Effects of home access to active video games on child self-esteem, enjoyment of physical activity and anxiety related to electronic games: results from a randomised controlled trial.

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Abstract

Importance: Active input video games could provide a useful conduit for increasing physical activity by improving child self-confidence, physical activity enjoyment and reducing anxiety.

Objective: To evaluate the impact of a) the removal of home access to traditional electronic games, or b) their replacement with active video games, on child self-perception, enjoyment of physical activity and electronic game use anxiety.

Design: Cross-over randomised controlled trial, over 6 months.

Setting: Family homes in metropolitan Perth, Australia from 2007 to 2010.

Participants: 10-12 year old children were recruited through school and community media. From 210 children who were eligible, 74 met inclusion criteria, and 8 withdrew, leaving 66 children (33 female) for analysis.

Intervention: A counterbalanced randomised 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.

Outcome measures: Perception of self-esteem (Harter's Self Perception Profile for Children), enjoyment of physical activity (PACES questionnaire) and anxiety towards electronic game use (modified Loyd and Gressard Computer Anxiety Subscale).

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.

Conclusion: Whilst active video games have been shown to be enjoyable in the short term, their ability to impact on psychological outcomes is yet to be established.

Trial Registration: Australia and New Zealand Clinical Trials Registry (ACTRN 12609000279224)

Introduction

Active input video games (AVG) 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 children spend in physically active behaviour and decrease the time spent in sedentary behaviour, thus increasing their physical activity and decreasing their sedentary time. Randomised 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 child self-confidence and/or enjoyment in being physically active and consequently increase their physical activity and decrease their 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 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-orientated 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 whilst 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 AVG or traditional sedentary video games) [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 aged 10-14 years-old 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 Davis' Technology Acceptance Model suggests anxiety associated with technology is a predictor of computer use [15] and thus anxiety related to electronic game use may be a barrier to engagement with AVG and thus 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 paper sought to explore the effects of introducing AVG into the household of children aged 10-12 years, on both their overall perception of self and their enjoyment of physical activity, and compare this to 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.

Methods

The study was conducted in Perth, Western Australia in 2007-2010, with the trial registered (Australia and New Zealand Clinical Trials Registry (ACTRN 12609000279224)) and the detailed study protocol published [16]. Children, aged 10-12 years, 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 children representative of a spread of socio-economic 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. Exclusion criteria included: parent reported diagnosed disorder likely to impact the child's study participation, movement or electronic game use (other than developmental coordination disorder). Ethical approval was provided by Curtin University Human Research Ethics Committee.

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 PlayStation 2® with a range of non-violent games requiring game pad input. 'Active games' involved the provision of a Sony PlayStation 2® with EyeToy® and dance mat input devices and a range of non-violent 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 which 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 (see Figure 2). To control for an order effect, children were randomised 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 (MVPA). Whilst 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 MVPA per day, and allowing for a 10% attrition in data. The study was curtailed earlier than planned, as new electronic game technologies (Sony PlayStation 3® and Microsoft 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 6 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 which 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, the psychosocial questionnaires, and set up the electronic game condition. This involved either removal of all electronic games or setting up electronic game equipment and instructing parent and child in its use. Follow-up phone calls were made the next day and after six days to ensure game equipment was working correctly. After eight 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. Individualised reports were 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 paper presents the findings on the *a priori* secondary outcome measures (see published protocol [16]).

1) Self-esteem

Self-esteem was measured using the Harter's Self-Perception Profile for children (SPPC) [17]. The SPPC is the most widely used measure of self-esteem for children 8 yrs 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 they do at school), social acceptance (the degree to which a child feels accepted by peers), athletic

competence (child perception of athletic ability), physical competence (how happy a child is with his or her appearance), and behavioural 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 6 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 0,75 for the global measure of self-worth.

2) 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 [20]. The revised PACES consist of 16 statements scored on a five-point Likert-type scale (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 have 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 .914). The PACES questionnaire was used for the cohorts in 2009 and 2010; in 2007 the Liking of Physical Activity questionnaire was used. Since this is not comparable with the PACES questionnaire, only the data from children in the 2009 and 2010 were included for this analysis.

3) 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' was 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 (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 analysed 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 $p<.05$. All participants (n=66) had complete SPPC data. PACES data was 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 non-biased estimates by imputation of missing responses based upon the surrounding responses and modelled 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 standardised residuals from each model were plotted against fitted values. Statistical analysis was performed using Stata/IC 10.1 for Windows (StataCorp LP, College Station TX, USA). All statistical tests were 2-tailed with α=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 in those who completed the study (33 female and 33 male), with a mean (SD) age of 11.3 (0.8) yrs. Participant height (1.49 (0.08) m), weight (41.1 (11.1) kg) and zBMI (-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%) and reported playing electronic games in the last month (95%), with 61% reporting playing at least 2-3 times a week. Duration of playing sessions was most commonly <30min (41%), though 31% usually played for 30-60min and 24% usually played for 1-2hrs. Participant socioeconomic status based on location of family home ranged from the second to tenth 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) v 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 AVG (3.3 v 3.4, p=0.469 for AVG compared to traditional electronic games and 3.4 v 3.4, p=0.195 for removal of games compared to traditional games), as measured by the SPPC. There was also no change to any of the SPPC sub-domains (see 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 AVG (4.2 v 4.2, p=0.902 for AVG compared to traditional electronic games and 4.1 v 4.2, p=0.607 for no games compared to traditional electronic games) – see Table 1.

Anxiety (in relation to electronic game technology)

Anxiety levels were also no different at completion of the AVG condition in comparison to either no games or traditional electronic games (23.1 v 23.0, p=0.923 for AVG compared to traditional electronic games and 23.0 v 23.0, p=0.942 for AVG no games compared to traditional electronic games) - see Table 1.

Discussion

This paper measured the real world effect of home access to AVG on child psychological outcomes. Replacing traditional electronic games with AVG, 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 in their anxiety towards electronic games.

These results are consistent with the lack of effect found in randomised controlled trials assessing real world effects of AVG on physical outcomes such as physical activity and sedentary behaviour. Furthermore, if changes to psychological outcomes are indeed antecedents of activity behavioural change as has been suggested [23], our results are not surprising, given that we found no measurable change in psychological outcomes, nor in physical activity behaviour in our previous analyses [3]. Baranowski et al. [5] observed no objectively measured increase in daily physical activity with AVG compared to traditional sedentary games in their home based study of overweight children. If, as hypothesised in the introduction, AVG use could indirectly improve physical activity behaviour by improving child 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 which, 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 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 the 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 their self-esteem than one who experiences failure. Indeed, game content and challenge have been identified as important components for sustained engagement in AVG and electronic games [13][14][24]. This possible mediating variable would be worth exploring in future research. It is also possible that AVG 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. AVG 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 to the baseline data may indicate that overall motivation to participate in playing AVG may have impacted on the study outcomes.

Strengths and limitations

The strengths of the study include the strong within subjects randomised 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 socio-economic 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 nor 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 the methods, by the unplanned reduction in sample size recruited to the study. Whilst 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% power to detect standardised mean changes of at least 0.35, and 95% power for at least 0.45, 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 AVG, only their self-report.

Conclusion

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

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Figure 1 Representation of potential direct and indirect effects of active video game use on physical activity and sedentary behaviour

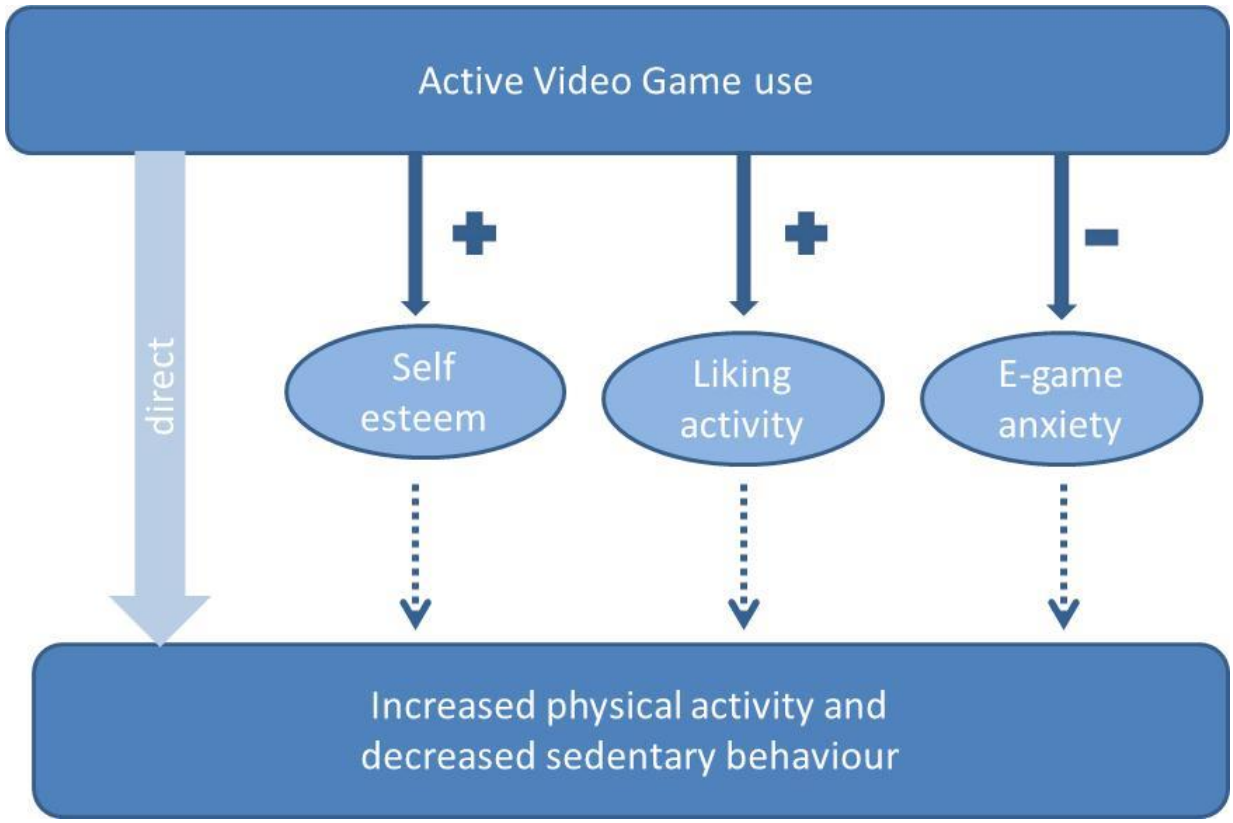
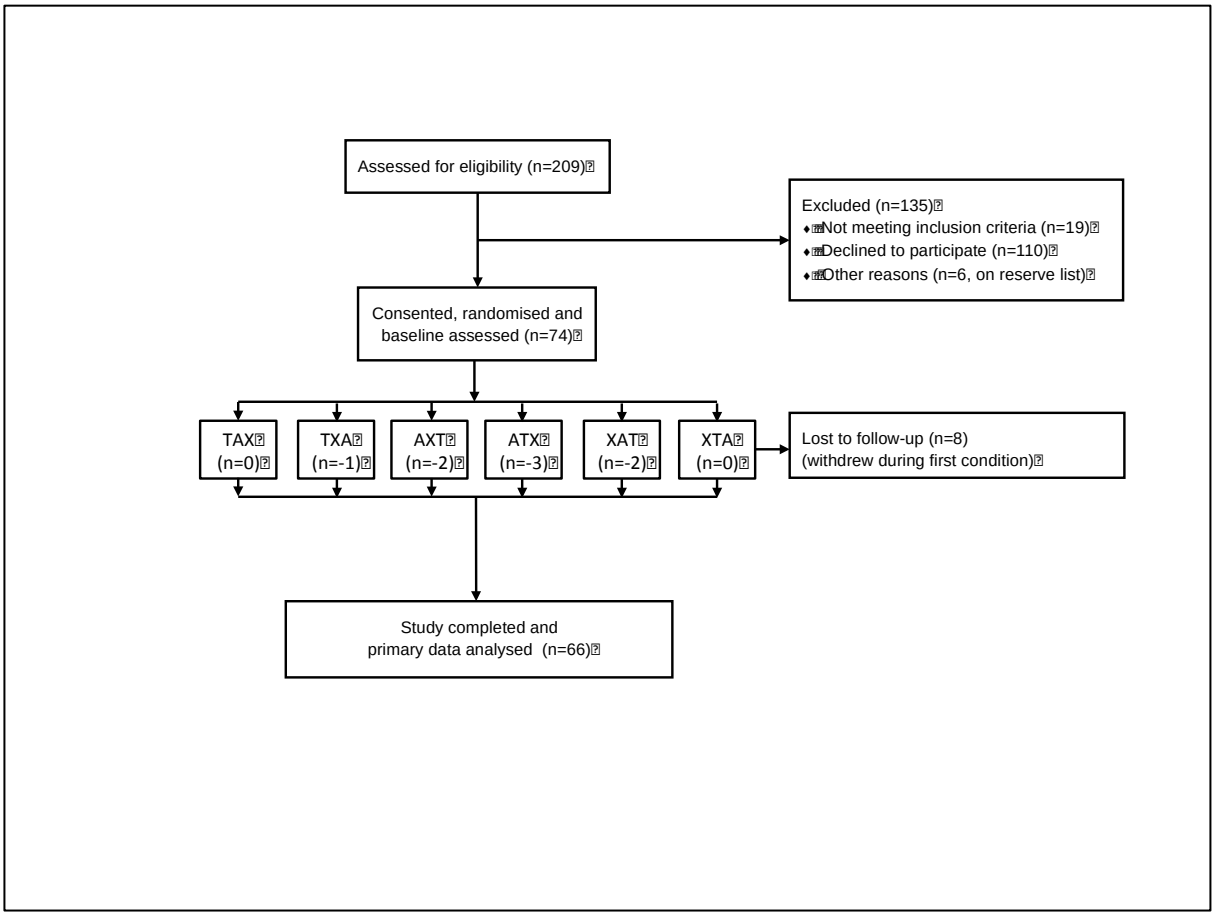


Figure 2 Flow of participants through the trial



Order of conditions through trial:
T – traditional electronic games
A – active video games (AVG)
X – no electronic games

Table 1 Mean (SD) values of self-esteem, physical activity and anxiety towards electronic games

	Baseline	No games (X)	Traditional Games (T)	Active Games (A)	Remove (X-T)	Replace (A-T)
	Mean(sd)		Mean (95% CI)		Difference (95% CI), p value	
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
Behavioural 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

SPPC – Self-Perception Profile for Children; PACES – Physical Activity Enjoyment Scale