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SYMPOSIUM

Motivating Effects of Cooperative Exergame Play for Overweight and Obese Adolescents

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Abstract

Background:

Exergames (i.e., video games that require gross motor activity) may provide intrinsically motivating experiences that engage youth in sustained physical activity.

Method:

Thirty-one low-income 15- to 19-year-old overweight and obese African American adolescents were randomly assigned to a competitive exergame (n = 17) or a cooperative exergame (n = 14) condition. Participants played a preassigned Wii Active exergame routine that took between 30 and 60 min each school day, and sessions occurred during lunch time or an after-school program over a 6 month period. Participation was voluntary, so students decided whether to come or not on a given day. Cooperative exergame players worked together with a peer to expend calories and earn points, while competitive exergame players competed individually against a peer to expend calories and earn points. Motivation was measured through surveys and interviews at the end of the intervention, and energy expenditure was measured by accelerometry during game play.

Results:

Compared with the competitive group, the cooperative players were significantly more intrinsically motivated to play (p = .034, partial eta-squared = 0.366) and more psychologically attracted to the design of the exergame (p = .034, partial eta-squared = 0.320). Intrinsic motivation was significantly positively correlated with energy expenditure during game play: individuals who were motivated by control/choice had higher energy expenditure (p = .026), and those who were more goal motivated (p = .004) and more immersed in game play (p = .024) had lower energy expenditure during game play.

Conclusions:

Cooperative exergame play produced higher intrinsic motivation to play the exergame than competitive exergame play did. Intrinsic motivation that came from a desire for control/choice was related to higher energy expenditure during game play. Cooperative exergame play holds promise as a method for engaging overweight and obese youth in physical activity.

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Abbreviations: (M) mean, (MANOVA) multivariate analysis of variance, (SD) standard deviation

Keywords: competition, cooperation, exergame, motivation, obese adolescents, physical activity intervention

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Introduction

Physical activity interventions for overweight and obese youth typically fail because of high attrition rates and low motivation.[1] Intrinsic, internally driven motivation to engage in physical activity, based on one's own internal satisfaction or fulfillment, is often low during adolescence, and this can lead to weight gain.[2] Youth often cease regular physical activity during adolescence, citing loss of interest and lack of competence or time.[2] Finding fun, sustainable physical activities that youth will be motivated to participate in consistently and frequently is essential to promote weight loss or healthy weight maintenance.

One such potential activity is the exergame, which is a highly popular video game genre with an interface that requires gross motor movement to play.[3] The properties of exergames, including those related to social interaction, may influence the motivation and interest of players, particularly during adolescence when peer group participation is important to youth. The present study examines how the social context of exergaming, i.e., cooperative versus competitive play, differentially influences youths' intrinsic motivation and the psychological attractiveness of exergame play.

Unlike traditional physical activities that obese youth do not regularly engage in,[4] exergames may provide a fun gaming environment with features that enhance intrinsic motivation and can therefore engage youth in sustained physical activity. Boys and girls, and gamers and non-gamers, are equally likely to play exergames,[5] making these technological tools a promising opportunity to promote physical activity in diverse groups of youth.

Lepper and Malone[6] developed a theory that described intrinsic motivators that enhance an individual's interest in playing a computer game, without the need for external inducement such as a reward. One important motivator is the *sensory immersion* experience, or "flow," in which concentration on a challenging activity produces a loss of self-consciousness and transformation of time.[7] A second motivator is a sense of *control* over what happens in the game, which might occur when a player selects games or chooses strategies to win games. *Challenge* involves working toward a goal that is personally meaningful and sufficiently difficult to require continuous effort. Applied to exergaming, challenge involves the game's difficulty level and the player's ability to attain the game goals.

Exergames are typically played with or against peers,[3] and this social interaction during exergame play may create additional motivation to continue playing with peers. A study of preadolescents demonstrated preference for a multiplayer dance exergame versus traditional solitary physical activity.[8] Social interaction can increase enjoyment, perceived competence, and self-efficacy for carrying out the group activity, and when the activity is an exergame or physical activity, these effects of social interaction correlate positively with physical activity participation.[9] These motivating aspects of social interaction, combined with increased self-worth from physical activity,[10] may foster intrinsic motivation to play regularly.

In addition to increasing the frequency of physical activity, playing exergames socially with peers may encourage more intense and sustained physical activity within each game play session. Energy expenditure during exergame play usually qualifies as light to moderate physical activity,[11] and heart rate usually reaches the level needed to attain cardiorespiratory fitness, similar to the heart rate that occurs during moderate-intensity walking.[12,13] A study of social game play with exergames found that youth expended more energy when playing an exergame with a peer versus alone.[14]

Motivation may differ depending on the cooperative versus competitive nature of game play. It has been conjectured that in a *cooperative* exergame environment, a player may derive satisfaction in performing well and also in assisting other players in achieving team goals.[6] In a *competitive* exergame context, by contrast, a player may only feel satisfied if individual performance is better than other players' performance.[6] This distinction is important because it points to the stronger benefits of cooperative play. For example, research has found that when people engage in exercise in teams, team cohesion promotes adherence to the exercise regimen.[15] Cooperation also increases social support and self-esteem,[16] which can motivate and sustain continued physical activity. Social interaction may also provide feedback and *recognition*, which lead to a sense of satisfaction in having one's accomplishments noted and appreciated. In an exergaming context, feedback within a game about individual and team performance achievements could enhance players' social recognition of each other's skills and accomplishments, which, in turn, could further increase motivation to engage in physical activity in the game and to strive harder to win.

Using Lepper and Malone's intrinsic motivation theory as a framework, the present study investigates effects of cooperative versus competitive exergame play during an intervention with overweight and obese youth. We predict that

1. Youth who play an exergame cooperatively will be more intrinsically motivated to play than those who play the game competitively,

2. Youth who play an exergame cooperatively will be more psychologically attracted to the design of the exergame than those who play the game competitively, and

3. Youth who are more intrinsically motivated and more psychologically attracted to the exergame will expend more energy during game play.

Methods

Participants

Thirty-one 15–19-year-old [mean (M) = 16.2 years, standard deviation (SD) = 1.2] low-income African American adolescents from an urban public high school participated in a 20-week exergame intervention. Participants, who had a body mass index at or above the 75th percentile, were recruited by word of mouth or through referral from the school-based wellness clinic. The Georgetown University Institutional Review Board approved this study (2007-482). Informed assent and consent were obtained from participants and parents/guardians.

Program attendance was encouraged through extensive efforts, including school flyers, announcements, and regular communication from research assistants (via phone calls, texts, and emails) and daily positive verbal reinforcement. External rewards, including cash gift cards and healthy snacks, were also given for attendance, but these did not exceed $200 per participant for the intervention.

Measures

Intrinsic Motivation

Motivation for exergame play was measured with the self-report Motivation for Exergame Play Inventory, a 28-item validated survey that assesses aspects of motivation.[17] The inventory was built on Malone's theory of intrinsic motivations for learning. Five categories, including sensory immersion, control/choice, challenge/optimal difficulty, goal setting, and feedback, were examined with 5-point Likert scales, where 1 = strongly disagree and 5 = strongly agree.

Psychological Attractiveness of Game Design

Psychological attractiveness was measured with a self-report multi-item 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) to assess players' perceptions of the game design.[18] The present analysis used four factors selected from the full scale related to interpersonal communication, including social interaction (the game encouraged player interaction), collaboration (the game encouraged cooperation among players), individual feedback (the game provided sufficient feedback about individual player performance), and team feedback (the game provided sufficient feedback about team performance).

Energy Expenditure

Energy expenditure during game play was measured by a hip-mounted Actical accelerometer (Philips Respironics, Bend, OR). Average expenditure per minute was calculated above resting metabolic rate. Actical accelerometer demonstrates high validity against a respiratory calorimeter (range 68% to 81%).[19]

Interview

Each participant was interviewed one-on-one by an adult research coordinator at the end of the intervention. Interviews followed a prescribed script, and research coordinators transcribed the participants' responses. Responses were then categorized by a third researcher, using thematic analysis, into the themes of sensory immersion, control/choice, challenge, and social interaction.

Nintendo Wii Active Exergame

The Wii Active game (Nintendo of America Inc., Redmond, WA) is a fitness video game involving gross motor movement. In the study, players used two remote-control devices held in the hand or placed in a leg strap to communicate body movements with a sensor bar beside the video screen, and they used a resistance band for leg and arm exercises. Game play sessions consisted of cardio (e.g., running, dancing), upper and lower body strength training (e.g. standing twists, side-to-side jumps), and sports games (e.g., basketball, tennis). Players could compete against each other or cooperate in a team dyad to earn points and expend calories, which were tracked by the Wii console and displayed during game play.

Treatment Conditions and Procedure

Participants were assigned within sex group to cooperative exergame (n = 14, 7 females) or competitive exergame (n = 17, 8 females) conditions. An adult research coordinator drew a number to randomly assign condition. When conditions became imbalanced due to attrition, new participants were assigned consecutively to the next available condition to maintain sample size balance. The exergame intervention was held during lunchtime and after school in two separate classrooms, each supervised by an adult coordinator. One classroom was used for cooperative game play, and the other was used for competitive game play. Each classroom contained 10 Wii stations with equipment for 20 students. Music was played during the gaming sessions. All elements of the classroom environment, including music, décor, and Wii setup, were constant across the two conditions. Participants played a preassigned exergame routine that took between 30 and 60 min to complete and gradually increased in difficulty and intensity across several game play sessions.

During each session, participants were randomly assigned to a peer in their condition, and the composition of the pairs varied each day depending on attendance. Participants in the cooperative exergame condition played with their partner to expend calories and earn points as a team. Those in the competitive condition competed to expend more calories and earn more points than their partner. Each day, the names of the top three winning teams in the cooperative condition were written on the board in the cooperative classroom, and the names of the top three winning individuals in the competitive condition were written on the board in the competitive classroom. Motivational and psychological attractiveness scales were administered at the end of the exergame intervention (M = 134.60 days, SD = 48.28).

Statistical Analysis

Multivariate analysis of variance (MANOVA) was used to examine differences between cooperative and competitive conditions for the intrinsic motivation scores, and a second MANOVA was computed for the psychological attractiveness scores. Univariate main effects were examined if the MANOVA was significant. To control for experiment-wise alpha inflation, the confidence level for the univariate tests was divided by the number of tests performed, such that the cutoff was $p < .01$ for intrinsic motivation scores and $p < .013$ for psychological attractiveness scores. Missing data accounted for 5.0% of the values (2.4% of values in the cooperative condition; 7.2% in the competitive condition). Condition Ms were imputed for each missing value.

Linear regression analysis was used to examine the influence of intrinsic motivation and psychological attractiveness on energy expenditure. Analyses were conducted on a subset of 24 participants who had complete energy expenditure data (n = 10 for cooperative condition, n = 14 for competitive condition). The independent variables for the intrinsic motivation analysis were the intrinsic motivation scores [sensory immersion, control/choice, and challenge (optimal difficulty, goals, and feedback)], controlling for condition and sex. The independent variables for the psychological attraction analysis were the attraction scores (social interaction, collaboration, individual feedback, and team feedback), controlling for condition and sex.

Results

Originally, 55 participants were enrolled in the exergame intervention which was called the Wii Club, putting the emphasis on being in a game club rather than being in a weight loss program. Participant attrition occurred by condition for 11 students in the competitive condition (39.3% dropout rate) and 13 students in the cooperative condition (48.1% dropout rate). Students who withdrew from the study before the completion of the intervention told the researchers that they did so for a variety of reasons including self-consciousness due to obesity, school truancy or dropout, school transfer, lack of interest, pregnancy, safety concerns about walking home in the dark, sports practice time conflicts, academic tutoring time conflicts, frequent headaches, and an injury outside of the program that required crutches.

Intrinsic Motivation

The first hypothesis predicted that youth who play exergames cooperatively will be more intrinsically motivated to play than those who play exergames competitively. The one-way MANOVA yielded a significant multivariate main effect for condition, Wilks's $\lambda = 0.634$, $F(5,25) = 2.883$, $p = .034$, partial eta-squared = 0.366, power = 0.753 (data from this study are not shown in tables). Significant univariate main effects favoring the cooperative over the competitive exergame condition were obtained for challenge optimal difficulty, $F(1,29) = 8.732$, $p = .006$ (M = 19.2, SD = 0.9 versus M = 15.8, SD = 0.8, respectively), partial eta-squared = 0.231, power = 0.815, and for sensory immersion, $F(1,29) = 7.692$, $p = .01$ (M = 28.4, SD = 1.5 versus M = 22.6, SD = 1.4, respectively), partial eta-squared = 0.210, power = 0.764.

Psychological Attractiveness of Exergame Design

The second hypothesis predicted that youth who play exergames cooperatively will be more psychologically attracted to the design of the exergame than those who play the game competitively. The one-way MANOVA yielded a significant multivariate main effect for condition, Wilks's λ = 0.680, $F(4,26)$ = 3.064, p = .034, partial eta-squared = 0.320, power = 0.727. Significant univariate main effects for condition were obtained favoring the cooperative over the competitive exergame condition for ratings of psychological attraction to the exergame, $F(1,29)$ = 10.261, p = .003 (M = 9.9, SD = 0.7 versus M = 6.6, SD = 0.7, respectively), partial eta-squared = 0.261, power = 0.872.

Influence of Intrinsic Motivation and Psychological Attraction on Energy Expenditure

The third hypothesis stated that youth who are more intrinsically motivated to play and more psychologically attracted to exergame play will expend more energy during exergame play. The linear regression model examining the influence of intrinsic motivation on physical activity revealed that control/choice (t = 2.577, p = .026), goals (t = -3.569, p = .004), and sensory immersion (t = -2.610, p = .024) were significantly related to physical activity. High levels of motivation due to control/choice predicted high amounts of energy expenditure, whereas high levels of goal motivation and sensory immersion predicted lower amounts of energy expenditure. Psychological attraction to game play did not significantly predict energy expenditure.

Qualitative Interview Observations

Sensory Immersion

The researchers noted anecdotally that sensory immersion was also evident in the participants' descriptions of their favorite Wii exergames, such as inline skating. One female in the competitive condition noted that, in inline skating, she could "watch the player on the game do flips and mirror the jumps" that she was doing. Another participant in the competitive condition said that he enjoyed the "pretty and relaxing" setting of the running game, which was on a virtual beach. Participants were also motivated by listening to music during their workouts.

Control

Students reported that they were able to use the exergame controllers with ease. They felt highly competent to play the game and to use the controllers, and they were highly confident in their ability to complete exergame workouts. However, participants became frustrated when the controller did not correctly read their movement, particularly in exercises performed with a resistance band. One male in the competitive condition stopped using the malfunctioning resistance band and stated he felt that he was "just standing moving [his] arms instead of getting a real workout," and he said he would not attend if the next day's workout used the resistance bands.

Participants had limited control and choice over game play because all exergame routines were preassigned. Participants expressed boredom with playing the Wii Active exergame for multiple weeks and requested additional exergames to play instead. We partially addressed this concern by adding a supplemental package of Wii exergames to both of the experimental conditions. A few participants also modified routines by creating their own dance steps to complete the dancing routine.

Challenge

Many participants found certain aspects of the exergame, such as the virtual obstacle course, to be too long and too challenging, which resulted in frustration and drops in attendance. A female participant in the competitive condition noted that she was upset by a particular day's routine because she found the workout included "too many squats and lunges" and made it feel "repetitive."

However, according to researchers' anecdotal accounts, as participants attended the program longer, their stamina and endurance to complete the exergame routine seemed to improve. In fact, some participants complained that their workouts were too easy and requested more challenging sessions. One male in the cooperative condition stopped attending the intervention after 4 weeks, stating the exergame was "boring." A male in the competitive group commented that he visited the school's weight room instead of the exergame sessions because he "felt the workouts were not going to give [him] the results [he] wanted in building muscle and losing fat." However, one female participant in the competitive condition stated that she preferred the easier workouts because they were "less challenging." These comments point to the importance of user control in order to create an optimal level of challenge for each participant.

Researchers observed several instances in which participants who were regularly engaged in outside activities and sports, such as the school football team, appeared to have more motivation to complete the challenge. Therefore, they did not require as much encouragement or verbal reinforcement from the adult coordinator as the participants who were not involved in outside activities and sports. It may be that the students involved in activities and sports were more accustomed to the demands of engaging in strenuous physical activity over a sustained period of time.

Specific aspects of the exergame proved particularly challenging and discouraging. For instance, the tennis game required players to align their arm at a certain angle and use precise timing in order to hit a virtual ball at a target. This difficult challenge did not increase motivation, and instead, it seemed to reduce enjoyment, especially because a player had to complete a certain number of successful hits in order to progress to the next game. In contrast to the tennis target game, a female participant in the competitive condition said that she especially enjoyed the games that were "faster paced" and "more interactive."

Social Interaction

Participants in both conditions reported that the most important influence on their interest and involvement in the exergame was the friendship and social cohesion they developed with their peers and the adult coordinators. Participants in the lunchtime groups also ate lunch together after their workouts, and this appeared to promote social bonding in both exergame conditions. The lunchtime groups each became a social club, as we had intended, where participants did not mind devoting time to working out with their peers. In comparison, the two after-school groups ate snacks after their workouts, but teams finished at different times and went home soon after eating instead of staying in the room to interact with peers, so there may have been less opportunity for group socializing and cohesion outside of game play for the after-school groups.

Participants in the lunchtime and after-school competitive groups stated that they enjoyed the cardio exercises in which they could compare their progress with their partner's, such as in the running exercise, where they could see their own character and their partner's character on the screen and see how their own progress compared with their partner's progress. On the other hand, even though participants in the cooperative groups saw displays of team rankings and participants in the competitive groups saw displays of individual rankings each day and each week throughout the intervention, participants did not mention these rankings as a key motivator.

When a participant's partner, whether in the competitive or cooperative condition, exhibited a slow pace in finishing the exergame routine, the participant often expressed frustration, particularly those in the competitive condition. In contrast, when a partner was energized and enthusiastic, the individual often expressed enjoyment and motivation for continued play. Gender differences also emerged, where many female participants enjoyed the aerobic and dancing activities and male participants reported not enjoying them, because they did not feel the activities were masculine. Instead, the males said they enjoyed basketball and inline skating activities the most.

Discussion

This study examined characteristics of exergames that motivate overweight and obese adolescents to play them over time. Building on Malone's theory of intrinsic motivation,[6] the study focused on the motivating features of sensory immersion, control/choice, challenge, and social interaction within a cooperative versus competitive game-playing context. As predicted, cooperative exergame players scored significantly higher than competitive exergame players on intrinsic motivation to play exergames and perceived psychological attractiveness of exergames.

Prior research has found that cooperation plays a key role in creating group cohesion,[20] and the current study finds that cooperation can promote more sustained physical activity than competition. With cooperation, a feeling of group cohesion may have influenced players' positive perceptions of exergame play. Specifically, cooperative players rated the sensory immersive experience of the visual effects and music higher than the competitive players did. Cooperative players also rated their motivation to play challenging games higher than the competitive players did, indicating team challenge may be more motivating than individual competition. Finally, the motivating quality of social interaction was rated higher among cooperative players.

Certain aspects of motivation and psychological attraction, by contrast, did not differ by condition, including the sense of control/choice, goal-setting, and feedback. To control exposure to the exergame across and within conditions, the intervention used preassigned exergame routines, eliminating players' freedom to choose which games to play. Even so, players created their own dance moves and physical adaptations to develop a sense of control of their play. Goal-setting did not emerge as an important motivator in the survey results or qualitative interview data. Had the intervention been framed as a weight loss program rather than a gaming club, these results may have differed. Despite team feedback and recognition varying based on whether a participant was playing cooperatively versus competitively, feedback did not affect motivation and did not differ between the conditions. The Wii console unit provides individual feedback regardless of whether the game is played cooperatively or competitively. Consequently, external feedback announcing individual versus team winners in each condition may not have been sufficient recognition to induce differences in motivation or psychological attractiveness toward game play.

Motivation due to control over game play was significantly related to increased energy expenditure. Sense of control relates to self-efficacy, a significant predictor of physical activity participation.[9] In contrast, the intrinsic motivators of goal-related challenge and sensory immersion were negatively related to energy expenditure. Becoming immersed in the game environment may distract teen players from the actual physical activity. For instance, qualitative data indicated participants became relaxed when immersed in the virtual water activities in the exergame, which may decrease energy expenditure. Some exergame challenges required precision of movement rather than intensity of movement, so achieving the goal of winning the game did not necessarily increase energy expenditure. Introducing an external goal such as weight loss or fitness may increase energy expenditure during game play, leading to positive physical health outcomes.

A study limitation was the high attrition rate, which is common in physical activity interventions, particularly with ethnic minority youth.[21] Although external rewards were given to retain participants, high levels of reported intrinsic motivation, particularly by the cooperative condition, indicate that exergame play *per se* also sustained their interest. Future studies are needed to investigate how exergames can effectively supplement physical activity and produce weight loss for all youth. Examining effects of competitive versus cooperative game play on aggression is an additional area for research, as competitive play of traditional sedentary video games has been demonstrated to increase aggressive behavior.[22]

Conclusion

In conclusion, this study provides preliminary evidence that exergames, especially when played cooperatively, promote intrinsic motivation and encourage psychological attraction to gaming experiences that sustain exergame play in overweight and obese adolescents. It also provides preliminary evidence that cooperative exergame play may provide a method for encouraging much-needed physical activity among overweight and obese youth.

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