary population, there are additional causative factors involved in the physical inactivity of American children. Many factors can contribute to inactivity and children being overweight, including modern conveniences, the built environment, self-concept and increased screen time such as television and video games (Veitch et al., 2010; Fisher, Saxton, Hill, Webber, Purslow, & Wardle, 2011; Laurson et al., 2008). One cause of physical inactivity that is being addressed in contemporary research is the safety of the environment in which the children live and play. Parental concerns of crime in the neighborhood can negatively affect the safety of children and thus result in more indoor play (Veitch et al., 2010). For this reason, square screen use is one entertainment option for these children and perhaps a viable physical activity option as well.

**Square Screen Use**

Strauss, Rodzilsky, Burack, & Colin. (2001) found that time spent on sedentary activities is inversely related to moderate-level PA. Studies have also shown that computer and television use are related to increasing weight in children (Laurson et al., 2008). As a matter of fact, children who do not meet public policy recommendations for
limited screen time are 3 to 4 times more likely to be overweight than those who follow these recommendations (Laurson et al., 2008). The American Academy of Pediatrics recommends that children limit total media time to no more than 2 hours per day and should also accumulate 11,000 to 13,000 pedometer steps per day (Laurson et al., 2008; American Academy of Pediatrics, 2011). In a 2008 study, 65% of children ages 4-11 were found to have high screen time, defined as greater than 2 hours per day (Anderson, Economos, & Must, 2008). Youth who are saturated with technology and by extension live a sedentary lifestyle, are at an increased risk for obesity-related morbidities that in the past were only seen in adults (Allcock et al., 2009).

The general decrease in everyday PA may be associated with an increase in square screen use such as television and computers. Today’s technology is widely available and strongly reinforcing. Compared to video games from the 1980’s, today’s games are very realistic and may reinforce the sedentary activity. However, with the recent introduction of physically interactive video games (i.e. “exergames” such as the Wii), there is potential to increase PA in children while at the same time satisfying their motivation to play video games. Exergames have been shown to significantly increase PA as measured by VO$_2$ and heart rate (Penko & Barkley, 2010). In this same study however, overweight and obese children found the exergame equally as reinforcing as the sedentary alternative.
Behavioral Factors

Self Efficacy

Psychologist Albert Bandura defines self-efficacy as a belief that one can succeed in specific situations. Bandura (1997) stated that self-efficacy is an important factor in the likelihood that one will do PA. It plays an important role in the amount of PA children participate in by directly affecting motivation. Children who believe they can succeed at an activity are more likely to do it. Kalaaja, Jaakkola, Liukkonen, & Watt (2010) showed that children who possessed high level movement skills as well as a high level of motivation were significantly more likely to be active. At the same time, children who do not have confidence in their own abilities may be less motivated to be active. If children perceive themselves to be less competent to do an activity, it is possible that they will not do as well at the activity. Not surprisingly, overweight children typically perceive themselves as less competent at PA. Additionally, the overweight children’s perception of their abilities was associated with their actual ability to do the activity (Jones, Okely, Caputi & Cliff, 2010).

When children perceive themselves as physically inadequate and are also overweight, it is predictive of poorer performance in a motor task compared to leaner peers (Cairney, Hay, Faught, Legar, & Mathers, 2008). Self efficacy plays an important role in the amount of PA that children do as well. In a 2001 study, Trost, Kerr, Ward, & Pate found that obese children had lower self efficacy for PA and concurrently had less social support and parental modeling for PA. The relationship between self efficacy, social support, and amount of PA can be illustrated in a 2011 study that showed that
overweight children, when paired with unknown peers, increased their PA relative to playing alone (Rittenhouse et al., 2011).

**Relative Reinforcing Value**

Lean, active children are more apt to display more motivation for active play or exercise (Penko & Barkley, 2010). Conversely, children who are overweight may lack motivation for exercise, generating a perpetual sedentary lifestyle. If the activity is not reinforcing, that is the child does not find it enjoyable enough to want to repeat it, the child may be less likely to do that activity. (Epstein, Kilanowski, Consalvi, & Paluch, 1999).

When people have more than one activity from which to choose, they tend to opt for the more reinforcing (i.e. motivating) one. Using the Relative Reinforcing Value (RRV) task, it is possible to determine how motivated a person is to do a particular activity relative to another option (Epstein, Bulik, Perkins, Caggiula, & Rodefer, 1991, Epstein, Smith, Vara, & Rodefer, 1991, Epstein et al., 1999). In the case of nutrition, it has been shown that overweight children find food more reinforcing than do lean children (Temple, Legierski, Giacomelli, Salvy, & Epstein, 2008). Similarly, some children are more attracted to PA than others. Both reinforcing value and liking of PA can be measured and have been shown to correlate with the likelihood that a child will choose to do a certain activity (Roemmich, Barkley, Lobarinas, Foster, White, & Epstein, 2008). In light of the childhood obesity epidemic, it is valuable to investigate ways that will help children find active play more motivating and more likable.
The Relative Reinforcing Value (RRV) task is an effective tool for determining the reinforcing value of an activity and has been validated by Epstein et al., 1999. The RRV is an operant responding computer task in which the child does work by pressing buttons to earn points for an activity. It has been used in a number of studies examining the reinforcing value of food, activity, and even smoking (Epstein, Bulik, Perkins, Caggiula, & Rodefer, 1991; Raynor & Epstein, 2003; Temple et al., 2008; Epstein, Smith, Vara, & Rodefer, 1991). Epstein, Smith, Vara, & Rodefer, (1991) demonstrated that, using the RRV task, overweight children were more likely than normal weight children to perform more work in order to gain more access to a sedentary activity. This raises questions about activity preferences in children and what interventions might be effective in increasing caloric expenditure in otherwise sedentary children.

Peer Influence

Importance of Peer and Parental Influence

PA plays an important role in obtaining and maintaining a healthy weight in children. There is a strong positive correlation between lower BMI in children and increased physical activity (Bukara-Radujković & Zdravković, 2009). In the interest of children’s health, many studies have examined interventions that may increase the likelihood that children will exercise. It has been found that childhood friendships are an especially important factor, both in the initiation and the motivation to continue with PA. Children often initiate activity due to the influence of friends, either through co-participation, modeling, or encouragement (Salvy et al., 2009; Jago et al., 2009). Further,
when children feel accepted by their friends they are more likely to be physically active (Coppinger et al. 2010). The reverse is true as well; children who sense low support from friends report less PA (Hohepa et al., 2007).

Adult as well as peer relationships can have an effect on children’s PA. A 2006 study (Beets et al., 2006) found that parents and peers both play an important role in determining quantity of PA, showing that children were more active in the presence of positive feedback and praise. Children who are encouraged by parents and who partner with peers tend to exercise more and perceive the benefits of PA as well (King et al., 2008). According to King et al., (2008) parents can contribute to the amount of PA their children receive simply by encouraging them. Research by Hohepa et al., (2007) adds to this argument by showing that one parent households can be just as effective as two parent households when it comes to successfully encouraging youth to be physically active. Children may even increase the intensity (Gubbels, Kremers, van Kann, Stafleu, Candel, Dagnelie, & Thijs, 2011) of PA and have more perceived confidence (Welk, G., Wood, & Morss, 2003) with prompting from adults and/or peers.

Support by parents and peers can include socialization and modeling of physically active behavior. Modeling has been used to help children improve in sports and newly acquired skills (Weiss et al., 1998) and can be an effective motivational tool. Horne et al., (2009) used fictional peer role-models and found significant differences in pedometer steps between an experimental group of children who received such modeling, compared to a control group who did not. Socialization and modeling may have positive or negative influences on children’s behavior. Parental modeling may not always predict
PA in children. Welk et al. (2003) found encouragement and parental facilitation to be strongly correlated with the child’s PA but parental role modeling was not a significant source of parental influence in this case. In fact, observational learning, in which children observe parents avoiding PA, can promote inactivity (Fogelholm, Nuutinen, Pasanen, Myohanen, & Saatela, 1999). This same study found higher correlations for learned inactivity than for vigorous PA, demonstrating that parental sedentary behavior may affect children more than active behavior. Steffen, Dai, Fulton, & Labarthe (2009) also demonstrated this phenomenon by showing that children of overweight parents tend to watch more television.

Whether parental influence is positive or negative, it has been shown that a child’s perceptions of parents’ beliefs and behaviors affect his or her attraction for PA (Brustad, 1996). When parental and peer support for PA is high, the odds of being physically active increase; when parental and peer support is low however, the odds of being physically active decline (Hohepa et al., 2007). While parental support and modeling can be an important factor affecting PA in early childhood, this influence declines as a child approaches adolescence (Davison & Jago, 2009). Additionally, as parental influence declines, peer influence increases (Davison & Jago, 2009). Keresztes et al. (2008) found that social influences from peers were particularly important for predicting the likelihood of sports participation in early adolescent girls.

Children’s PA may be affected more by peers than parents over time simply due to the fact that adolescents rate peer influence as more important than the influence of parents. Ries, Voorhees, Gittelsohn, Roche, & Astone (2008), examining minority teens,
utilized a Likert scale which showed that the adolescents rated the influence on PA from peers and siblings higher than they did parents. In the African American community in this study, parents were often more of a negative influence on the child’s PA as a result of keeping children inside due to fear of violence, having them care for younger siblings, or leading sedentary lifestyles themselves. Tengerson & King (2002) found that the teens in their study expressed having friends to exercise with as the most important factor influencing PA.

Clearly, social influences are an important factor determining PA in youth even when these influences are subtle. Even the perception of peer acceptance shows positive correlation to PA in children (Finnerty et al., 2010). In another 2009 study, the mere presence of a friend affected likelihood that children would take part in PA (Salvy, 2009). Interestingly, this effect was somewhat unidirectional. While the presence of a lean peer resulted in increased cycling time for the overweight youth, the reverse did not hold true. A similar effect was noted by Rittenhouse et al., (2011). This study showed an apparent, albeit non-significant trend pointing towards lean peers influencing the PA of overweight children. However, the participants in this study became more active in all cases, regardless of weight, when paired with another child as opposed to being alone.

Friendship networks have been shown to be a determinate in many weight-related behaviors, including sports participation and exercise (Ali et al., 2011). Conversely, social isolation may be a contributor to the many hours that today’s youth spend watching television or playing video games. Overweight and obese children report spending more time alone (Salvy et al., 2008) and this may be an important contributor to sedentary
behavior. Children who are overweight are often isolated from peers, have a poorer self-concept, and develop a preference for sedentary and isolative activities (Hayden-Wade, Stein, Ghaderi, Saelens, Zabinski, & Wilfley, 2005). A new experimental study that examines the affect of simulated ostracism demonstrates this phenomenon. Barkley, Salvy, & Roemmich, (2012) showed that simulated ostracism significantly decreased physical activity in children. This is worrisome as overweight/obese children are more likely to experience ostracism than their non-overweight counterparts (Young-Hyman, Tanofsky-Kraff, Yanovski, Keil, Cohen, & Peyrot, 2006).

While sedentary behaviors, especially square screen use, may increase the risk of overweight and obesity in children, the effect that peer influence has on these behaviors is unanswered. More importantly, no previous studies have examined peer influence as it relates to physically interactive video game play and the possible increase in caloric expenditure that may result. For this reason, the aim of this study is to examine the effect of peer influence on children’s motivation to play a physically interactive video game as opposed to a sedentary alternative.
Summary

It has been established that the presence of peers affects children’s PA and may influence a child’s motivation to be physically active. Active play can be positively influenced by friends and negatively influenced by social isolation/victimization. Self-efficacy and positive social interaction are both positively correlated with higher intensity PA, reinforcing that a relationship exists between PA and a healthy social life (Strauss et al. 2001). Fisher et al. (2011) also found that the amount of time children spend in moderate to vigorous PA is positively correlated with self-efficacy.

Inactivity and social isolation on the other hand can create an environment in which children are at higher risk for obesity (Hayden-Wade et al., 2005). Research aimed at increasing PA in children therefore needs to include an appreciation for the effect of social influences on the health and well-being of children.

Maddison et al., (2007) showed that playing physically interactive video games results in similar caloric expenditure as many light to moderate physical activities. Further, when comparing sedentary to certain active video games, the caloric expenditure of children doubles (Lanningham-Foster et al., 2006). As children become more skilled at the games, the potential for additional calorie burning may increase as well. This has been found to be the case with college students. Sell, Lillie, & Taylor (2008) found that college students not only burned more calories, they experienced higher Respiratory Exchange Ratio (RER), Rating of Perceived Exertion (RPE), had higher VO$_2$ and higher heart rate in less time. RER is a method of measuring energy expenditure by calculating oxidation of carbohydrates and fats.
Previous studies have shown that “exergaming” can potentially increase PA. It has also been demonstrated that the presence of a peer may increase PA in children. Two previous studies have shown that males and females may have different energy expenditure in the presence of a peer (Graf, Pratt, Hester, & Short, 2009; Barkley & Penko, 2009; Penko & Barkley, 2010). For this reason, we examined both boys and girls in order to compare sex differences in energy expenditure, liking and motivation. The current study sought to show that children may expend more energy and would be more likely to choose an “exergame” when playing with a peer.
Hypotheses

We hypothesized that children would expend a greater amount of energy, as assessed by oxygen consumption (VO$_2$), while playing an “exergame” (Wii) with a friend versus playing the same game alone. Additionally, we hypothesized that relative to the alone condition, the presence of a friend would increase children’s motivation (as measured by RRV) to play an “exergame” (Wii) versus a traditional, sedentary video game (PS2). Finally, we hypothesized that children would like Wii in the presence of a friend more than PS2 as assessed by a Visual Analog Scale for liking.
CHAPTER III

RESEARCH DESIGN AND METHODS

Participants

Participants were recruited from a database of children who had previously volunteered for research at the Applied Physiology Laboratory at Kent State University (Appendix A) and through recruitment flyers given to parents of participants (Appendix B). Participants included 15 Caucasian and 2 African American, six to ten year old children ($N = 17$ total friends) to participate in the friend condition with them. Parents of all participants and parents of his or her friend completed a health questionnaire (Appendix C) in order to rule out any contraindications to physical activity. No children who participated in the study had any known cardiovascular, pulmonary, orthopedic, metabolic, cognitive, neurological, muscular or behavioral concerns or impairments.

Design

Study design is illustrated in Table 1 and Table 2. This was a within-subjects design with two social conditions (alone, peer) and three gaming conditions (resting, PS2, Wii). Between subjects factors were examined for sex (boys, girls).
Table 1. *Study Design for VO₂, Liking, and RPE*

<table>
<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>Rest</th>
<th>PS2</th>
<th>Wii</th>
<th>Rest</th>
<th>PS2</th>
<th>Wii</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>9</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>F</td>
<td>8</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

X’s represent the means and SE of the means (SEM) in each condition for the dependent variables VO₂, Liking, and RPE.
Table 2. Study Design for $O_{\text{max}}$

<table>
<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>PS2</th>
<th>Alone</th>
<th>Wii</th>
<th>PS2</th>
<th>Peer</th>
<th>Wii</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>9</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>F</td>
<td>8</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

$O_{\text{max}}$ = output maximum

X’s represent the means and SEM in each condition for the dependent variable $O_{\text{max}}$. 
Procedures

All participants came to the Applied Physiology Laboratory in the School of Health Sciences at Kent State University for two visits; alone and with a peer, which was completed in a random order (Table 3). During the initial visit children were measured for height and weight and all study procedures were explained. Parents were given the Parent/Child Informed Consent form and the Parent/Child Informed Consent for Friend to read (appendix D and E) and were given the opportunity to ask questions prior to signing. The Child Assent form (appendix F) and The Child Assent Form for Friend (appendix G) were read to the children and they were also given an opportunity to ask questions. All parents, participants and friends were informed that they were under no obligation to finish the study and were free to quit at any time. Children then signed the Assent form as well as the Parent/Child Informed Consent form. During each visit, research staff demonstrated video game play and participants were given an opportunity to practice Wii and PS2 for five minutes each if they were not familiar with the game.

Table 3. Random Order for Alone Condition First or Peer Condition First

<table>
<thead>
<tr>
<th>Order</th>
<th>N</th>
<th>Visit 1</th>
<th>Visit 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X Boy</td>
<td>Alone</td>
<td>Peer</td>
</tr>
<tr>
<td></td>
<td>X Girl</td>
<td>Alone</td>
<td>Peer</td>
</tr>
<tr>
<td>2</td>
<td>X Boy</td>
<td>Peer</td>
<td>Alone</td>
</tr>
<tr>
<td></td>
<td>X Girl</td>
<td>Peer</td>
<td>Alone</td>
</tr>
</tbody>
</table>
After familiarization with each game, participants completed the following 10-minute gaming conditions; seated resting first, then playing PS2 and Wii in a random order. PS2 is a sedentary video game in which the participant controls a boxer on the television with a hand-held control. In the alone condition for PS2, the child’s boxer fights another boxer controlled by the game software. The child was allowed to pick his or her own boxers. In order to be consistent, all children played the game at the beginner level and were seated. None of the children who participated in the study had played the PS2 boxing game prior to the study. In the peer condition, the participant and his or her friend each used the hand-held controls to fight one another’s boxer.

All of the participants in the study were familiar with the Wii boxing game. The participants held a control in one hand and a “num-chuck” control in the other. These were used to box either an imaginary boxer controlled by the software or his or her friend in the case of the peer condition. The participants’ movements were sensed by the game such that if the child threw a punch, the animated character on the screen would also throw a punch. This game was also programmed for a beginner. The children stood up during the Wii condition.

During each 10-minute gaming condition VO\textsubscript{2} (ml·kg\textsuperscript{-1}·min\textsuperscript{-1}) was recorded via indirect calorimetry. Children were asked to indicate how much they liked each 10-minute gaming condition by making a mark on a 10 cm visual analog scale (VAS) anchored by “do not like it at all” on the left and “like it very much” on the right. After completing these three 10-minute gaming conditions, participants completed an RRV
computer game to earn access to 11 additional minutes of the Wii, PS2 or a combination of both.

Procedures for the alone and friend conditions were identical except that during the alone condition participants completed all procedures alone. In the friend condition participants completed the 10-minute gaming conditions and the time earned from the RRV task along with his or her friend who underwent the same procedures. During the friend condition, the children played both video games together however the friend’s energy expenditure was not measured (VO$_2$). VO$_2$ for the participant was measured using a Parvo® metabolic cart and the child wore a Hans Rudolph 7600® mask. It was important that the participant and the friend had a similar experience in the lab. For this reason the friend also wore the same kind of mask, however it was not attached to the metabolic cart and no data was collected. It is also important to note that during the friend condition only the participants played the RRV computer task. After completing the RRV task the participant and his or her friend then played the video games for the amount of time earned from the RRV task by the participant. Participants were compensated with a $20.00 gift card to a local store. Participants’ friends received a $10.00 gift card.
Anthropometrics

Height and weight was obtained by an American College of Sports Medicine Certified Health Fitness Specialist. Each variable was measured 3 times and the median score was recorded (Appendix H). Height was measured to the nearest 0.1 cm and weight was measured to the nearest 0.1Kg with a balance beam scale (Health O Meter, Alsip, I). Body mass index (BMI) was calculated as follows: Weight in kg/height in m$^2$.

VO$_2$

Oxygen consumption (VO$_2$ ml kg$^{-1}$min$^{-1}$) was recorded during each of the four gaming conditions. Data was recorded via indirect calorimetry with a calibrated metabolic cart (Parvo Medics®) using Hans Rudolph 7600® masks. The Hans Rudolph 7600® Masks are used to collect expired gases (VO$_2$ and CO$_2$) during indirect calorimetry. The masks are necessary as they allow for collection of expired gases without the use of a mouthpiece and nose-clips (the equipment traditionally used in the laboratory). This allowed the children in the friend condition to talk with one another while we monitored VO$_2$. This was necessary as the study was assessing the impact of peer influence on children’s video game play. It would not be possible to speak using the mouthpiece and nose-clips.
Liking

After the participants completed a condition (seated resting, sedentary video game or physically interactive video game), they were asked how much they liked the activity using a Visual Analog Scale (VAS). The VAS consists of a 10 cm line. On one end of the scale is “like it very much” and the other end reads “do not like it at all” (Appendix I). The children were asked to plot a pen mark on the line, indicating how much they liked or disliked the activity. The measure of liking was the distance from the left hash mark on the VAS to the child’s pen mark. The liking scale is a validated tool for determining how much a participant enjoys a particular activity (Roemmich et al., 2008).

RPE

RPE data was collected at the mid-point of each 10 minute condition using the validated OMNI Rating of Perceived Exertion Scale (Appendix J) to determine how tired the child felt during activity (Roemmich, Barkley, Kuo, Epstein, White, Foster, & Paluch, 2006). No RPE data was collected from the friend. The scale’s use was explained with a standardized set of instructions. Perceived exertion for this study was defined as “How tired did your body feel during exercise?”
Relative Reinforcing Value

The RRV computer task is an operant button pressing task that requires children to perform work in the form of computer mouse presses to gain access to one activity (Wii) versus another (PS2). The participants had two computer screens available to them, one for the purpose of earning points for the Wii and the other for PS2. Each screen had three simple shapes and the participant was informed that he or she could press the computer mouse to change the shapes. When all three shapes matched, the child earned one point, representing one minute of game play. He or she was able to earn points for a total of 11 minutes of game play and was allowed to earn points on either or both screens, meaning he or she was then allowed to play 11 minutes of one game or divide the 11 minutes between the two games. The first point earned was set for a fixed ratio (FR) of 1. This means that for one press of the computer mouse, the child earned one point. However, for the second and all subsequent points, the FR doubled for every time a point was earned for a particular game. If the participant wanted to earn a second point for the same game, he or she had to press the mouse 2 times. If all 11 minutes were earned for one game the FR increased as follows: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, and 1024 presses of the mouse. The FR only increased for a given game when the child earned a point for that game.

The participant earned access to a video game based on how much work he or she was willing to do to earn a minute of activity for each gaming condition. The output maximum ($O_{\text{max}}$) is the maximal amount of responding that the child performed to earn a single minute for a given activity (Epstein, Roemmich, Cavanaugh, & Paluch, 2011).
$O_{\text{max}}$ for Wii versus PS2 in each of the two social conditions was the measure of RRV. RRV is a valid predictor of children’s actual PA behavior (Epstein, et al., 1999).
**Statistical Analysis**

All statistical analyses were performed utilizing the statistical package for the social sciences (SPSS, Version 17, Chicago, IL). Significance level for all calculations was set a priori at $\alpha \leq 0.05$.

Physical characteristics (age, height, weight, BMI) were compared between boys and girls using independent-samples t-tests. Two sex (boys, girls) by two social condition (alone, peer) by three gaming conditions (rest, Wii, PS2) analyses of variance (ANOVA)s with repeated measures on the final two variables were performed to assess differences in VO$_2$, liking and RPE.

$O_{max}$

A two sex by two social condition by two gaming condition (Wii, PS2) ANOVA with repeated measures on the final two variables was performed to assess differences in $O_{max}$. Post hoc tests included Paired-Samples $t$ Tests which were performed on any significant main or interaction effects from the ANOVA$s.$
CHAPTER IV

RESULTS

The present study sought to determine if children would find a physically interactive video game more reinforcing than a sedentary game in the presence of a peer versus playing the games alone. Seventeen participants between the ages of six and ten years completed two visits to the Applied Physiology Laboratory at the School of Health Sciences at Kent State University. Seventeen friends of the participants also between the ages of six and ten years completed one visit to the Laboratory with the participant. After completion of parental consent, child assent, medical history and collection of anthropometric measures, children were given five minutes of practice time with each game and were familiarized with the mask required for VO$_2$ collection. VAS, RPE and RRV were explained and demonstrated.

Data was collected as follows: Ten minutes of resting VO$_2$ was measured with the child sitting quietly in a chair. VO$_2$ was recorded every minute and these were averaged (Appendix K). Half way through the ten minutes of sitting, the participant was asked how tired his or her body felt utilizing the RPE between 0 and 10. This number was recorded. After the ten minute seated condition the child was asked to draw a vertical line on the ten centimeter long “liking” scale. The distance from the left hash mark on the ten centimeter scale to the child’s vertical line was measured in centimeters and this number was recorded. The same procedure was repeated for the PS2 and the Wii for ten minutes each in both the alone and the peer conditions. At the completion of game play
for both the alone and the peer condition, the child played the RRV computer task and earned eleven additional minutes of video game play for the game or games he or she preferred. $O_{max}$ and total responses were recorded as well as the number of minutes earned in each social condition and for each game.

The means for VO$_2$, liking and RPE during each game and social condition are shown in table 4. VO$_2$ is converted into kilocalories (kcal) and metabolic equivalents (METS) and are shown in tables 5 and 6.

Table 4. Omnibus Table of Means for VO$_2$, Liking and RPE

<table>
<thead>
<tr>
<th></th>
<th>Alone</th>
<th>With Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rest</td>
<td>PS2</td>
</tr>
<tr>
<td>VO$_2$</td>
<td>5.2 ± 0.7</td>
<td>5.82 ± 0.7</td>
</tr>
<tr>
<td>Liking</td>
<td>3.4 ± 0.7</td>
<td>8.1 ± 0.6</td>
</tr>
<tr>
<td>RPE</td>
<td>1.7 ± 0.5</td>
<td>2.1 ± 0.5</td>
</tr>
</tbody>
</table>

Data are means ± SEM
Table 5. Kilocalories (kcal) Per Minute

<table>
<thead>
<tr>
<th></th>
<th>Rest kcal/minute</th>
<th>PS2 kcal/minute</th>
<th>Wii kcal/minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>0.73 ± 0.22</td>
<td>1.00 ± 0.33</td>
<td>2.1 ± 0.59</td>
</tr>
<tr>
<td>Girls</td>
<td>0.92 ± 0.4</td>
<td>0.86 ± 0.46</td>
<td>1.72 ± 0.78</td>
</tr>
<tr>
<td>All</td>
<td>0.82 ± 0.32</td>
<td>0.94 ± 0.39</td>
<td>1.93 ± 0.69</td>
</tr>
</tbody>
</table>

Data are means ± SEM
Table 6. *Metabolic Equivalents (METS)*

<table>
<thead>
<tr>
<th></th>
<th>Alone</th>
<th>With Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rest</td>
<td>PS2</td>
</tr>
<tr>
<td><strong>Boys</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.58 ± 0.95</td>
<td>1.86 ± 0.97</td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.39 ± 0.61</td>
<td>1.41 ± 0.54</td>
</tr>
<tr>
<td><strong>All</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.49 ± 0.79</td>
<td>1.64 ± 0.81</td>
</tr>
</tbody>
</table>

Data are means ± SEM
Physical Characteristics

Participants’ physical characteristics are shown in table 7. There were no significant differences (p ≥ 0.43) between boys and girls for age, weight, height, BMI or BMI percentile (BMI %).

Table 7. Physical Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Age (years)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
<th>BMI</th>
<th>BMI %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boys</strong></td>
<td>8.8 ± 0.5</td>
<td>31.4 ± 2.2</td>
<td>132.2 ± 2.9</td>
<td>17.7 ± 0.5</td>
<td>73 ± 5.5</td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td>8.2 ± 0.5</td>
<td>33.5 ± 4.0</td>
<td>131.8 ± 4.5</td>
<td>18.7 ± 1.3</td>
<td>70.5 ± 9.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8.5 ± 0.4</td>
<td>32.3 ± 2.2</td>
<td>132.1 ± 2.6</td>
<td>18.2 ± 0.7</td>
<td>71.8 ± 5.1</td>
</tr>
</tbody>
</table>

Data are means ± SEM
VO$_2$

A significant social condition by gaming condition by sex interaction effect was found for VO$_2$ ($p = 0.04$, Figure 1). To explore this three-way interaction, two additional social condition by gaming condition ANOVAs were performed for boys and girls separately. Boys had a significant social condition by gaming condition interaction ($p = 0.01$) whereas girls did not ($p = 0.77$). The interaction in boys was due to a significantly greater increase ($p = 0.02$) in VO$_2$ from the alone to the peer condition for Wii compared to the resting condition.

There was no significant difference in the increase in VO$_2$ from the alone to peer conditions for boys in the PS2 versus the Wii conditions ($p \geq 0.08$) or in the rest versus PS2 conditions ($p = 0.06$). Girls showed no significant change in VO$_2$ from the alone to the peer condition for any of the gaming conditions ($p \geq 0.44$).
Figure 1. VO₂ for social condition by gaming condition by sex: Mean ± SEM for social condition by gaming condition by sex interaction for VO₂. In the peer condition males had significantly greater increase (Δ 9.0 ± 3.7 ml·kg⁻¹·min⁻¹; p = 0.02) in VO₂ from rest to Wii (upper panel). Females showed no significant change (p ≥ 0.44) from alone to peer for any gaming conditions (lower panel).
There was a significant gaming condition by sex interaction effect (p = 0.02, Figure 2). This was caused by a greater (p = 0.02) increase in VO$_2$ from the resting to the Wii condition in boys (Δ 9.0 ± 3.7 ml·kg$^{-1}$·min$^{-1}$) relative to girls (Δ 4.9 ± 2.9 ml·kg$^{-1}$·min$^{-1}$). Boys demonstrated an increase in caloric expenditure of 1.39 ± 0.61 kcal ·min$^{-1}$ from the resting condition to Wii, increasing from 0.73 ± 0.22 kcal ·min$^{-1}$ in the resting condition to 2.12 ± 0.59 kcal ·min$^{-1}$ in the Wii condition. Girls increased caloric expenditure 0.8 ± 0.45 kcal ·min$^{-1}$ from the resting condition to Wii, increasing from 0.92 ± 0.4 kcal ·min$^{-1}$ at rest to 1.72 ± 0.78 kcal ·min$^{-1}$ when playing Wii.

![Figure 2](image_url)

*Figure 2. VO$_2$ for gaming condition by sex: Mean ± SEM for gaming condition by sex. There was a significant increase (p = 0.02) in VO$_2$ from the resting condition to Wii in boys but not girls.*
There was also a significant main effect for gaming (p < 0.001). Paired-Samples t-test revealed that the main effect for gaming was due to higher (p < 0.001) VO₂ with Wii (12.2 ± 4.1 ml·kg⁻¹·min⁻¹; 3.5 ± 0.26 METS) relative to the resting condition (5.1 ± 1.5 ml·kg⁻¹·min⁻¹; 1.46 ± 0.1 METS) and a higher (p < 0.001) VO₂ with Wii relative to PS2 (5.8 ± 2.0 ml·kg⁻¹·min⁻¹; 1.65 ± 0.13 METS). Children increased caloric expenditure from 0.82 ± 0.32 kcal · min⁻¹ at rest to 1.93 ± 0.69 kcal · min⁻¹ while playing the Wii. There was no significant difference (p = 0.08) between VO₂ in the resting condition and PS2. There were no additional significant main or interaction effects (p ≥ 0.23) for VO₂.

**Liking**

A significant main effect for gaming was found (p < 0.001). Post-hoc Paired-Samples t-tests revealed that this main effect was due to greater (p < 0.001) liking in the PS2 condition (8.3 ± 1.3 cm) relative to the resting condition (4.0 ± 2.8 cm) and greater (p = 0.001) liking in the Wii condition (7.7 ± 1.9 cm) relative to the resting condition. Post-hoc comparisons did not reveal any significant difference between liking for the PS2 versus the Wii (p = 0.37). There were no additional significant (p ≥ 0.21) main or interaction effects for liking.
**RPE**

There was a significant (p = 0.002) main effect for gaming condition for RPE. Post-hoc Paired-Samples $t$-tests revealed that this effect was due to a significant increase (p = 0.005) in RPE from the resting condition (1.9 ± 1.7) to the Wii (3.7 ± 2.3) and a significant increase (p = 0.014) from PS2 (2.0 ± 1.6) to the Wii. There was no significant difference in RPE from the resting condition to the PS2 (p = 0.66). There were no additional significant (p ≥ 0.21) main or interaction effects for RPE.

**$O_{\text{max}}$**

There was a significant (p = 0.03) social condition by gaming condition interaction for $O_{\text{max}}$. Post-hoc Paired Samples $t$-Tests showed that $O_{\text{max}}$ for PS2 significantly increased (p = 0.05) from the alone condition (245.5 ± 108.0 presses) to the peer condition (427.0 ± 115.6 presses), while scores for the Wii significantly decreased (p = 0.04) from the alone condition (340.8 ± 106.8 presses) to the peer condition (147.8 ± 81.6 presses, Figure 3). There were no additional significant main or interaction effects for $O_{\text{max}}$ (p ≥ 0.25).
Figure 3. O\textsubscript{max} for social condition by gaming condition: Mean ± SEM for O\textsubscript{max} social by gaming conditions. PS2 significantly increased (p = 0.05) from the alone to the peer condition, while scores for the Wii significantly decreased (p = 0.04) from alone to the peer condition.
CHAPTER V
DISCUSSION

While video game and other square screen use among American children continue to rise, sedentary behavior and obesity rates have increased as well (Hedley et al., 2004). The current research was conducted for the purpose of addressing childhood sedentary behavior by examining the effect of peer influence on the motivation to play a physically interactive video game. This is the first investigation to research the effect of the presence of a peer on children’s metabolic expenditure and the RRV of a physically interactive video game versus a traditional sedentary video game. As was the case in previous studies, energy expenditure (i.e. VO\textsubscript{2}) and RPE was significantly higher overall for the physically interactive game (Wii) compared to the resting condition and the PS2 video game (Graf et al., 2009; Barkley & Penko, 2009; Penko & Barkley, 2010). Also similar to a previous study was the fact that boys achieved a greater VO\textsubscript{2} during Wii play than girls did (Barkley & Penko, 2009). This was however the first study to demonstrate that the presence of a peer, relative to the alone condition, significantly increased VO\textsubscript{2} during Wii play for boys but not girls.

Sex differences in energy expenditure have been shown in previous studies, both with children and adults. Barkley & Penko (2009) found that adult men increased energy expenditure with Wii boxing significantly more than females. Similarly, a 2009 study found that boys demonstrated significantly higher energy expenditure than girls in Wii
Dance Dance Revolution® and Wii Bowling® (Graf et al., 2009). Therefore it was not surprising that the boys, relative to girls, exhibited greater increase in energy expenditure during Wii play. Since the current study utilized both a sedentary and a physically interactive boxing game, it is possible that the nature of the games were not as appealing to girls as to boys, thus affecting energy expenditure. Boys have been shown to demonstrate more peer directed physical aggression than girls (Maccoby, & Jacklin, 1980). In our investigation the boys exhibited higher VO\(_2\) with the Wii and the increase from rest to Wii was greater in the peer condition. This suggests that the boys were moving more in an effort to punch the opponent, possibly due to greater aggressive tendencies than the girls.

Liking scores in the present research indicated that children did not show a significant preference for the exergame compared to the sedentary alternative. While they did prefer both games better than rest, the Wii was not liked more than the sedentary game, either alone or with a friend as we had hypothesized. Unlike liking, the RRV task in our study revealed that motivation for Wii versus PS2 was different between social conditions. Children showed a significant increase in motivation to play the PS2 in the presence of a peer, while at the same time decreased motivation for the Wii when with a friend. Past research has shown that Wii is highly reinforcing when children played the game alone (Penko & Barkley, 2010). We observed a similar effect in the present study as children were more motivated to play Wii versus PS2 when alone. However, it was interesting and surprising that children’s motivation to play the exergame declined when they were with a friend.
In multiple previous studies focusing on traditional physical activity behavior (e.g., playing in a gymnasium), children have been shown to increase physical activity in the presence of a peer (Anderssen & Wold, 1992; Coppinger et al., 2010). This was especially true when the peer who is present is a friend as was the case in this present study. These previous findings were the basis for our hypothesis that children would increase their motivation to play the exergame relative to a traditional sedentary alternative when playing with their friend versus playing alone. While it is unclear why we found the opposite effect, it would appear that peer influence’s effect on physically active video game play is different than that of traditional physical activity. We have offered some potential reasons as to why that may be below.

Motivation to play a physically interactive game was examined by Staiano, Abraham, & Calvert (2012). They found that cooperative play resulted in higher intrinsic motivation to play the exergame. Anecdotally, several of the children in our study asked if they could be on the same team rather than compete against each other. This raises the question as to whether the children felt that the Wii boxing was a first person experience, as though they were truly hitting or being hit by their friends. Wii Boxing requires the player to perform actual punching motions to play the game which may make it more realistic than PS2. PS2 may have felt less real to the children due to the cartoon-like graphics and the use of a controller as opposed to the more realistic punches the children were throwing with Wii. When the children played PS2 they used a handheld controller in which pushing a button would cause the boxer on the screen to throw a punch. The boxers in PS2 were various interesting animated characters whereas the Wii boxer,
although animated, actually represented the child’s friend. It is possible that young children prefer not to be in direct opposition to their close friends and that the opposition associated with Wii Boxing was less appealing than PS2.

An alternate explanation for our surprising findings may have simply been that children found it easier to converse with their friend when playing PS2 versus the Wii. Anecdotally children were far more conversant with one another during PS2 play. This is likely because the Wii required more physical exertion making conversation more difficult. Thus, the ability to interact with their peers may have been what reinforced the desire to play the sedentary game.

Many studies show the benefits of exergames for increasing energy expenditure in children (Graf et al., 2009; Mitre, Foster, Lanningham-Foster, & Levine, 2011; Graves, Stratton, Ridgers, & Cable, 2008; White, Schofield & Kilding, 2011; Siegel, Haddock, Duboid, & Wilkin, 2009; Lanningham-Foster et al., 2006; Graves, Stratton, Ridgers, & Cable, 2007) but unfortunately this does not always translate into the likelihood children will be motivated to play an exergame over a sedentary game. Our research illustrates that there can be a discordant relationship between the higher energy expenditure of an exergame and a lower motivation to play the game in the presence of a peer. The children in our study expended more than double the kilocalories playing Wii than they did playing the sedentary alternative and yet motivation to play the Wii declined when the children were in the presence of a peer. Our results certainly present a challenge, but it may be that lack of intrinsic motivation in this case is not a barrier to providing greater opportunity for children to be physically active. Motivating children to choose an
exergame over a sedentary option is still a worthy inquest. Just as important however, may be examining ways to keep children active once they begin to play. The children in our study often expressed a desire to continue playing the Wii at the end of the 10 minute gaming condition even though they later chose the sedentary game when offered a choice with the RRV task. Roemmich, Lambiase, McCarthy, Feda, & Kozlowski (2012) showed that children played an exergame 87% longer than they did the traditional physically active games when in a free-choice gaming environment. This showed that once they have begun to play an exergame, children will likely continue and expend more energy than they would if they remained sedentary. Thus, even if children opt for a sedentary game when given the choice, the physically interactive game may be very motivating once they start playing it. The challenge then is to simply initiate the activity in the first place.

There are a number of studies that examine ways to incentivize children to be more physically active (Juvancic-Heltzel, Glickman, & Barkley, 2012; Staiano et al., 2012; Wilson, Williams, Evans, Mixon, & Rheaume, 2005). Juvancic-Heltzel et al., (2012) demonstrated that increasing variety of choices increased exercise participation and enjoyment. Increasing choice of activity has also been associated with increased intensity and duration of play (Feda, Lambiase, McCarthy, Barkley, & Roemmich, 2012). The amount of time that children choose to be active has been addressed utilizing exergames as well. One study determined that providing exergames as an option to traditional physical education classes resulted in an increase in the amount of time that
the children were active (Shayne et al., 2012). It is useful to ask whether simply providing exergame options may be enough over time to increase PA for most children. In our study, only the boxing game was used. Wii® Sports boxing consistently yields higher energy expenditure than other exergames and as a result was a good choice for this study (Graves et al., 2008; Graves et al., 2007). However, many options exist for Wii and other exergames. Offering children more exergame options than traditional sedentary game options may be enough in itself to encourage and motivate children to play.

Several limitations existed in the current research. First, our study was relatively small (n = 17), however previous studies have also shown an increase in energy expenditure with exergames using similar size or larger samples (Maddison, et al., 2007; Lanningham-Foster et al., 2006). Additionally, there was only the option of boxing for this particular study which may have limited motivation for all of the children and influenced liking, especially for the girls. Since girls have been shown to be less physically aggressive than boys, it is possible that girls found boxing to be too combative (Maccoby et al., 1980). Wii boxing was chosen due to the potential for greater energy expenditure compared to other games (Graves et al., 2008; Graves et al., 2007). The game for the PS2 was also a boxing game, which allowed us to compare sedentary boxing to physically interactive boxing with two players. However, as mentioned previously, the fact that both games were competitive may also have limited liking and motivation for children who prefer cooperative play. It should also be noted that all of the children were familiar with and had played the Wii boxing game. At the same time, none of the children were familiar with the PS2. It is possible that the novelty of the PS2
affected the motivation or liking of the games and is therefore an additional limitation of this study.

In light of the popularity of exergames like the Nintendo Wii, and their potential to increase energy expenditure over traditional sedentary video games, exergames are an obvious choice when seeking activity interventions for inactive children. Several studies have found that exergames can be a preferable alternative to traditional games (Shayne et al., 2012; Sun, 2012; Fogel, Miltenberger, Graves, & Koehler, 2010; Kraft, Russell, Bowman, Selsor 3rd, & Foster, 2011; Mitre et al., 2011) and has been examined as a physical education option in schools (Shayne et al., 2012; Sun, 2012). In light of the sex differences found in our research future investigations should examine energy expenditure and peer influence utilizing exergames that may be more appealing to girls. Variety of choice with exergames is another direction for future research. The expanding number of physically interactive games allows for evaluation of upper and lower body energy expenditure as well as presenting options for children that did not exist in the current study. Peer influence might have had a different effect in our study if there had been more options, given that children may choose differently when with a friend versus alone. Finally, cooperative play should be examined as it relates to energy expenditure and motivation to play an exergame versus a sedentary alternative.
Conclusion

The presence of a peer during exergame play increased energy expenditure in boys but did not increase the motivation to play these games in boys or girls. It is possible that decreased motivation to play the Wii in the peer condition was the result of a diminished ability to socialize with a peer versus PS2 game play. It may also be that children perceived the Wii in the peer condition as more realistic than PS2 and they did not want to be in direct opposition with their friends. However, since energy expenditure did increase with the Wii, exergames remain a worthy area of ongoing and future research.
APPENDICES
APPENDIX A

PARENT/CHILD PHONE SCRIPT
Appendix A

Parent/Child Phone Script

The effect of peer influence on the reinforcing value of physically interactive video games in children

Hello, this is _____________________ from the Applied Physiology Lab at Kent State University. I am calling because you have previously expressed interest in a study in our laboratory, and you indicated your willingness to be contacted for future studies. Would you like to hear about a new study that your child may qualify to participate in? The purpose of this study is to determine how boys and girls, ages 6-10, like traditional, seated vs. physically active (Wii) video games when they play by themselves and with a friend. Children could potentially over exert themselves but play will be self-regulated, so this is unlikely. The children will be supervised by researchers who are certified in CPR and you will also be asked to remain near the laboratory until your child is finished playing the games. We will keep the play area free of potential hazards as well.

There will be a total of 2 visits for this study. On the first visit we will explain the games and a computer task to your child and measure his or her height and weight. Then he/she will complete the following conditions: 10 minutes of resting, 10 minutes of traditional seated video game play and 10 minutes of Nintendo™ Wii play. Both visits will be the same, but during one of the visits your child will play the games alone and during the other visit, he or she will play with a friend. At both of these visits your
child will wear a face mask that allows us to measure the oxygen and carbon dioxide that your child exhales so that we can evaluate how hard your child exercised.

Your child will then perform a computer matching task to acquire points that will allow them access to their choice of the traditional, seated game, the Nintendo™ Wii game, or a combination of both, for a total of 11 minutes. We will also ask your child how he/she liked each of the sessions. At the end of the study your son or daughter will receive a $10.00 gift certificate for each laboratory visit ($20.00 total) to Target. Your child’s friend will receive a $10.00 gift certificate for completing their single visit.

Any information obtained from you, including this phone screen, will be treated in strict confidence. This phone screen is voluntary and you may stop at any time. Do you have any questions? Does this sound like something you and your child are interested in?

If no. Thank you for your time.

If yes. Great, I have a few questions to ask you to determine if your child is eligible to participate in this study. This will only take a couple of minutes and you can ask me questions at any time.

1. Answer questions on medical history.

2. What times are convenient for you to bring your child in for the study?

3. What is the name and contact information for the friend your child will bring for the study?
4. Let’s go ahead and set up your appointment times.

*(See time sheet)*

If for some reason you are unable to attend a session please try to give as much advanced notice as possible.

**Parent/Child phone script for friend:**

Hello, this is _____________________ from the Applied Physiology Lab at Kent State University. I am calling because your child ______________friend ______________said that you might be willing to participate with him/her in a research study in our laboratory. Would you like to hear about a new study that your child may qualify to participate in?

The purpose of this study is to determine how boys and girls, ages 6-10, like traditional, seated vs. physically active (Wii) video games when they play by themselves and with a friend. Your child would participate in 1 of the visits with his/her friend and would play video games with him/her.

Children could potentially over exert themselves but play will be self-regulated, so this is unlikely. The children will be supervised by researchers who are certified in CPR and you will also be asked to remain near the laboratory until your child is finished playing the games. We will keep the play area free of potential hazards as well.

Your child will wear a face mask that allows us to measure the oxygen and carbon dioxide that the children exhale so that we can evaluate how hard they exercised. Not all of the children will be measured in this way however, all of them will wear the mask.
At the end of the study your son or daughter will receive a $10.00 gift certificate for completing their single visit.

Any information obtained from you, including this phone screen, will be treated in strict confidence. This phone screen is voluntary and you may stop at any time. Do you have any questions? Does this sound like something you and your child are interested in?

If no. Thank you for your time.

If yes. Great, I have a few questions to ask you to determine if your child is eligible to participate in this study. This will only take a couple of minutes and you can ask me questions at any time.

1. Answer questions on medical history.

2. Your child’s friend is scheduled to come on _____________. Will that work for you?

3. Let’s go ahead and set up your appointment times.

(See time sheet)

If for some reason you are unable to attend a session please try to give as much advanced notice as possible.
Appendix B

Recruitment Flyer

ACTIVE VIDEO GAME RESEARCH OPPORTUNITY FOR 6-10 YEAR OLD CHILDREN

Participants will come to Kent State University twice and complete approximately 30 minutes of video game play in the Applied Exercise Physiology Laboratory

Participants will be compensated with two $10.00 gift certificates to a local retailer upon the completion of the study

For more information, please contact
Lee Anne Siegmund R.N., M.A.
Doctoral Student, Kent State University
Email: lsiegmun@kent.edu
Phone: 440-823-1574
APPENDIX C

HEALTH QUESTIONNAIRE
Appendix C

Health Questionnaire

Child Medical History – Phone Screen

Participant #__________________ Date___/___/____

ChildName_________________________________Parent_____________________________________

Address______________________________________________________________________________

Phone Number__________________________________________________________

Age_______ (must be 6-10 y) DOB_____/___/____ Sex m f

Height ________in Wt _________lbs

Height _______cm (inches *2.54) Wt_________kg (lbs/2.2) BMI_________kg/m2

Weight percentile_____________________

Which ethnic group does your child (do you) most identify with (circle response):

American Indian, Alaskan Native, Asian or Pacific Islander, Black, not of Hispanic

Origin, Hispanic, White, Other_____________________

Y/N

____ Has a doctor ever said that your child’s blood pressure was too high or too low?

____ Does your child ever have pain in their heart or chest?

____ Does your child ever notice extra heart beats, skipped beats or a racing heart?

____ Has a doctor ever said that your child has heart trouble, an abnormal

electrocardiogram (ECG or EKG), heart attack, or coronary?
___ Has your child ever been diagnosed with asthma?

___ Does your child often have trouble breathing?

___ Has your child ever been diagnosed with diabetes?

___ Does your child have any orthopedic limitations to physical activity?

Does your child have any other medical conditions that affect his/her ability to safely participate in physical activity? If yes, explain.

______________________________________________________________________  
______________________________________________________________________  

Is your child currently taking any medication(s)?  Y   N

If yes, please describe the medication(s)

______________________________________________________________________  
______________________________________________________________________  

Is your child involved in any club or school sport teams?  Y   N

If yes, what sport(s) and how frequently each week? ______________________

Do you have any questions?

Does the participant seem eligible?  Y   N

Schedule Appointments:

Date of first appointment: __________________________

Second: _________________________________________
APPENDIX D

PARENT/CHILD INFORMED CONSENT
Appendix D
Parent/Child Informed Consent

The effect of peer influence on the reinforcing value of physically interactive video games in children

Hello, we are conducting a research project on how children enjoy exercising by using a Nintendo Wii™ video game and how the presence of a peer influences that enjoyment. We would like your child to take part in this project. If you decide to allow your child to participate, you will be asked to bring your child to the Exercise Physiology Laboratory on two separate occasions for approximately one hour per visit. We will ask you to stay at the laboratory with your child until the completion of each visit. The first visit will be a little longer because we need to measure your child’s height and weight. We will also give an explanation of the video games your child will play and a computer matching task your child will also complete. During the matching task your child can earn more time for the video game(s) he or she prefers.

On both days, your child will spend 10 minutes resting, 10 minutes playing a traditional seated video (Playstation 2™) game and 10 minutes playing video game on the Nintendo Wii™. The two days are the same except one of the days your child will play the games alone and the other day he/she will play the games with a friend. During these 10 minute sessions, your child will wear a face mask that allows us to measure the oxygen and carbon dioxide that your child exhales so that we can evaluate how hard your
child exercised. On the day that your child plays the games with a friend, both children will wear the face masks but only your child’s activity will be measured.

After doing all three of the 10 minute sessions, your child will complete a computer matching task in which he or she will earn access to 11 additional minutes to the video game he or she prefers. During this computer task your child will perform work, in the form of button presses on a computer mouse, to earn a total of 11 additional minutes of access to either of the two games or a combination of both. After the computer task is completed your child will play the video games for the amount of time that they earned for each. On the day that your child plays the games with a friend, only your child will play the computer matching game to earn time for the activity or activities of his or her choice. The 11 minutes that he or she earns will then be played with a friend.

If your child is very physically active during these sessions, he or she may experience muscle soreness a day or two after the activity. An exercise physiologist will be present to assure that your child is exercising safely during the activity. Medical assistance or emergency medical treatment by the University Health Center is only provided to currently registered students. Please be advised that for all others, “911” will be called for physical injuries occurring on the Kent State University main campus. You or your medical insurance will be billed for this service. No other medical treatment or financial compensation for injury from participation in this project is available.
Confidentiality will be maintained to the limits of the law. Confidentiality may not be maintained if you indicate that you may do harm to yourself or have done harm to others. All files will be kept in Dr. Jacob Barkley’s applied physiology laboratory in a locked filing cabinet. Your child’s name will not be used during the study; they will be assigned a number that will serve as their identity. If your child takes part in this project they will receive a $10.00 gift certificate for completing each visit ($20.00 total) and your child’s friend will receive a $10.00 gift certificate to Target. Taking part in this project is entirely up to you and no one will hold it against you or your child if you decide not to do it. If your child does take part, he or she may stop at any time.

If you want to know more about this research project, please call me, Lee Anne Siegmund, at (440) 823-1574 or Dr. Jacob Barkley at (330) 672-7040. The project has been approved by Kent State University. If you have any questions about your rights as a research participant or complaints about the research please call the IRB at (330) 672-2704.

You will get a copy of this consent form.

Sincerely,

Lee Anne Siegmund

Graduate Student

Exercise Physiology program

Kent State University
B. CONSENT STATEMENT (S)

1. I agree to have my child to take part in this project. I know what my child will have to do and that he/she may stop at any time.

Parent Signature_____________________________________ Date _______________

Child Signature_______________________________________ Date _______________

Witness Signature Date _______________________________ Date _______________
APPENDIX E

PARENT/CHILD INFORMED CONSENT FOR FRIEND
Appendix E

Parent/Child Informed Consent for Friend

The effect of peer influence on the reinforcing value of physically interactive video games in children

Hello, we are conducting a research project on how children enjoy exercising by using a Nintendo Wii™ video game and how the presence of a peer influences that enjoyment. We would like your child to take part in this project. If you decide to allow your child to participate, you will be asked to bring your child to the Exercise Physiology Laboratory on one occasion for approximately one hour. We will also give an explanation of the video games your child will play. We will ask you to stay at the laboratory with your child until the completion of the visit.

Your child will spend 10 minutes playing a traditional seated video (Playstation 2™) game and 10 minutes playing a video game on the Nintendo Wii™. During these 10 minute sessions, your child will wear a face mask that allows us to measure the oxygen and carbon dioxide that is exhaled so that we can evaluate how hard you’re the children exercised. Both children will wear the face masks but only your child’s friend’s activity will be measured.

After doing the 10 minute sessions, your child’s friend will complete a computer matching task in which he or she will earn access to 11 additional minutes to the video game he or she prefers. After the computer task is completed your child and his/her friend will play the video games for the amount of time that was earned for each game.
Only your child’s friend will play the computer matching game to earn time for the activity or activities of his or her choice. The 11 minutes that he or she earns will then be played by both your child and his/her friend.

If your child is very physically active during these sessions, he or she may experience muscle soreness a day or two after the activity. An exercise physiologist will be present to assure that your child is exercising safely during the activity. Medical assistance or emergency medical treatment by the University Health Center is only provided to currently registered students. Please be advised that for all others, “911” will be called for physical injuries occurring on the Kent State University main campus. You or your medical insurance will be billed for this service. No other medical treatment or financial compensation for injury from participation in this project is available.

Confidentiality will be maintained to the limits of the law. Confidentiality may not be maintained if you indicate that you may do harm to yourself or have done harm to others. All files will be kept in Dr. Jacob Barkley’s applied physiology laboratory in a locked filing cabinet. Your child’s name will not be used during the study; they will be assigned a number that will serve as their identity. If your child takes part in this project he/she will receive a $10.00 gift certificate to Target for completing the visit. Taking part in this project is entirely up to you and no one will hold it against you or your child if you decide not to do it. If your child does take part, he or she may stop at any time.
If you want to know more about this research project, please call me, Lee Anne Siegmund, at (440) 823-1574 or Dr. Jacob Barkley at (330) 672-7040. The project has been approved by Kent State University. If you have any questions about your rights as a research participant or complaints about the research please call the IRB at (330) 672-2704.

You will get a copy of this consent form.

Sincerely,

Lee Anne Siegmund
Graduate Student
Exercise Physiology program
Kent State University

B. CONSENT STATEMENT (S)

1. I agree to have my child to take part in this project. I know what my child will have to do and that he/she may stop at any time.

Parent Signature______________________________________ Date _______________
Child Signature ______________________________________ Date _______________
Witness Signature Date ________________________________ Date _______________
APPENDIX F

CHILD ASSENT
Appendix F

Child Assent

Title of Study: “The effect of peer influence on the reinforcing value of physically interactive video games in children”

Who are we?

My name is Lee Anne Siegmund and I am doing a special project, which is a lot like homework. I am doing this so that I can graduate from college. One of my teachers, Dr. Jacob Barkley is helping me finish my research project.

Why are we meeting with you?

We want to tell you about our project to see if you would like to help too.

Why are we doing this study?

We want to learn more about the kinds of video games you like. We would like to see how much you like to play them when you are playing by yourself and when you are playing them with a friend.

What will happen to you if you are in the study?

If you decide to help with the project, you should ask a friend to be with you. Your friend will come and play the video games with you on one of the visits. You will come to the lab here at Kent State University two times. On the first day, you and one of your parents will learn about the project and you will let us know if you want to help. If you decide to help we will measure to see how tall you are and then we will weigh you.
Both times you come with your parent you will play a video game in which you are sitting and another video game in which you are moving around (Wii™). On one of these visits you will play the games by yourself. On the other visit you will play the games with a friend. Each time you will wear a special mask on your face that helps us measure how hard you are playing. It is not uncomfortable and it will be easy for you to breathe and talk. You will have a chance to try it on and see what it feels like at the first visit.

You will play each game for 10 minutes then take a break to play a different computer game. This different game will let you earn more time to play one or both of the video games you just tried out. You will be asked how much you liked the video games and how tired you are after playing each of the games. We will give you a $10.00 gift certificate to Target each time you come.

**What are the good or bad things that may happen?**

Your arms and legs may get tired if you are not used to being active and your muscles may be a little sore the day after you play. This is normal.

**Do you have to help with the project?**

No you don’t. No one will get angry or upset with you if you don’t want to do this. Just tell us if you don’t want to be in the study. And remember, you can change your mind later if you decide you don’t want to do it anymore.
**Do you have any questions?**

You can ask questions at any time. You can ask now. You can ask later. You can talk to me or you can talk to someone else at any time during the study. Here are the telephone numbers to reach us:

Jacob Barkley, PhD, Exercise Physiology, (330) 672-0209.

Kent State Applied Physiology Lab, (330) 672-7040.

If you want to be in the study, sign your name on the line below:

Signature of Child: ___________________________ Date: __________

Signature of Parent: ___________________________ Date: __________

Signature of Witness: ___________________________ Date: __________

Signature of PI: ___________________________ Date: __________
APPENDIX G

CHILD ASSENT FOR FRIEND
Appendix G

Child Assent for Friend

Title of Study: “The effect of peer influence on the reinforcing value of physically interactive video games in children”

Who are we?

My name is Lee Anne Siegmund and I am doing a special project, which is a lot like homework. I am doing this so that I can graduate from college. One of my teachers, Dr. Jacob Barkley is helping me finish my research project.

Why are we meeting with you?

We want to tell you about our project to see if you would like to help too.

Why are we doing this study?

We want to learn more about the kinds of video games you like. We would like to see how much you like to play them when you are playing by yourself and when you are playing them with a friend.

What will happen to you if you are in the study?

Your friend has asked if you would like to be in this study with him/her. The two of you will come and play the video games together. Your friend will come one other time and play by himself/herself.

You will come with one of your parents and we will tell you all about the games you will be playing. Then you will let us know if you want to help with this project.
When you come to the lab you will play a video game in which you are sitting and another video game in which you are moving around (Nintendo Wii™). You will play these games with your friend. You will be asked to wear a special mask on your face that helps us measure how hard you are playing. It is not uncomfortable and it will be easy for you to breathe and talk. You will have a chance to try it on and see what it feels like before you play.

You will play each game for 10 minutes then take a break. You and your friend will play one or both of the games for 11 more minutes. You will be given a $10.00 gift certificate to Target for your visit.

What are the good or bad things that may happen?

Your arms and legs may get tired if you are not used to being active and your muscles may be a little sore the day after you play. This is normal.

Do you have to be in the study?

No you don’t. No one will get angry or upset with you if you don’t want to do this. Just tell us if you don’t want to be in the study. And remember, you can change your mind later if you decide you don’t want to be in the study anymore.

Do you have any questions?

You can ask questions at any time. You can ask now. You can ask later. You can talk to me or you can talk to someone else at any time during the study. Here are the telephone numbers to reach us:

Jacob Barkley, PhD, Exercise Physiology, (330) 672-0209.
Kent State Applied Physiology Lab, (330) 672-7040
If you want to be in the study, sign your name on the line below:

Signature of Child: __________________________________ Date: __________

Signature of Parent: _________________________________ Date: __________

Signature of Witness: _______________________________ Date: __________

Signature of PI: _____________________________________ Date: __________
APPENDIX H

ANTHROPOMETRICS DATA RECORDING FORM
Appendix H

Anthropometrics Data Recording Form

Date: _________________________________

Name: ________________________________

Birth date: ___________________________

Age: _________________________________

Height (cm):__________________________

Weight (kg):__________________________

BMI percentile: ______________________
APPENDIX I

LIKING VISUAL ANALOG SCALE
Appendix I

Liking Visual Analog Scale

Name: _____________________

Date: ___/___/___

_______________________________________________________________________________

Do not like it at all.                             Like it very much.

APPENDIX J

VALIDATED OMNI RATING OF PERCEIVED EXERTION SCALE
Appendix J

Validated OMNI Rating of Perceived Exertion Scale
APPENDIX K

DATA COLLECTION FORM
Appendix K

Data Collection Form

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Output maximum: 

Total responses: 

**RPE:**

**Remember VAS**
REFERENCES


