January 2014

A Video Game Cycling Intervention Assessing Exercise Enjoyment, RPE, Heart Rate, And Total Work Output In College Students

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A VIDEO GAME CYCLING INTERVENTION ASSESSING EXERCISE ENJOYMENT, RPE, HEART RATE, AND TOTAL WORK OUTPUT IN COLLEGE STUDENTS

by

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Bachelor of Science, University of North Dakota, 2012

A Thesis

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science
Kinesiology

Grand Forks, North Dakota
August
2014

This thesis, submitted by Shawn Ryan Reich in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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This thesis is being submitted by the appointed advisory committee as having met all of the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.

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August 6, 2014
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PERMISSION

Title	A Video Game Cycling Intervention Assessing Exercise Enjoyment, RPE, Heart Rate, and Total Work Output in College Students
Department	Kinesiology and Public Health Education
Degree	Master of Science

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07-31-14

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ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to the members of my advisory committee. Thank you to Dr. Tanis Hastmann and Dr. John Fitzgerald for allowing me to think more outside the box as well as letting me use some of your research equipment to make my study a reality. Also, I want to give a special thanks to Dr. Dennis Caine as you were the one who suggested that I further pursue my undergraduate research into something more. And to Dr. James Whitehead, thank you for your always positive encouragement and guidance throughout my college education and for that I am forever grateful.

I would also like to thank my fellow graduate students and friends (you know who you are) for helping me with various thesis-related tasks such as recruitment to just providing simple, but effective feedback. You all were a tremendous help and I am very thankful for that.

But most of all, thank you Mom and Dad. You have been there with me every step of the way. Thank you for your patience, understanding, guidance, love, and for pushing me to do my best. I am very much appreciative to have you as my parents. I love you Mom and Dad.

To Mom and Dad,
With great appreciation and love

ABSTRACT

Background: Physical inactivity can lead to numerous health issues. More recently, advances in technology have catered to this area of concern. Activity-promoting video games or exergames, have recently been providing consumers with an innovative and alternative experience to exercise. Traditional exercise modalities such as the cycle ergometer (CE) have utilized video game (VG) play to help increase exercise enjoyment and overall health benefits. However, few studies have examined CE and VG play in this regard.

Purpose: The purpose of this study was to investigate if cycling with a non-interactive CE while playing a VG is a viable option to increasing exercise enjoyment while eliciting low perceived exertion and increased physiological benefit.

Methods: A within-subjects experimental design was utilized. College-aged males (n=24; ages 18-25 years [*SD*±22.17]) participated in four sessions: (i) Familiarization, (ii) cycling while playing an Xbox® 360 VG console, (iii) cycling while watching music videos (MV), and (iv) cycling with no external media (CT). Measures included exercise enjoyment (modified PACES; Whitehead et al., 2008), perceived exertion (Borg's 6-20 RPE scale, [Borg, 1982]), heart rate (HR), and total work output. It was hypothesized that: (i) experimental condition of CE with VG play would produce higher enjoyment scores, (ii) would keep perceived exertion levels the same or below the music video and control conditions and elicit higher HRs and total work output. *Data Analysis* included descriptive statistics and paired t-tests with Holm's Sequential Bonferroni adjustments.

Results: Paired t-tests with Holm's Sequential Bonferroni adjustment was utilized for analyzing any statistically significant differences between the three treatment conditions. In terms of exercise enjoyment, the VG and MV conditions consisted of the highest PACES scores, but there was no statistically significant difference between the two treatments. RPE was significantly lower in the VG condition than both the MV and CT conditions (VG M=13.21, SD=±1.56; MV M=14.46, SD=±1.72; t(23)=-3.55, p<.005, d=.73 and VG M=13.21, SD=±1.56; CT M=14.25, SD=±1.62; t(23)=-3.65, p<.001, d=.64). There were no statistically significant differences in HR between the three conditions. A significantly higher total work output was observed in the MV condition over the VG condition and CT over the VG condition (VG M=113.12, SD=±29.21; MV M=128.11, SD=±30.17, t(23)=-6.22, p<.001, d=.51 and VG M=113.12, SD=±29.21; CT M=122.75, SD=±33.30 t(23)=-3.96, p<.005, d=.33).

Conclusion: The obesity epidemic is a great health concern and it has been linked to many causal factors. Insufficient daily PA and exercise has been shown to spur the onset of obesity development and potentially other serious health consequences. PA is necessary for helping to negate these health risks. This investigation has shown that positive benefits can be produced from cycling with a non-interactive CE while playing a console video game. The results of this study suggest that this particular cycling and video game setup can elicit an exercise bout that is just as effective as with cycling using other external media (i.e., watching music videos) as well as without any external media. The use of video games intertwined with traditional exercise modalities could help combat the obesity epidemic as it can be potentially used as another avenue for improving ones' health and fitness. This in turn, may provide a more enjoyable, motivating, and engaging experience for an individual who is not meeting the recommended daily PA guidelines. This may ultimately keep their PA and exercise adherence at a high state.

CHAPTER I

INTRODUCTION AND REVIEW OF THE LITERATURE

The advancements of technology have generated a plethora of creations that have impacted the workings of our civilization. Whether it is driving to work in one's hybrid vehicle, navigating an unmanned aircraft through a warzone even when one is thousands of miles away, or even as simply connecting one's USB drive to a computer, the evolution of technology has changed the way we go about our daily lives. While many technological innovations serve to make us more efficient, others are created for mere entertainment purposes. Video games seem to have become the forefront of home entertainment with U.S. sales reaching $21.53 billion in 2013, besting the $18.2 billion U.S. sales of DVD and Blu-ray media. In 2008, U.S. video game sales garnered significant growth as there was a $4 billion increase from 2007, even surpassing DVD and Blue-Ray media in global sales for the first time in that same year (Electronic Software Association [ESA], 2014; The Digital Entertainment Group, 2014; NDP, 2008; Sliwinski, 2009). While the video game industry has bolstered staggering sales, its public persona has been under scrutiny due to its possible adverse effects on health, more specifically in relation to the significant health concern of obesity.

According to the Centers for Disease Control and Prevention (CDC) from data taken from the National Health and Nutrition Examination Survey (NHANES), more than one-third of U.S. adults (35.7%) and approximately 17.5% of children and adolescents ages 2-19 years are obese (Ogden, Carrol, Kit, & Flegal, 2014). And while recent data illustrate that obesity rates in the U.S. appear to be slowing or leveling off, the numbers are still significantly high (CDC, 2012). The underlying mechanisms for obesity development are not fully understood. Interestingly, childhood obesity may stem from genes such as leptin deficiency, gender-related differences, and other medical issues such as hypothyroidism and growth hormone deficiency or side effects from certain drugs like steroids (Dehghan, Akhtar-Danesh, & Merchant, 2005). However, there is growing research-based evidence that points to environmental factors that may have a significant impact on this widespread health concern (Dietz & Gortmaker, 1984; Hill & Peters, 1998; French, Story, & Jeffery, 2001; Hill, Wyatt, Reed, & Peters, 2003). Despite the fact that obesity has strong genetic determinants, a rapid change in the genetic composition does not occur. Thus, the significant prevalence of obesity must reflect major changes in non-genetic factors (Hill & Trowbridge, 1998).

One such non-genetic factor is physical activity (PA) which has been shown to help reduce the risk of developing cardiovascular disease, stroke, type II diabetes and metabolic syndrome, aid in the treatment of certain types of cancers as well as help prevent and improve the outcome of bone and joint issues, such as osteoporosis and osteoarthritis, respectively (Li & Siegrist, 2012; Fretts, 2012; Cho, Shin, Kim, Jee, & Sung, 2009; Speck, Courneya, Mâsse, Duval, & Schmitz, 2010; Pedersen & Saltin, 2006). PA has also been shown to improve mental health and mood (Taylor, Sallis & Needle, 1985; Saxena, Van Ommeren, Tang, & Armstrong, 2005). A review conducted by Pedersen and Saltin (2006) found that daily PA and exercise can improve depressive symptoms and quality of life in individuals with clinical depression. However, it is estimated that less than 5% of American adults participate in the daily recommendations of PA (Troiano et al., 2008) which includes 30 minutes a day of moderate-intensity PA on at least 5 days of the week (Physical Activity Guidelines for America, 2008). More than 80% of U.S. adults do not meet guidelines for both aerobic and muscle-strengthening activities (CDC, 2011) and just less than half (48%) of all adults meet the 2008 Physical Activity Guidelines (CDC, 2011).

While the data to support American physical inactivity is well-documented, the reasons for why this gradual progression towards unhealthy practices may be attributed to external influences such as technology which plays a significant role in many of our everyday lives. One technological innovation that is a ubiquitous part of the environment of children, adolescents, and especially adults that encourages sedentary behavior is television. It is estimated that 99% of American households have at least one television set (Nielsen, 2013). As a whole, it is estimated that Americans spend an average of just over 35 hours per week watching television (Nielsen, 2013). There have been several studies that have found little to no association between television viewing and weight status (Ford, 2012; Laurson, Eisenmann, & Moore, 2008; Must, 2007; Marshall, Biddle, Gorely, Cameron, & Murdey, 2004; Crawford, Jeffery, & French, 1999). However, there seems to be more evidence that has found television to be linked with the obesity health concern in some sort of capacity. The associations between increased television viewing and future health practices and issues have been investigated with various age groups (see Table 1). In fact, it has been found that overweight, raised serum cholesterol, higher incidence of smoking, and poor fitness levels can be linked with watching television for more than 2 hours a day during childhood and adolescence (Hancox, Milne, & Pouton, 2004). Interestingly, less time spent watching television was found to be associated with healthier dietary intake in U.S. children and adults which may help prevent the development of these future health issues (Sisson, Shay, Broyles, & Leyva, 2012).

Table 1. Potential health issues from excessive television viewing.

Authors of Study,Year	Study Design	Population Sample	Outcome Measured	Resultant Outcome
(Inoue et al., 2012)	Population-based, Cross-sectional Mail Survey	1,086 Japanese older adults (age: 65-74 years, men: 51.1%)	The joint associations of television viewing time and moderate-vigorous physical activity (MVPA) with overweight/obesity development	Independent of meeting physical activity guidelines, spending less time watching television was associated with lower risk of being overweight or obese
(Dunstan et al., 2010)	National Population-based Cohort	8,800 adults (3,846 men, 4,954 women; ages ≥25 years)	The relationships of prolonged television viewing time with total, CVD, cancer, and non-CVD/non-cancer mortality	Television viewing time was associated with increased risk of all-cause and CVD mortality. Reducing sitting time, particularly television screen time, along with promotion of exercise and other chronic disease prevention strategies may prevent these increased risks
(Healy et al., 2008)	Cross-sectional	Data from Australian Diabetes, Obesity and Lifestyle Study 4,064 physically healthy adults (2,031 men, 2,033 women aged ≥25 years)	The dose-response associations of television-viewing time with continuous metabolic risk. Also, to examine the extent to which central obesity mediated relationships of television-viewing time with other metabolic factors (e.g., fasting and 2-h plasma glucose, triglycerides)	Increased television-viewing time, regardless of meeting physical activity guidelines, was found to elicit detrimental dose-response associations with metabolic risk
(Hancox, Milne, & Poulton, 2004)	Longitudinal	1,037 children (535 boys and 502 girls) at age 3 years, follow-up of 980 out of 1019 at age 26 years	The amount of television watched each day and assessments of adult health (BMI, Vo_2 max, cholesterol levels, smoking status, and systolic blood pressure (At 26 years of age)	Television viewing in childhood and adolescence is associated with overweight, poor fitness, smoking, and raised cholesterol in adulthood
(Hu, Li, Colditz, Willett, & Manson, 2003)	Prospective Cohort	For obesity analysis: 50,277 women (ages 30-55 years) who had a BMI of less than 30 and were free from cardiovascular (CVD) disease, diabetes, or cancer For diabetes analysis: 68,497 women (ages 30-55 years) who at baseline were free from diagnosed diabetes mellitus, CVD, or cancer	The relationship between several common sedentary behaviors and incidence of obesity and type 2 diabetes mellitus	Out of the sedentary behaviors that were monitored, television watching was associated with significantly higher risk for obesity and type 2 diabetes development, independent of the amount of exercise performed

Table 1. cont.

Authors of Study, Year	Study Design	Population Sample	Outcome Measured	Resultant Outcome
(Gore, Foster, DiLillo, Kirk, & West, 2003)	Questionnaires Non-experimental	74 overweight women seeking obesity treatment (body mass index, BMI 27-50) with type 2 diabetes (oral medications)	To assess television viewing and meal habits (including average intake and portion sizes)	Snacking, not necessarily eating meals, while watching television is associated with increases overall caloric intake and calories from fat
(Janz et al., 2002)	Cross-sectional	470 children (ages 4-6 years) from The Iowa Bone Development Study	The cross-sectional associations between fatness, leanness, physical activity (used accelerometry for measurement), and television viewing (used parental report)	Body fat percentages were 4% higher in children that scored in the lowest quartile for vigorous activity than those in the highest quartile for vigorous activity. And 3% higher in children that were high in levels of television viewing than those who watched the least amount of television
(Hu et al., 2001)	Prospective Cohort	38,918 men (ages 40 to 75 years) from the Health Professional's Follow-up Study (1986-1996)	Prolonged television watching and whether it predicts future diabetes risk independent of physical activity as well as total physical activity, vigorous exercise, and moderate-intensity activity in relation to risk for type 2 diabetes	Higher levels of physical activity are associated with a decreased risk for diabetes, whereas an increase in sedentary activities such as prolonged television watching is directly related to a heightened risk of diabetes
(Klesges, Shelton, & Klesges, 1993)	2x2x3 Mixed design with one between-subjects factor of television sequences, one between-subjects factor of weight status, and one within-subjects factor of television administration	15 obese children (mean=30.5 kg) and 16 normal-weight children (mean=30.5 kg);ages 8 to 12±119 years	The watching of television and its effects on metabolic rate	Watching television was found to acutely decrease resting energy expenditures in both obese and normal-weight children. Television may be an important factor in predicting children who are at risk for overweight and obesity
(Wong et al., 1992)	Correlational	1,081 children (aged 2-20 years, mean 7.4 ± 3.6 [SD] years)	Predictive values of family history, reported television viewing, physical activity and dietary habits and its association between hypercholesterolemia	Excessive television viewing in children was found to be associated with high cholesterol values (200 mg/dL or higher)
(Dietz & Gortmaker, 1985)	Cross-sectional	National Health Examination Survey Cycle II (6,965 children aged 6-11 years) National Health Examination Survey Cycle III (6,671 children aged 12-17 years)	The amount of television hours viewed each day and various control variables such as past obesity or super-obesity, season, region, population density, mother's/father's education, age, income, number of children, birth order, race, any conditions restricting activity.	A dose-response effect observed; each hourly increment of television viewed was associated with a 2% increase in the prevalence of obesity. Data suggest that some causes of obesity are environmental

With the advent of television came technological peripherals such as the VHS, DVD, and the more recent addition of Blu-Ray players. However, the innovation of video games (in conjunction with television), which became commercially available before the aforementioned peripheral technologies, has been criticized throughout its relatively short existence for promoting physical inactivity because of its possible role it may play in obesity development (Stettler, Signer, & Suter, 2004). The high obesity rates have recently sparked an upsurge in the development of video game technologies that look to take advantage of this widespread health concern by helping to improve the health and well-being of individuals. And while much of the products that have been sold to consumers have been in the form of DVDs and exercise equipment, the rising popularity of more recent video game technologies have allowed for activity-promoting games to make their presence known to the public.

Activity-promoting video games combine PA and exercise with the playing of video games and are often called "exergames." Video game developer and publisher, Konami Corporation®, were one of the first companies to develop a mainstream exergame which was called Dance Dance Revolution (DDR). This game requires the player(s) to stand on the included "dance platform" and timely hit colored arrows laid out in a cross pattern with their feet to musical and visual cues on the screen. A number of popular songs are available to the user with varying degrees of difficulty (Wiki, 2013). The more challenging songs move at a faster beats per minute (bpm) which requires the player(s) to keep up with the arrows on screen, thus creating increased full-body movement. Dance video games have provided unique ways of performing PA and exercise and have been extensively studied over the years yielding positive effects on health leading to widespread use among society in numerous settings (Liberman, 2006).

Today, video game hardware and software companies, Nintendo®, Microsoft®, and Sony® are tapping into new technologies in order to create video game experiences that blur the line between the virtual world and reality. The incorporation of such technologies like motion-based video game controllers and near full-body motion-control into the video game hardware and accessories has allowed video game developers the freedom to design games that cater to most everyone and take advantage of current societal consensus' such as maintaining a healthy and fit lifestyle. The Nintendo® Wii™ video game system was developed for the sole purpose of getting individuals off the couch and moving all while enjoying the pleasures of playing a video game. Exergames such as DDR and innovative system technology such as the Nintendo® Wii™ have opened up new avenues of research in studying activity-promoting video gaming's potential health effects on society. For instance, Trout and Zamora (2008) had twenty-six college students (14 female, 12 male; ages 18-29 years) play DDR 3 times per week for 20 minutes for 8 weeks. The researchers found that males expended an average of 276 calories per session, while females expended an average of 177 calories per session. A positive effect on body composition was seen with participants showing a significant reduction in body fat after 8 weeks of playing DDR. Additionally, it has been found that the playing of DDR and Nintendo® Wii™ is comparable to moderate-intensity walking (Graf, Pratt, Hester, & Short, 2009). A recent meta-analysis found that activity-promoting video games significantly increased heart rate (HR), oxygen consumption (VO_2), and energy expenditure (EE) with similar effect sizes to that of traditional physical activities (Peng, Lin, & Crouse, 2011). Other health related benefits have been found from playing a variety of exergames in the general population (see Table 2).

Various special populations and rehabilitative settings have also benefited from the use of exergames (see Table 3) which further lends credence to the emerging research on activity-promoting video gaming.

Table 2. Potential health benefits from playing exergames on the general population.

Authors of Study, Year	Study Design	Population Sample	Outcome Measured	Resultant Outcome
(Devereaux, Pack, Piccott, Whitten & Rohr, 2012)	Repeated Measures (Within-subjects) Experimental	12 university-aged male (N=5; age=21.4 ±1.14) and female (N=7; age=22.1±1.35)	To compare perceived exertion on the Nintendo Wii™ and two traditional exercise modalities: treadmill and cycle ergometer with exercise intensity being maintained at 65% of participant's maximal HR ± 5 beats/min for each modality	Overall RPE was lowest for the Nintendo Wii™ (9.50) followed by the treadmill (9.92) and cycle ergometer (11.08), $F_{(1,11)}=10.17$, $p<0.01$
(Osorio, Moffat, & Sykes, 2012)	Survey Non-experimental	3 participant groups: exercise (19F and 24M; ages 34.84 ± 14.93 years), standard gaming (11F and 74M; ages 21.2 ± 4.09 years), and exergaming (17F and 25M; ages 23.21 ± 5.41 years)	To compare the motivations that encourage participation in three contexts (exercise, computer games, and exergaming) to identify key elements that support such participation. The three psychological needs of SDT (Autonomy, Competence, and Relatedness) were addressed using a 15-item, 7-point Likert Scale "Basic Psychological Need Scale." A 12-item, 7-point Likert scale Self-Regulation Questionnaire to address the type of motivation (intrinsic or extrinsic) and the individual's regulations in relation to a particular behavior.	Autonomy was the highest psychological need rated by all groups, followed by relatedness and competence, respectively. The exergame group's need for competence was the lowest out of all groups which suggests that individuals who exergame play because of the social interactions and not necessarily because of physical challenge.
(Finkelstein et al., 2011)	Usability Testing	30 participants (19M, 11F) ranging in age from 6 to 50 years (mean age=21.17 ± 9.53)	To evaluate HR response and perceived exertion in relation to motivation when playing the virtual reality game, Astrojumper	Significant increases in HR were observed after gameplay. The participants' ratings of perceived workout intensity correlated with their level of motivation. Participants were motivated to exercise after playing Astrojumper

Table 2 cont.

Authors of Study, Year	Study Design	Population Sample	Outcome Measured	Resultant Outcome
(Noah, Spierer, Tachibana, Bronner, 2011)	Single-group Pilot Study	12 healthy adults (4M and 8F;18 to 53 years; mean age of 27.2±11.3 years)	To determine whether DDR can provide vigorous exercise in a wide range of adults.	The playing of DDR achieved mean values of 8 METS, HR of 157 bpm and enery expenditure of 9 kcal/min. DDR is effective in meeting various PA requirements for improving or maintaining physical fitness.
(Jordan, Donne, & Fletcher, 2011)	Within-subjects Experimental	Healthy male volunteers (n=15, mean ± SD, age 29 ± 4 years, mass 81 ± 12kg, height 1.77 ± 0.05m, body fat 19.7 ± 4.8%, BMI 25.9 ± 3.8kg m^{-2}, VO_2peak 44.8 ± 5.5 ml kg^{-1} min^{-1} and HR_{max} 195 ± 11 beats/min^{-1})	The difference in energy expenditure (EE) between a modified Sony PlayStation 2 (PS2) video game system (which utilized the lower limbs in order to play the game [Need for Speed: Hot Pursuit 2]) with interactive computer (Nintendo Wii™; utilized Wii Boxing) and standard seated PS2 (utilized Need for Speed: Hot Pursuit 2) gaming [referenced against traditional exercise modalities such as treadmill walking (at 5.6 km/h^{-1}), treadmill running (at 9.6 km/h^{-1}), and cycle ergometry (at 120 W]). HR, percent of HRmax, peak VO_2, RER values, and post-exercise blood lactate levels were observed	EE and post-exercise blood lactate in the modified PS2 exergame was significantly higher than the standard PS2 game, Wii gaming, and walking at 5.6 km/h^{-1}. The modified PS2 exergame also met the ACSM guidelines for cardiovascular fitness (although on the lower end of the recommendations). However, the Nintendo Wii™ did not meet the ACSM recommendations for cardiovascular fitness
(Worley, Rodgers, & Kraemer, 2011)	Within-subject Experimental	8 apparently healthy female college students (ages 21.88 ± 2.20 years)	To determine the %VO_2max and EE from different Wii Fit™ games at different levels including step and hula games. Ratings of perceived exertion (RPE) and respiratory exchange ratio (RER) were also observed	The highest measurements of RPE, RER, %VO_2max, and caloric expenditure were found during the intermediate hula game (equivalent to walking at a speed of >3.5 mph) than the step game.
(Seigel, Haddock, Dubois, & Wilkin, 2009)	Single-group Pilot Study	13 participants (6M and 7F with ages 26.6 ± 5.7 years)	To evaluate HR, ratings of perceived exertion, VO_2, and energy expenditure between three different exergames	VO_2 was higher than baseline values as well as significant increases in HR and EE. On average, RPE was 14.0 ± 2.04 (6-20 scale) which corresponded to "somewhat hard" and "hard." The subjects' mean energy expenditure was 226.07 ± 48.68 kcal which was within the ACSM recommendations for daily physical activity
(Graves, Ridgers, & Stratton, 2008)	Single-group Pilot Study	12 youths (7 male, 5 female) aged 11-17 years with average BMI of 21.8 ± 3.1	The effectiveness of AVGs on energy expenditure, HR, and upper and lower body movement	*Wii Boxing* provided the youths with the highest energy expenditure (0.0639 ± 0.0277 kcal/kg/min) and HR (136.7 ± 24.5 beats/min). All AVGs increased levels of physical activity from sedentary gaming; increased use of upper and lower limbs may enable higher levels of physical activity to be reached

Table 3. Potential health benefits from playing exergames on special populations.

Authors of Study,Year	Study Design	Population Sample	Outcome Measured	Resultant Outcome
(Gil-Gómez, Lloréns, Alcañiz, & Colomer, 2011)	Randomized and Controlled Single-**Blind**	17 Hemiparetic patients who had sustained an acquired brain injury (ABI) (11 male, 6 female) with a mean age of 47.3 ±17.8	To evaluate the efficacy of the Nintendo® Wii™ eBaViR balance board system as a rehabilitation tool for balance recovery	The Nintendo® Wii™ eBaViR system has the potential to improve balance in patients with ABI. Patients using the eBaVir showed significant improvements in static balance, in the Berg Balance Scale, and in the Anterior Reach Test compared to patients who underwent traditional therapy.
(Hurkmans, van den Berg-Emons, & Stam, 2010)	Cross-sectional	8 Adults (5 male, 3 female) with bilateral spastic cerebral palsy and ambulatory ability (Gross Motor Function Classification System Level I or II) with a mean age of 36 ± 7 years	To determine energy expenditure of adults with bilateral spastic cerebral palsy while playing Nintendo® Wii Sports™ Tennis and Boxing in a one time, 15 minute clinic session	All participants attained energy expenditures greater than 3METS while playing Nintendo® Wii Sports™ Tennis and Boxing. These AVGs have the potential for being a useful treatment and promoting a more active and healthful lifestyle in these patients
(Joo et al., 2010)	Pre-post Intervention Pilot	20 patients within 3 months after a stroke with upper limb weakness (13 male, 12 female) with a mean age of 64.5 ± 9.6	To assess the feasibility of using the Nintendo® Wii™ as an adjunct to conventional rehabilitation of patients with post-stroke upper limb weakness	Improvements in the Fugl-Meyer Assessment and Motricity Index Scores were observed. The use of the Nintendo® Wii™ gaming system has the potential to enhance conventional stroke rehabilitation programs
(Lotan, Yalon-Chamovitz, & Weiss, 2009)	Pre-post Intervention	59 Individuals with intellectual and developmental disabilities (IDD) (28 research: 16 male and 12 female with a mean age of 52.3 ± 5.8 years; 31 controls: 15 male and 16 female with a mean age of 54.3 ± 5.4 years)	To assess the effectiveness of a Virtual Reality (VR)-based exercise program using the Sony PlayStation II EyeToy™ VR system in improving the physical fitness of adults with IDD	Significant improvements were demonstrated in the Modified Cooper Test and Total Heart Beat Index (THBI) in the research group compared to the control group. VR technology can be a suitable intervention for adults with IDD by increasing their fitness levels
(Yavuzer, Senel, Atay, & Stam, 2008)	Randomized Controlled Trial	20 Hemiparetic inpatients within 12 months after stroke with a mean age of 61.1 years	To examine the effects of PlayStation EyeToy™ games with inpatient stroke rehabilitation on upper-extremity function	Significant improvements were seen at the follow-up in the EyeToy™ group compared to the control group in FIM self-care scores. Assessment of Brunnstrom stages for hand and upper-extremity were similar for both groups. AVGs have the potential to enhance conventional stroke rehabilitation programs

Table 3. cont.

Authors of Study, Year	Study Design	Population Sample	Outcome Measured	Resultant Outcome
(Widman, McDonald, & Abresch, 2006)	Pre-post Intervention	8 Adolescent Subjects with spina bifida (4 male with a mean age of 17.5 ± 0.9 years; 4 female with a mean age of 15.5 ± 0.6)	To determine whether a new upper extremity exercise device integrated with a video game (GameCycle) requires sufficient metabolic demand and effort to induce an aerobic training effect and to explore the feasibility of using this system as an exercise modality in an exercise intervention	Six of the 8 subjects were able to reach a Vo_2 of at least 50% of their Vo_2 reserve while using the GameCycle. Seven out of the 8 subjects reached a HR of at least 50% of their HR reserve. Seven of the 8 subjects increased their maximum work capability after training with the GameCycle at least 3 times per week for 16 weeks. The GameCycle has the potential to improve fitness levels in these individuals
(O'Connor, Fitzgerald, Cooper, Thorman, & Boninger, 2002)	Cross-sectional	10 Subjects with spinal cord injuries (10 male, 10 female) with a mean age of 38.7 ± 8.0 years and were 17.6 ± 12.2 years post-diagnosis	To ascertain the forces imparted on manual wheelchair users when playing on the GAME^{wheels} system by propulsion, as well as to determine differences in metabolic parameters with and without gameplay	Propulsion patterns did not change significantly when wheelchair users exercised while playing a computer video game via the Game^{wheels} system. However, data do suggest that increased physiological responses may be achieved with continued gameplay

Much of the more recent literature on exergames has utilized the Nintendo® Wii™ video game system (Peng, Crouse, & Lin, 2012). However, the technology of the Wii™, in regards to its motion-sensing controller, only allows for movements limited to the individuals' wrist. Thus, the players' movements are primarily from the upper extremities. Also, the player(s) need not to perform the required gameplay motions in order to play the game. A simple flick of the wrist has been shown to provide the same gameplay result on the screen as with a full range-of-motion movement (Pasch, Bianchi-Berthouze, Dijk, & Nijholt, 2009). Another type of motion-based video game controller is the Sony® PlayStation 3 Move™ which is similar to the Wii™, but is able to properly calculate the players' position in 3D space by perceiving depth whereas the Wii fully does not. This perception of depth allows for an actual1:1 ratio (the players actual movement is precise to onscreen movement). The Xbox® 360 Kinect™ goes one step further in providing activity-promoting video game interactivity in that it does not require a controller to play games; instead, the players themselves are the controller in which both upper and lower limbs are utilized. And while these activity-promoting video game systems have shown promise in regards to helping meet the recommended PA guidelines, (Peng, Lin, & Crouse, 2011), there are only certain games such as dancing and boxing that have elicited significant results in terms of energy expenditure, oxygen consumption, and total work (Smallwood, Morris, Fallows, & Buckley, 2012, Naugle, Naugle, & Wikstrom, 2014). However, these games may not cater to all individuals who are interested in improving their health from exergaming.

More recently to help foster exergaming variety, video games are being integrated into traditional exercise modalities. A prime example is the cycle ergometer (CE) which is one of the more common types of exercise equipment utilized in health and fitness centers. To date, there have been several studies that have investigated the playing of video games while cycling. Emerging research has shown that cycling while playing video games may elicit positive physiological health benefits as well as potentially increasing exercise adherence (see Table 4). Prior video game cycling interventions used specially designed upright CEs (e.g., Gamebike® [Cat Eye Electronics, Ltd., Boulder, CO] and Exerbike Pro® [Motion Fitness Co., Palatine, IL]) that allowed participants to control the speed and steering of the character in the game (i.e., vehicle avatar) by pedaling cadence and with the built-in handlebars, respectively. Preliminary results indicated that these interactive CEs may improve ones' overall fitness and exercise adherence (see Table 4). However, the interactive bikes that have been researched limit the exerciser to only playing a racing game. A new interactive video game CE called the

Exerbike GS® (Motion Fitness Co., Palatine, IL) is a recumbent CE with a built-in Xbox 360® game controller that is connected to the display console of the ergometer. In this case, the participants' pedaling cadence determines whether or not the video game controller stays on or turns off based on the minimum cadence cycled via several different RPM minimum levels.

Utilizing a traditional exercise modality (i.e., CE) with a form of technological entertainment (i.e., video game) may be a viable option to improving ones' overall health and future PA and exercise habits. Since long-term adherence to PA is critical, more research is needed to validate this form of activity-promoting video gaming.

Table 4. Recent Studies on interactive video game cycling.

Author(s) of Study, Year	Study Design	Population Sample	Outcome Measured	Resultant Outcome
(Keats, Jakob, & Rhodes, 2011)	Randomized Controlled Trial	19 undergraduate college students (8M and 11F, ages 18-25 years; mean age: 20.2 ± 2.0 years)	To primarily examine the effects of active gaming while cycling on physical activity attitudes/affective judgments, intentions, and activity adherence. And to secondarily examine the impact of the cycling intervention on levels of aerobic fitness	Activity enjoyment, intention, adherence, and aerobic fitness levels were higher in cycling intervention. Active gaming may play an important role in supporting sustainable, active lifestyles
(Kraft, Russell, Bowman, Selsor III, & Foster, 2011)	Within-subjects Simple Experimental	37 healthy college-age volunteers (20 men; age [23.15 ± 8.12 years])	To assess HR responses and RPE at self-selected intensities during 2 modes of exergame activity (video game interactive CE and interactive dance game) vs, traditional exercise (cycling while watching television	No significant difference in peak HR, recovery HR, or minutes above target HR was observed between DDR and CE. Session RPE was significantly higher for the video game interactive CE. All modes elicited extended portions of time above target HR. Exergames are capable of eliciting physiological responses necessary for fitness improvements
(Adamo, Rutherford, & Goldfiel, 2010)	Randomized Controlled Trial	26 (14M and 12F) overweight (with at least 1 metabolic complication)	To comparatively examine the effects of interactive video game cycling using the GameBike with stationary cycling to music on adherence, duration, intensity of exercise, sub-maximal aerobic fitness, metabolic parameters, and body composition	Both interactive video game cycling and traditional stationary cycling while listening to music produced significant improvements in submaximal indicators of aerobic fitness. However, the music group showed a higher rate of attendance along with more time spent cycling at vigorous intensity and average distance pedaled per session than the video game cycling group

Table 4. cont.

Author(s) of Study, Year	Study Design	Population Sample	Outcome Measured	Resultant Outcome
(Haddock, Seigel, & Wikin, 2009)	Within-subjects Simple Experimental	20 children (13 boys and 7 girls, ages 7-14 years; mean age: 10.9 ± 2 years)	The efficacy of interactive video game cycling on EE and RPE in overweight children compared to traditional cycling	VO_2 and EE were significantly higher than both baseline conditions. EE was significantly higher in the interactive cycling condition versus traditional cycling. Perceived exertion was not significantly different between the two conditions
(Rhodes, Warburton, & Bredin, 2009)	Randomized Controlled Trial	29 inactive young men (mean age: 22.7 ± 4.0 years)	The effect of interactive video game cycling on physical activity (PA) social cognition and to compare single to repeat/continued exposures. And to examine whether social cognitions could account for the covariance between EV or standard cycling and adherence	Affective attitude and adherence favored the interactive video game cycling group. Interactive video game cycling may improve adherence over traditional cycling due to its role in producing higher affective attitudes
(Warburton et al., 2009)	Within-subjects Simple Experimental	14 adults (7M and 7F, mean age: 24.6 ± 4.2 years)	To determine whether there are differences in the metabolic requirements and ratings of perceived exertion between interactive video game cycling and traditional cycling at identically matched workloads	EE (61% ± 41% and 25% ± 21%) , steady-state HR 26% ± 18% and 14% and 13%), and VO_2 (34% ± 17% and 18% and 12%) were significantly higher in the interactive video game cycling group at submaximal workloads of 25% and 50%, respectively
(Warburton et al., 2007)	Prospective, Randomized Controlled Trial	14 College-aged males (7 experimental, 7 control; ages 18-25 years; mean age: 22.7 ± 2.0 years for experimental and 23 ± 5.0 years for control)	To determine the efficacy of interactive video game cycling on producing significant improvements in multiple risk factors for chronic disease versus traditional stationary cycling as well as differences in exercise attendance rates	Attendance rates were higher in the interactive video game cycling group. VO_2 significantly increased and resting systolic blood pressure significantly decreased after interactive video game cycling training

Purpose of Study

In light of the need for further research, the purpose of the this study was to investigate the effectiveness of cycling while playing a video game in regards to exercise enjoyment, perceived exertion, heart rate (HR), and total work output. This investigation used a standard, non-interactive upright CE in conjunction with a home console video game system via wireless controller. To the researcher's knowledge, there have been no studies that have utilized this type of cycling/video game setup.

Hypotheses

In this study, it was hypothesized that cycling while playing a video game (experimental condition) would: 1) demonstrate higher enjoyment scores (via Physical Activity Enjoyment Scale [PACES] than the two other conditions (cycling while watching music videos and cycling with no external media) and 2) produce ratings of perceived exertion (RPE) scores that are lower or the same along with higher HRs and total work output compared to the other treatment conditions.

Significance of Study

This investigation assessed whether cycling while playing a console video game could be a viable option in helping to increase an individuals' exercise enjoyment as well as provide an alternative effectual training stimulus to aid in reaching ones' health and wellness goals. This investigation was intended to add to the emerging research in the area of activity-promoting video gaming.

CHAPTER II

METHOD

The primary aim of this study was to investigate if playing a console video game while cycling elicited higher enjoyment scores, lower or the same RPE along with higher average HRs and total work outputs (in kilojoules) than cycling with music videos and cycling with no external media.

Setting and Participants

The current study was conducted at a moderately-sized upper Midwestern university. A sample of 24 English-speaking 18-25 year old male college students were recruited for this research investigation via campus-wide fliers as well as through undergraduate courses in the researcher's department. This study was delimited to male college students because 68% of video game players are 18 years of age and over with 32% being between the ages of 18-35 years. The majority of undergraduate and graduate college students fall within this age group. Males (55%) have been found to be the most prevalent video game players as well as the most frequent purchasers of video games (54% of males) (ESA, 2013). Thus, it was intuitive to select from this specific population for the current study. Eligible participants also needed to be sedentary or moderately active based on the *2008 Physical Activity Guidelines for Americans* (U.S. Department of Health and Human Services, 2008). A PAR-Q was utilized to further screen out individuals who may have had any potential health issues that warranted physician approval for participation in an exercise program or a research study in this case. Participants were also excluded if they were a varsity athlete or have had any significant medical history that would prevent them from participating in this intervention. The study was approved by the Institutional Review Board of the researcher's university.

Measures

Demographics. Baseline demographics included age, height and weight status, BMI, and days of moderate-intensity PA preformed each week.

Height and Weight Status. The participants' height was measured to the nearest 5mm using a portable stadiometer (Seca Corp, Model 213, Hamburg, Germany). Weight was measured to the nearest 0.1kg via an electronic scale (Seca Corp, Model 876, Hamburg, Germany). Body Mass Index (BMI) was calculated from both height and weight measurements.

Exercise Enjoyment. The Physical Activity Enjoyment Scale (PACES) was used to assess the participants' enjoyment of the exercise sessions. The current study utilized the Modified PACES (see Appendix I) in which the questions were re-worded in the past tense in order for post-exercise perceptions of enjoyment from the participant. This instrument is a 16-item, 5-point Likert-type Scale with rank agreement with each statement (e.g., *I enjoyed it*….5-Agree a lot). The PACES has been validated by past research efforts such as in the two studies conducted by Kendzierski & DeCarlo (1991) in which they found high internal consistency between both studies (α=.96) (as cited in Dorsher, 2010). The modified version of the PACES was found to have satisfactory internal reliability (scale alphas 0.91 to 0.94) and is scored using the mean of each item which is judged against verbal anchors (Whitehead et al., 2008).

Perceptions of Exertion. Borg's Rating of Perceived Exertion (RPE) 6-20 Scale (Borg, 1982) (see Appendix H) was used to measure the participants' perception of exertion after each exercise session and therefore, RPE was categorized as a session RPE. The decision to use Borg's 15-point RPE Scale versus Borg's 10-point Category Ratio RPE Scale was based on which the former generally resembles an individual's HR during exercise (Borg, 1982) and thus would give the researcher a better sense of the intensity level that the participant is working at during exercise. Every two numbers on the Borg 15-point RPE scale corresponds to an adjective which allows the participant to better subjectively indicate how hard they are working. For instance, an RPE of 7 would be *very, very light* and a rating of 19 would be considered *very, very hard*. An RPE of 20 would indicate *maximum effort*. The Borg RPE scales have shown good validity. A meta-analysis conducted by Chen, Fan, & Moe (2002) found that the Borg RPE scales are a valid measure for determining exercise intensity.

Heart Rate. The participants' HR was assessed every 2 min. and 45 seconds as well as at the completion of the 20 minute exercise sessions via a HR monitor and watch (Polar A1, Lake Success, NY).

Total Work Output. A sensor connected from the desktop computer was attached to the side of the CE's flywheel in order to collect real-time power measurements of watts (W), watts/kg (W/kg), and kilopond meter/minute (kpm) every 30 seconds. The kpm was later converted to kilojoules for standardization of measurement for total work output for each exercise session as well as for comparative analysis with other studies. The computer software utilized for all sessions was SMI Power Extend (Sports Medicine Industries, St. Cloud, MN).

Procedures

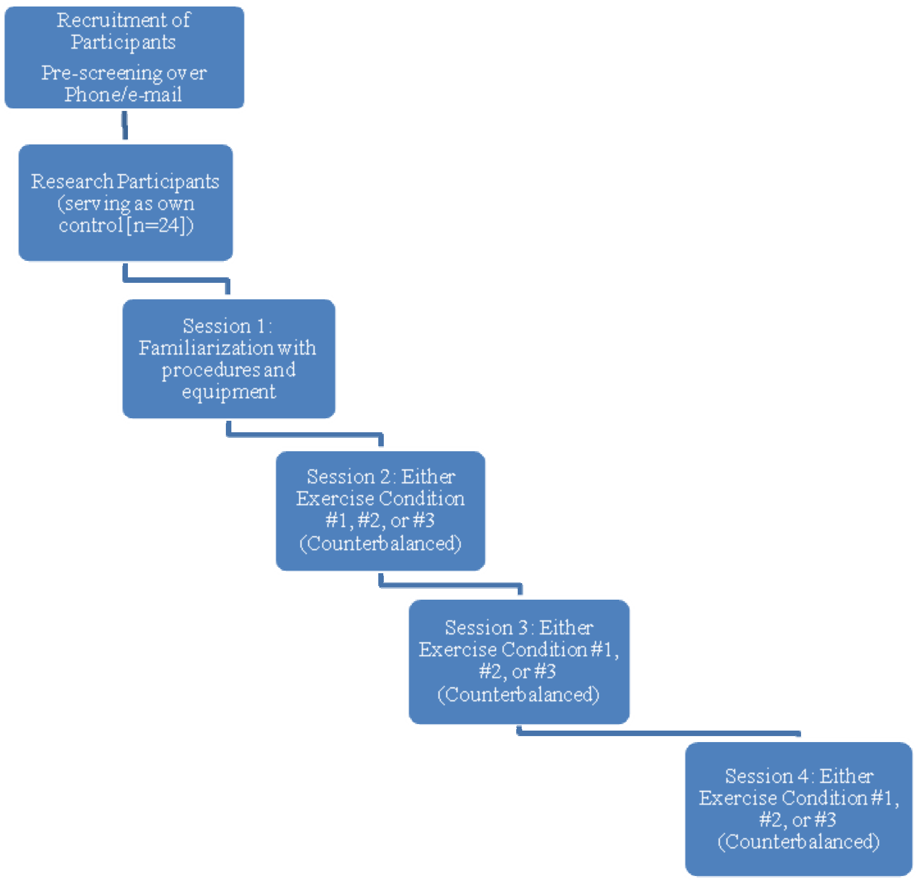

Figure 1. Procedures flow chart of study recruitment and subsequent sessions.

The study design was similar to the work of Haddock, Seigel, and Wikin (2009), utilizing a within-subjects experimental design which consisted of four sessions (see Figure 1): (i) Familiarization, and three conditions: (ii) Exercise Condition #1, (iii) Exercise Condition #2, and (iv) Exercise Condition #3. There was only a maximum of one participant in the laboratory at a time in order to prevent any external influences that may arise from having multiple participants during each protocol. The order of conditions that the participants performed was randomized and counterbalanced. The randomization of assignment within the conditions assured that each group is equivalent at the beginning of the experimental study. The use of complete counterbalancing allowed for each of the three conditions to occur equally often and to make sure that carry over effects are equalized between the three conditions. Of note, the desired number of 24 participants was based on the maximum number of combinations from the three exercise conditions (which is a total of six sequence combinations). Thus, it was intuitive to have four participants in each of the sequence combinations to make them equal (therefore, a total number of 24 participants). The participants were randomized by using a random number table for designation to one of the six total sequence combinations.

The following sections describe each session of the study intervention:

Familiarization Session

The participants first completed a Physical Activity Readiness Questionnaire (PAR-Q) (see Appendix A) followed by an informed consent (see Appendix B) which included demographical information such as age, height and weight status, BMI, as well as days of moderate-intensity PA performed each week based on the *2008 Physical Activity Guidelines for Americans* ((Physical Activity Guidelines for America, 2008). Each participant then completed a video game and music genre preferences form in which they wrote down the Xbox® 360 video game they wanted to play and selected up to three musical genres (options included *Pop*, *Country*, *Hip-Hop*/*R&B*, *Dance/Electronic*, *Rock*, and *Other*) along with writing in their favorite musical artists for each respective genre chosen (see Appendix C). Participant height and weight measurements were then taken in order to determine their BMI (see Appendix D). Next, the participant put on a HR monitor (Polar A1, Lake Success, NY) and relaxed in a chair for 5 minutes as their resting heart rate (RHR) was recorded by the researcher. The participants' RHR was used to help calculate their target heart rate (THR) which was later used with the subsequent modified YMCA CE test protocol to aid in determining their proper cycling resistance that was fixed throughout during each of the three cycling sessions. In order to attain the appropriate cycling resistance for each participant, a THR was established as 40% of their heart rate reserve (HRR). It has been identified that 40% of THR is the minimal intensity necessary to bring about changes in maximal oxygen consumption (VO_2max) (Pollock et al., 1998). The participants' THR was calculated by using the Karvonen HRR method to determine estimated maximum HR (ACSM, 2006; Karvonen, Kentala, & Mustala, 1956). Once calculated, the participants' RHR was subtracted from the estimated maximum HR, multiplied by 40% and then added back to yield the desired THR.

After their THR was calculated, the researcher helped the participants with their CE settings (i.e., seat height). The participant was then instructed to warm-up on an upright, basket-loaded CE (Monark 824E, Stockholm, Sweden) for 5 minutes with minimal resistance (weight basket only). The researcher then explained the purpose of the YMCA CE modified protocol (comprised of four 3 minute stages for a maximum duration of 12 minutes) in which the participant continuously cycled at 50 revolutions per minute (RPM). HR was collected for every 3minutes by the researcher, but was actually recorded at the 2 minute and 45 second mark to account for any delay that may have occurred when assessing the participants' HR monitor and watch. The researcher also asked and recorded the participants' RPE as well as added resistance to the CE weight basket if necessary (Appendix E). Once the participants reached their desired THR, they went another stage to elicit a steady state HR. The protocol was concluded if HR was stable or if the 12-minute duration was reached. RPE was used as a secondary measure to add congruence to the participants' reaching their THR. An RPE of 13 on Borg's 6-20 Scale was chosen as a marker for average intensity. When the protocol concluded, the corresponding resistance in the CE weight basket was then used for each of the subsequent exercise sessions. Thus, the participants' cycling resistance was chosen in both an objective and subjective manner. A 5-minute cool-down with minimal resistance was performed after the CE test. After the protocol, the participants who chose to play the video game that was provided (*Top Spin 4*) were able to try the game for 10 minutes to get individualized gameplay settings (e.g., character selection, difficulty level, etc.) and get accustomed to the gameplay controls. The *Familiarization* session was around 45 minutes in duration. After the completion of the *Familiarization* session, the participants signed up for *Exercise Condition #1*. The researcher then instructed the participants to not eat for a minimum of two hours prior to their appointment time(s) in order to avoid any potential nausea that may occur from the protocol(s). However, they were allowed to drink water and were also reminded that they should wear comfortable workout clothes (e.g., T-shirt and shorts) (see Appendix F).

The current study consisted of three different randomized exercise conditions and is described as follows:

Exercise Condition #1 (*cycling while playing a console video game*)

Participants cycled on a basket-loaded, upright CE (Monark 824E, Stockholm, Sweden) for a total of 20 minutes while playing Microsoft's Xbox® 360 video game console. The Xbox® 360 was connected to a 32" LCD HDTV flat screen television (Magnavox, 32MF301B/F7, Daitō, Osaka, Japan) via a 6' HDMI cable (GE, Fairfiled, CT, USA) for optimum picture resolution. An Xbox® 360 wireless controller was used to reduce any interference (e.g., tangling of wire while cycling). Participants had the choice to bring in their own Xbox 360 video game. If they did not choose to bring in their own game or if they did not own an Xbox 360 video game console then the tennis game, *Top Spin 4*, was provided due to its simplicity of controls and the fact that recent data indicate that sports video games are one of the best-selling video game genres by units sold (ESA, 2013). Also, the participant was free to choose a game of their liking from the researcher's personal game collection. During the familiarization with the video game, it was paused appropriately at the correct gameplay starting point in order to skip the loading times of the game. The participant's HR was monitored through the wearing of a HR monitor (Polar A1, Lake Success, NY). SMI Power Extend computer software was connected to the CE via wired connection to the front side of the CE flywheel in order to collect and record work output data (in kpm, then later converted to kilojoules).

Exercise Condition #2 (*cycling while watching music videos*)

Participants cycled on the same upright CE (Monark 824E, Stockholm, Sweden) for a total of 20 minutes while watching music videos. The protocol utilized the same television, HDMI cable, HR monitor, and analysis software as *Exercise Condition #1*. A laptop (Toshiba Satellite A505, Minato, Tokyo, Japan) connected to the flat screen television via the HDMI cable allowed for the music videos to be streamed from www.musicvideomachine.com, which is a site that allows for the continuous streaming of personalized music video playlists with no commercials in-between videos. The genres of the music videos were based on the participants' preferences during the *Familiarization* session.

Exercise Condition #3 (*cycling without any external media*)

Participants cycled on the same upright CE for a total of 20 minutes in front of a blank wall with no external media. The protocol used the same HR monitor and watch and analysis software as *Exercise Conditions #2 and #3*.

For All Exercise Conditions

Participants began by putting on the HR monitor and watch followed by performing a 5 minute warm-up on the CE. Once the warm-up time was complete, the researcher answered any questions that the participants had and told them to "just get a good workout" prior to the start of the 20-minute cycling intervention. The participants cycled at their own pace using their same predetermined workload from the *Familiarization* session. All clocks and time indicators were removed from sight in the lab as the researcher told the participants that they would be signaled when the 20-minute cycling was complete. Thus, the researcher kept track of the 20 minute duration of the exercise session. This procedure was carried out in order for the participants to focus solely on the task at hand. HR was recorded every 2 minutes and 45 seconds (see Appendix G). Work rate, work output, and energy expenditure (based on analysis software) was assessed every 30 seconds during the protocol. The SMI Power Extend computer software unit and connection was hidden from the participant so that the premise of the study was not revealed so that they could focus more on the exercise session (computer turned opposite direction and positioned further away from participants).

Once the 20 minutes of the protocol was complete, the researcher immediately asked and recorded the participants' RPE via the Borg 6-20 RPE Scale as well as their HR (see Appendix H). The participants were then instructed to perform a 5-minute cool-down with no workload. This was followed by having the participants complete the Modified PACES to assess their enjoyment of the exercise session (see Appendix I).

After the completion of *Exercise Condition #1*, the participants scheduled for *Exercise Condition #2* and *Exercise Condition #3* at around the same time of day. A minimum of 48 hours in-between testing conditions was required in order to provide adequate rest for the participant. A similar protocol respective of each condition was followed for the subsequent testing appointments (e.g., researcher preparation, data collection protocol, and participant RPE and PACES assessment). After completion of *Exercise Condition #3*, participants were told the aim of the study and thanked along with being entered into a drawing for a chance to win one of six cash prizes.

Data Analysis

The current study was a within-subjects experimental design where participants performed three separate treatment conditions; cycling while playing a video game, cycling while watching music videos, and cycling without any external media. All data were analyzed using IBM® SPSS® Statistics (SPSS® v. 21, Armonk, NY). Descriptive statistics were used to determine mean differences between age, BMI, total days per week of at least 30 minutes of moderate-intensity PA, exercise enjoyment, RPE, HR, work rate, and total work output**.** Paired *t*-tests with subsequent standard Bonferroni and Holm's Sequential Bonferroni adjustments were utilized to determine if there were any significant differences between the three exercise conditions.

CHAPTER III
RESULTS

The primary aim of this study was to investigate cycling while playing a console video game and its effects on exercise enjoyment, RPE, HR, and total work output (in kilojoules). There were a total of 24 male college students ages 18-25 years **(***M*= 21.17 years) that participated in this intervention with no occurrences of participant drop-out. Participant demographics and descriptive statistics are presented (see Table 5).

Table 5. Participant demographics and descriptive statistics for all variables.

Demographics	Mean	Range	Std. Dev.
Age (years)	21.17	18-25	1.8
Height (cm)	180.10	164.60-197.00	7.10
Weight (kg)	87.8	64.0-119.0	16.0
Body Mass Index (BMI)	27.13	21-37	4.4
Days/Week of MPA	3.71	1-6	1.2
Variables			
PACES Score for VG	4.31	3-5	.44
PACES Score for MV	4.32	2-5	.55
PACES Score for CT	3.33	1-5	.85
RPE for VG	13.21	10-17	1.56
RPE for MV	14.46	11-17	1.71
RPE for CT	14.25	12-18	1.62

Table 5. cont.

Variables	Mean	Range	Std. Dev.
Work Rate for VG	97.15	62.40-159.86	25.25
Work Rate for MV	108.93	69.78-162.93	25.64
Work Rate for CT	104.26	63.90-167.83	28.26
Total Work Output for VG (kJ)	113.12	73.37-188.09	29.21
Total Work Output for MV (kJ)	128.11	82.00-191.66	30.16
Total Work Output for CT (kJ)	122.75	75.07-197.51	33.30
Resistance (kg)	1.6	1.2-2.5	.31
HR Average (bpm) of Exercise for VG	136.54	102-180	18.51
HR Average (bpm) of Exercise for MV	140.38	96-172	17.83
HR Average (bpm) of Exercise for CT	134.50	105-172	16.52

VG=video game condition, MV=music video condition, CT=control condition

<u>Scale Psychometrics</u>

Chronbach's alpha reliability coefficients were computed as a check for possible adverse effects on the scale psychometrics due to the PACES items being reworded to the past tense for this study. All three treatment conditions exhibited a good to excellent internal consistency (α=.88-.95) via Chronbach's alpha and in no case would removing an item have improved the scale alpha for each of the conditions.

<u>Main Experimental Effects</u>

Exercise Enjoyment

A paired *t*-test with Holm's Sequential Bonferroni adjustment revealed that there was no statistically significant difference between the video game and music video conditions (video game M=4.31, SD=.44; music video M=4.32, SD=.56; $t(23)$=-.14, p=.88). However, there was a statistically significant difference with a *very large* effect size (*d*) observed in the video game condition over the control condition indicating that participants enjoyed the former considerably more (video game *M*=4.31, *SD*=.44; control *M*=3.33, *SD*=.86; *t*(23)=7.43. p<.001, *d*=1.14). The music video condition also illustrated a statistically significant difference over the control condition with a *very large* effect size (music video *M*=4.32, *SD*=.56; control *M*=3.33, *SD*=.86; *t*(23)=7.21, p<.001, *d*=1.15) (see Figure 2).

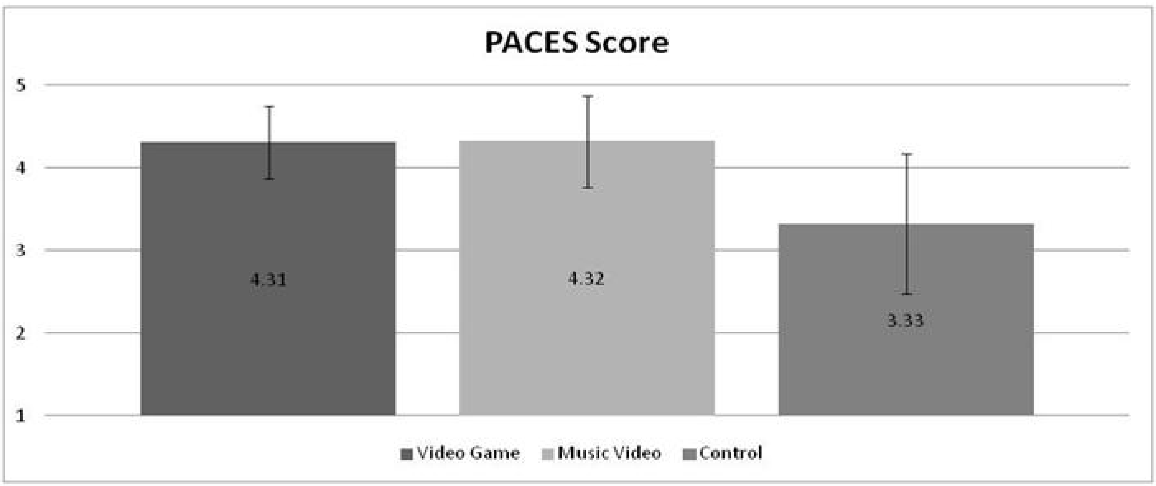

Figure 2. The mean PACES score for each of the three treatment conditions.

Perceptions of Exertion

In regards to RPE, a paired *t*-test with Holm's Sequential Bonferroni adjustment indicated a statistically significant difference with a *medium* effect size in which participants elicited a lower session RPE in the video game condition compared to the music video condition (video game *M*=13.21, *SD*=1.56; music video *M*=14.46, *SD*=1.72; t(23)=-3.55, *p*<.005, *d*=.73). A statistically significant difference along with a *medium* effect size supported the video game condition over the control condition (video game *M*=13.21, *SD*=1.56; control *M*=14.25, *SD*=1.62; *t*(23)=-3.65, *p*<.001, *d*=.64). However, there was no statistically significant difference between the music video and control condition (music video *M*=14.46, *SD*=1.72; control *M*=14.25, *SD*=1.62; *t*(.23)=.61, *p*=.55) (see Figure 3).

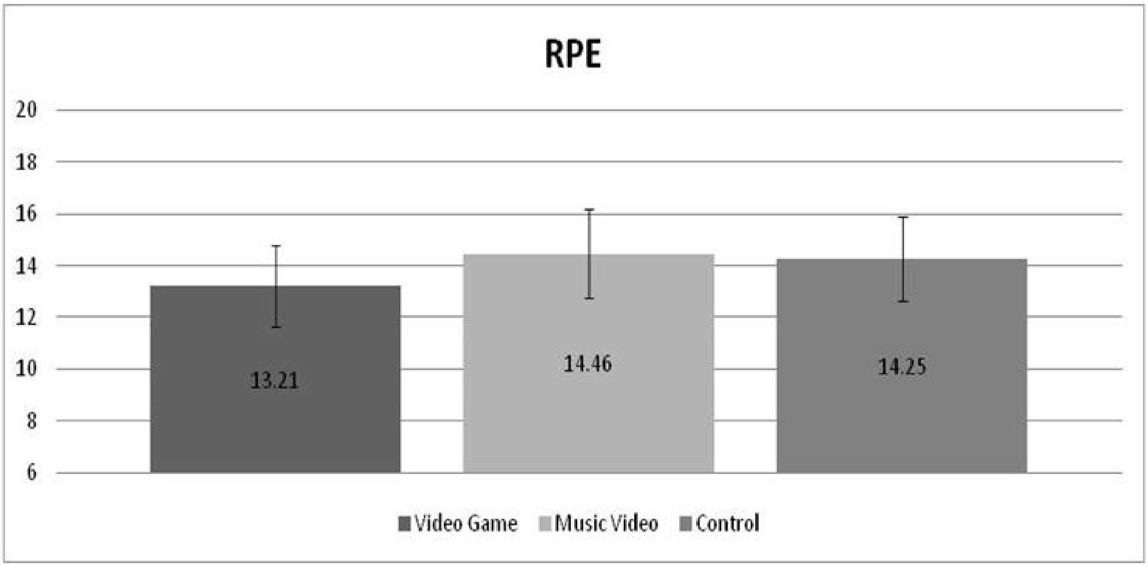

Figure 3. Mean RPE measurements for each of the three treatment conditions.

Heart Rate

A paired *t*-test with Holm's Sequential Bonferroni adjustment indicated that there were no statistically significant differences in HR between any of the three treatment conditions (see Figure 4).

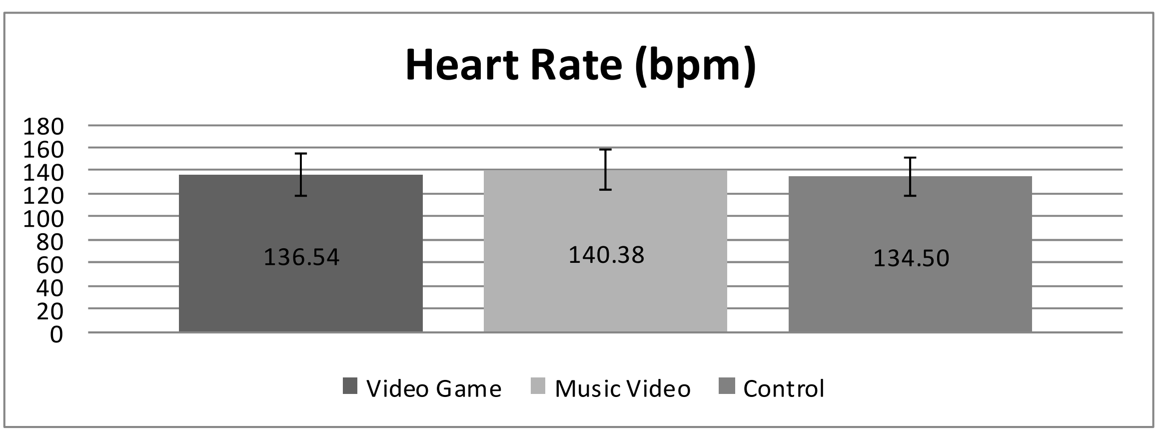

Figure 4. Participant mean HRs produced for each of the three treatment conditions.

Total Work Output

Utilizing a paired *t*-test with Holm's Sequential Bonferroni adjustment, there was a statistically significant difference with a *medium* effect size seen in the music video condition over the video game condition indicating that participants completed less total work on the latter condition (video game M=113.12, SD=29.21; music video M=128.11, SD=30.17, $t(23)$=-6.22, p<.001, d=.51). A statistically significant difference with a *small* effect size was observed in the control condition when compared to the video game condition (video game M=113.12, SD=29.21; control M=122.75, SD=33.30; $t(23)$=-3.96, p<.005, d=.33). When using a standard Bonferroni adjusted paired *t*-test, there was no statistical significance observed between the music video and control condition. However, when incorporating a Holm's Sequential Bonferroni adjustment, a statistically significant difference was seen with a *small* effect size in the music video condition over the control condition (music video M=128.11, SD=30.17; control M=122.75, SD=33.30; $t(23)$=2.33, [p= .029*], d=.16) (see Figure 5).

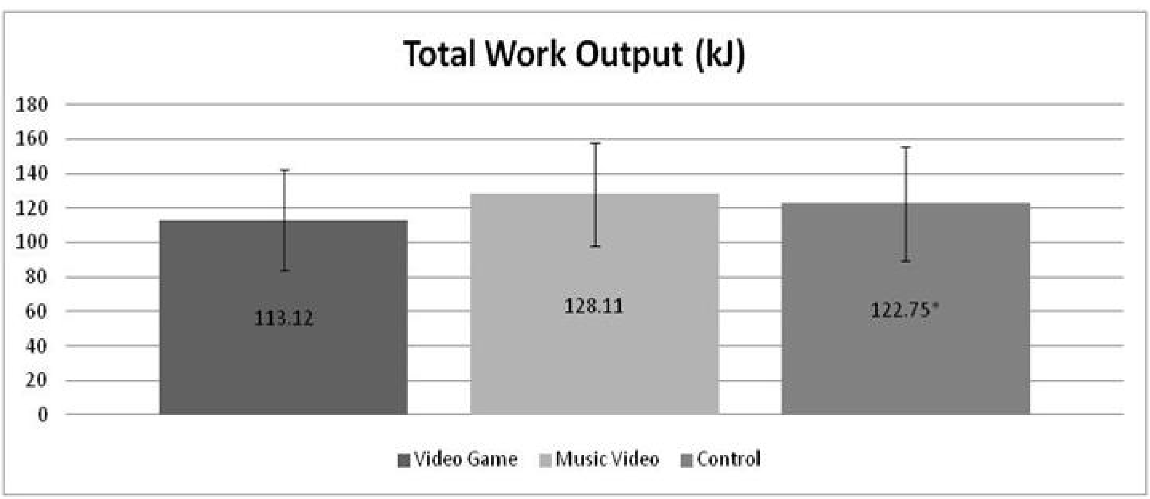

Figure 5. Mean for total work output in each of the three treatment conditions.

CHAPTER IV
DISCUSSION

The health consequences that have been associated with consistent physical inactivity have led to widespread societal concern, partly in relation to the obesity epidemic. And while the use of technology has been widely criticized for contributing to obesity development, it may play a role in helping to combat this significant health issue. With the rising popularity of video games and the emerging health repercussions in today's society, largely attributed to insufficient PA and exercise, game companies are pursuing innovative ways to target the wide array of individuals who are looking to incorporate a more active daily lifestyle.

To the researcher's knowledge, this is the first study to utilize a regular, upright CE with the playing of a console video game. As was previously highlighted in the literature review, prior video game cycling studies used interactive ergometers that were controlled by pedaling cadence and a handlebar component to dictate interaction with the on-screen vehicle avatar and thus were built to play only racing games. The newest interactive video game CE model now encompasses a traditional recumbent design and is connected to a home console video game system allowing for the choice to play any type of game of the individuals' choosing. And while the current investigation did not utilize the new interactive video game CE model, it served as the basis for this study's design setup.

The primary aim of this study was to investigate if cycling while playing a console video game produced 1) higher enjoyment scores (via modified PACES) than cycling while watching music videos and cycling with no external media and 2) Results in a lower or the same RPE alongside higher HRs and total work output elicited in the experimental condition (video game and cycling).

Exercise Enjoyment

In regards to the first hypothesis, the data only provided limited support as participants found the music video condition similarly enjoyable as the video game condition. However, both conditions were significantly more enjoyable than cycling without any external media, and this finding is consistent with previous research efforts investigating the area of exergaming (Gao, Zhang, & Podlog, 2013; Duncan & Dick, 2012; Graves et al., 2010; Sell, Lillie, & Taylor, 2008) and the use of music during exercise in terms of enjoyment (Wininger & Pargman, 2003). Moreover, Leininger, Coles, & Gilbert (2010) compared the playing of the exergame, DDR, to traditional treadmill walking each for 30 minutes at similar exercise intensity (based on VO_2) on separate days and found that the former elicited statistically greater exercise enjoyment with no significant difference in RPE. Recently, Naugle, Naugle, & Wikstrom, (2014) found that participants produced more enjoyment and positive emotion from playing Nintendo® Wii™ boxing and tennis compared to performing traditional exercise. The use of music videos for this study is partly based on preliminary evidence indicating that watching music videos also promotes exercise enjoyment (Dorsher, 2010; Whitehead, Kleven, Brinkert, & Short, 2008).

In this current study, participants were able to choose which video game they wanted to play as well as the musical artists they wanted to listen to during the video game and music video exercise session, respectively. However, some participants had not played or did not own an Xbox 360 video game system and chose to play the *Top Spin 4* game that was provided or a game that was close to their liking which was also provided by the researcher if available. Thus, it is speculated that these situations may have influenced the enjoyment of the video game cycling session by decreasing the mean PACES score.

RPE

Between the three treatment conditions, session RPE was significantly lower in the video game condition compared to the music video and control conditions. Evidence suggests that playing activity-promoting video games can elicit lower or no significant difference in RPE values when compared to traditional exercise modalities when exercise intensity is kept the same. Warburton et al., (2009) had participants perform interactive video game cycling and regular stationary cycling (using same CE) at three increasingly identical workloads. Key measures included anthropometry, EE, HR, VO_2, and RPE. The researchers found that participants produced greater increases in EE, HR, and VO_2 when performing interactive video game cycling, but with no significant differences in RPE between the two conditions. These findings support previous research in that it has found that using virtual reality-enhanced equipment (i.e., video games) during exercise may promote an interesting and challenging environment that effectively masks the feelings of discomfort and boredom (Annesi & Mazas, 1997; Warburton et al., 2009 as cited in Keats, Jakob, & Rhodes, 2011). Additionally, evidence suggest that audiovisual media (e.g., video games and music) can distract individuals during uncomfortable tasks (Bonk, France, & Taylor, 2001; Wint, Eshelman, Steele, & Guzzetta, 2002; Windlick-Biermeier, Sjoberg, Dale, Eshelman, & Guzzetta, 2007) as cited in Warburton et al., 2009; Chow, 2012) by reducing perceptions of exercise (De Bourdeaudhuij et al., 2002; Boutcher & as cited in Warburton et al., 2009) by allowing individuals to shift their focus and attention more externally by using dissociative strategies (such as video games and music videos in this case) compared to concentrating more on the more internal somatic cues associated with activities such as exercise (Masters & Ogles, 1998 as cited in Razon, Basevitch, Land, Thompson, & Tenenbaum, 2009). This, in turn, could result in better adherence to daily PA and exercise among most of the population.

Many studies have investigated only the auditory condition of music during exercise (e.g., Waterhouse, Hudson, & Edwards, 2010; Potteiger, Schroeder, & Goff, 2000; Elliot, Carr, & Savage, 2004) as it has been shown to be an effective distractor from the physiological and psychological demands of exercise (Karageorghis & Priest, 2012). In this study, audio-visual media such as music videos were chosen for comparison to playing a video game due to its audiovisual nature and positive effectiveness that it may have during exercise (Whitehead, Kleven, Brinkert, & Short, 2008). A study conducted by Barwood, Weston, Thelwell, & Page, (2009) measured differences in total treadmill running distance, HR, blood lactate accumulation and RPE between three exercise conditions: watching motivational music videos (M), watching non-motivational video content (public speaker from political trial) (NM) and exercising without any external media (CON). The researchers found that participants ran significantly further in the M condition compared with the NM and CON conditions, but did not increase their peak RPE rating. Interestingly, the music video condition in this current study produced a higher RPE than the control condition. And while it was not a statistical difference, the result contradicts previous studies utilizing music and video during exercise (Dorsher, 2010; Whitehead, Kleven, Brinkert, & Short, 2008). However, the researcher speculates that the participants may have been distracted by the song durations since they were familiar with their chosen artist's music (even though the playlist time was not showing on the television screen). Thus, the participants may have been distracted from the distractor (the music video times) which may have shifted the perceived dissociative nature of the music video condition to a more associative one leading to a higher session RPE than both the video game and control conditions. Conversely, the statistically significant differences observed in regards to RPE may have minimal practical significance, meaning that individuals in general may not even notice a substantial difference between one point on Borg's 6-20 RPE Scale.

Heart Rate

HR was collected every 2 minutes and 45 seconds as well at the end of each 20-minute cycling condition. Significant differences in HR between the three treatment conditions were not observed in this study which did not support the second hypothesis. However, participants on average were working at 53%, 57%, and 52% of their HRR in the video game, music video, and control conditions, respectively. This, in turn, would suggest that they were under significant cardiovascular stress for all three treatment conditions. Previous research has found that participants attain significantly higher mean HRs and time spent above their THR in the video game cycling condition compared to the other treatment conditions (Warburton et al., 2009; Kraft, Russell, Bowman, Selsor

III, & Foster, 2011). Interestingly, Adamo, Rutherford, Goldfield, (2010) found that the music only cycling group spent more time in minutes per session at vigorous intensity which was 80-100% of predicted peak HR as well as produced higher pedaling rates than the interactive video game cycling condition. However, the video game and cycling setup in this present study differs by design and therefore, may have led to this non-significant finding of HR between the three conditions.

Total Work Output

The video game condition did not produce higher total work outputs as opposed to the other two conditions and therefore, did not support the second hypothesis. And while participants elicited significantly higher total work outputs in the music video and control conditions, the practical significance may be minimal. Total work output was based on the total amount of kilojoules (kJ) that the participants expended. It is estimated that 4.184 kJ is essentially equivalent to 1 kilocalorie (kcal). Based on the SMI Power Extend computer software that was utilized for CE data collection, the participants' EE in the video game, music video, and control condition was 150.30 kcal, 165.16 kcal, and 159.39 kcal, respectively. This finding would suggest that participants completed more work in the music video condition, however, the formula that the SMI Power Extend computer software utilized was not known and thus the validity of EE calculation is not fully certain.

Limitations

It is worth noting that there were some limitations to this investigation. For example, in regards to the video game condition, the upright nature and smaller seat design of the CE used for this study may have affected the participants' observed measures (i.e., enjoyment, RPE, HR, and total work output). As mentioned earlier in a previous section, the video game and CE setup was based on a newer model of an interactive video game CE which utilizes a recumbent design. It is speculated that the absence of a back rest due to the upright positioning of the CE used for this study may possibly have caused participants to feel uncomfortable due to the possible strain from sitting upright for an extended period of time while holding the video game controller. This, in turn, may be partly the reason for the significantly lower total work outputs exhibited from the participants when cycling in the video game condition. As a result, this also could explain why the session RPE in the video game condition was lower. However, as previously mentioned, the practical significance of these lower total work outputs may not yield any significant real-world difference between the three treatment conditions. Also, the monitoring of overall cycling distance (e.g., in meters) would have further clarified the work output results among the three treatment conditions. It is worth mentioning, that while all the necessary steps were taken to make sure that the intervention venue mirrored real-world settings, the ecological validity was still affected as participants were still in a laboratory setting being surrounded by various equipment.

As mentioned previously in this section, some participants just selected the best available video game options that the researcher provided since they did not own or have even played an Xbox® 360 video game console and this may explain the non-significant difference in enjoyment scores between the two audiovisual conditions (video game and music video). Also, as was indicated earlier, session RPE was higher in the music video condition. It is speculated that participants had a sense of how much time had elapsed which is possibly due to the familiarity of the musical artists and their respected songs that they chose to watch/listen to. Thus, the participants may have been distracted from the distractor; that being the music videos. Interestingly, there was a time element in certain sports video games that were played (e.g., game clock in hockey games), but amid the accelerated game clock option being turned on and various stoppages in play, the focus on how much time had elapsed was likely not a factor.

Conclusions

This investigation has shown that positive benefits can be produced from cycling with a non-interactive CE while playing a console video game. The results of this study suggest that this particular cycling and video game setup can elicit an exercise bout that is just as effective as with cycling using other external media (i.e., watching music videos) as well as without any external media. And while participants found the music video condition just as enjoyable as the video game condition, they had an overall lower perception of exertion in the latter. Total work output was significantly lower in the video game condition compared to both the music video and control conditions; however, the practical significance being translated into real-world settings may be minimal. The study consisted of only college-aged males as they comprise of the larger U.S. demographic that buys and plays the most video games. Unfortunately, this specific population also contributes to the high obesity rates seen in the U.S. Obesity development is likely caused by a multitude of factors. Insufficient daily PA and exercise has been shown to spur the onset of obesity and potentially other serious health consequences. PA is necessary for helping to negate these health risks. The use of video games intertwined with traditional exercise modalities could help combat the obesity epidemic as it can be potentially used as another avenue for improving ones' health and fitness. This, in turn, may provide a more enjoyable, motivating, and engaging experience for an individual who is not meeting the recommended daily PA guidelines. This may ultimately keep their PA and exercise adherence at a high state. Future research should further investigate this new cycling and video game design setup that was utilized in this study. More specifically, research on the Exerbike GS®, which was the basis for this investigation, would add additional credence to this new form of activity-promoting video gaming.

APPENDICES

Appendix A
PAR-Q

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME ____________________

SIGNATURE ____________________ DATE ____________________

SIGNATURE OF PARENT ____________________ WITNESS ____________________
or GUARDIAN (for participants under the age of majority)

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

Supported by: Health Canada Santé Canada

continued on other side...

Appendix B
Informed Consent Form
UND Exercise and Video Game Research Study

Principle Investigator: Shawn Reich, BS Exercise Science, NSCA-CPT
Phone#: 701-330-0841
Department: Kinesiology and Public Health Education

What is Informed Consent?
A person who is to participate in the research must give his or her informed consent to such participation. This consent must be based on an understanding of the nature and risks of the research. This document provides information that is important for this understanding. Research projects include only subjects who choose to take part. Please take your time in making your decisions as to whether to participate. If you have questions at any time, please ask.

What is the Exercise and Video Game Study?
You are invited to participate in the UND exercise and video game study. This research study is to find out which type of video games and music videos are more enjoyable during exercise in both sedentary and moderately active 18-25 year old male college students. You will perform exercise on an upright stationary bike while either playing a video game, watching music videos, or by just cycling.

If you want to be in this study, you are asked to do the following things:

1. On the *first session (**Familiarization [45 Min.-1-hour duration]**)*, **YOU WILL**:

    a. Fill out a Physical Activity Readiness Questionnaire (PAR-Q) form to screen for potential health issues such cardiovascular disease (CVD) and joint problems.

    b. Get your resting heart rate (HR) measured to help in determining an appropriate and comfortable bike resistance for you.

    c. Select Xbox 360 video game and music genre preferences.

    d. Get your height and weight measured to determine your body mass index (BMI).

    e. Perform a modified YMCA aerobic endurance bike test which will be no longer than 12 minutes in duration. The purpose of this test is to determine a comfortable biking resistance based on your HR, thus you will wear a HR strap and watch during this session and the following exercise sessions.

    f. Sign up for exercise session #1, #2, and #3.

2. On the *second session* (Exercise Session #1 [**no longer than 45 minutes**]), **YOU WILL WEAR A HR STRAP AND WATCH AND WILL PERFORM EITHER**:

   a. Cycling while playing an Xbox 360 video game console for 20 minutes.

   b. Cycling while watching music videos for 20 minutes.

   c. Cycling with no external media for 20 minutes.

***After cycling for 20 minutes, you will complete the Borg 6-20 RPE scale by selecting a number corresponding to how hard your workout felt. This will be followed by completing the PACES enjoyment scale. You can then sign up for Exercise Session #2.**

3. On the *third session* (Exercise Session #2 [**no longer than 45 minutes**]), **YOU WILL WEAR A HR STRAP AND WATCH AND PERFORM A DIFFERENT CYCLING PROTOCOL FROM EXERCISE SESSION #1 OF EITHER**:

   a. Cycling while playing an Xbox 360 video game console for 20 minutes.

   b. Cycling while watching music videos for 20 minutes.

   c. Cycling with no external media for 20 minutes.

***After cycling for 20 minutes, you will complete the Borg 6-20 RPE scale by selecting a number corresponding to how hard your workout felt. This will be followed by completing the PACES enjoyment scale. You can then sign up for Exercise Session #3.**

4. On the *fourth session* (Exercise Session #3 [**no longer than 45 minutes**]), **YOU WILL WEAR A HR STRAP AND WATCH AND PERFORM A DIFFERENT CYCLING PROTCOL FROM EXERCISE SESSION #2 OF EITHER**:

   a. Cycling while playing an Xbox 360 video game console for 20 minutes.

   b. Cycling while watching music videos for 20 minutes.

   c. Cycling with no external media for 20 minutes.

***After cycling for 20 minutes, you will complete the Borg 6-20 RPE scale by selecting a number corresponding to how hard your workout felt. This will be followed by completing the PACES enjoyment scale.**

UNIVERSITY OF NORTH DAKOTA.

Participation and Confidentiality
Participating in the study is voluntary. All of your information that will be collected is confidential and no one else will know except you and the researcher and his three advisors. A report will be written when the study is complete. Your name will not be used in the report. You may withdraw at any time during the study. Your decision whether or not to participate will not affect your current or future relations with the University of North Dakota.

Potential concerns
While the risk is minimal, there is a chance you might experience some dizziness, fatigue, or soreness when performing the YMCA submaximal aerobic endurance bike test or any of the exercise conditions.

What do I benefit from this study?
Not everyone in this study will benefit. However, it is with great hope that you will learn that there are many ways to make physical activity and exercise more enjoyable. The results may have you consider its use as a way of increasing your adherence to daily physical activity and exercise.

Questions/comments?
This project was approved by the Institutional Review Board at the University of North Dakota (701-777-4279); they will be able to answer any questions you have about your rights when participating in this study. If you have any other question about this study, please feel free to contact Shawn Reich (701-330-0841) or e-mail at shawn.reich@my.und.edu.

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***** PLEASE KEEP PAGES 1, 2, & 3 FOR YOUR RECORDS *****

UND Exercise and Video Game Research Study

Participant Informed Consent Form

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study.

I agree to take part in this study as a research participant.

___________________________________ ______________

Print YOUR name Date

Sign YOUR Name: ____

INFORMATION ABOUT YOU:

Degree: ____________________________ Year in College: ____________

Age: _______

How many days of the week do you get at least 30 minutes of moderate-intensity

physical activity (Please circle one): 0 1 2 3 4 5 6 7

What is your race? (Check all that are correct):

- ☐ White
- ☐ Black/African
- ☐ American Indian or Alaska Native
- ☐ Asian or Pacific Islander
- ☐ Other (please specify): ________________________

Appendix C
Video Game and Music Genre Preferences Form

ID:

Video Game and Music Genre Preferences

1) **Video Game Choice:** Please write down the Xbox 360 video game that you own and would like to play:

____

Or: If you don't have an Xbox 360 video game you own and would like to play, the following game will be provided for you!

Top Spin 4 (a tennis game)

2) **Music Choice:** Please select up to three genres below:

1. Pop (Any specific artists with their songs? Please write in space below):
2. Country (Any specific artists? Please write in space below):
3. Hip-Hop/R&B (Any specific artists? Please write in space below):
4. Dance/Electronic (Any specific artists? Please write in space below):
5. Rock (Any specific artists? Please write in space below):
6. Other :_________________________________

Appendix D
Participant Height and Weight data sheet

ID: ____________________ AGE: ______ DATE: _____________________

Resting Heart Rate: ________ THR (40% of HRR): _____________

Estimated HRMAX:________

Weight Data (in kilograms to 0.1kg):

MEASURE #1 ☐☐☐ . ☐ kg

MEASURE #2 ☐☐☐ . ☐ kg

MEASURE #3 ☐☐☐ . ☐ kg (if necessary)

Height Data (in centimeters to 5mm):

MEASURE #1 ☐☐☐ . ☐ cm

MEASURE #2 ☐☐☐ . ☐ cm

MEASURE #3 ☐☐☐ . ☐ cm (if necessary)

Appendix E
YMCA Cycle Ergometer Protocol (Modified)
Participant Data Sheet

ID: ____________________________ AGE: __________ Seat Height: __________

DATE: _________________________ THR (40% of HRR): ___________

Stage One (pedal at 50 RPM at 0.5 kg):			
Time (√ **for completion)**	Heart Rate	Resistance (kg)	Notes
1st Minute			
2nd Minute			
2 min. 45 sec.			
3rd Minute			
Stage Two (pedal at 50 RPM [resistance depends on HR measured at 2 min. 45 sec.])			
4th Minute			
5th Minute			
5 min. 45 sec.			
6th Minute			
Stage Three (pedal at 50 RPM [resistance depends on HR measured at 5 min. 45 sec.])			
7th Minute			
8th Minute			
8 min. 45 sec.			
9th Minute			
Stage Four (**pedal at 50 RPM [resistance depends on HR measured at 11 min. 45 sec.])**			
10th Minute			
11th Minute			
11 min. 45 sec.			
12th Minute			

RESISTANCE THAT WILL BE USED FOR EXERCISE SESSIONS: __________kg

Appendix F
Participant Instructions

Below is a list of instructions for you to keep. Please read over them carefully and if you have any questions please do not be afraid to ask. You are asked to restrict certain things to ensure as much as possible that those extraneous variables are not the cause of the results. Thank you for your participation and adherence to the following:

1) Do not eat anything for one hour prior to participation in the study.
2) Do not drink anything containing caffeine for one hour prior to participation in the study.
3) Wear comfortable, loose fitting clothing that can be used for exercising (e.g., shorts, athletic pants, T-shirt, tank top, athletic shoes, etc.).
4) Report to the Exercise Physiology Laboratory in the Hyslop, room 301, 5 minutes before your scheduled time. If you need directions call Shawn at 701-330-0841.
5) Drink plenty of water before your scheduled time so you are hydrated for the activity.
6) Make sure to set aside a minimum of 45 minutes in your schedule to ensure you have plenty of time for cool down and questions.
7) Do not do anything out of the ordinary 24 hours before your scheduled time. Try and get the same amount of sleep, food, relaxation, etc. before your scheduled participation time.

If you have any questions about the above written instructions or anything regarding your participation in this study, please feel free to contact Shawn at 701-330-0841 or by e-mail at shawn.reich@my.und.edu. Again, I thank you for your cooperation and participation in this study.

Appendix G
Participant Data Sheet

ID: ___________________________ Age: ______ Workload: ________kg

DATE: ________________________ THR (40% of HRR): ___________

MUSIC VIDEOS BEING WATCHED (Write order of MVs being used for MV Condition)				
1. **Artist:** **Song:**	**2.** **Artist:** **Song:**	**3.** **Artist:** **Song:**	**4.** **Artist:** **Song:**	**5.** **Artist:** **Song:**

SESSION #: _______ EXERCISE CONDITION (Circle): VG, MV, or Control

VIDEO GAME BEING PLAYED: ______________________________________

SEQUENCE COMBINATION (Circle): 1, 2, 3, 4, 5, or 6 1=VG, 2=MV, 3=Control					
123 (1)	132 (2)	213 (3)	231 (4)	321 (5)	312 (6)

20 Minute Cycling Intervention			
Time (min.) (√ **for completion)**	HR	Resistance (kg)	Notes
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Appendix H
Borg 6-20 Ratings of Perceived Exertion (RPE) Scale

ID:
HR:

How Hard Was The Workout?

How hard was the cycling workout you just completed? When you circle a number, your rating should reflect the total amount of exertion and fatigue, combining all sensations and feelings of physical stress, effort, and fatigue that you felt. Don't concern yourself with any one factor, such as arm pain, shortness of breath or exercise intensity, but try to *summarize your overall feeling of exertion for the whole workout*. Try not to underestimate or overestimate your feeling of exertion; be as accurate as you can.

6	
7	**Very, very light**
8	
9	**Very light**
10	
11	**Fairly light**
12	
13	**Somewhat hard**
14	
15	**Hard**
16	
17	**Very hard**
18	
19	**Very, very hard**
20	

9 on the scale corresponds to “very light” exercise. For a healthy person, it is like walking slowly at his or her own pace for some minutes.

13 on the scale corresponds to “somewhat hard” exercise, but still feels OK to continue.

17 on the scale corresponds to “very strenuous” exercise. A very healthy person can still go on, but he or she really has to push him- or herself. It feels very heavy, and the person is very tired.

19 on the scale corresponds to “very, very hard” exercise. For most people, this is the most strenuous exercise they have experienced.

20 on the scale corresponds to “maximal exertion.” The person cannot physiologically continue as they have reached their max exercise level.

Borg RPE scale

Appendix I

Modified PACES ID:

Physical Activity Enjoyment Scale

For each statement below, select the response which best represents how much you “disagree” or “agree” with the statement. Mark your response by checking the appropriate box.

With regard to the exercise that I just completed ...	**Disagree a lot**	**Disagree a little**	**Neither agree nor disagree**	**Agree a little**	**Agree a lot**
1. ... I enjoyed it					
2. ... I felt bored					
3. ... I disliked it					
4. ... I found it fun					
5. ... it wasn’t fun at all					
6. ... it gave me energy					
7. ... it made me depressed					
8. ... it was very pleasant					
9. ... my body felt good					
10. ... I got something out of it					
11. ... it was very exciting					
12. ... it frustrated me					
13. ... it was not at all interesting					
14. ... it gave me a strong feeling of success					
15. ... it felt good					
16. ... I felt as though I would rather be doing something else					

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