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Effects of Home Access to Active Videogames on Child Self-Esteem, Enjoyment of Physical Activity, and Anxiety Related to Electronic Games: Results from a Randomized Controlled Trial

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Abstract

Objective: Active-input videogames could provide a useful conduit for increasing physical activity by improving a child's self-confidence, physical activity enjoyment, and reducing anxiety. Therefore this study evaluated the impact of (a) the removal of home access to traditional electronic games or (b) their replacement with active-input videogames, on child self-perception, enjoyment of physical activity, and electronic game use anxiety.

Subjects and Methods: This was a crossover, randomized controlled trial, conducted over a 6-month period in participants' family homes in metropolitan Perth, Australia, from 2007 to 2010. Children 10–12 years old were recruited through school and community media. Of 210 children who were eligible, 74 met inclusion criteria, and 8 withdrew, leaving 66 children (33 girls) for analysis. A counterbalanced randomized order of three conditions sustained for 8 weeks each: No home access to electronic games, home access to traditional electronic games, and home access to active-input electronic games. Perception of self-esteem (Harter's Self Perception Profile for Children), enjoyment of physical activity (Physical Activity Enjoyment Scale questionnaire), and anxiety toward electronic game use (modified Loyd and Gressard Computer Anxiety Subscale) were assessed.

Results: Compared with home access to traditional electronic games, neither removal of all electronic games nor replacement with active-input games resulted in any significant change to child self-esteem, enjoyment of physical activity, or anxiety related to electronic games.

Conclusions: Although active-input videogames have been shown to be enjoyable in the short term, their ability to impact on psychological outcomes is yet to be established.

Introduction

Active-input videogames (AVGs) have been suggested by some as a potentially useful avenue to help engage children to be more active and less sedentary.[1,2] The mechanism for this may either be direct or indirect. Directly, AVG may increase the time that children spend in physically active behavior and decrease the time spent in sedentary behavior, thus increasing their physical activity and decreasing their sedentary time. Randomized trials in the home setting to date, however, have found limited success of this in the medium term.[3–5] Indirectly, AVG may provide the opportunity to enhance movement skills[6] or increase a child's self-confidence and/or enjoyment in being physically active and consequently increase his or her physical activity and decrease sedentary time.

Physical activity and participation in sport have been associated with multiple psychological benefits, including improved self-esteem.[7] The relationship between physical activity and positive psychological traits may be reciprocal. Not only are children who enjoy physical activity more likely to participate in future physical activity,[8,9] but physical

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activity has also been shown to improve self-esteem[10] and positive emotions.[11] AVGs may also provide children with positive physical activity experiences that are enjoyable and thus encourage participation in future physical activities. The goal-oriented nature of AVGs and the ability for children to get immediate feedback may be attractive features to children. Provision of immediate feedback on player success, and ability to keep trying, assists in learning and offers opportunities to practice to the point of mastery.[12] AVGs may also assist in transferring knowledge or skills to real-world physical activity. By simply being active while playing the AVG, children may improve psychological well-being, including improved self-esteem. Despite the potential for AVGs to enhance self-esteem and liking of physical activity, there is limited real-world experimental evidence to support these potentially beneficial effects of AVGs.

Motivations for children to play AVGs are varied. Observational studies have shown that children cite self-esteem-related factors such as ''ownership'' and ''success'' as reasons for why they like engaging with electronic games (either AVGs or traditional sedentary videogames).[13] The same study also showed that children value electronic games as an opportunity to experience challenges without negative consequences. An exploratory qualitative study with New Zealand children 10–14 years of age showed that boys and girls varied on why they would be motivated to play with AVGs: The younger boys thought AVGs would be ''fun and challenging'' and would help them ''keep fit,'' the younger girls liked the thought of being able to ''dance and sing,'' but both older boys and older girls showed less enthusiasm.[14] Another reason children may not use AVGs is anxiety related to the use of technology. The technology acceptance model of Davis[15] suggests anxiety associated with technology is a predictor of computer use, and thus anxiety related to electronic game use may be a barrier to engagement with AVGs and therefore their potential beneficial effects.

If AVG use demonstrated positive effects on self-esteem, liking of physical activity, and electronic game anxiety, it may have an indirect effect on enhanced physical activity profiles, as illustrated in Figure 1. This article sought to explore the effects of introducing AVGs into the household of children, 10–12 years of age, on both their overall perception of self and their enjoyment of physical activity and to compare this with the effects of home access to traditional games or no access to electronic games. The effects of AVG on electronic game use anxiety levels were also explored.

Subjects and Methods

The study was conducted in Perth, WA, Australia, in 2007–2010; the detailed study protocol was published previously.[16] Children, 10–12 years of age, were recruited through mass media (radio, newspapers), community newsletters, and local school notices. The recruitment was staggered to account for seasonal variation and targeted to enable participation of equal numbers of males and females and of children representative of a spread of socioeconomic status, electronic game experience, and motor competence. Inclusion criteria were being 10–12 years of age at the start of the study and able to access the electronic games provided in the study on most days of the week. The exclusion criterion included having a parent-reported diagnosed disorder likely to impact the child's study participation, movement, or electronic game use (other than a developmental coordination disorder). Ethical approval was provided by Curtin University Human Research Ethics Committee.

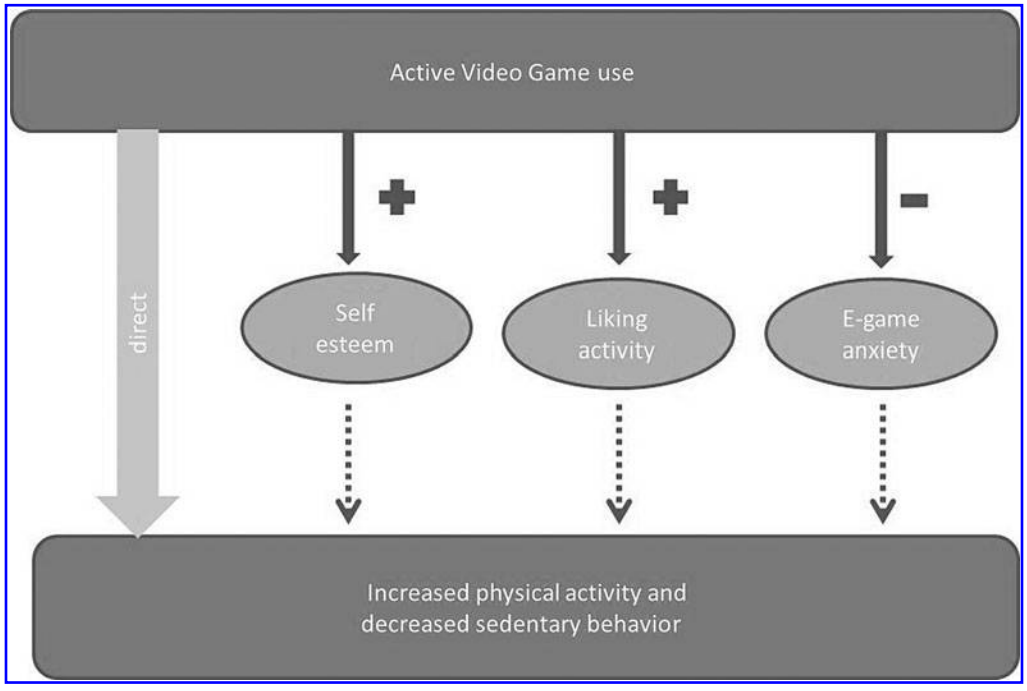

FIG. 1. Representation of potential direct and indirect effects of active videogame use on physical activity and sedentary behavior. E-game, electronic game.

Intervention

The study involved three conditions of electronic game access: No games, traditional games, and active games. ''No games'' involved all dedicated electronic game devices being removed from the family home with a contract by each child that electronic games were to be avoided where possible on other devices and locations. ''Traditional games'' involved the provision of a Sony® (Tokyo, Japan) PlayStation® 2 with a range of nonviolent games requiring game pad input. ''Active games'' involved the provision of a PlayStation 2 with EyeToy® and dance mat input devices and a range of nonviolent games. For each condition, children selected six games and were allowed to change games mid-intervention.

Study design

A challenge for the design of this study was to select a design that provided a ''no games''' condition with high internal and external validity. From our discussions with children, the removal of all electronic games was only acceptable if they could eventually get access to a range of new games and equipment. This is why a within-subjects design was chosen (Fig. 2). To control for an order effect, children were randomized to a balanced ordering of the three electronic game conditions.

Sample size

Power calculations were based on the primary outcome variable of daily moderate/vigorous physical activity. Although the more detailed specifics of this have been presented elsewhere,[16] it was calculated that a study sample of 72 subjects would be sufficient to reject the null hypothesis. This was based on finding a 15-minute difference in moderate/vigorous physical activity per day and allowing for a 10 percent attrition in data. The study was curtailed earlier than planned, as new electronic game technologies (Sony PlayStation 3 and Microsoft® [Redmond, WA] Xbox® Kinect®) became popular in late 2010 in Perth, making it unfeasible to recruit children to the older game technology. Thus, the planned sample of 72 was not reached.

Recruitment and study procedure

Following screening, participants were randomly allocated to an order of conditions. A balance of orders across the year was achieved by having sets of the six possible order permutations in each cohort. A research officer visited the home and, after explaining the study in more detail, obtained informed consent/assent from both parent and child. At this visit, the families were instructed in the physical activity measurements that were to be made over the following 10 days, and the psychosocial questionnaires (see specific outcome measures below) were given to the child. At this visit, data were also collected on the child's height, weight, socioeconomic status, motor coordination, and electronic game experience. The research officer returned after 10 days to collect all the baseline physical activity data and the psychosocial questionnaires and to set up the electronic game condition. This involved either removal of all electronic games or setting up electronic game equipment and instructing the parent and child in its use. Follow-up phone calls were made the next day and after 6 days to ensure game equipment was working correctly. After 8 weeks in each condition, the research officer returned and set up the next condition. Assessments were scheduled to avoid school and public holidays where possible. Individualized reports were

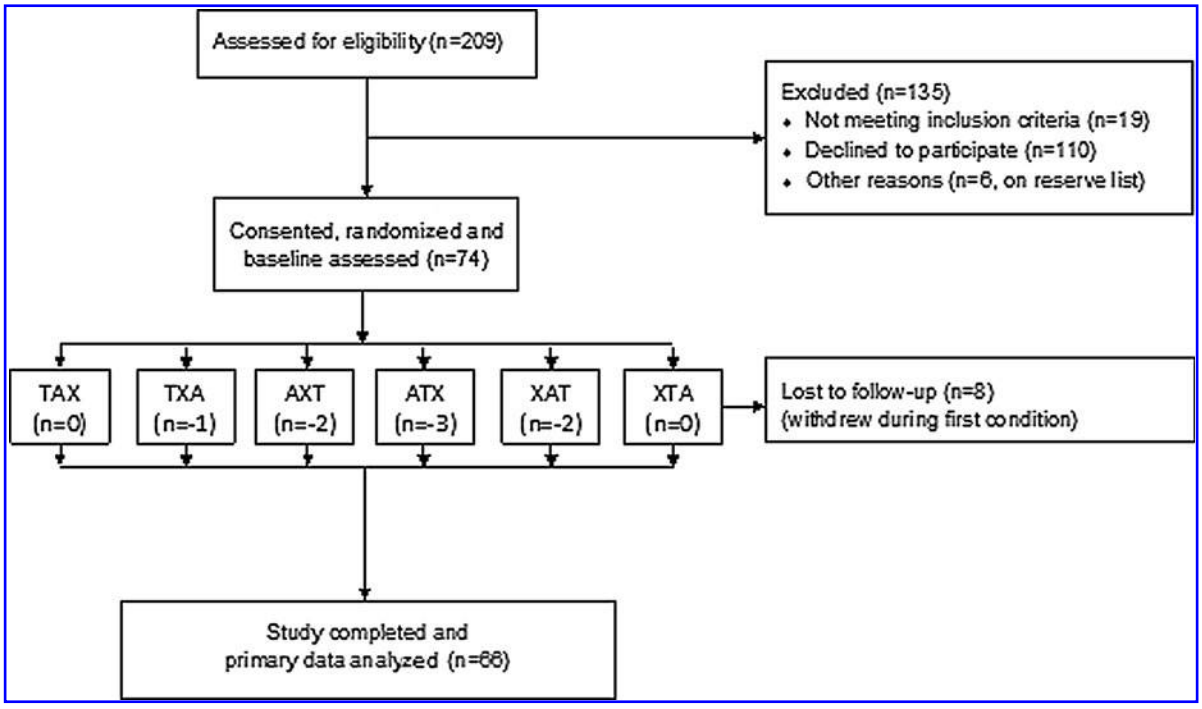

FIG. 2. Flow of participants through the trial showing the order of conditions through trial. A, active videogames (AVG); T, traditional electronic games; X, no electronic games.

provided to participants on study completion. The research officers involved with the setting up each condition were not involved in the subsequent analyses of the primary and secondary outcomes.

Outcome measures

This article presents the findings on the *a priori* secondary outcome measures (see the previously published protocol[16]).

Self-esteem. Self-esteem was measured using the Self-Perception Profile for Children (SPPC) of Harter.[17] The SPPC is the most widely used measure of self-esteem for children 8 years of age and over.[17] It measures five domains of self-perception, as well as providing a global measure of self-worth. The five domains are scholastic competence (how well a child perceives he or she does at school), social acceptance (the degree to which a child feels accepted by peers), athletic competence (child's perception of athletic ability), physical competence (how happy a child is with his or her appearance), and behavioral competence (how well a child believes that he or she does the right thing). The questionnaire consists of 36 questions, with each subscale consisting of six questions, with possible scores ranging from 1 to 4 for each subscale measures and lower scores indicating lower perceived competence. The SPPC has been shown to be both valid and reliable.[18] For the sample in this study, internal consistency (Cronbach's alpha) ranged from 0.79 to 0.87 for the subscales and was 0.75 for the global measure of self-worth.

Liking of physical activity. The Physical Activity Enjoyment Scale (PACES) was used to assess enjoyment in the children. The PACES was initially developed by Kendzierski and DeCarlo[19] for adolescents (12–16 years) and more recently for children younger than 12 years of age.[20] The revised PACES consists of 16 statements scored on a 5-point Likert-type scale (from 1 = ''disagree a lot'' to 5 = ''agree a lot''). The instrument starts with the stem, ''When I am physically active …'' with the average of the 16 items calculated. The averaged scores can range from 1 to 5, with lower scores indicating less enjoyment of physical activity. The revised PACES has been shown to have good psychometric properties[20,21] and to be suitable for the population under investigation and demonstrated internal consistency in this sample (Cronbach's alpha = 0.914). The PACES questionnaire was used for the cohorts in 2009 and 2010; in 2007 the Liking of Physical Activity questionnaire was used. Because this is not comparable with the PACES questionnaire, only the data from children in the 2009 and 2010 were included for this analysis.

Electronic game use anxiety. Anxiety related to electronic game use was assessed with a modified version of the Computer Anxiety Subscale from the Computer Attitudes Scales of Loyd and Gressard.[22] The Computer Anxiety Subscale has demonstrated reliability and factorial validity with children of the same age as the current study. The Anxiety Subscale consists of 10 items and was modified with the word ''computer'' replaced by ''electronic games.'' Example items are ''electronic games do not scare me at all'' and ''electronic games make me feel uneasy and confused.'' Items were rated on a 7-point Likert-type scale (from 1 = ''strongly agree'' to 7 = ''strongly disagree''). The scores are summed to range from 10 to 70, with higher scores indicating higher levels of anxiety related to electronic game use (Cronbach's alpha for this measure was 0.76).

Data analysis

Data were analyzed using mixed-model repeated-measures analyses to estimate the magnitude of two condition contrasts for each outcome—no games versus traditional electronic games and active electronic games versus traditional electronic games—using measures from participants with valid data from at least two of the three conditions, adjusting for period. Absence of carryover effect was confirmed by testing for a treatment by period interaction with statistical significance set at $P < 0.05$. All participants ($n = 66$) had complete SPPC data. PACES data were also complete for children from the 2009 and 2010 cohorts ($n = 54$). Four children had missing anxiety data in one condition. There were no participants missing data for more than one condition. These missing values were accounted for in the linear mixed model, which uses a likelihood-based estimation procedure resulting in nonbiased estimates by imputation of missing responses based on the surrounding responses and modeled covariance structure. All distributions were assessed and suitable for analysis by linear mixed models. To verify the absence of influential outliers, initial screening was performed by graphical examination of condition differences plotted against averages, and standardized residuals from each model were plotted against fitted values. Statistical analysis was performed using Stata/IC version 10.1 software for Windows (StataCorp LP, College Station TX). All statistical tests were two-tailed with alpha = 0.05. All analyses were conducted using intention-to-treat principles.

Results

The trial flow of participants is shown in Figure 2. There was an equal mix of boys and girls among those who completed the study (33 females and 33 males), with a mean (standard deviation) age of 11.3 (0.8) years. Participant height (1.49 [0.08] m), weight (41.1 [11.1] kg), and z score for body mass index (−0.1 [1.2]) were similar to the national distribution for this age. At baseline, nearly all children had home access to electronic games (91 percent) and reported playing electronic games in the last month (95 percent), with 61 percent reporting playing at least two or three times a week. Duration of playing sessions was most commonly <30 minutes (41 percent), although 31 percent usually played for 30–60 minutes and 24 percent usually played for 1–2 hours. Participant socioeconomic status based on location of family home ranged from the 2nd to 10th Australian decile. Participant motor coordination status ranged from poor to excellent. At baseline, mean values of reported self-esteem were similar to previously reported data from children of a comparable age.[17] Physical activity enjoyment levels were slightly higher than reported values for a large sample ($n = 546$) of healthy children of the same age (4.1 [0.6] versus 3.8 [0.213]; $P < 0.001$).[21]

Self-esteem

There was no significant change to global self-worth on either removal of electronic games or replacement of

traditional games with AVGs (3.3 versus 3.4 [$P = 0.469$] for AVGs compared with traditional electronic games and 3.4 versus 3.4 [$P = 0.195$] for removal of games compared with traditional games), as measured by the SPPC. There was also no change to any of the SPPC subdomains (Table 1).

Enjoyment of physical activity

For the 2009 and 2010 cohorts ($n = 54$), there was no significant change to self-reported enjoyment of physical activity on either removal or electronic games or replacement of traditional games with AVGs (4.2 versus 4.2 [$P = 0.902$] for AVGs compared with traditional electronic games and 4.1 versus 4.2 [$P = 0.607$] for no games compared with traditional electronic games) (Table 1).

Anxiety (in relation to electronic game technology)

Anxiety levels were also not different at completion of the AVG condition in comparison with either no games or traditional electronic games (23.1 versus 23.0 [$P = 0.923$] for AVGs compared with traditional electronic games and 23.0 versus 23.0 [$P = 0.942$] for no games compared with traditional electronic games) (Table 1).

Discussion

This article measured the real-world effect of home access to AVGs on child psychological outcomes. Replacing traditional electronic games with AVGs, or removing home access to electronic games, did not have an effect on the psychological outcomes measured: Children did not report any improvement or deterioration in their self-esteem, their enjoyment of physical activity, or their anxiety toward electronic games.

These results are consistent with the lack of effect found in randomized controlled trials assessing real-world effects of AVGs on physical outcomes such as physical activity and sedentary behavior. Furthermore, if changes to psychological outcomes are indeed antecedents of activity behavioral change as has been suggested,[23] our results are not surprising, given that we found no measurable change in psychological outcomes or in physical activity behavior in our previous analyses.[3] Baranowski et al.[5] observed no objectively measured increase in daily physical activity with AVGs compared with traditional sedentary games in their home-based study of overweight children. If, as hypothesized in the Introduction, AVG use could indirectly improve physical activity behavior by improving a child's self-concept and enjoyment of being physically active, such improvements in both the psychological outcomes and the physical activity outcomes should have been observed.

The reasons for the lack of effect are worth exploring because if they reflect a true lack of impact of electronic games (either active or traditional inactive) on physical or psychological outcomes, then they suggest that children's use of electronic games may be relatively benign, contrary to popular perception. These data do not suggest any trend in effect of a clinically meaningful magnitude that, were a larger sample recruited, would lead to statistically significant results. It is possible that the lack of effect in this study was due to insufficient weekly AVG use or overall duration of use to facilitate changes in psychosocial health. Our previously

Table 1. Values of Self-Esteem, Physical Activity, and Anxiety Toward Electronic Games

	Mean (95% CI)				*Difference (95% CI) [P value]*	
	Baseline [mean (SD)]	*No games (X)*	*Traditional games (T)*	*Active games (A)*	*Remove (X–T)*	*Replace (A–T)*
Self-esteem (SPPC)						
Global self-worth	3.3 (0.5)	3.4 (3.3, 3.6)	3.4 (3.2, 3.5)	3.3 (3.2, 3.4)	0.1 (−0.1, 0.1) [0.195]	0.0 (−0.1, 0.1) [0.469]
Scholastic competence	3.1 (0.7)	3.2 (3.0, 3.3)	3.2 (3.0, 3.3)	3.2 (3.1, 3.4)	0.0 (−0.1, 0.1) [0.904]	0.0 (−0.1, 0.1) [0.702]
Social acceptance	3.0 (0.8)	3.2 (3.0, 3.4)	3.2 (3.0, 3.3)	3.1 (2.9, 3.3)	0.0 (−0.1, 0.2) [0.382]	0.0 (−0.1, 0.1) [0.634]
Athletic competence	3.0 (0.7)	3.2 (3.0, 3.3)	3.1 (2.9, 3.3)	3.1 (3.0, 3.3)	0.1 (0.0, 0.2) [0.134]	0.1 (0.0, 0.2) [0.268]
Physical competence	3.1 (0.6)	3.2 (3.0, 3.3)	3.1 (3.0, 3.3)	3.2 (3.1, 3.4)	0.1 (0.0, 0.2) 0.267	0.1 (0.0, 0.2) [0.066]
Behavioral competence	3.1 (0.6)	3.2 (3.0, 3.3)	3.2 (3.0, 3.3)	3.2 (3.0, 3.3)	0.0 (−0.1, 0.1) [0.559]	0.0 (−0.1, 0.1) [0.983]
PACES	4.1 (0.6)	4.2 (4.1, 4.4)	4.2 (4.1, 4.4)	4.2 (4.1, 4.4)	0.0 (−0.1, 0.1) [0.607]	0.0 (−0.1, 0.1) [0.902]
Computer anxiety	26.0 (7.5)	23.0 (21.6, 24.4)	23.0 (21.6, 24.4)	23.1 (21.7, 24.5)	−0.1 (−1.4,1.3) [0.942]	0.1 (−1.2, 1.4) [0.923]

CI, confidence interval; PACES, Physical Activity Enjoyment Scale; SD, standard deviation; SPPC, Self-Perception Profile for Children.

reported findings from this study population[3] that only 33 of the children in the study used the active games for more than 15 minutes per day (through self-report in a contemporaneous diary) would lend support to this conclusion. However, the ecological validity of the study conditions would suggest that this dose may represent the realistic experience of children under non-study conditions.

The study did not measure a child's progress or success with the game. One might expect that a child who experiences success playing an AVG would be more likely to improve his or her self-esteem than one who experiences failure. Indeed, game content and challenge have been identified as important components for sustained engagement in AVGs and electronic games.[13,14,24] This possible mediating variable would be worth exploring in future research. It is also possible that AVGs may not be able to improve perceptions of self-esteem or enjoyment of physical activity in children whose levels are already in the normal range. Indeed, the children in this study had higher levels of enjoyment of physical activity than has been reported by others.[20] Perhaps greater changes would be observed in children with low self-concept and in those who report not enjoying physical activity. AVGs have been shown to improve self-esteem, measured using Harter's SPPC, in overweight girls,[25] whose baseline values were lower than the values for children from our study. We also observed no change in anxiety toward electronic games, which may also have been related to the very low levels of anxiety reported and that over 90% of children had electronic game access and experience prior to the study. This suggests that anxiety was not a barrier as the participants were already familiar with playing electronic games.

It is notable that although the study provided a substantial range and variation in game offerings, addressing the known issue of active games being less engaging,[2] it was difficult at times to keep all participants engaged as the most popular game genre—killing—was excluded from the study on ethical grounds. Different game platforms and genres may be able to offer more versality and motivating factors to engage or sustain the player. Indeed, in adults, game-themed aerobic games were found to be more enjoyable than exercise-themed aerobic games.[26] The relatively low exposure to games compared with the baseline data may indicate that overall motivation to participate in playing AVGs may have impacted on the study outcomes.

Strengths and limitations

The strengths of the study include the strong within-subjects randomized controlled trial design with staggered starts and counterbalanced orders to control for extraneous factors. The participants were representative of a general population of 10–12-year-old children in terms of sex, weight, motor coordination, electronic game experience, and socioeconomic status, informing the likely broad impact of replacement or removal as public health interventions. The study was also grounded in the naturalistic setting of the family home. We did not explicitly control the type of game played or investigate whether the children enjoyed the choice of games that were available to them, nor did we measure game content and degree of challenge experienced. We were also limited, as explained in Subjects and Methods, by the unplanned reduction in sample size recruited to the study. Although the study was originally powered to detect clinically meaningful changes in physical activity, full recruitment would also have been of benefit to enhance power for psychological outcome measures. Nevertheless, this sample size had 80 percent power to detect standardized mean changes of at least 0.35, as well as 95 percent power of at least 0.45 for changes considered small- to medium-sized effects. Therefore, we can be confident in our findings of no clinically meaningful effects. A further limitation of the study is that we had no objective measure of how much time the children spent on AVGs, only their self-report.

Conclusions

Although laboratory studies have shown that AVGs are enjoyable in the short term, their impact on attitudes toward physical activity, self-esteem, and related anxiety in the longer term may be small.

Author Disclosure Statement

No competing financial interests exist.

References

1. Baranowski T, Frankel L. Let's get technical! Gaming and technology for weight control and health promotion in children. Child Obes 2012; 8:34–37.
2. Biddiss E, Irwin J. Active video games to promote physical activity in children and youth: A systematic review. Arch Pediatr Adolesc Med 2010; 164:664–672.
3. Straker LM, Abbott RA, Smith AJ. To remove or to replace traditional electronic games? A crossover randomised controlled trial on the impact of removing or replacing home access to electronic games on physical activity and sedentary behaviour in children aged 10–12 years. BMJ Open 2013; 3:6.
4. Maddison R, Foley L, Ni Mhurchu C, et al. Effects of active video games on body composition: A randomized controlled trial. Am J Clin Nutr 2011; 94:156–163.
5. Baranowski T, Abdelsamad D, Baranowski J, et al. Impact of an active video game on healthy children's physical activity. Pediatrics 2012; 129:e636–e642.
6. Straker LM, Campbell AC, Jensen LM, et al. Rationale, design and methods for a randomised and controlled trial of the impact of virtual reality games on motor competence, physical activity, and mental health in children with developmental coordination disorder. BMC Public Health 2011; 11:654.
7. Eime RM, Young JA, Harvey JT, et al. A systematic review of the psychological and social benefits of participation in sport for adults: Informing development of a conceptual model of health through sport. Int J Behav Nutr Phys Act 2013; 10:135.
8. Kiviniemi MT, Voss-Humke AM, Seifert AL. How do I feel about the behavior? The interplay of affective associations with behaviors and cognitive beliefs as influences on physical activity behavior. Health Psychol 2007; 26:152–158.
9. Schneider M, Dunn A, Cooper D. Affect, exercise, and physical activity among healthy adolescents. J Sport Exerc Psychol 2009; 31:706–723.
10. Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: A review of reviews. Br J Sports Med 2011; 45:886–895.

11. Williamson D, Dewey A, Steinberg H. Mood change through physical exercise in nine- to ten-year-old children. Percept Mot Skills 2001; 93:311–316.
12. Gentile DA, Gentile JR. Violent video games as contemporary teachers: A contemporary analysis. J Youth Adolesc 2008; 37:127–141.
13. Hamlen KR. Children's choices and strategies in video games. Comput Human Behavior 2011; 27:532–539.
14. Dixon R, Maddison R, Ni Mhurchu C, et al. Parents' and children's perceptions of active video games: A focus group study. J Child Health Care 2010; 14:189–199.
15. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q 1989; 13:319–340.
16. Straker LM, Abbott RA, Piek JP, et al. Rationale, design and methods for a randomised and controlled trial to investigate whether home access to electronic games decreases children's physical activity. BMC Public Health 2009; 9:212.
17. Harter S. *Manual for the Self-Perception Profile for Children: Revision of the Perceived Self-Competence Scale for Children*. Denver: University of Denver; 1985.
18. Muris P, Meesters C, Fijen P. The Self Perception Profile for Children: Further evidence of its factor structure, reliability and validity. Personality Individ Diff 2003; 35: 1792–1802.
19. Kendzierski D, DeCarlo KJ. Physical Activity Enjoyment Scale: Two validation studies. J Sport Exercise Psychol 1991; 13:50–64.
20. Moore J, Yin Z, Hanes J, Duda J. Measuring enjoyment of physical activity in children: Validation of the Physical Activity Enjoyment Scale. J Appl Sport Psychol 2009; 21:S116–S129.
21. Motl RW, Dishman RK, Saunders R, et al. Measuring enjoyment of physical activity in adolescent girls. Am J Prev Med 2001; 21:110–117.
22. Loyd B, Gressard C. Reliability and factorial validity of computer attitude scales. Educ Psychol Meas 1984; 44: 501–505.
23. Rhodes RE, Pfaeffli LA. Mediators of physical activity change among adult non clinical populations: A review update. Int J Behav Nutr Phys Act 2010; 7:37.
24. Baranoswki T, Buday R, Thompson D, et al. Developing games for health behavior change: Getting started. Games Health J 2013; 2:183–190.
25. Christison A, Khan HA. Exergaming for health: A community-based pediatric weight management program using active video gaming. Clin Pediatr (Phila) 2012; 51:382–388.
26. Lyons EJ, Tate DF, Komoski SE, et al. Novel approaches to obesity prevention: Effects of game enjoyment and game type on energy expenditure in active video games. J Diabetes Sci Technol 2012; 6:839–848.

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