

From the Couch to the Sports Field: The Longitudinal Associations Between Sports Video Game Play, Self-Esteem, and Involvement in Sports

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The majority of research on video games has focused on negative outcomes such as aggression, at the expense of research on positive outcomes. Recently, however, research on the link between video game play and positive outcomes has been increasing. Importantly, a potential positive outcome of sports video game play among adolescents that has been unexplored is greater involvement in real-life sports. Given that sports attrition increases during adolescence, it is critical to identify predictors of increased involvement in sports during this developmental period. In the present study, we examined this question by testing the bidirectional association between sports video game play and involvement in sports with 1492 adolescents over 4 years. In addition, we investigated whether self-esteem was an underlying mechanism of the predictive effect of sports video game play on involvement in sports. The results indicated a bidirectional association between sports video game play and involvement in sports, in that sports video game play predicted greater involvement in sports over time, and that adolescents who played sports more frequently were more likely to play sports video games than adolescents who played sports less frequently. In addition, we found evidence that self-esteem may be an underlying mechanism of the predictive effect of sports video game play on involvement in sports. These novel findings suggest that sports video games may be an effective tool to promote self-esteem as well as participation in sports among adolescents.

Keywords: sports video game play, involvement in sports, self-esteem

The impact of video game play on adolescent development is an important issue, as video games are the fastest growing form of entertainment in the world, with a global market value of US\$67 billion in 2010 and a predicted value of US\$112 billion by 2015 (Biscotti et al., 2011). In fact, video game play has become ubiquitous among adolescents, as 97% of American adolescents aged 12–17 years play computer, web, portable, or console video games (Lenhart et al., 2008). In terms of frequency, 31% of adoles-

cents play video games every day and another 21% play games 3–5 days a week. Despite the importance of video game play to adolescents, however, over the past few decades psychologists have focused primarily on the link between video game use (not including “serious games” that are designed for purposes other than entertainment) and negative outcomes, such as addiction and aggression (see Anderson et al., 2010, but also Ferguson & Kilburn, 2010 for criticisms of this work), at the expense of research on positive outcomes (see review by Adachi & Willoughby, 2013a). More recently, however, researchers have begun to investigate some positive outcomes of video game play (see review by Granic, Lobel, & Engels, 2014), such as elevations in pro-social behavior (Ferguson & Garza, 2011; Greitemeyer & Osswald, 2010, but also see Tear & Nelson, 2013 for a failure to replicate this finding), problem-solving skills (Adachi & Willoughby, 2013b), and cooperative behavior (Greitemeyer, Traut-Mattausch, &

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Osswald, 2012), as well as decreases in aggression (Jerabeck & Ferguson, 2013; Greitemeyer & Osswald, 2009).

A potential positive outcome of playing sports video games that has been unexplored, to date, is greater involvement in real-life sports. Involvement in sports often has been associated with positive youth development, including higher self-esteem (Blomfield & Barber, 2009; Erkut & Tracy, 2002; Taylor, Wamsler, Welch, & Nanney, 2012) and lower levels of obesity (Ara et al., 2004; Quinto Romani, 2011). Yet, adolescence is a period when sports attrition increases (Guillet, Sarrazin, Fontayne, & Brustad, 2006), and thus it is especially important to investigate predictors of increased involvement in sports among adolescents. Interestingly, playing sports video games may be associated with higher levels of involvement in real-life sports. For example, adolescents who play sports video games may find the sports fun and enjoyable, learn the rules and strategy of the sports, and experience the thrill of victory, and thus they may be more likely to get involved in real-life sports. In addition, the association between sports video game play and involvement in real-life sports may be bidirectional, in that adolescents who play sports more frequently may be attracted to sports video games more than adolescents who play sports less frequently. Only longitudinal studies can directly assess the direction of effects between sports video game play and sports involvement; that is, by assessing both measures over time, longitudinal studies can address the question of whether higher sports video game play leads to increased real-life involvement in sports over time (socialization effect), or whether higher levels of involvement in sports leads to increased sports video game play over time (selection effect). The primary goal of the current study, therefore, was to assess the long-term bidirectional association between sports video game play and real-life involvement in sports among adolescents. The second goal of the current study was to examine a potential underlying mechanism of the socialization effect of sports video game play on involvement in sports.

The Media Practice Model

The media practice model (Steele & Brown, 1995) has been used to explain why adolescents' and emerging adults' interactions with media (Brown, 2006), including video game play in particular (Padilla-Walker, Nelson, Carroll, & Jensen, 2010), may influence their real-world beliefs and behaviors. According to the model, adolescents' and emerging adults' specific motivations will influence which types of media they consume. For example, adolescents and emerging adults who are interested in sports may seek out sports video games. In addition, their interactions with media and how they incorporate it into their lives may affect their beliefs and behaviors. For example, adolescents and emerging adults who play sports video games and experience the thrill of victory or develop sport-related knowledge or skills may be more likely to get involved in real-sports over time. The long-term association between sports video game play and involvement in sports, therefore, may be bidirectional, consistent with the media practice model. To date, however, no researchers have examined whether a bidirectional longitudinal association exists between sports video game play and involvement in sports among adolescents, as the majority of research on sports video game play has been focused on its association with aggression (Adachi & Willoughby, 2013a; Anderson & Carnagey, 2009). Thus, research on this long-term association is needed.

Sports Video Game Play and Physical Activity

Media use often has been thought of a risk factor for negative health outcomes such as physical inactivity or obesity among youth (Krause & Benavidez, 2014). For example, several studies have demonstrated a positive association between media consumption and being overweight or obese (Heelan & Eisenmann, 2006; Nelson, Gortmaker, Subramanian, Cheung, & Wechsler, 2007; but also see Kowert, Festl, & Quandt, 2014 for a study in which limited support was found for negative social, physical, and psychological stereotypes of video game players). In contrast, researchers recently have examined whether there is a positive link between playing active video games

(AVGs) and physical activity (see Leblanc et al., 2013; Barnett, Cerin, & Baranowski, 2011). AVGs (e.g., *Wii Fit*, *DanceDanceRevolution*) require greater physical activity to play the game (e.g., moving one's arms and legs to mimic athletic movements) than traditional video games that often involve using a handheld controller or keyboard to play the game (Leblanc et al., 2013). In a meta-analysis, LeBlanc et al. (2013) found that playing AVGs was associated with elevations in levels of energy expenditure among children and adolescents. Similarly, the results of a meta-analysis by Peng, Jih-Husan, and Crouse (2011) demonstrated that playing AVGs was associated with elevations in energy expenditure, heart rate, and oxygen consumption among children, adolescents, and adults (also see systematic reviews by Barnett et al., 2011).

What is less clear, however, is whether AVGs may have a "gateway" effect in terms of promoting interest in physical activities or sports outside of the video games. According to Krause and Benavidez (2014), successful experiences in AVGs, such as experiencing victory in a tennis match, may promote feelings of self-efficacy regarding the player's tennis ability, and, in turn, may encourage future participation in tennis. Research to date examining whether playing AVGs is associated with increased involvement in physical activity or sports outside of the video games is scarce; yet, there is some preliminary support for this link. Specifically, Kastenmüller, Greitemeyer, Fairclough, Waite, and Fischer (2013) found that young adults who identified more strongly with their game character when playing AVGs were more motivated to engage in physical activity outside of the game, and were more likely to participate in other forms of physical activity a week later than young adults who identified less strongly with their game character.

Interestingly, traditional sports video games also may have the potential to promote participation in real-life sports. For example, Ballard, Gray, Reilly, and Noggle (2009) examined the link between video game play (not specific to AVGs) and physical health outcomes such as body mass index and involvement in physical activity among young adults. They found that the overall frequency of video game play was associated with shorter lengths of time spent exercising, and that the length of video game

play during one sitting was positively linked to body mass index. Yet, when the researchers examined the link between playing specific types of video games, such as sports video games or massive multiplayer online role playing games (MMORPG), they found disparate patterns of results. Importantly, frequency of sports video game play was *positively* related to frequency of exercise and days of vigorous physical activity. In contrast, the length of playing MMORPGs in one sitting was *negatively* associated with frequency of exercise. Ballard et al. concluded that participants who played sports video games may have had a greater intrinsic interest in physical activities than participants who played MMORPGs. The direction of effects (i.e., sports video game play predicting physical activity over time or physical activity predicting sports video game play over time), however, were not clear due to the concurrent design of the study. These findings suggest that even though traditional sports video games do not involve physical activity to play the game, they may allow the player to develop sport-related knowledge, skills, and strategies, as well as to experience the thrill of victory and enjoyment of the sport, which, in turn, may positively predict involvement in real-life sports. In addition, players often can create a character in their own image (e.g., they can give the character similar facial features, and hair and skin color, and can name the character after themselves) in traditional sports video games, which may encourage identification with the character and may further promote involvement in real-life sports, consistent with Kastenmüller et al. (2013).

Self-Esteem as a Mechanism Through Which Sports Video Game Play Predicts Involvement in Sports

Self-esteem is thought to be composed of several dimensions, including self-concept about one's knowledge and ability in sports (Sonstroem, Harlow, & Josephs, 1994; Slutzky & Simpkins, 2009). According to Kinch (1963), social interactions may influence self-concept. Thus, positive experiences in sports video game play, such as developing skills and strategy, experiencing the thrill of victory, and having fun, may positively impact sport self-concept, and thus may lead to increases in general self-

esteem. For example, when playing a football video game, players may gain knowledge about football, develop skills and strategies, and experience victory, which may increase their self-esteem. In addition, self-concept may guide behavior (Kinch, 1963). Specifically, Taylor and Brown (1988) hypothesize that individuals with higher self-esteem may be more likely to feel optimistic about what they are capable of and have the confidence necessary to attempt and conquer novel challenges, compared with individuals with lower self-esteem (see also Bowker, Gadbois, & Cornock, 2003; Harter, 1990). An individual with a more positive sport self-concept and higher levels of self-esteem, therefore, may be more likely to get involved in real sports than an individual with a less positive sport self-concept and lower levels of self-esteem (Adachi & Willoughby, 2013c). Overall then, adolescents who play sports video games may experience increased self-esteem, and in turn, may be more likely to participate in real-life sports over time.

In contrast, self-esteem likely is not a mechanism of the predictive effect of involvement in real-life sports on sports video game play. For example, researchers have demonstrated that involvement in sports does not predict self-esteem over time among adolescents (Adachi & Willoughby, 2013c). Hence, we did not predict that self-esteem would be a mechanism of the long-term predictive effect of sports involvement on sports video game play.

The Current Study

The goals of the current study were twofold. The first goal was to investigate the bidirectional longitudinal association between sports video game play and involvement in real-life sports among adolescents. Consistent with the media practice model, we hypothesized that sports video game play would predict greater involvement in sports over time (socialization effect). In addition, we hypothesized that adolescents who play real sports more frequently may be more likely to play sports video games than youth who play real sports less frequently (selection effect).

The second goal was to examine whether self-esteem was an underlying mechanism of the socialization effect of sports video game play on involvement in sports. Specifically, we

hypothesized that playing sports video games would predict higher self-esteem, and, in turn, higher self-esteem would predict greater involvement in sports over time. In contrast, we did not predict that self-esteem would be a mechanism of the long-term predictive effect of involvement in sports on sports video game play. To address these goals, we surveyed a large sample of adolescents over four years about their sports video game play, involvement in sports, self-esteem, gender, parental education, and at-risk background.

Method

Participants

Students ($N = 1492$) from eight high schools in Ontario, Canada, took part in the study over four years from Grade 9 to 12 (M age in Grade 9 = 13 years, 10 months). This study was part of a larger cohort-sequential project examining youth lifestyle choices. The overall participation rate ranged from 83% to 86% across the four waves. Consistent with the broader Canadian population (Statistics Canada, 2001), 92.4% of the participants were born in Canada and the most common ethnic backgrounds reported other than Canadian were Italian (31%), French (18%), British (15%), and German (12%). Data on socioeconomic status indicated mean levels of education for mothers and fathers falling between “some college, university or apprenticeship program” and “completed a college/apprenticeship/technical diploma.” Furthermore, 70% of the respondents reported living with both birth parents, 12% with one birth parent and a stepparent, 15% with one birth parent (mother or father only), and the remainder with other guardians (e.g., other relatives, foster parents, etc.).

Only students who completed the survey at a minimum of two time points over the four waves were included, resulting in 1492 participants (50.8% female), or 84% of the total sample of 1771 adolescents. There were no significant differences on any of the study measures between participants who completed the survey only in Grade 9 and the longitudinal participants, $ps > .05$. Missing data resulted from absenteeism and because some students did not finish the entire questionnaire (10.6% of the data, consistent with other longitudinal survey

studies; Ciarrochi, Leeson, & Heaven, 2009; Feldman, Masyn, & Conger, 2009; Hyde & Peterson, 2009). We included three versions of the survey at each time period so that the same scales were not always near the end of the survey. As missing data were not dependent on the values of the study measures, it is reasonable to assume that these data are missing at random (Little & Rubin, 2002; Schafer & Graham, 2002). Expectation maximization was used to impute missing data.

Measures

All measures were assessed across all four grades of high school (i.e., Grades 9 through 12) except for gender, parental education, and at-risk background, which were only assessed in Grade 9.

Demographic factors. A single-item question was used to assess participant sex. Parental education was an average of two items (one per parent, $r = .58$). At-risk background was assessed by counting the number of risk factors that participants reported (i.e., participants were asked to indicate *yes* or *no* to the question of whether they have a learning disability, are living or have lived in foster care, started using marijuana prior to age 13, have parents/guardians who engage in narcotic use, had a teen mother, have parents who are depressed, or have parents who divorced). Higher scores indicated female gender, more computers, greater parental education (1 = *did not finish high school* to 6 = *professional degree*), and a greater number of risks.

Sports involvement. Sports involvement was measured each year with two items ("How often in the last month have you played organized sports in school?" and "How often in the last month have you played organized sports outside of school?"), based on a 5-point scale (1 = *never* to 5 = *everyday*; Adachi & Willoughby, 2013c). The correlation between the two items in each grade was $>.43$.

Sports video game play. When participants were in Grades 11 and 12 only, frequency of sports video game play (e.g., *FIFA Soccer*) was assessed on a scale from 1 (*not at all*) to 5 (*5 or more hours on an average day*). This measure is similar to measures of violent video game play in which participants are asked how frequently they play violent genres of video

games such as fighting games (Adachi & Willoughby, 2013d; Richmond & Wilson, 2008; Willoughby, Adachi, & Good, 2011). Prevalence of sports video game play also was assessed each year (i.e., Grades 9 to 12). Participants were asked to indicate yes or no to whether they played sports video games.

Self-esteem. Self-esteem was measured in Grades 9 and 10 with Rosenberg's (1965) Self-Esteem Scale. The measure included 10 items (e.g., I take a positive attitude toward myself) that were rated on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Cronbach's alpha was $>.85$ each year. The validity of the test score interpretations of the Rosenberg Self-Esteem Scale has been demonstrated in previous studies with adolescents, such as Hagborg (1993), which found a strong association ($r = .76$) between this scale and a measure of global self-worth (Harter, 1988).

Plan of Analysis

We performed autoregressive cross-lagged path analysis models (Campbell & Stanley, 1963; see also Taris, 2000) in AMOS 19 (Arbuckle, 1995–2012) to simultaneously assess the bidirectional long-term association between sports video game play and involvement in sports. First, we tested this bidirectional association with our Likert scale measure of frequency of sports video game play in Grades 11 and 12 (see Figure 1). Second, we tested this association with our dichotomous prevalence measure of sports video game play (i.e., yes or no) from Grades 9 through 11 (see Figure 2). Third, to examine whether self-esteem is an underlying mechanism of the predictive effect of sports video game play on involvement in sports, we created an autoregressive path analysis model to assess the indirect effect of sports video game play on involvement in sports through self-esteem. Specifically, we examined whether sports video game play in Grade 9 predicted elevations in levels of self-esteem in Grade 10 after controlling for previous levels of self-esteem, and, in turn, whether self-esteem in Grade 10 predicted elevated levels of involvement in sports in Grade 11 after controlling for previous levels of involvement in sports (see Figure 3). Gender, parental education, and at-risk background were included as covariates in all three analyses.

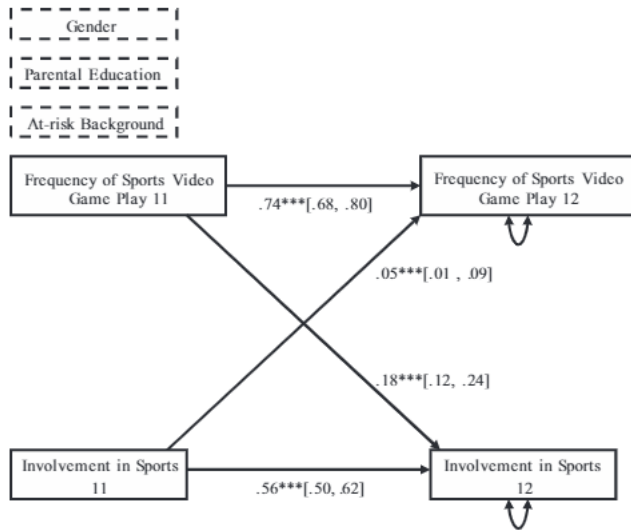


Figure 1. Final model results for analysis assessing the bidirectional association between the frequency of sports video game play and involvement in sports from Grade 11 to Grade 12.

Results

Preliminary Analyses

Table 1 outlines the means and standard deviations for the study variables. All measures showed acceptable skewness and kurtosis.

Long-Term Association Between Sports Video Game Play and Involvement in Sports

First, we simultaneously assessed the socialization and selection hypotheses between self-

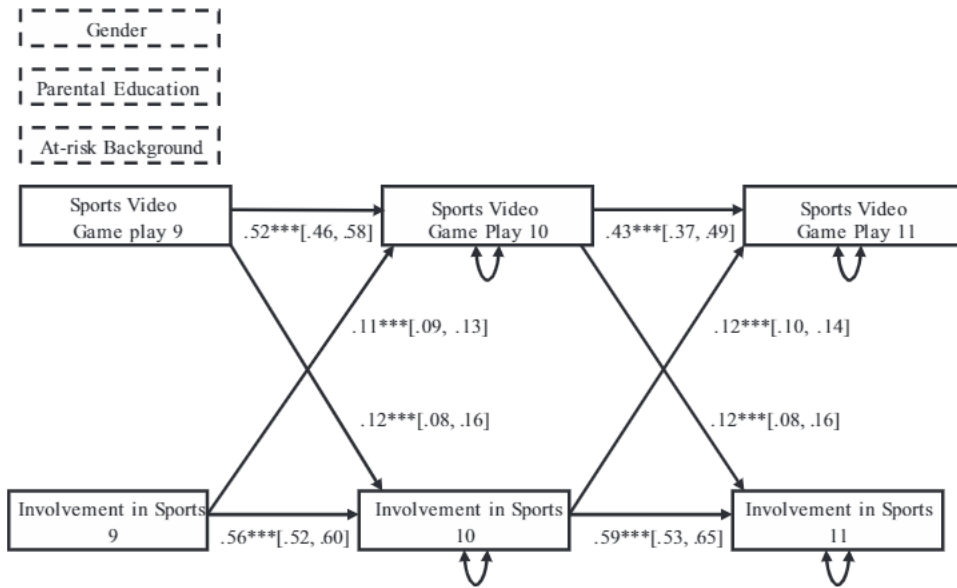


Figure 2. Final model results for analysis assessing the bidirectional association between sports video game play and involvement in sports from Grade 9 to Grade 11.

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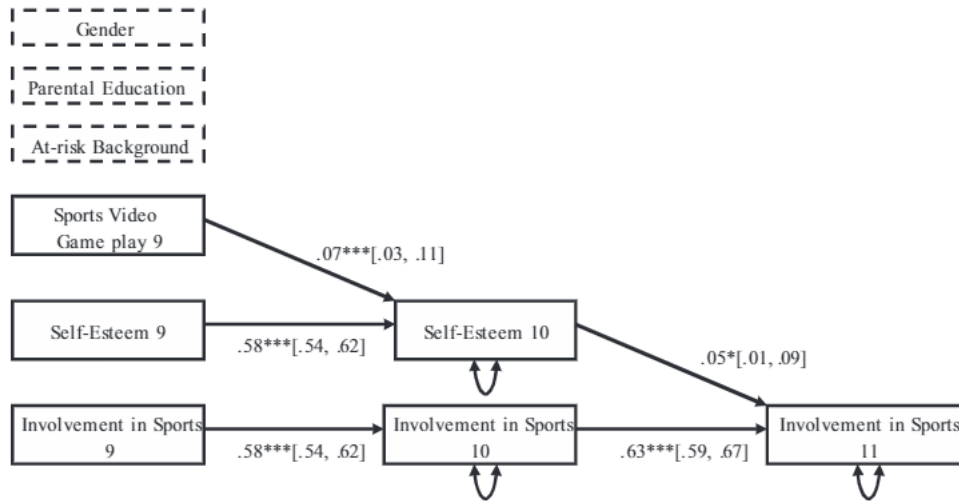


Figure 3. Final model results for analysis assessing indirect effect of sports video game play on involvement in sports through self-esteem.

esteem and involvement in sports with our Likert scale measure of frequency of sports video game play in Grades 11 and 12. We created a two-wave autoregressive cross-lagged model in which bidirectional paths were estimated between sports video game play and involvement in sports (see Figure 1). Stability paths across grades within each variable and covariances among the variables within each grade were specified. Gender, parental education, and at-risk background were included as covariates (see Figure 1 for a summary of the significant path estimates). The model was fully saturated, and thus model fit statistics are not interpretable. We found support for a bidirectional association between frequency of sports video game play and involvement in sports over time. Spe-

cifically, higher frequency of sports video game play significantly predicted greater sports involvement over time, after controlling for previous sports involvement, and higher levels of sports involvement significantly predicted greater frequency of sports video game play over time, after controlling for previous frequency of sports video game play.

Next, we simultaneously assessed the socialization and selection hypotheses between self-esteem and involvement in sports with our dichotomous measures of sports video game play in Grades 9, 10, and 11. We created a three-wave autoregressive cross-lagged model in which bidirectional paths were estimated between sports video game play and involvement in sports (see Figure 2). Stability paths across

Table 1
Means and Standard Deviations of Study Measures and Demographic Variables

Variable	Scale range	Grade 9 M (SD)	Grade 10 M (SD)	Grade 11 (SD)	Grade 12 M (SD)
Gender	1–2	50.8% female			
Parental education	1–6	3.27 (1.03)			
At-risk background	n/a	0.53 (0.84)			
Frequency of sports vg play	1–5			1.73 (0.83)	1.62 (0.73)
Self-esteem	1–5	3.81 (0.71)	3.76 (0.65)		
Sports vg play	1–2	1.36 (0.45)	1.32 (0.44)	1.44 (0.42)	
Sports involvement	1–5	2.47 (1.17)	2.38 (1.22)	2.21 (1.19)	2.18 (0.92)

Note. vg = video game.

grades within each variable and covariances among the variables within each grade were specified. Gender, parental education, and at-risk background were included as covariates (see Figure 2 for a summary of the significant path estimates). We first tested whether the pattern of results was invariant across grade (i.e., consistent across the high school years). Invariance was tested by comparing a model in which all cross-lagged paths were constrained to be equal across grade with the unconstrained model in which all structural paths were free to vary. The chi-square difference test of relative fit indicated that the unconstrained model in which all structural paths were free to vary was not a significantly better fit than a model in which all cross-lagged paths were constrained to be equal across grade, suggesting that the patterns of associations among the measures were consistent across the high school years, $p > .05$. As the constrained model was the most parsimonious model, all further interpretations were based on the constrained model. Model fit was good, $\chi^2(4) = 18.65, p = .001$, Comparative Fit Index (CFI) = 1.00, root mean square error of approximation (RMSEA) = .050 (.028–.073). Again, we found support for a bidirectional association between sports video game play and involvement in sports over time. Specifically, sports video game play significantly predicted greater sports involvement over time, after controlling for previous sports involvement, and higher levels of sports involvement significantly predicted sports video game play over time, after controlling for previous sports video game play.

Self-Esteem as an Underlying Mechanism of the Long-Term Predictive Effect of Sports Video Game Play on Involvement in Sports

To examine whether sports video game play indirectly predicted involvement in sports through self-esteem, an autoregressive path model was specified in which paths were estimated between Grade 9 sports video game play, Grade 10 self-esteem, and Grade 11 involvement in sports, while simultaneously controlling for previous levels of self-esteem and involvement in sports, as well as gender, parental education, and at-risk background. Model fit was acceptable, $\chi^2(2) = 24.94, p <$

.001, CFI = .99, RMSEA = .088 (.059–.120). Sports video game play in Grade 9 predicted elevated levels of self-esteem in Grade 10 after controlling for previous levels of self-esteem, and self-esteem in Grade 10 predicted elevated levels of involvement in sports in Grade 11 after controlling for previous levels of involvement in sports. Given these significant direct predictive effects, we assess the indirect predictive effect between Grade 9 sports video game play and Grade 11 involvement in sports through Grade 10 self-esteem. Using bias-corrected bootstrapping (bootstrap samples = 2000), we found a significant indirect effect, $\beta = .003 (.001-.008), p = .008$. Thus, the results provide support for an indirect mediation model (MacKinnon, Fairchild, & Fritz, 2007; Zhao, Lynch, & Chen, 2010) in which playing sports video games predicted higher self-esteem, and in turn, self-esteem predicted greater involvement in sports.

Self-Esteem as a Mechanism of the Long-Term Predictive Effect of Involvement in Sports on Sports Video Game Play

As predicted, involvement in real-life sports in Grade 9 did not significantly predict self-esteem in Grade 10, $\beta = .03, p = .12$. In addition, the indirect effect of involvement in sports on sports video game play through self-esteem was not significant, $\beta = .001 (.000-.005), p = .09$.

Discussion

The majority of research on video game play (again, not including “serious games”) among adolescents has focused on negative outcomes such as aggression, at the expense of research on positive outcomes (Adachi & Willoughby, 2013a). Recently, however, research on the link between video game play and positive outcomes has been increasing. Importantly, a potential positive outcome of sports video game play among adolescents that has been unexplored is greater involvement in real-life sports. Furthermore, self-esteem may be a mechanism of the predictive effect of sports video game play on involvement in sports. The current study significantly contributes to the growing literature on the positive outcomes of video game play on adolescent development, there-

fore, by examining the long-term associations between sports video game play, self-esteem, and involvement in sports.

We found support for a long-term bidirectional association between sports video game play and involvement in sports among a large sample of adolescents. The finding that adolescents who play more sports video games may be more likely to get involved in real-life sports over time than youth who play less sports video games (socialization effect) is consistent with the media practice model, which suggests that youth may use video games as self-socialization tools that impact their beliefs and behaviors. In addition, consistent with the media practice model's notion that youth's specific motivations may influence the type of media that they seek out, we found that adolescents who were involved in sports more frequently were more likely to play sports video games than adolescents who were involved in sports less frequently (selection effect). This pattern of findings was consistent across the high school grades, and highlights the advantage of conducting longitudinal studies in which all study measures are assessed at each wave of data collection.

In addition, we found evidence that self-esteem may be a mechanism through which sports video game play predicts involvement in sports over time. This finding suggests that sports video games may provide a safe environment for adolescents to develop sport-related skills and knowledge, and experience the thrill of victory, which over time may enhance their self-esteem, and, in turn, encourage them to participate in real-life sports. Therefore, although video games often are thought of as promoting inactivity, sports video games may be effective agents in increasing self-esteem and encouraging adolescents to become active by participating in sports. These findings are especially important considering that adolescence is a period when sports attrition increases (Guillet et al., 2006). Sports video games, therefore, may be useful tools to promote interest in sports among adolescents, which, in turn, may help to reduce adolescents' attrition from sports.

Future research is needed to examine why involvement in sports predicted higher levels of sports video game play over time. It may be that adolescents who play sports more frequently have a greater intrinsic interest in sports, and

thus are more motivated to engage in sports simulations, such as sports video games, than adolescents who play sports less frequently. Similarly, adolescents who enjoy playing sports more may be attracted to sports video games to a greater degree than adolescent who enjoy playing sports less. For example, enjoyment of sports is the most common motive that individuals report for participating in sports (Battista, 1990; Scanlan & Lewthwaite, 1986; Shaffer & Wittes, 2006), and this motivation may transfer to sports video game play.

Another important direction for future research is to examine whether the type of sports video games that youth play, such as traditional games versus AVGs, is a potential moderator of the predictive effect of sports video game play on involvement in sports. For example, after playing sports AVGs in which players use *real physical motions* to play the game (e.g., making the motions of swinging a baseball bat or tennis racquet), players may gain more confidence in their physical ability to play real sports than after playing sports games on regular consoles with handheld controllers. Thus, playing sports video games may have stronger predictive effects on involvement in real-life sports when played on motion gaming consoles than on regular consoles. Future research is needed to examine this hypothesis.

Limitations and Strengths

An important limitation of the present study stems from the reliance on self-report measures. Reports of video game use and sports involvement would benefit from corroboration from other informants (e.g., friends, parents). Yet, it is not clear whether anyone other than the adolescent can provide an accurate assessment of their video game use given that much of the activity may be conducted alone. Importantly, however, we specified covariances among all of the variables within each time period in both models, thus accounting for common method variance. In addition, the structural paths that were significant in the autoregressive path analyses were small in magnitude. However, considering that frequency of sports video game play, involvement in sports, and self-esteem were highly stable over time (stability effects of $\beta = .74, .56, \text{ and } .58$, respectively), small predictive effects of change in levels of these vari-

ables were expected. Indeed, these effect sizes are common in longitudinal models when accounting for stability between adjacent waves of data and for concurrent associations among variables within each wave.

Our measures of adolescents' involvement in sports also were limited, in that these measures could not assess the heterogeneity of adolescents' sports experiences, such as whether they played competitive versus house league sports or team based versus individualized sports. These differences in adolescents' participation in sports may be important to examine in future research, as they may be associated with adolescents' levels of self-esteem or sports video game play. In addition, although the longitudinal design of the current study allows for an examination of the direction of effects, it does not allow for causal conclusions to be made. Experiments are needed in the future to investigate causal links.

Another limitation was that although we measured general self-esteem, we did not include a measure of sport self-concept. Future research, therefore, should be focused on examining whether sports video game play predicts a more positive sport self-concept in particular, and, in turn, whether sport self-concept predicts involvement in sports over time. In addition, it is important to note that these results only apply to the adolescent developmental period, and may not generalize to different age-groups. For example, many youth begin playing sports in childhood (Slutzky & Simpkins, 2009), and thus it is unclear whether the frequency of involvement in sports may be associated with sports video game play and self-esteem during this earlier development period. Future research should be aimed at examining the longitudinal association between the frequency of involvement in sports, sports video game play, and self-esteem in a younger sample. Finally, although the participants in the present study included a large sample of enrolled students from a school district, findings may not generalize to other geographic regions, including those with differing ethnic and/or demographic populations.

Conclusion

The present study makes a significant contribution to the growing literature regarding the

associations between video game play and positive outcomes among youth, by demonstrating a long-term bidirectional association between sports video game play and involvement in sports among adolescents. In addition, we found evidence that self-esteem may be an underlying mechanism of the predictive effect of sports video game play on involvement in sports. Also, the fact that we had four waves of longitudinal data was an important strength of the current study, as it allowed us to examine the bidirectional association between adolescents' sports video game play and involvement in sports over the long-term.

The current study has important positive implications for adolescents, as the findings suggest that playing sports video games may help combat sports attrition during the adolescent period of development. Specifically, sports video games may be useful tools to promote interest in sports as well as elevations in self-esteem among adolescents, which, in turn, may encourage adolescents to participate in real-life sports. Future research should include an examination of the associations between sports video game play, self-esteem, and involvement in sports with children, as sports video games may be an effective tool that children can use to increase their sport-related confidence early in life, which in turn may help set them on active and healthy trajectories that continue into their adolescent years.

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