Demolishing the Competition: The Association between Competitive Video Game Play and Aggression among Adolescents and Young Adults

by

Paul J. C. Adachi

A thesis
Submitted in partial fulfilment
of the requirements for the degree
Doctor of Philosophy

Department of Psychology
Brock University
St. Catharines, Ontario, Canada

April 28, 2015

Abstract

The link between video game play and aggression is an important issue as video games are the fastest growing form of entertainment in the world. Past research on this association has been focused primarily on the link between video game violence and aggression; however, this research has confounded the effect of video game violence versus competition on aggression. The main goal of the current dissertation, therefore, was to examine the short- and long-term associations between competitive video game play and aggression. In addition, the longitudinal work on this association to date has been limited to adolescent samples, but not young adults. Thus, the second goal of the dissertation research was to investigate whether video game play predicts aggression in the long-term among young adults in addition to adolescents. To address these goals, three studies were conducted. Study 1 consisted of a series of experiments examining the short-term effect of video game violence versus competition on aggression. Study 2 examined the long-term association between competitive video game play and aggression among adolescents, and Study 3 examined this long-term link among young adults, in addition to adolescents. Taken together, the results of the three dissertation studies converged to suggest that video game competition, rather than violence, may be a stronger predictor of aggression in both the short- and long-term. Overall, the current research represents an important advance in our understanding of the association between video game play and aggression, and leads to a new direction in the video game and aggression literature.

Acknowledgements

I am extremely grateful for all of the mentorship and support that I have received from my Ph.D. supervisor Dr. Teena Willoughby. You have played an integral role in my development as a researcher, and I will be forever thankful for your guidance and support. In addition to providing me with excellent training in research and teaching, you helped me persevere through the tough times and you always encouraged me to savor my accomplishments (usually with good wine). I look forward to continuing to collaborate with you throughout my career as a researcher.

I am also very thankful for the guidance and support of my Ph.D. committee members, Dr. Gordon Hodson and Dr. Zopito Marini. In addition to receiving excellent feedback and guidance from you regarding my dissertation work, I have had the pleasure of collaborating with each of you on side research projects. You have played a critical role in my development as a researcher, and I hope to continue to collaborate with you in the future.

I also would like to thank Dr. Michael Busseri for his dedication to statistical training and mentorship. Through your statistical courses in longitudinal data analysis and structural equation modeling, I developed the knowledge and ability to conduct complicated longitudinal analyses, including those in Study 2 and Study 3 of my dissertation.

I am also honored to have been a member of the Adolescent Development Lab. I would like to offer a special thank you to all of the members of this lab, especially Marie Good, Chloe Hamza, Royette Tavernier, Thalia Semplonius, and Tina Brook for all of

your encouragement and support over the years. I look forward to watching your careers develop and I hope that we continue to collaborate in the future.

I want to offer my deepest gratitude to my parents for their unconditional love and support, and their encouragement to pursue my intrinsic interests in psychology. Thank you for always believing in me and for showing me what a strong work ethic is all about.

And of course, I want to thank the number 1 person in my life, my loving wife Ashlynn for all of her love and support through this journey. You have put up with many late nights in the lab, research discussions, and even sat through many of my practice presentations. You encouraged me to persevere through the tough times, and you are always excited to celebrate my accomplishments. I can't imagine the past six and a half years without you.

Table of Contents

List of Tables

List of Figures

List of Appendices

Chapter 1: General Introduction

The video game industry is the fastest growing form of entertainment in the world, with a global market value of $67 billion in 2010 and a predicted value of $112 billion by 2015 (Biscotti et al. 2011). Given the extreme popularity of video games, therefore, the scientific investigation of the association between video game play and aggression (i.e., behavior that is intended to harm another individual; Dodge, Coie, & Lynam, 2006) is important. In fact, U.S. President Barack Obama recently requested that Congress provide $10 million to fund research on the link between video game play and violent/aggressive behavior (Dinan, 2013). Over the past two decades, the majority of research on the link between video game play and aggression has been focused on the effect of *violent* video game content on elevating aggression (see Anderson et al., 2010 for a review; but see Ferguson & Kilburn, 2010 for critiques of this work). A potential confound exists in this literature, however, which has not been adequately addressed by researchers in this field. Specifically, violent video games in general tend to be more competitive than non-violent games (Carnagey & Anderson, 2005), yet most researchers have not attempted to control for competition when examining the link between violent video game play and aggression. Thus, it is unclear whether the *violent* content or the *competitive* content in video games has a stronger association with aggression. The primary goal of my dissertation work, therefore, was to examine the link between competitive video game play and aggression. In addition, the long-term association between video game play and aggression primarily has been examined among adolescents (e.g., Adachi & Willoughby, 2013; Krahé & Möller, 2010; Möller & Krahé, 2009; Willoughby, Adachi, & Good, 2011), but not young adults. Thus, the second goal

of the dissertation research was to examine whether video game play predicts aggression in the long-term among young adults in addition to adolescents.

To examine the association between competitive video game play and aggression, I conducted three studies. Study 1 consisted of a series of experiments in which I matched video games on violence and competition, in order to test the short-term effects of each game characteristic on aggression among a sample of young adults. I then conducted longitudinal studies of adolescents (Study 2) and young adults (Study 3) in which I examined the long-term association between competitive video game play and aggression. Given the current public concern about the effects of video games on aggression (e.g., Parents Television Council, 2011), this research has practical implications for social policy and intervention efforts to reduce aggression. For example, the current research may encourage caution among researchers when making causal conclusions regarding the link between video game violence and aggression to inform public policy (see Ferguson, 2013). In addition, this research elucidates the specific elements of video game play that are associated with aggression, which can inform intervention efforts.

As the first author of the three published studies, I conceived the research questions and hypotheses. I collected the data in Study 1 and contributed to data collection in Study 3, and I independently conducted the statistical analyses for each study. In addition, I wrote a full draft of each manuscript that was submitted for publication. I collaborated with my advisor, Dr. Teena Willoughby, who is the second author on each study, in the crafting of all three publications.

Theoretical Background: The Frustration-Aggression Hypothesis and Self-Determination Theory

The Frustration-Aggression Hypothesis. The frustration-aggression hypothesis (Berkowitz, 1989; Dollard, Doob, Miller, Mowrer, & Sears, 1939) offers a cogent explanation for the link between competition and aggression. This hypothesis posits that when an individual's goal is thwarted (or threatened), the individual may experience aggressive affect such as anger and hostility, which, in turn, may make the individual more likely to behave aggressively. Importantly, people are even more likely to become aggressive if they believe that their goal is deliberately blocked than if they believe that the goal thwarting is inadvertent (e.g., Berkowitz, 1989; Kulik & Brown, 1979). In addition to experiencing aggressive affect associated with the goal thwarting experience, when an individual's goal is deliberately blocked the individual may feel that he/she has been "attacked personally," which may further influence aggressive affect, and, in turn, aggressive behavior (Berkowitz, 1989, p. 68).

The frustration-aggression hypothesis is especially pertinent for explaining the link between competition and aggression, therefore, as competitors deliberately block each other's goal of winning the competition during competitive encounters (Berkowitz, 1962). For example, when competing against another player in a video game (either a human opponent or a computer-generated opponent), each player's goal of winning directly impedes the other player's goal of winning, as only one player can be victorious. Thus, the deliberate goal thwarting that occurs during competitive video game play may result in elevated levels of anger and hostility, and, in turn, anger and hostility may lead to elevations in aggressive behavior. Furthermore, competition may lead to elevations in

aggressive affect and aggressive behavior even among competitors who reach their goal of winning the competition (Berkowitz, 1989). For example, research with children has shown that although competitors who reached their goal of winning a competition behaved less aggressively than participants who lost the competition, winners still behaved more aggressively than participants in the control group who were not involved in competition (e.g., Nelson, Gelfand, & Hartmann, 1969). Thus, elevations in aggression that are produced by a competitive experience (e.g., the deliberate obstruction or threat of obstruction of one's goals) may not be fully assuaged by achieving the end-goal of winning.

Self-Determination Theory. The prominent theory of human motivation, Self-Determination Theory (SDT; Deci & Ryan, 2000; Ryan & Deci, 2000), offers a more fundamental explanation of the link between competitive video game play and aggression. The primary focus of SDT is on the degree to which social contexts satisfy three universal human needs: competence (sense of efficacy), autonomy (personal agency), and relatedness (social connectedness). According to SDT, the satisfaction of these basic needs facilitates optimal functioning, intrinsic motivation, and well-being. In contrast, the impedance (or threat of impedance) of these needs undermines intrinsic motivation and may produce human aggression (e.g., Ryan, Deci, Grolnick, & La Guardia, 2006; Ryan & Grolnick, 1986; Weinstein, Hodgins, & Ostvik-White, 2011).

Recently, researchers have applied an SDT-based approach to study the effect of video game play on aggression (see Pryzbylski, Rigby, & Ryan, 2010). Przybylski, Deci, Rigby, & Ryan, (2014) demonstrated that the impedance of players' satisfaction of their need for competence during video game play produced elevations in aggressive thoughts,

feelings, and behavior. For example, they found that more difficult video games impeded participants' competence need satisfaction to a greater degree than less difficult video games, and, in turn, competence impedance predicted higher levels of aggression. Furthermore, they demonstrated that violent content was not a significant predictor of motivational or aggressive outcomes, suggesting that human need satisfaction/thwarting, but not violent content, had robust associations with aggression. Importantly, an SDT-based approach also could be applied to the link between competitive video game play and aggression. Whereas the frustration-aggression hypothesis suggests that the impedance (or the threat of impedance) of one's goal of winning a video game competition may influence aggressive affect, and, in turn, aggressive behavior (Berkowitz, 1989), an SDT-based approach predicts that the critical impedance is at the fundamental level of need satisfaction (e.g., competence need impedance), which, in turn, may elevate aggression (Przybylski et al., 2014).

The Effect of Video Game Violence versus Competition on Aggression: A Case for the Existence of a Competitive Confound

Over the past two decades, the research on the short-term link between video game play and aggression has been primarily focused on the *violent* content in games. Indeed, several studies have found a positive association between violent video game play and aggression, and a negative association between violent video game play and prosocial behavior (see Anderson et al., 2010; Ferguson, in press; Greitemeyer & Mügge, 2014 for meta-analytic reviews of this work; but also see Breuer, Vogelgesang, Quandt, & Festl, in press; Ferguson et al., 2008; Ferguson, Garza, Jerabeck, Ramos, & Galindo, 2013; Ferguson & Olsen, 2013; Ferguson & Reuda, 2010; Pryzbylski, et al., 2014; Tear

& Nelson, 2013; Williams & Skoric, 2005 for evidence of null effects of violent content). However, research demonstrating an effect of violent video game play on aggression has been critiqued (e.g., Adachi & Willoughby, 2011; Elson & Ferguson, 2013; Ferguson et al., 2008; Ferguson & Dyck, 2012; Ferguson & Kilburn, 2010). For example, researchers have noted that the majority of studies reporting a positive association between violent video game play and aggression have confounded the effect of video game *violence* versus *competition* on aggression (see Adachi & Willoughby, 2011). Specifically, researchers who have found that playing a violent video game produced more aggression than a non-violent game in an experimental study often did not match the games on competitiveness prior to testing. This is problematic, as violent video games in general tend to be more competitive than non-violent games (Carnagey & Anderson, 2005). Players compete in shooting battles with opponent characters in first-person shooter games (e.g., the *Call of Duty* series), for example, or in hand-to-hand combat in fighting games (e.g., the *Mortal Kombat* series). In contrast, many non-violent video games do not involve competition with other opponent characters, such as puzzle games (e.g., *Tetris*).

A prime example of this confound is demonstrated in an experiment by Anderson and Dill (2000), in which they examined the effect of playing the violent video game *Wolfenstein 3D* versus the non-violent video game *Myst* on aggressive behavior in the short-term. Specifically, *Wolfenstein 3D* is a first-person shooter game in which the player competes in shooting battles for survival with every other opponent character in the game. Thus, *Wolfenstein 3D* involves high levels of competition. In contrast, *Myst* is an adventure puzzle game in which the player must solve a series of puzzles to advance through the game. *Myst* is not a competitive game, as there are no other characters in the

game with whom to compete. Although playing *Wolfenstein 3D* produced higher levels of aggressive behavior compared to playing *Myst*, therefore, it is not clear whether the violent content or the competitive content in *Wolfenstein 3D* was responsible for the elevations in aggression.

In addition, researchers examining the longitudinal association between video game play and aggression also have confounded video game violence versus competition (e.g., Anderson, Gentile, & Buckley, 2007; Möller & Krahé, 2009; Wallenius & Punamäki, 2008; Willoughby et al., 2012). For example, Möller and Krahé (2009) investigated the bidirectional association (i.e., both socialization and selection effects) between violent video game play and aggression in a 30-month longitudinal study of German adolescents. Specifically, Möller and Krahé examined whether violent video game play predicted higher levels of aggression over time (socialization effect) and whether aggression predicted higher levels of violent video game play over time (selection effect). They found evidence of a socialization effect, as the results indicated that exposure to violent video games at time 1 predicted physical aggression at time 2 (but not relational aggression), after controlling for aggression at time 1. In contrast, there was no evidence of selection effects, as neither physical aggression nor relational aggression at time 1 predicted greater exposure to violent video games at time 2, after controlling for exposure to violent video games at time 1. Yet, they did not assess adolescents' exposure to *competitive* video game content, and thus it is unclear whether it was the violence or the competition in the games that was associated with aggression over time.

In summary, although research on the link between video game play and aggression over the past two decades has focused on the impact of video game violence on aggression, the link between video game competition and aggression is unclear. Research is needed, therefore, to investigate the association between video game competition and aggression in both the short- and long-term. In addition, it is important to examine the link between competitive video game play and aggression from a developmental lens. In the following section, the developmental implications of this association for adolescents and young adults will be discussed.

Developmental Context: Adolescents and Young Adults

Video game play is particularly popular among adolescents and young adults. For example, 97% of American adolescents aged 12 to17 years play video games and 31% play video games every day (Lenhart et al., 2008). In addition, 81% of 18-29 year old Americans play video games and half of these young adult video game players play video games at least a few times a week (Lenhart, Jones, & Macgill, 2008). Although the majority of experiments on the short-term effects of video game play on aggression have been conducted with young adults (e.g., Barlett, Branch, Rodeheffer, & Harris, 2009; Englehardt, Bartholow, & Saults, 2011; see also Ferguson & Rueda, 2010 for null effects), no researchers have examined long-term predictive effects during this developmental period. It is unclear, therefore, whether video game play has predictive effects on aggression over time among young adults.

Video game play may have similar effects on behavior among adolescents and young adults, consistent with research on brain development during these two developmental periods. According to the Dual Systems Model (Steinberg 2007, 2008),

there is a temporal gap between a relatively early maturing affective/approach system and a slower maturing cognitive control system (e.g., Ernst, Pine, & Hardin, 2006). Specifically, it is hypothesized the early maturation of the affective/approach system is due to increased dopaminergic activity in subcortical brain structures such as the ventral striatum, which is associated with reward seeking. In contrast, the cognitive control network, which is hypothesized to be led by the prefrontal cortex and responsible for planning, judgment, and inhibition, is thought to mature gradually into the mid-20s (Ernst et al. 2006; Galvan et al., 2006). Neural connections among brain regions also continue to strengthen across adolescence into young adulthood (Dosenbach, Petersen, & Schlaggar, 2013; Eluvathingal, Hasan, Kramer, Fletcher, & Ewing-Cobbs, 2007; Paus, 2009). Thus, both adolescents and young adults sometimes may have difficulty in regulating their arousal and may be more likely to engage in risk-taking behaviors (Steinberg, 2007; 2010), such as aggression, relative to other age groups. Competitive video game play may lead to elevations in aggression among young adults, therefore, similar to adolescents. Research examining the longitudinal link between competitive video game play and aggression among adolescents as well as young adults, therefore, is needed to address this developmental question.

Overview of the Current Studies

Overall, the goal of my dissertation research was to examine the short- and long-term associations between competitive video game play and aggression among adolescents and young adults. Study 1 consisted of two experiments in which I tested the short-term effect of video game violence versus competition on aggressive behavior among young adults. Importantly, to examine the effect of video game violence on

aggression I first conducted a pilot study to find games that were matched on competitiveness but different in terms of violence. Similarly, to examine the effect of video game competition on aggression, I first conducted a pilot study to find games that were systematically matched in terms of violence, but differed in terms of competitiveness. This was the first study to date to directly test the effect of competitive video game content on aggression.

After examining the short-term effect of video game competition on aggression in Study 1, I then investigated the long-term association between competitive video game play and aggression among adolescents in Study 2. In addition, if competition in video games is associated with aggression, then other competitive activities, such as competitive gambling, also may predict aggression over time. The goal of Study 2, therefore, was to examine the long-term associations between adolescent aggression and competitive video game play, and between adolescent aggression and competitive gambling. Importantly, whereas past researchers have confounded the longitudinal link between aggression and video game violence versus competition by using measures of violent video game play which did not account for the level of competition in the games (e.g., Anderson et al., 2007; Möller & Krahé, 2009), we eliminated this confound by assessing adolescents' playing of competitive video games that were non-violent (i.e., sports and racing games). Similarly, we assessed adolescents' involvement in competitive gambling activities that did not involve violence (i.e., playing cards for money, betting on sporting events). Thus, positive associations found between aggression and competitive video game play, and between aggression and competitive gambling would suggest that

the competition, rather than the violence in these activities, likely is the driving force behind these links.

Although I investigated the longitudinal association between competitive/non-violent video game play and aggression in Study 2, I did not examine the link between violent video game play and aggression. To date, there is a dearth of longitudinal research which has simultaneously examined the predictive effects of violent video game play, as well as *non-violent* video game play, on aggression. Thus, the first goal of Study 3 was to examine the fundamental question of whether violent video game play (i.e., action/fighting games) and non-violent video game play (i.e., sports/racing games) each had unique long-term associations with aggression. Next, given that action/fighting (violent) video games and sports/racing games (non-violent) video games are both highly competitive, the second goal was to examine the long-term predictive effect of the commonality (e.g., competitiveness) among action/fighting video game play and sports/racing video game play on aggression. The third goal of Study 3 was to investigate a potential underlying mechanism of the long-term link between video game play and aggression. Specifically, consistent with the frustration-aggression hypothesis, I examined whether aggressive affect was an underlying mechanism of this long-term association. Finally, the long-term association between video game play and aggression primarily has been examined among adolescents (e.g., Adachi & Willoughby, 20130; Krahé & Möller, 2010; Möller & Krahé, 2009; Willoughby et al., 2011), but not young adults. Thus, the fourth goal of Study 3 was to examine whether video game play predicts aggression in the long-term among young adults in addition to adolescents.

Taken together, these three dissertation studies investigated the short- and long-term associations between competitive video game play and aggression among adolescents and young adults, representing an important advance in the video game and aggression literature. In addition, this research examined a potential underlying mechanism of the long-term link between video game play and aggression, which is grounded in the frustration-aggression hypothesis. Finally, my dissertation research has important developmental implications, as Study 3 is the first to examine the long-term association between video game play and aggression among young adults.

References

Adachi, P. J. C., & Willoughby, T. (2013). Demolishing the competition: The longitudinal link between competitive video games, competitive gambling, and aggression. *Journal of Youth and Adolescence, 42*, 1090-1104. doi:10.1007/s10964-013-9952-2

Adachi, P. J. C., & Willoughby, T. (2011). The effect of violent video games on aggression: Is it more than just the violence? *Aggression and Violent Behavior, 16*, 55-62. doi:10.1016/j.avb.2010.12.002

Anderson, C.A., & Dill, K.E. (2000). Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. *Journal of Personality and Social Psychology, 78,* 772-790. doi:10.1037//O022-3514.78.4.772

Anderson, C. A., Gentile, D. A., & Buckley, K. E. (2007). Violent video game effects on children and adolescents. New York: Oxford University Press.

Anderson, C. A., Ihori, N., Bushman, B. J., Rothsetin, H, R., Shibuya, A., Swing, E. L., Sakamoto, A., Saleem, M. (2010). Video Game effects on aggression, empathy, and prosocial behavior and eastern and western countries: A meta-analytic review. *Psychological Bulletin*, *136*, 151-173. doi:10.1037/a0018251

Barlett, C. P., Branch, O., Rodeheffer, C., & Harris, R. (2009). How long do the short-term violent video game effects last? *Aggressive Behavior, 35*, 1−12. doi:10.1002/ab.20301

Berkowitz, L. (1989). Frustration-aggression hypothesis: Examination and reformulation. *Psychological Bulletin, 106*, 59–73. doi:10.1037/0033-2909.106.1.59

Berkowitz, L. (1962). *Aggression: A social psychological analysis.* New York: McGraw-Hill.

Biscotti, F., Blau, B., Lovelock, J-D., Nguyen, T. H., Erensen, J., Verma, S., Liu, V. (2011). *Market trends: Gaming ecosystem, 2011*. Retrieved from Gartner Newsroom: http://www.gartner.com/it/page.jsp?id=1737414.

Breuer, J. Vogelgesang, J., Quandt, T., Festl, R. (in press). Violent video games and physical aggression: Evidence for a selection effect among adolescents. *Psychology of Popular Media Culture*. doi:10.1037/ppm0000035

Carnagey, L. N., & Anderson, C. A. (2005). The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychological Science, 16*, 882-889. doi:10.1111/j.1467-9280.2005.01632.x

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11,* 227–268. doi:10.1207/S15327965PLI1104_01

Dinan, S. (2013, January 16). Critics of violent film, video games note the call for study, not controls. *The Washington Times*. Retrieved from http://www.washingtontimes.com

Dodge, K. A., Coie, J. D., & Lynam, D. (2006). Aggression and antisocial behavior in youth. In N. Eisenberg, W. Damon & R.M. Lerner (Eds.), Handbook of child psychology (6th ed.): Social, emotional, and personality development (Vol. 3, pp. 719–788). New Jersey: Wiley.

Dollard, J., Miller, N. E., Doob, L. W., Mowrer, O. H., & Sears, R. R. (1939). *Frustration and aggression.* New Haven, CT: Yale University Press.

Dosenbach, N. U. F., Petersen, S. E., & Schlaggar, B. L. (2013). The teenage brain: Functional connectivity. *Current Directions in Psychological Science, 22*(2), 101-107. doi:10.1177/0963721412474297

Elson, M., Breuer, J., Van Looy, J., Kneer, J., & Quandt, T. (2013). Comparing apples and oranges? Evidence for pace of action as a confound in research on digital game and aggression. *Psychology of Popular Media Culture*. doi:10.1037/ppm0000010

Engelhardt, C. R., Bartholow, B. D., Saults, J. S. (2011). Violent and nonviolent video games differentially affect physical aggression for individuals high vs. low in dispositional anger. *Aggressive Behavior*, *37,* 539-546. doi:10.1002/ab.20411

Ernst, M., Pine, D. S., & Hardin, M. (2006). Triadic model of the neurobiology of motivated behavior in adolescence. Psychological Medicine, 36(3), 299–312 doi:10.1017/S0033291705005891

Eluvathingal, T., Hasan, K., Kramer, L., Fletcher, J., & Ewing-Cobbs, L. (2007). Quantitative diffusion tensor tractography of association and projection fibers in normally developing children and adolescents. *Cerebral Cortex, 17*, 2760-2768. doi:10.1093/cercor/bhm003

Ferguson, C. J. (in press). Do angry birds make for angry children? A meta-analysis of video game influences on children's and adolescents' aggression, mental health, prosocial behavior and academic performance. *Perspectives on Psychological Science*.

Ferguson, C. J. (2013). Violent video games and the Supreme Court: Lessons for the scientific community in the wake of Brown v EMA. *American Psychologist, 68*(2), 57-74. doi:10.1037/a0030597

Ferguson, C. J., & Dyck, D. (2012). Paradigm change in aggression research: The time has come to retire the General Aggression Model. *Aggression and Violent Behavior, 17*, 220-228. doi:10.1016/j.avb.2012.02.007

Ferguson, C. J., Garza, A., Jerabeck, J., Ramos, R., & Galindo, M. (2013). Not worth the fuss after all? Cross-sectional and prospective data on violent video game influences on aggression, visuospatial cognition and mathematics ability in a sample of youth. *Journal of Youth and Adolescence, 42*(1), 109-122. doi:10.1007/s10964-012-9803-6

Ferguson, C. J., & Kilburn, J. (2010). Much ado about nothing: The misestimation and overinterpretation of violent video game effects in eastern and western nations: Comment on Anderson et al. (2010). *Psychological Bulletin, 136*, 174-178. doi:10.1037/a0018566

Ferguson, C. J., & Olson, C. K. (2014). Video game violence use among "vulnerable" populations: The impact of violent games on delinquency and bullying among children with clinically elevated depression or attention deficit symptoms. *Journal of Youth and Adolescence, 43*(1), 127-136. doi:10.1007/s10964-013-9986-5

Ferguson, C. J. & Rueda, S. M. (2010). The Hitman study: Violent video game exposure effects on aggressive behavior, hostile feelings and depression. *European Psychologist, 15*(2), 99-108. doi:10.1027/1016-9040/a000010

Ferguson, C. J., Rueda, S. M., Cruz, A. M., Ferguson, D. E., Fritz, S., & Smith, S. M. (2008). Violent video games and aggression: Byproduct of family violence and intrinsic violence motivation? *Criminal Justice and Behavior*, *35*, 311-332. doi:10.1177/0093854807311719

Galvan, A., Hare, T. A., Parra, C. E., Penn, J., Voss, K., Glover, G., & Casey, B. J. (2006). Earlier development of the accumbens relative to orbitofrontal cortex might underlie risk-taking behavior in adolescents. *The Journal of Neuroscience*, *26*(25), 6885-6892. doi: 10.1523/JNEUROSCI.1062-06.2006

Greitemeyer, T., & Mügge, D. O. (2014). Video games do affect social outcomes: A meta-analytic review of the effects of violent and prosocial video game play. *Personality and Social Psychology Bulletin*, *40*, 578-589. doi:10.1177/0146167213520459

Krahé, B., & Möller, I. (2010). Longitudinal effects of media violence on aggression and empathy among german adolescents. *Journal of Applied Developmental Psychology*, *31*, 401-409. doi:10.1016/j.appdev.2010.07.003

Kulik, J. A., & Brown, R. (1979). Frustration, attribution of blame, and aggression. *Journal of Experimental Social Psychology*, *15*, 183-194. doi:10.1016/0022-1031(79)90029-5

Lenhart, A., Jones, J., & Macgill, A. R. (2008). *Adults and video games*. Washington, DC: Pew Internet and American Life Project.

Lenhart, A., Kahne, J., Middaugh, E., Macgill, A. R., Evans, C., & Vitak, J. (2008). *Teens, video games, and civics.* (Report No. 202-415-4500). Washington, DC: Pew Internet and American Life Project.

Möller, I., & Krahé, B. (2009). Exposure to violent video games and aggression in German adolescents: A longitudinal analysis. *Aggressive Behavior, 35*, 75-89. doi:10.1002/ab.20290

Nelson, J., Gelfand, D., & Hartmann, D. (1969). Children's aggression following competition and exposure to an aggressive model. *Child Development, 40*, 1085-1097. doi:10.2307/1127014

Parents Television Council. (2011). *PTC denounces Supreme Court ruling on CA video game law.* Retrieved 4/25/12 from https://www.parentstv.org/PTC/news/release/2011/0627a.asp.

Paus, T. (2009). Brain development. In R. M. Lerner & L. Steinberg (Eds.), *Handbook of adolescent psychology: Individual bases of adolescent development.* Vol. 1, 3rd ed, pp. 95-115. NJ: Wiley.

Pryzbylski, A. K., Deci, E. L., Rigby, C. S., & Ryan, R. M. (2014). Competence-impeding electronic games and players' aggressive feelings, thoughts, and behaviors. *Journal of Personality and Social Psychology, 106*(3), 441-57. doi:10.1037/a0034820

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A motivational model of videogame engagement. *Review of General Psychology, 14*, 154-166. doi:10.1037/a0019440

Ryan, R. M., & Deci, E. L. (2000). Self-Determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78. doi:10.1037/0003-066X.55.1.68

Ryan, R. M., Deci, E. L., Grolnick, W. S., & LaGuardia, J. G. (2006). The significance of autonomy and autonomy support in psychological development and psychopathology. In D. Cicchetti & D. Cohen (Eds.), *Developmental psychopathology: Vol. 1. Theory and methods* (2nd ed., pp. 295–849). New York, NY: Wiley.

Ryan, R. M., & Grolnick, W. S. (1986). Origins and pawns in the classroom: Self-report and projective assessments of individual differences in children's perceptions. *Journal of Personality and Social Psychology, 50*, 550–558. doi:10.1037/0022-3514.50.3.550

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking.*Developmental Review, 28*, 78–106. Doi:10.1016/j.dr.2007.08.002.

Steinberg, L. (2007). Risk taking in adolescence. *Current Directions in Psychological Science, 16*(2), 55-59. doi:10.1111/j.1467-8721.2007.00475.x

Tear, M. J., Nielsen, M. (2013). Failure to demonstrate that playing violent video games diminishes prosocial behavior. *PLoS ONE*, *8*, 1-7. doi:10.1371/journal.pone.0068382

Wallenius, M., & Punamäki, R-L. (2008). Digital game violence and direct aggression in adolescence: A longitudinal study of the roles of sex, age, and parent-child communication. *Journal of Applied Developmental Psychology, 29*, 286-294. doi:10.1016/j.appdev.2008.04.010

Weinstein, N., Hodgins, H. S., & Ostvik-White, E. (2011). Humor as aggression: Effects of motivation and hostility on humor appreciation. *Journal of Personality and Social Psychology, 100*, 1043–1055. doi:10.1037/a0022495

Williams, D., & Skoric, M. (2005). Internet fantasy violence: A test of aggression in an online game. *Communication Monographs, 72,* 217–233. doi:10.1080/03637750500111781

Willoughby, T., Adachi, P. J. C., Good, M. (2012). A longitudinal study of the association between violent video game play and aggression among adolescents. *Developmental Psychology, 48,* 1044-1057. doi:10.1037/a0026046

Chapter 2 (Study 1): The Effect of Video Game Competition and Violence on Aggressive Behavior: Which Characteristic has the Greatest Influence?[1]

The effect of violent video games on aggression, which is defined as behavior that is intended to harm another individual (Coie & Dodge, 1998), is a hot topic today as video games continue to increase in popularity. For instance, a large scale study in the United States found that 88% of youth aged 8 to 18 years play video games (Gentile, 2009). In terms of frequency, youth played 3 or 4 times per week on average (median) and the average amount of time spent playing video games per week was 13.2 hours. Although some research has failed to find a relation between violent video game play and aggression (e.g., Ferguson et al., 2008; Ferguson & Reuda, 2010; Williams & Skoric, 2005), other research has shown that playing violent video games produces higher levels of aggressive behavior, aggressive cognition, aggressive affect and physiological arousal in the short-term than non-violent video games (see Anderson, Gentile & Buckley, 2007). However, there are three major limitations with the studies that have found an effect. First, to date, no study has matched a violent and non-violent video game on competitiveness, difficulty, and pace of action simultaneously, and thus, the violent content has not been isolated. Consequently, it is unclear whether the violent content alone is responsible for elevated levels of aggression. Second, previous experimental studies have tended to use a measure of aggression that may also measure

[1] A version of this chapter has been published. Adachi, P. J. C., & Willoughby, T. (2011). The effect of video game competition and violence on aggressive behavior: Which characteristic has the greatest influence? *Psychology of Violence*, *1*, 259-274. doi:10.1037/a0024908.

competitiveness, leading to questions about whether violent video games are related to aggression or competitiveness. Third, the effect of video game competition on aggressive behavior has not been examined. Hence, the goal of the current study was to examine whether a violent video game produced greater levels of aggression than a non-violent video game using an unambiguous measure of aggressive behavior, when both games were equated on competitiveness, difficulty, and pace of action. In addition, we tested whether a competitive video game produced more aggressive behavior than a less competitive video game when matched on violence, difficulty, and pace of action.

The General Aggression Model

The most comprehensive theory of the association between violent video games and aggression is Anderson and Bushman's (2002) General Aggression Model (GAM), which was adapted from past theories of aggression (see also Anderson & Carnagey, 2004 for a detailed description of the model). The model depicts a cyclical relationship between an individual and the environment, in which person variables such as trait hostility, as well as situation variables such as exposure to real-world or media violence (e.g., violent video games), interact to influence an individual's present internal state. Within an individual's internal state are cognition (aggressive scripts or hostile thoughts), affect (anger and frustration) and arousal (elevated heart rate or blood pressure). Cognition, affect, and arousal are the hypothesized mechanisms that interact to then influence an individual's aggressive behavior. According to Anderson and Bushman, violent video games function as a situation variable that can increase aggressive cognition, affect, and arousal, in turn leading to increased aggressive behavior.

Empirical Background

Experimental studies examining the short-term effect of violent video games on aggression have typically involved randomly assigning participants to play either a violent or non-violent video game, followed by a measure of aggression (e.g., Bushman & Anderson, 2002). Some of the researchers have found that participants in the violent video game condition have shown more aggression than participants in the non-violent condition for both males and females (see Anderson et al. 2007; 2010 for a detailed review, as well as Ferguson & Kilburn, 2010, for a critique of this research). However, there are three limitations with this research that have yet to be concurrently addressed in a single study. Each limitation will be reviewed in turn.

Differences between violent and non-violent video games other than violence. In general, violent video games tend to be more competitive than non-violent video games (Carnagey & Anderson, 2005). Consequently, studies that have found that violent video games produced more aggression than non-violent video games, but failed to equate the games on competitiveness, cannot conclude that the violent content alone was responsible for the elevated levels of aggression. We propose that violence (e.g., fighting, shooting, killing), competitiveness (e.g., competing with other players or computer-controlled opponents), difficulty (e.g., how difficult the game is to successfully complete), and pace of action (e.g., rate of speed of action sequences) are four main video game characteristics that may influence aggressive behavior through the mechanisms (i.e., physiological arousal, aggressive cognition, and aggressive affect) proposed by the GAM (see Adachi & Willoughby, 2011, for a detailed explanation). For example, Barlett, Branch, Rodeheffer, and Harris, (2009) found that a violent video game produced greater elevations in heart rate, hostility, aggressive thoughts, and aggressive behavior

compared to a non-violent video game. Similarly, video game competition may influence heart rate, as well as aggressive thoughts and feelings (see Adachi & Willoughby for a more detailed discussion regarding the relation between competition, difficulty, and pace of action, and the mechanisms proposed by the GAM).

Although researchers have attempted to equate games on competitiveness, difficulty, and pace of action, no one to date has equated a violent and non-violent game on these characteristics simultaneously. For example, Carnagey and Anderson (2005) attempted to control for competition while examining the effect of video game violence on aggressive behavior by manipulating the game-play settings of the car-racing video game *Carmageddon 2*. Participants were randomly assigned to one of three conditions: 1) awarded points for destroying other vehicles during the race (violence rewarded), 2) deducted points for destroying other vehicles during the race (violence punished), or 3) could not come into contact with other vehicles during the race (non-violent). Since the same game was used in all three conditions, Carnagey and Anderson assumed that the level of competitiveness across the conditions was equal; however, without having participants rate each condition in terms of competitiveness, it is unclear whether they were actually equal. For instance, in the violence-punished and non-violent conditions, there is only one competitive goal: defeat the other opponents in the race. However, in the violence-rewarded condition there are two competitive goals: defeat the other opponents in the race and defeat the other opponents in a battle for survival. Thus, the violence-rewarded condition contained more competition which may have caused participants to feel more competitive, and in turn, behave more aggressively than the participants in the violence-punished and non-violent conditions.

Problems with measures of aggression. The most commonly used measure of aggressive behavior in the violent video game literature is the modified Taylor competitive reaction time test (TCRTT; Epstein & Taylor, 1967), in which the participant is told that he or she is competing with another participant (confederate) to see who can push a button faster upon the appearance of a cue. After each trial, the winner chooses the intensity and duration of a punishment for the loser (such as a loud noise blast). The level of punishment intensity and duration that the participant sets for his or her opponent are indicative of aggressive behavior.

The first problem with the modified TCRTT is that the participant's motivation to behave aggressively is ambiguous (see Adachi & Willoughby, 2011). Because aggression refers to behavior that is intended to harm another individual, it is unclear whether participants view their behavior as competitive instead of aggressive, in that participants' motivation to give intense punishments may be to slow their opponents' response time on subsequent trials, thus allowing participants to win the competition (Lieberman et al., 1999). Furthermore, because violent games generally involve more competition than non-violent games, violent video games may prime competitive schemas more than non-violent video games, making the competitive element of the TCRTT especially salient. The second problem with the modified TCRTT is that it has been shown to lack validity as a measure of aggressive behavior. Ferguson and Rueda (2009) found that both intensity and duration scores for the modified TCRTT were not related to paper and pencil measures of trait aggression, domestic violence, or violent criminal behavior.

In order to assess direct and unambiguous aggressive behavior, Lieberman et al. (1999) created the Hot Sauce Paradigm. In the Hot Sauce Paradigm, the participant is given an already completed food preference questionnaire and told that another participant down the hall has completed this questionnaire and, as indicated by the questionnaire, does not like hot or spicy food. The participant is then given four bottles of hot sauce ranked in terms of hotness and is informed that his or her job is to choose one of the four bottles and mix up some hot sauce for the other participant to drink. The amount of hot sauce given and the degree of hotness is indicative of overt aggressive behavior (Barlett et al., 2009), and there are no competitive benefits gained from administering a hotter sauce to the confederate. Furthermore, Lieberman et al. found that scores on this paradigm were positively related to both trait and physical aggression scores on the Buss and Perry (1992) Aggression Questionnaire, supporting the convergent validity of the Hot Sauce Paradigm, although to date no study has measured its association with aggressive behavior outside the lab.

Aggression-related video game characteristics. Research regarding the effects of video game difficulty and pace of action on aggressive behavior is scarce. In contrast, competition has been shown to be related to aggression. For example, Anderson and Morrow (1995) examined whether giving participants competitive versus cooperative instructions led to differences in how aggressively they played the video game *Super Mario Brothers*. In this game, various creatures try to attack the main character (Mario or Luigi), and the main character in turn has the option to either attack the creatures or try to avoid them. Participants played the game in pairs, and each participant took turns playing the game. In the competitive condition, participants were told that their goal was

to get further in the game than the other participant, and the participants each used a different character (Mario or Luigi). In the cooperative condition, participants were told that their goal was to get as far in the game as possible together, and they took turns using the same character (Mario). Anderson and Morrow found that participants in the competitive condition killed significantly more enemy creatures than participants in the cooperative condition. Thus, they concluded that competition elevated aggressive behavior compared to cooperation (see also Williams & Clippinger, 2002).

Although Anderson and Morrow (1995) used a video game that is competitive in nature, the game is not very violent (also true for Williams & Clippinger, 2002). Specifically, the violence is cartoonish and unrealistic. Schmierbach (2010) addressed this gap in the literature by examining the effect of competitive video game play on aggressive cognition using the violent first-person shooter video game *Halo*. In *Halo*, the main character must compete in a battle for survival with the other opponent characters using a variety of different guns. Schmierbach randomly assigned pairs of participants to one of three conditions: 1) participants played the game on their own against computer opponents (solo mode), 2) participants played against each other in a one-on-one battle (competitive mode), and 3) participants played on the same team against computer opponents (cooperative mode). Immediately after video game play, participants completed a word completion task to assess aggressive cognition. The results showed that participants in the competitive condition had the highest aggressive cognition scores, followed by participants in the solo condition, while participants in the cooperative condition had the lowest aggressive cognition scores. Thus, consistent with past research, it appears that competition in a video game elevates aggression compared to cooperation.

The Current Studies

The purpose of Pilot Study 1a was to test whether two games chosen through pilot testing differed in terms of violence, but were matched in terms of competitiveness, difficulty, and pace of action. The two matched games were then used in Experiment 1a to test the effect of video game violence on aggressive behavior (the Hot Sauce Paradigm). Pilot Study 1b was conducted to test whether four video games chosen through pilot testing were matched on difficulty and pace of action, but differed on violence and competitiveness, such that two of the games were equally violent but one was more competitive than the other, while the other two games were equally non-violent but one was more competitive than the other. These four games were then used in Experiment 1b to test the effect of video game competition on aggressive behavior, and whether there was an interaction between competition and violence.

Pilot Study 1a

The goal of Pilot Study 1a was to test whether a violent action video game called *Conan* (THQ, 2007) and a non-violent racing video game called *Fuel* (Codemasters, 2009) were matched on game characteristics, but differed in violence. The goal was then to use these games in Experiment 1a. *Conan* is a violent game in which the main character must compete in a battle for survival using swords and axes against the opponent characters in order to progress through the levels. *Fuel* is a non-violent racing game in which the main character must compete in several different races using vehicles such as motorcycles and ATVs.

Fourteen Introductory Psychology students from a mid-sized university in Ontario, Canada (6 males, 8 females; *M* age = 20 years, 1 month) played the violent

video game *Conan* and the non-violent video game *Fuel* for 12 minutes each in a counterbalanced order. This study was approved by the University Ethics board and all participants provided active consent before participation. The games were played on an XBOX 360 gaming system and 42-inch television screen. In order to accurately compare participants' ratings of game characteristics, we controlled for their previous experience with the relevant video game genres of action (*Conan*) and racing (*Fuel*). Participants also completed a demographic questionnaire that assessed age and gender.

Participants rated each game in terms of the four video game characteristics. Violence was measured on a scale from 1 (very low) to 7 (very high) by asking "how violent was the game." Difficulty was measured by asking "how difficult was the game" on a scale of 1 (very low) to 7 (very high). Pace of action was assessed on a scale from 1 (very slow) to 7 (very fast) by asking "how was the pace of the game." Competitiveness was assessed on a scale from 1 (very low) to 7 (very high) using Anderson and Carnagey's (2009) four questionnaire items: "to what extent did this video game involve competition", "to what extent did you feel like you were competing with your opponents (i.e., in a battle or in a race)", "how competitive was this video game", and "how hard were you trying to win the game/match/contest." Alphas for the competitiveness scale were acceptable for both *Conan* ($\alpha = .86$) and *Fuel* ($\alpha = .78$).

Participants' experience with the two genres of games (action and racing) did not significantly differ, $F(1,12) = 3.41$, $p > .05$, *partial* $\eta^2 = .22$. A repeated measures ANOVA was then conducted to compare the two video games on the four video game characteristics of violence, competitiveness, difficulty and pace of action. Sex was included as a between-subjects variable and experience with racing and action games

were entered as covariates. Only the type of game (i.e., *Conan* and *Fuel)* x game characteristics (i.e., violence, competitiveness, difficulty, and pace of action) interaction was significant, $F(3,30) = 7.59$, $p < .01$, *partial* $\eta^2 = .43$. To assess this interaction, followup analyses were conducted to compare each of the four video game characteristics between the two games (see Table 1 for mean ratings). *Conan* was rated as significantly more violent than *Fuel*. However, the two games did not differ on competitiveness, difficulty, or pace of action. Consequently, *Conan* and *Fuel* were used in Experiment 1a to test whether video game violence alone could produce elevations in aggressive behavior.

Experiment 1a

The purpose of Experiment 1a was to test whether *Conan* and *Fuel* produced differences in aggressive behavior when using an unambiguous measure of aggressive behaviors, the Hot Sauce Paradigm. Similar to Barlett et al. (2009), deception was used to disguise the purpose of the Hot Sauce Paradigm so that participants would not be aware that we were assessing the effect of violent video games on aggressive behavior. Specifically, participants were told that they were participating in two unrelated studies looking at 1) video game play and eye-gaze and 2) food preference and personality (the hot sauce paradigm). In terms of expectations: 1) No specific hypothesis was made as to whether there would be a main effect of game. That is, it was not clear whether differences in hot sauce scores (i.e., standardized summation of the amount of sauce and the degree of hotness) would be found between the two video games, as this was the first study to match a violent and non-violent game on competitiveness, difficulty, and pace of action; 2) We predicted a main effect for sex, with males expected to have higher hot

Table 1

Pilot Study 1a and Experiment 1a Mean (SD) Ratings of Video Game Characteristics for Conan and Fuel

Pilot Study 1a					Experiment 1a			
	Video game				Video game			
Game rating	Violent	Non-violent	F^a	Partial η^2	Violent	Non-violent	F^b	Partial η^2
Violence	5.36 (1.28)	1.50 (0.52)	19.31**	0.66	5.14 (1.35)	2.05 (1.20)	61.75***	0.63
Competition	5.07 (1.23)	5.54 (1.30)	0.21	0.02	5.00 (0.99)	5.19 (1.19)	0.15	0.00
Difficulty	3.93 (1.07)	3.71 (1.44)	0.35	0.03	3.00 (1.14)	3.48 (1.17)	2.54	0.07
Pace of action	5.07 (0.83)	4.93 (1.21)	0.64	0.06	4.74 (1.08)	5.00 (0.89)	2.56	0.07

Notes: $N = 14$ for Pilot study 1a and $N = 42$ for Experiment 1a; Violent = *Conan*, Non-violent = *Fuel*; [a]$df = 1, 10$; $^{**}p < .01$; [b]$df = 1, 34$; $^{***}p < .001$

sauce scores than females, consistent with past literature showing that males are more aggressive than females (e.g., Coie & Dodge, 1998); 3) We did not expect to find an interaction between game and sex as past research has shown that the relation between video game play and aggression does not differ for males and females (e.g., Anderson et al., 2010); and 4) We also included a measure of trait aggression at the end of the study to test the convergent validity of the Hot Sauce paradigm. It was hypothesized that hot sauce scores would be moderately related to scores on a trait aggression questionnaire, consistent with past research (e.g., Lieberman et al., 1999, r = .30; Ferguson & Rueda, 2009, r = .25).

Method

Participants. Participants consisted of 42 Introductory Psychology students from the same university as in Experiment 1a (25 males, 17 females; *M* age = 18 years, 6 months). There were 21 participants that played *Conan* (13 males and 8 females) and 21 that played *Fuel* (12 males, 9 females). This study was approved by the University Ethics board and all participants provided active consent before participation. Students were recruited using the psychology participant pool and earned course credit in exchange for their participation.

Materials.

Demographics. As in Pilot Study 1a, a demographic questionnaire was used to assess age, gender, and experience with action and racing games. Participants indicated how many hours per weekday and weekend (1 = not at all to 5 = 5 or more hours per day) that they played action and racing games.

Video games and equipment. *Conan* and *Fuel* were played using an XBOX 360 console on a 42-inch television screen.

Aggressive behavior. The Hot Sauce Paradigm (Lieberman et al, 1999) was used to measure overt aggressive behavior. Participants were asked to prepare some hot sauce for another participant to drink who does not like hot sauce (note that there actually was no other participant). Participants were asked to choose the intensity of hot sauce (ranging from 1 = least hot to 4 = most hot) and the amount, knowing that the other participant had to drink whatever amount was in the cup. Participants could also taste the sauce in order to see how hot it was. Aggressive behavior was operationalized as the sum of the standardized number (i.e., hotness rating) of sauce selected and the weight in grams (Barlett et al, 2009). Hot sauce was purchased from a local food establishment that has a ranked system of hotness for the sauces and four sauces were selected that ranked in order from least to most hot. Each sauce was transferred into a plastic squeeze bottle and was given a number from one to four (with one being the least hot and four being the hottest). In addition, a styrofoam cup to place the hot sauce into, a cup of water, popsicle sticks, and white bread (to help ease the hot sensation after tasting the sauce) were used.

Ratings of the video game characteristics. See Pilot Study 1a for a description. Alphas for the competitiveness scale were acceptable for both *Conan* ($\alpha = .74$) and *Fuel* ($\alpha = .89$).

Food preference. Food preference was assessed by asking "how much do you LIKE the following kinds of foods" for six items (i.e., sweet, savory, spicy, hot, bland, and salty foods) on a 1 (*not at all)* to 5 (*extremely)* scale (Barlett et al, 2009). Consistent with Barlett et al., we confirmed that both the degree of hotness and the amount the hot

sauce selected by participants was not a function of their liking hot food. Liking hot food did not account for a significant portion of the variability in the degree of hotness R^2 = .07, $F(1,40) = 2.78$, $p > .05$, or the amount of sauce $R^2 = .04$, $F(1,40) = 1.44$, $p > .05$.

Suspiciousness. Due to the growing popularity of research proposing a relation between violent video games and aggression and the fact that deception was used, a suspiciousness questionnaire was given which asked participants if knew the true purpose of the study, whether anyone had told them about the study before completing it, and whether they were aware of any deception (Barlett et al. 2009).

Trait aggression. The Buss-Perry Aggression Questionnaire (Buss & Perry, 1992) was used to measure trait aggression and to examine the convergent validity of the Hot Sauce Paradigm. The scale consists of 29 items (e.g., "once in a while, I can't control the urge to strike another person") and responses range from 1 (*strongly disagree*) to 7 (*strongly agree*), with higher scores indicating higher trait aggression. The internal consistency for this scale was good ($\alpha = .89$).

Procedure. Participants were tested one at a time by the first author. First, they were told that they were participating in two unrelated studies: a video game study examining video games and eye gaze and a study looking at personality and food preference. For the food study, participants were told that they were randomly assigned to the role of "food administrator" and that when the time came their job would be to prepare a certain type of food for another participant who had been assigned to the role of "food taster." Participants were then given the demographic questionnaire followed by the food preference questionnaire.

Next, participants were told that they were going to begin the video game and eye-gaze study. Participants were randomly assigned to play either the violent or non-violent video game for 12 minutes while wearing a piece of eye-tracker headgear which they believed was measuring their eye-gaze, although we did not actually record their eye-gaze. Upon completion, participants were then given the questionnaire assessing the video game characteristics and were then told it was time to complete the food preference study. Specifically, the experimenter explained that it was time for the participant to prepare some food for the food taster. Participants were given an already completed food preference questionnaire and were told that the food taster completed this questionnaire. The food preference questionnaire clearly indicated that the food taster did not like hot or spicy food.

The experimenter then provided the participant with the materials for the food preference study (i.e., the hot sauce, a cup, a cup of water, bread, and popsicle sticks) and explained that the participant could choose the intensity of hot sauce (ranging from 1 = least hot to 4 = most hot) and the amount, and that the food taster would have to drink whatever amount was in the cup. As in Barlett et al. (2009), participants were told that they could not mix sauces. Also, if they wished to know how hot the sauces were before choosing one, they could sample the sauces using the popsicle stick. The experimenter left the room and watched from behind a two-way mirror as the task was performed, and then returned to retrieve the cup of hot sauce to allegedly bring to the food taster. The time lapse between the video game play and hot sauce preparation was 2 to 3 minutes, well within the 5- to 10-minute time frame in which the effect of violent video games on aggression has been shown to last (Barlett et al.). Finally, participants completed the

suspiciousness questionnaire to assess whether participants knew the true purpose of the study before being debriefed or whether they were aware of any deception (Barlett et al.). Furthermore, 26[2] participants (13 who played *Conan* and 13 who played *Fuel*) completed the Buss and Perry (1992) Trait Aggression Questionnaire to examine the convergent validity of the Hot Sauce Paradigm. The time lapse between the video game play and the completion of the trait aggression questionnaire was over 10 minutes (*M* = 11 minutes).

Results and Discussion

Suspiciousness. We originally had 48 participants, but six participants indicated that they knew the true purpose of the study or were aware of the deception and thus, their data were not included in the analysis (final *N* = 42).

Experience. In order to include past video game experience for both genres of games as covariates in the main analyses, we first determined that participants' experience with action and racing games did not differ between the two game conditions, $F(1,38) = .93$, $p > .05$, *partial* $\eta^2 = .02$.

Video game ratings. A MANOVA was conducted to confirm that *Conan* and *Fuel* were equated on the three video game characteristics of competitiveness, difficulty, and pace of action, but differed on violence, and experience with racing and action games were included as covariates. There was a main effect for game, $F(4,33) = 28.98$, $p < .01$, *partial* $\eta^2 = .78$. The video games differed only in ratings of violence, as *Conan* was rated as more violent than *Fuel* (see Table 1 for mean ratings). Thus, consistent with Pilot

[2] Due to the post hoc nature of our examination of the external validity of the Hot Sauce Paradigm, we were unable to administer the Buss and Perry (1992) Trait Aggression Questionnaire to the full sample of participants.

Study 1a, participants rated *Conan* as more violent than *Fuel*, but not significantly different in terms of competitiveness, difficulty, and pace of action.

Aggressive behavior. A univariate ANOVA was conducted with the summation of the standardized amount of hot sauce given and the standardized degree of hotness as the dependent variable, video game condition (i.e., violent versus non-violent) and sex as the independent variables, and game experience for both genres of games as the covariates. Participants who played *Conan* did not differ in hot sauce scores (M = .09) compared to participants who played *Fuel* (M = -.09), $F(1,36) = .00$, $p > .05$, *partial* η^2 = .00. As predicted, males (M = .40) had higher hot sauce scores than females (M = -.59), $F(1,36) = 6.34$, $p < .05$, *partial* $\eta^2 = .15$, and the interaction between game and sex was not significant, $F(1,36) = .23$, $p > .05$, *partial* $\eta^2 = .01$. The results suggest that the violent content alone was not sufficient to produce elevations in aggressive behavior compared to a non-violent video game.

Convergent validity of the Hot Sauce Paradigm. We decided to test the convergent validity of the hot sauce paradigm after the study had begun, so only the final twenty-six participants completed the trait aggression questionnaire. As predicted, hot sauce scores were positively correlated with trait aggression (r = .32), although this correlation was not statisticially significant due to the small sample size. However, the size of the moderate correlation is consistent with previous results (e.g., Lieberman et al, 1999; Ferguson & Rueda, 2009).

Experiment 1a, therefore, demonstrated that video game violence alone is not sufficient to produce elevations in aggressive behavior in a lab setting. Using an unambiguous measure of aggressive behavior, participants did not have higher hot sauce

scores after playing a violent game compared to a non-violent game that was equated on competitiveness, difficulty and pace of action. This finding suggests that the level of violence in video games may be less influential in elevating aggression than previously believed. In addition, the present study provided support for the validity of the Hot Sauce Paradigm as a measure of aggressive behavior, due to its positive relation with a measure of trait aggression.

An alternative explanation for this finding may be that neither video game elevated aggressive behavior from baseline because the games may not have been sufficiently violent, competitive, difficult, or contained fast enough action to influence aggression. To assess this hypothesis, we compared hot sauce scores for participants who played *Conan* and *Fuel* with hot sauce scores from participants in Barlett et al.'s (2009) violent and non-violent video game conditions. In terms of intensity, scores for both *Conan* (2.52) and *Fuel* (2.33) were larger compared to scores found in both violent (2.12) and non-violent (1.76) games reported by Barlett et al. In terms of weight, scores for *Conan* (1.01) and *Fuel* (1.01) were larger compared to the scores for Barlett et al.'s non-violent video game (.60) and slightly smaller than the scores for the violent video game (1.27). Thus, hot sauce scores for *Conan* and *Fuel* were very similar to Barlett et al.'s violent video game, and larger than their non-violent video game. The fact that Barlett et al.'s violent video game produced more aggressive behavior than their non-violent video game suggests that in our study, *Conan* and *Fuel* likely elevated aggressive behavior from baseline.

Another possible criticism of the current study is that the sample size may have been too small to find a significant effect for video game condition on aggressive

behavior. However, a power analysis using *G*Power 3.1.2* revealed that with the current sample size of $N = 42$, we had power of .755 to detect the significance of an effect size equivalent to Barlett et al. (2009; *partial* $\eta^2 = .15$). In addition, the effect size for game in the current study was zero (*partial* $\eta^2 = .000$), and thus increasing the sample size would not have made the effect statistically significant. Given our finding that video game violence alone is not sufficient to produce elevations in aggressive behavior in a lab setting, the next step is to examine which video game characteristics have the largest impact on aggressive behavior and how these characteristics interact. Although a few researchers have attempted to control for the level of competitiveness when testing the effect of video game violence on aggressive behavior, no one has examined the effect of video game competition on aggressive behavior. Thus, Pilot Study 1b and Experiment 1b were conducted to test the effect of the level of competitiveness in video games on aggressive behavior.

Pilot Study 1b

The purpose of Pilot Study 1b was to isolate competitiveness by matching four games on difficulty and pace of action, and to systematically control for violence, so that we could use these games in Experiment 1b to examine the effect of competitiveness on aggressive behavior. After extensive testing by the first author, four games were selected that appeared to be matched on difficulty and pace of action. Two of the games appeared to be equally violent, and the other two games appeared to be equally non-violent. Of the two violent games, one was more competitive than the other, and of the two non-violent games, one was more competitive than the other. The two violent games that were chosen were *Mortal Kombat vs. DC Universe* (Midway Games, 2008) and *Left 4 Dead 2* (Valve,

2009). *Mortal Kombat vs. DC Universe* is a fighting game in which the main character must battle another opponent character in hand-to-hand combat. The goal of the game is to defeat the opponent character in a 3-round fight so a new opponent can be faced. Due to the competitive nature of the game (i.e., three rounds of one-on-one combat), the competitive element of this game is quite salient. Thus, *Mortal Kombat vs. DC Universe* was hypothesized to be the more competitive violent game. *Left 4 Dead 2* is a first-person shooter in which the main character must battle zombies using guns and other weapons. Although the main character must compete in a battle for survival with every other character in the game, *Left 4 Dead 2* was hypothesized to be less competitive than *Mortal Kombat vs. DC Universe*. Unlike most other first-person shooters, the opponent characters in *Left 4 Dead 2* are zombies, and hence they do not possess weapons. Consequently, instead of engaging in a competitive shoot-out against other armed characters as in most first-person shooters, many scenarios in *Left 4 Dead 2* involve standing at a distance and shooting a barrage of charging zombies.

The two non-violent games were *Fuel* (Codemasters, 2009) and *Marble Blast Ultra* (GarageGames, 2006). As previously described, *Fuel* is a racing game in which the main character must compete against other characters while in a series of races while driving a variety of vehicles such as motorcycles and ATVs. Due to the competitive nature of the game, *Fuel* was hypothesized to be the competitive non-violent game. In contrast, *Marble Blast Ultra* involves controlling a marble through a series of labyrinth-like mazes as quickly as possible. As there are no other characters in the game with which to compete with, *Marble Blast Ultra* was hypothesized to be less competitive than *Fuel*. In terms of comparing the violent and non-violent games, *Fuel* was hypothesized to

be equally competitive to *Mortal Kombat vs. DC Universe*, and more competitive than *Left 4 Dead 2*. *Marble Blast Ultra* was hypothesized to be less competitive than *Mortal Kombat vs. DC Universe* and *Left 4 Dead 2* (since *Left 4 Dead 2* does contain some competition against opponent characters). The games were played on an XBOX 360 gaming system and 42-inch television screen.

Nineteen undergraduate students from the same university as in Experiment 1a (12 males, 7 females; *M* age = 22 years, 2 months) played the four games for 10 minutes each in a counterbalanced order, and rated each game in terms of the four characteristics after playing it. This study was approved by the University Ethics board and all participants provided active consent before participation. Instead of using a 4-item composite to assess competitiveness, only two items were used, "to what extent did this video game involve competition" and "to what extent did you feel like you were competing with your opponents (i.e., in a battle or in a race)". The remaining two items, "how competitive was this video game," and "how hard were you trying to win the game/match/contest" were not used because they did not discriminate between competitive and non-competitive games. For example, after playing a non-competitive game, a participant might report that he or she tried very hard to win the game, even though there was no competition. Correlations for the two competitiveness items were acceptable for *Mortal Kombat vs. DC Universe* (r = .73), *Left 4 Dead 2* (r =.77), *Marble Blast Ultra* (r = .57), and *Fuel* (r = .64). As in Experiment 1a, a demographic questionnaire was used to assess age, gender and past video game experience.

A repeated measures ANOVA revealed that participants' experience across the different genres did not significantly differ, $F(3,51) = 1.32$, $p > .05$ *partial* $\eta^2 = .07$. A

repeated measures ANOVA was conducted to compare the four video games on the four video game characteristics of violence, competitiveness, difficulty and pace of action. Sex was included as a between-subjects variable and experience with all game genres were entered as covariates. Only the type of game (i.e., *Fuel*, *Left 4 Dead*, *Marble Blast Ultra*, *Mortal Kombat vs. DC Universe)* x game characteristics (i.e., violence, competitiveness, difficulty, and pace of action) interaction was significant, $F(9,117) = 5.01$, $p < .01$, *partial* $\eta^2 = .28$ (see Table 2 for mean ratings of the video game characteristics for the four video games). Thus, participants' ratings of video game characteristics differed between the four video games. Followup comparisons indicated that the four games did not significantly differ in their ratings of difficulty, $F(3,42) = .17$, $p > .05$, *partial* $\eta^2 = .01$, or in pace of action, $F(3,42) = .48$, $p > .05$, *partial* $\eta^2 = .03$. Thus, all four games were matched on difficulty and pace of action.

Followup comparisons were then conducted to examine differences in violence ratings between the four games. The two non-violent games, *Marble Blast Ultra* and *Fuel*, were not rated differently in terms of violence, $F(1,16) = 2.24$, $p > .05$, *partial* $\eta^2 = .12$. Similarly, the two violent games, *Mortal Kombat vs. DC Universe* and *Left 4 Dead 2*, did not differ in terms of violence ratings $F(1,16) = 2.00$, $p > .05$, *partial* $\eta^2 = .11$. Importantly, however, *Mortal Kombat vs. DC Universe* was significantly more violent than both *Fuel*, $F(1,16) = 50.96$, $p < .01$, *partial* $\eta^2 = .76$, and *Marble Blast Ultra*, $F(1,16) = 52.19$, $p < .01$, *partial* $\eta^2 = .77$. Similarly, *Left 4 Dead 2* was significantly more violent than both *Fuel*, $F(1,16) = 71.73$, $p < .01$, *partial* $\eta^2 = .82$, and *Marble Blast Ultra*, $F(1,16) = 84.32$, $p < .01$, *partial* $\eta^2 = .84$. Therefore, as predicted, the two violent games (*Mortal Kombat vs. DC Universe* and *Left 4 Dead 2*) were equally violent, and both were more

violent than the two non-violent games (*Fuel* and *Marble Blast Ultra*). In addition, the two non-violent games were both equally non-violent.

Followup analyses were then conducted to examine differences in competitiveness ratings between the four games. *Fuel* and *Mortal Kombat vs. DC Universe* were the two most competitive games, and they did not differ in competitiveness ratings $F(1,16) = 1.45$, $p > .05$, *partial* $\eta^2 = .08$. *Fuel* was more competitive than *Marble Blast Ultra*, $F(1,16) = 80.01$, $p < .01$, *partial* $\eta^2 = .83$, and *Left 4 Dead 2*, $F(1,16) = 5.39$, $p < .05$, *partial* $\eta^2 = .25$. Similarly, *Mortal Kombat vs. DC Universe* was more competitive than *Left 4 Dead 2*, $F(1,16) = 7.12$, $p < .05$, *partial* $\eta^2 = .31$, and *Marble Blast Ultra*, $F(1,16) = 94.85$, $p < .01$, *partial* $\eta^2 = .86$. Finally, *Left 4 Dead 2* was more competitive than *Marble Blast Ultra* $F(1,16) = 6.06$, $p < .05$, *partial* $\eta^2 = .28$. Thus, we confirmed that of the four games, two were significantly more competitive than the other two.

Experiment 1b

The purpose of Experiment 1b was to examine the effect of video game competitiveness on aggressive behavior (using the Hot Sauce Paradigm), as well as test whether competitiveness interacts with violence to influence aggression, using the four video games from Pilot Study 1b. Although previous research has attempted to equate video games on competitiveness (e.g., Anderson & Carnagey, 2009; Carnagey & Anderson, 2005), this was the first experiment to directly test the effect of video game competition on aggressive behavior. Moreover, as previously described, video game

Table 2

Pilot Study 1b and Experiment 1b Mean (SD) Ratings of Video Game Characteristics for the Four Video Games

Pilot Study 1b					Experiment 1b			
	Video game				Video game			
Game rating	C, NV	C, V	LC, V	NC, NV	C, NV	C, V	LC, NV	NC, NV
Violence	1.52_b	5.37_a	6.42_a	1.00_b	1.33_b	5.20_a	5.87_a	1.07_b
	(0.70)	(0.90)	(0.84)	(0.00)	(0.82)	(0.86)	(1.13)	(0.26)
Competition	5.86_a	6.32_a	3.18_b	1.36_c	5.40_a	6.13_a	3.10_b	1.40_c
	(0.76)	(0.58)	(1.67)	(0.44)	(1.02)	(0.93)	(1.67)	(0.69)
Difficulty	3.63_a	4.47_a	4.42_a	4.68_a	3.27_a	3.67_a	3.53_a	3.60_a
	(1.38)	(1.58)	(1.74)	(1.16)	(1.10)	(0.82)	(0.92)	(1.18)
Pace of action	4.74_a	5.42_a	5.11_a	4.57_a	4.73_a	5.20_a	4.87_a	4.47_a
	(1.05)	(0.90)	(1.29)	(1.26)	(1.33)	(0.77)	(0.92)	(0.99)

Notes. *N*=19 for Pilot study 1b and *N*=60 for Experiment 1b; Cells within a row with common subscripts for the pilot study and experiment do not different at *p*=.05. C=competitive, NC=non-competitive, LC=less competitive, V=violent, NV=non-violent; C,NV=*Fuel*, C,V=*Mortal Kombat vs. DC Universe*, LC,V=*Left 4 Dead 2*, NC,NV=*Marble Blast Ultra.*

competitiveness may influence aggressive behavior through the mechanism of physiological arousal. In order to further examine the relation between competitiveness and aggressive behavior, we recorded participants' heart rate at baseline and during video game play to test whether video game competitiveness would produce elevations in heart rate from baseline.

Four hypotheses were tested: 1). Consistent with research showing a relation between video game competition and aggression (e.g., Anderson and Morrow, 1995; Williams and Clippinger, 2002; Schmierbach, 2010), we expected that there would be a significant main effect for type of game. Specifically, we hypothesized that the highly competitive, violent video game, *Mortal Kombat vs. DC Universe,* and the highly competitive non-violent video game *Fuel* would produce more aggressive behavior than the less competitive, violent video game *Left 4 Dead 2,* and the less competitive, non-violent game, *Marble Blast Ultra*. As the less competitive, violent video game *Left 4 Dead 2* was rated as moderately competitive in Pilot Study 1b (i.e., mean score = 3.18/7), it was unclear whether it would produce greater levels of aggressive behavior than the less competitive, non-violent game *Marble Blast Ultra*. 2). It was predicted that there would be a significant main effect for sex, such that males would give more of a hotter sauce than females, consistent with the results of Experiment 1a. However, we did not expect to find an interaction between game and sex, again consistent with the results of Experiment 1a. 3) Consistent with our predictions regarding aggressive behavior, we expected a significant main effect for type of game on heart rate scores. Specifically, we hypothesized that *Fuel* and *Mortal Kombat vs. DC Universe* would produce the greatest elevations in heart rate from baseline. Also consistent with predictions regarding

aggressive behavior, it was unclear whether the moderately competitive, violent game *Left 4 Dead 2* would produce greater increases in heart rate from baseline compared to the less competitive, non-violent game *Marble Blast Ultra*.

Method

Participants. Participants consisted of 60 Introductory Psychology students from the same university as in Pilot Study 1b (32 males, 28 females; *M* age = 18 years, 4 months). Participants were randomly assigned to play one of the four video games, and thus, each video game was played by 15 participants (8 males and 7 females). This study was approved by the University Ethics board and all participants provided active consent before participation. Students were recruited using the psychology participant pool and earned course credit in exchange for their participation.

Materials.

Demographics. See Experiment 1a for a description.

Video games and equipment. *Fuel*, *Left 4 Dead 2*, *Marble Blast Ultra*, and *Mortal Kombat vs. DC Universe* were played using an XBOX 360 console on a 42-inch television screen.

Aggressive behavior. See Experiment 1a for a description of the paradigm.

Ratings of the video game characteristics. See Pilot Study 1b for a description. Correlations for the two competitiveness items were acceptable for *Fuel* (r = .72), *Left 4 Dead 2* (r = .59), *Marble Blast Ultra* (r = .54), and *Mortal Kombat vs. DC Universe* (r = .67).

Food preference. See Experiment 1a for a description. Consistent with Experiment 1a, liking hot food did not account for a significant portion of the variability

in the degree of hotness R^2 = .00, $F(1,58) = 0.01$, $p > .05$, or the amount of sauce R^2 = .00, $F(1,58) = 0.01$, $p > .05$.

Suspiciousness. See Experiment 1a for a description.

Trait aggression. See Experiment 1a for a description (in the current sample α = .84).

Heart rate. Electrocardiogram (ECG) recordings were collected during a 5-minute rest period at the beginning of the session (baseline), and throughout the video game session. ECG signals were recorded from two electrodes placed on the participants' collarbone with a hardware gain of 1000. R-R (interbeat) intervals were visually checked in the MindWare program and edited where necessary according to principles advocated by Berntson and Stowell (1998).

Procedure. The procedure was identical to Experiment 1a, other than participants were told that in addition to assessing their eye-gaze, their heart rate would be monitored for five minutes at baseline as well as continuously during video game play.

Results and Discussion

Suspiciousness. We originally had 65 participants, but 5 participants indicated that they knew the true purpose of the study or were aware of the deception and thus, their data were not included in the analysis (final N = 60).

Experience. A repeated measures MANOVA was conducted to examine whether participants in the four video game conditions differed in their experience with the four genres of games. Experience with the four genres did not differ between video game conditions, $F(9,156) = .46$, $p > .05$, *partial* $\eta^2 = .03$.

Video game ratings. A MANOVA was conducted to confirm that *Fuel*, *Left 4 Dead 2*, *Marble Blast Ultra*, and *Mortal Kombat vs. DC Universe* were equated on difficulty and pace of action, but differed on competitiveness and violence, and experience with the four video game genres were included as covariates. There was a main effect for game, $F(12,141) = 39.10$, $p < .01$, *partial* $\eta^2 = .76$. The video games differed only on ratings of competitiveness, $F(3,48) = 54.02$, $p < .01$, *partial* $\eta^2 = .77$, and violence, $F(3,48) = 216.78$, $p < .01$, *partial* $\eta^2 = .93$. Followup analyses revealed that consistent with Pilot Study 1b, *Mortal Kombat vs. DC Universe* was rated as more competitive than *Left 4 Dead 2* and *Marble Blast Ultra*, but not significantly different than *Fuel* (see Table 2 for mean ratings of video game characteristics). Similarly, *Fuel* was rated as more competitive than *Marble Blast Ultra* and *Left 4 Dead 2*. Finally, *Left 4 Dead 2* was rated as more competitive than *Marble Blast Ultra*. Thus, ratings of the video game characteristics in this experiment were consistent with Pilot Study 1b. Consequently, we were able to isolate the effect of video game competitiveness on aggressive behavior. In addition, we were able to examine whether competitiveness and violence interact to influence aggression.

Aggressive behavior. A univariate ANOVA was conducted with the summation of the standardized amount of hot sauce given and the standardized degree of hotness as the dependent variable, video game condition (four games) and sex as the independent variables, and experience with the four genres of games as the covariates. There was a main effect for game $F(3,48) = 7.04$, $p < .01$, *partial* $\eta^2 = .31$. Followup analyses revealed that participants who played *Fuel* ($M = .79$) and *Mortal Kombat vs. DC Universe* ($M = .90$) had significantly higher hot sauce scores (see Figure 1) than

participants who played *Marble Blast Ultra* (*M* = -.91) and *Left 4 Dead 2* (*M* = -.78). Hot sauce scores did not differ between *Fuel* and *Mortal Kombat vs. DC Universe*, or between *Marble Blast Ultra* and *Left 4 Dead 2*. Although males (*M* = .31) had higher hot sauce scores than females (*M* = -.35), this difference did not reach significance $F(3,48) = 1.49$, $p > .05$, *partial* $\eta^2 = .03$, and the interaction between game and sex also was not significant, $F(3,48) = .41$, $p > .05$, *partial* $\eta^2 = .03$.

Trait aggression. In order to confirm that random assignment was successful in placing equally aggressive participants in the four video game conditions, an ANOVA was conducted with trait aggression as the dependent variable, and game and sex as the independent variables. There were no differences in trait aggression scores among the four conditions, $F(3,52) = .06$, $p > .05$, *partial* $\eta^2 = .00$. Thus, the four video game conditions contained equally aggressive participants.

Heart rate. A repeated measures MANOVA was conducted to examine differences in heart rate between baseline and video game play among the four video game conditions. Game and sex were entered as the between-subjects variables, while heart rate (baseline and during video game) was entered as the within-subjects variable. A significant heart rate x video game interaction was found, $F(3,48) = 12.76$, $p < .01$, *partial* $\eta^2 = .44$. Followup analyses were then conducted for each video game condition to see which video games produced elevations in heart rate from baseline (see Table 3). *Fuel* and *Mortal Kombat vs. DC Universe* both led to significant elevations in heart rate from baseline, while *Marble Blast Ultra* and *Left 4 Dead 2* did not.

In summary, Experiment 1b confirmed the hypothesis that the two most competitive games, *Fuel* and *Mortal Kombat vs. DC Universe*, would produce greater

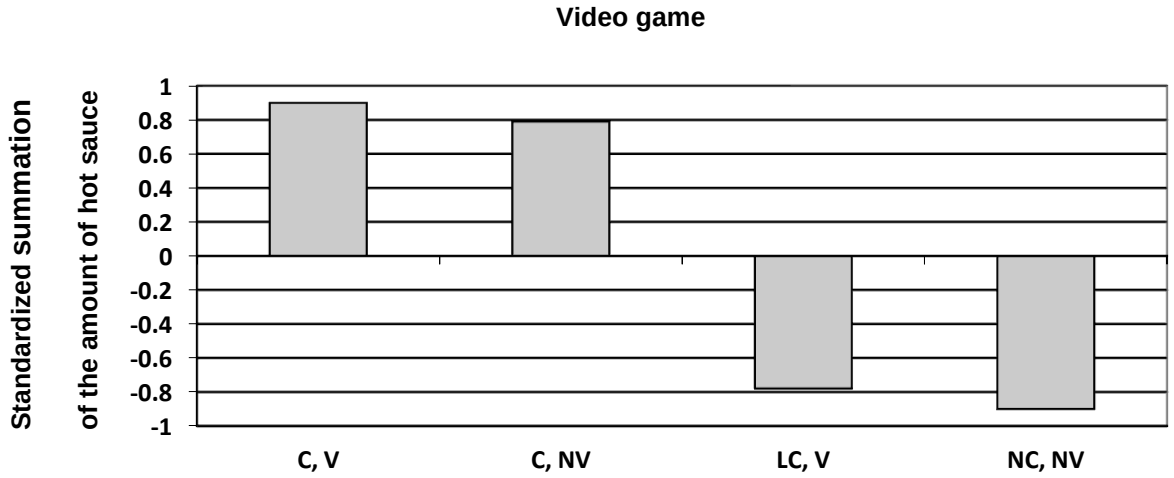


Figure 1. The effect of video game condition on aggressive behavior in Experiment 1b. C = competitive, NC = non-competitive, LC = Less competitive, V = violent, NV = non-violent. C, V = *Mortal Kombat vs. DC Universe*, C, NV = *Fuel*, LC, V = *Left 4 Dead 2*, NC, NV = *Marble Blast Ultra*

Table 3

Experiment 1b Baseline and Heart Rate Scores for the Four Video Games

	Heart rate			
Video game	Baseline	Game	F^a	Partial η^2
Competitive, non-violent	76.92 (10.18)	78.95 (11.25)	6.07*	0.32
Competitive, violent	74.89 (16.15)	86.36 (17.52)	1.00**	0.71
Less competitive, violent	78.85 (11.88)	77.32 (8.53)	0.78	0.06
Non-competitive, non-violent	75.81 (11.88)	76.62 (12.25)	0.72	0.05

Notes. [a]*df* = 1, 13; *p < .05, **p < .01; Standard deviations are in parentheses.

N = 60; Means are unadjusted; Competitive, Non-violent = *Fuel*, Competitive, Violent = *Mortal Kombat vs. DC Universe*, Less competitive, Violent = *Left 4 Dead 2*, Non-competitive, Non-violent = *Marble Blast Ultra*.

aggressive behavior scores than the less competitive games, *Marble Blast Ultra* and *Left 4 Dead 2*. Also as expected, *Fuel* and *Mortal Kombat vs. DC Universe* did not produce differences in aggressive behavior. In addition, we found that a moderately competitive, highly violent game (*Left 4 Dead 2*) was not sufficient to elevate aggressive behavior compared to a less competitive, non-violent game (*Marble Blast Ultra*). These findings suggest that the level of competitiveness in video games is an important factor in the relation between video games and aggressive behavior, with highly competitive games leading to greater elevations in aggression than less competitive games. As expected, males gave more of a hotter sauce than females, although this difference did not reach significance. Also as expected, there was no interaction between game and sex when predicting aggressive behavior. Finally, we found that only the two highly competitive games, *Fuel* and *Mortal Kombat vs. DC Universe*, elevated heart rate from baseline.

General Discussion

The present study was the first to isolate the violent content in a video game by matching a violent and non-violent game on competitiveness, difficulty, and pace of action (Pilot Study 1a). We then demonstrated that the violent content alone was not sufficient to elevate aggressive behavior in the short-term (Experiment 1a). This finding suggests that the level of violence in video games may be less influential in elevating aggression than previously believed.

After demonstrating that video game violence alone was not sufficient to elevate aggressive behavior, we examined the effect of video game competitiveness. The present study was the first to isolate video game competitiveness by matching two violent games, and two non-violent games on violence, difficulty, and pace of action (Pilot Study 1b).

We found that video game competitiveness elevated aggressive behavior in the short-term, regardless of the level of violent content, as the two most competitive video games, *Mortal Kombat vs. DC Universe* (violent) and *Fuel* (non-violent), produced the greatest levels of aggressive behavior. We also found that a moderately competitive game (*Left 4 Dead 2*), even when paired with a high level of violence, was not sufficient to elevate aggressive behavior compared to a less competitive, non-violent game (*Marble Blast Ultra*). In addition, we found that the two highly competitive video games (*Mortal Kombat vs. DC Universe* and *Fuel* produced elevations in heart rate from baseline, whereas the two less competitive games (*Left 4 Dead 2* and *Marble Blast Ultra*) did not produced changes in heart rate.

Limitations

There were several limitations with this study. First, the present study only used samples of university students. Findings, however, may be different for other age groups. For example, the relation between video game competitiveness and aggression may be different for adolescents (e.g., 12 to 19 years) versus adults (e.g., 25 years and older), due to the hypothesis that some adolescents may experience a temporal gap between an early maturing socio-emotional system (hypothesized to be a result of increases in dopaminergic activity, perhaps linked to puberty, leading to increases in reward seeking, need for novelty and stimulation), and a slower maturing self-regulatory system (hypothesized to be led by the prefrontal cortex, responsible for planning, judgment, and inhibition, which may not be fully mature until the mid 20s; Steinberg, 2010). Thus, adolescents on average may be more likely to behave aggressively than adults after playing a competitive video game due to their potentially greater difficulty (on average)

in regulating their arousal than adults. Future research should compare the effect of video game competitiveness on aggression between these different age groups. Second, although this study addressed the short-term effect of video game competition on aggressive behavior, we did not examine long-term effects. Thus, longitudinal research examining the relation between video game competition and aggression is needed. Finally, findings may not generalize to other geographic regions, including those with differing ethnic and/or demographic mixes.

Research Implications

We have expanded on previous research that has found a relation between violent video games and aggression (see Anderson et al., 2010) by demonstrating that when isolating specific video game characteristics, competitiveness had a much larger impact on aggressive behavior than the violent content. At first glance, this finding may seem to contradict past research which has found that violent video games produced more aggression than non-violent video games. However, since past studies have failed to equate the violent and non-violent video games on competitiveness, difficulty, and pace of action simultaneously, researchers may have attributed too much of the variability in aggression to the violent content. For example, since violent video games are more competitive in general than non-violent games, it was likely the competition, rather than the violence, that was responsible for the elevations in aggression in past studies. Furthermore, in the only study that successfully matched a violent and non-violent video game on competitiveness (Anderson & Carnagey, 2009), the violent game was rated higher in terms of difficulty and pace of action. Thus, it was unclear whether the violence, difficulty, pace of action, or a combination of the three influenced aggressive

behavior. Future research should test the effect of both video game difficulty and pace of action on aggressive behavior, as well as how the four video game characteristics interact. For example, a competitive game that is more difficult, in that people lose more often and must exert considerable effort in order to succeed may be more likely to influence aggressive behavior. Thus, an interaction between competitiveness and difficulty may be related to elevated aggression.

In addition, research examining the effects of video game competitiveness on aggression may also apply to other competitive situations, such as sports. Unlike video games, many sports contain physical contact (e.g., football, hockey) and offer opportunities to behave aggressively, and even to become violent (e.g., fighting or unnecessary roughness). Thus, there is clearly a need for a better understanding of the relation between competition and aggression, and video games may be an excellent vehicle to investigate this relation.

Conclusion

Some researchers believe that they have already shown that violent video games are a risk factor for aggressive behavior (Anderson et al., 2010) and that this effect stems from the violent content in the games (Anderson et al., 2004). On the contrary, results from the present study indicate that video game competitiveness, not violent content, is responsible for elevating aggressive behavior in the short-term. The present findings lead to a new direction in video game and aggression research and should encourage researchers to continue to critically examine this issue.

References

Adachi, P. J. C., & Willoughby, T. (2011). The effect of violent video games on aggression: Is it more than just the violence? *Aggression and Violent Behavior, 16,* 55-62. doi:10.1016/j.avb.2010.12.002

Anderson, C. A. (2004). An update on the effects of playing violent video games. *Journal of Adolescence, 27,* 113-122. doi:10.1016/j.adolescence.2003.10.009

Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A metal-analytic review of the scientific literature. *Psychological Science, 12,* 353-359. doi:10.1111/1467-9280.00366

Anderson, C. A., & Bushman, B. J. (2002). Human aggression. *Annual Review of Psychology, 53,* 27-51. doi:10.1146/annurev.psych.53.100901.135231

Anderson, C. A., & Carnagey, N. L. (2009). Causal effects of violent sports video games on aggression: Is it competitiveness or violent content? *Journal of Experimental Social Psychology, 45,* 731-739. doi:10.1016/j.jesp.2009.04.019

Anderson, C. A., & Carnagey, N. L. (2004). Violent evil and the general aggression model. In A. Miller (Ed.), *The social psychology of good and evil* (pp. 168-192). New York: Guilford Publications.

Anderson, C. A., Carnagey, N. L., Flanagan, M., Benjamin, A. J., Eubanks, J., & Valentine, J. C. (2004). Violent video games: Specific effects of violent content on aggressive thoughts and behavior. *Advances in Experimental Social Psychology, 36,* 199–249.

Anderson, C. A., Gentile, D. A., & Buckley, K. E. (2007). *Violent video game effects.* New York: Oxford University Press.

Anderson, C. A., Ihori, N., Bushman, B. J., Rothsetin, H, R., Shibuya, A., Swing, E. L., Sakamoto, A., Saleem, M. (2010). Video Game effects on aggression, empathy, and prosocial behavior and eastern and western countries: A meta-analytic review. *Psychological Bulletin, 136,* 151-173. doi:10.1037/a0018251

Anderson, C. A., & Morrow, M. (1995). Competitive aggression without interaction: Effects of competitive versus cooperative instructions on aggressive behavior in video games. *Personality and Social Psychology Bulletin, 21,* 1020-1030.

Barlett, C. P., Branch, O., Rodeheffer, C., & Harris, R. (2009). How long do the short-term violent video game effects last? *Aggressive Behavior, 35,* 1-12. doi:10.1002/ab.20301

Berkowitz, L. (1989). Frustration-aggression hypothesis: Examination and reformulation. *Psychological Bulletin, 106,* 59-73. doi:10.1037/0033-2909.106.1.59

Berntson, G. G., & Stowell, J. (1998). ECG artifacts and heart period variability: Don't miss a beat! *Psychophysiology, 35,* 127-132.

Bushman, B. J., & Anderson, C. A. (2002). Violent video games and hostile expectations: a test of the general aggression model. *Personality and Social Psychology Bulletin, 28,* 1679-1686. doi:10.1177/014616702237649

Buss, A. H., & Perry, M. (1992). The aggression questionnaire. *Journal of Personality and Social Psychology, 63,* 452-459. doi:10.1037/0022-3514.63.3.452

Carnagey, L. N., & Anderson, C. A. (2005). The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychological Science, 16,* 882-889. doi:10.1111/j.1467-9280.2005.01632.x

Coie, J. D., & Dodge, K. A. (1998). Aggression and antisocial behavior. In W. Damon and N. Eisenberg (Eds.), *Handbook of child psychology* (5th ed.), vol. 3: *Social, emotional, and personality development* (pp. 779-862). New York: John Wiley & Sons.

Ferguson, C. J., & Kilburn, J. (2010). Much ado about nothing: The misestimation and overinterpretation of violent video game effects in eastern and western nations: Comment on Anderson et al. (2010). *Psychological Bulletin, 136,* 174-178. doi:10.1037/a0018566

Ferguson, C. J., Rueda, S. M., Cruz, A. M., Ferguson, D. E., Fritz, S., & Smith, S. M. (2008). Violent video games and aggression: Byproduct of family violence and intrinsic violence motivation? *Criminal Justice and Behavior, 35,* 311-332. doi:10.1177/0093854807311719

Ferguson, C. J., & Rueda, S. M. (2009). Examining the validity of the modified Taylor competitive reaction time test of aggression. *Journal of Experimental Criminology, 5,* 121-137. doi:10.1007/s11292-009-9069-5

Ferguson, C. J., & Rueda, S. M. (2010). The hitman study: Violent video game exposure effects on aggressive behavior, hostile feelings, and depression. *European Psychologist, 15,* 99-108. doi:10.1027/1016-9040/a000010

Gentile, D. A. (2009). Pathological video-game use among youth ages 8 to 18: A national

study. *Psychological Science*, 20, 594-602. doi:10.1111/j.1467-9280.2009.02340.x

Lieberman, J. D., Soloman, S., Greenberg, J., & McGregor, H. A. (1999) A hot new way to measure aggression: Hot sauce allocation. *Aggressive Behavior, 25,* 331-348.

Miller, G., A., & Chapman, J., P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology, 110,* 40-48. doi:10.1037//0021-843X.110.1.40

Schmierbach, M. (2010). "Killing spree": Exploring the connection between competitive game play and aggressive cognition. *Communication Research*, *37*, 256-274. doi:10.1177/00 93650209356394

Steinberg, L. (2010). A dual systems model of adolescent risk taking. *Developmental Psychobiology, 52,* 216-224. doi:0.1002/dev.20445

Williams, D., & Skoric, M. (2005). Internet fantasy violence: A test of aggression in an online game. *Communication Monographs*, *72*, 217-233. doi:10.1080/03637750500111781

Williams, R. B., & Clippinger, C, A. (2002). Aggression, competition and computer games: Computer and human opponents. *Computer in Human Behavior*, *18*, 495-506. doi:10.1016/S0747-5632(02)00009-2

Chapter 3 (Study 2): Demolishing the Competition: The Longitudinal Link between Competitive Video Games, Competitive Gambling, and Aggression[3]

The link between video game play and aggression, which is defined as behavior that is intended to harm another individual (Dodge, Coie, & Lynam, 2006), continues to be an important issue as games have become the fastest growing form of entertainment in the world, with a global market value of $67 billion in 2010 and a predicted value of $112 billion by 2015 (Biscotti et al., 2011). Furthermore, video game play has become ubiquitous among adolescents, as 97% of adolescents aged 12 to 17 years in the United States play video games (Lenhart et al., 2008). The vast majority of research on the relationship between video game play and aggression has been focused on the effect of violent game content on elevating aggression in the short- and long-term (see Anderson et al., 2010 for a review; also see Ferguson & Kilburn, 2010 for criticisms of this work). In contrast, it has been shown recently that competition, not violence, is the main video game characteristic that influences aggressive behavior in the short-term (Adachi & Willoughby, 2011a; also see Schmierbach, 2010 for effects of video game competition on aggressive thoughts). It is unclear, however, whether competition also is the driving force behind the longitudinal link between video game play and aggression, as no researchers have examined this relationship in the long-term. To date, researchers who have examined the longitudinal association between video game play and aggression have

[3] A version of this chapter has been published. Adachi, P. J. C., & Willoughby, T. (2013). Demolishing the competition: The longitudinal link between competitive video games, competitive gambling, and aggression. *Journal of Youth and Adolescence*, *42*, 1090-1104. doi:10.1007/s10964-013-9952-2

typically included video games that are both competitive and violent, so researchers have been unable to ascertain whether it is the violence or competition that is responsible for the predictive effect on aggression (Willoughby, Adachi, & Good, 2011). Furthermore, the direction of long-term effects between competitive video game play and aggression has not been investigated. Specifically, it is not clear whether competitive video games predict higher aggression (i.e., the socialization hypothesis) or whether individuals who are more aggressive are more likely to play competitive video games (i.e., the selection hypothesis; see Möller & Krahé, 2009, for a more detailed discussion of socialization versus selection effects regarding the link between video games and aggression).

In addition, if video game competition is a significant predictor of aggression, then other activities that involve competition also may predict aggression over time. For example, gambling activities that involve competition, such as playing cards for money or betting on sports games, also may predict aggression; however, no researchers have investigated the association between competitive gambling and aggression. This is an important question because if both competitive video game play and competitive gambling (but not non-competitive video game play or non-competitive gambling) predict higher levels of aggression in the long-term, then it may be that competitive activities *in general* predict aggression over time. Thus, there may not be anything unique about the link between violent video games and aggression (i.e., because violent video games tend to be more competitive than non-violent video games). To address these questions, the goals of the current study were to examine the longitudinal, bidirectional relationship between competitive (and non-competitive) video game play and aggression,

as well as between competitive (and non-competitive) gambling and aggression, using a 4-wave dataset of adolescents.

Theories of Competition and Aggression

There are several theories that explain why competition may be associated with increased aggressive behavior. According to excitation transfer theory (Zillmann, 1983), the transfer of physiological arousal may be a mechanism through which competition may lead to aggression. Specifically, physiological arousal from a stimulus (e.g., competitive video games) can linger after that stimulus is gone and can transfer to a future encounter (even without awareness), increasing the chance of aggressive behavior. Consistent with excitation transfer theory, in addition to elevating aggressive behavior in the short-term, competitive but not non-competitive video games have led to elevations in physiological arousal (i.e., heart rate) from baseline (Adachi & Willoughby, 2011a). Competition also may influence aggression through the mechanisms of frustration and hostility, consistent with the frustration-aggression hypothesis (Berkowitz, 1989; Dollard, Miller, Doob, Mowrer & Sears, 1939). For instance, when competing against another player (either a real person or a computer generated character in a video game), each player's goal of winning directly impedes the other player's chance of winning, as only one player can be victorious. Having someone constantly obstructing one's goal of winning may lead to frustration and hostility, which in turn may lead to elevations in aggression. In addition, competition can create or activate networks of aggressive thoughts, emotions, and memories through aggressive cues, such as feelings of frustration. Thus, consistent with Berkowitz's (1990) cognitive neoassociation model, competition may influence aggression through spreading activation of aggressive

networks. In terms of longitudinal effects, repeated exposure to competition, even in non-violent activities such as video games or gambling (e.g., playing cards for money) may teach people that aggression is an appropriate way of dealing with competition-related increases in frustration and arousal. Furthermore, a variety of past experiences with competitive situations that result in aggressive outcomes may strengthen associative links between competition and aggression (Anderson & Carnagey, 2009; Anderson & Morrow, 1995), which in turn may make long-term competitive video game players and competitive gamblers more likely to react aggressively to future competitive situations.

Developing associative links between competition and aggression also may explain why more aggressive people may be drawn to competitive situations to a greater extent than less aggressive people (selection hypothesis). According to Anderson and Morrow (1995), competitive situations often are thought of as aggressive. For example, the goal of inflicting physical or psychological harm to one's opponent in sports games and debates might be normative among competitors, as they often are encouraged to "demolish, destroy, or blow away their opponents" (Anderson & Morrow, 1995, p. 1021). Furthermore, Anderson and Morrow argue that as competitive situations occur early in life, the conceptualization of competitive situations as aggressive may occur at an early age. Thus, because competitive situations often are thought of as aggressive, more aggressive people may self select into competitive situations to a greater extent than less aggressive people.

The Link between Video Game Play and Aggression, and between Gambling and Aggression

Video game competition and aggression. To date, the majority of research on the link between video games and aggression has been focused on the violent content in games (e.g., see Anderson et al., 2010); however, this work has faced criticism (e.g., Adachi & Willoughby, 2011b; Ferguson et al., 2008; Ferguson & Ivory, 2012; Ferguson & Kilburn, 2010) for issues such as not controlling for other video game characteristics that could be related to aggression, such as competition. For example, in several experiments in which a violent video game was shown to produce more aggression than a non-violent video game, the violent game also was more competitive than the non-violent game, and thus it was not clear whether the violence or competition was responsible for the elevations in aggression (e.g., Anderson & Dill 2001; Anderson et al., 2004). In addition, researchers have attempted to statistically control for differences in video game characteristics between violent and non-violent games using analysis of covariance (e.g., Anderson & Carnagey 2009). However, according to Miller and Chapman (2001), it is invalid to use analysis of covariance for preexisting groups (e.g. violent versus non-violent video game conditions) that do not vary randomly and that differ on the variables which are to be included as the covariates. For example, when the covariate is affected by the treatment (or in this case, the condition), removing the covariate also may remove part of the treatment effect or produce a spurious treatment effect, and thus the grouping variable will be altered in a way that often cannot be specified in a conceptually meaningful way (Miller & Chapman, 2001).

In order to examine whether violent or competitive content in games has a greater influence on aggressive behavior in the short-term, Adachi and Willoughby (2011a) matched video games on other characteristics that may be related to aggression. First, the

violent content was isolated by matching a violent and non-violent game on competitiveness, difficulty, and pace of action - no differences were then found between the two games in terms of their effect on aggressive behavior. Thus, Adachi and Willoughby concluded that video game violence alone was not sufficient to elevate aggression. Next, competitive content was isolated by matching competitive and non-competitive games in terms of difficulty and pace of action, and systemically controlling for violence. Adachi and Willoughby found that the competitive games produced more aggressive behavior than the non-competitive games irrespective of the amount of violent content. Therefore, they concluded that competition, not violence, is the video game characteristic that has the greatest influence on aggressive behavior in the short-term.

Researchers also have demonstrated that playing a video game in a competitive context (i.e., playing against another person) influences aggressive cognition. For instance, Schmierbach (2010) used a competitive (and violent) first-person shooter game, and randomly assigned pairs of participants to one of three conditions: (a) participants played the game on their own against computer opponents (solo mode), (b) participants played against each other in a one-on-one battle (competitive mode), and (c) participants played on the same team against computer opponents (cooperative mode). Immediately after video game play, participants completed a word completion task to assess aggressive cognition. The results showed that participants in the competitive condition had the highest aggressive cognition scores, followed by participants in the solo condition, while participants in the cooperative condition had the lowest aggressive cognition scores. Thus, consistent with research showing that competitive video game content elevates aggressive behavior, playing a video game with competitive content in a

competitive context (i.e., competing against another player) may further elevate aggressive cognition.

In contrast, no known researchers have examined the longitudinal relationship between competitive video game play and aggression. Instead, they have focused on the link between violent video games and aggression (e.g., Anderson, Gentile, & Buckley, 2007; Möller & Krahé, 2009; Wallenius & Punamäki, 2008; Willoughby et al., 2011). For example, Willoughby et al. conducted a 4-year longitudinal study of adolescents in which they examined the bidirectional relationship between games that were both violent and competitive (i.e., fighting and action games) and aggression. They found evidence for the socialization hypothesis as violent and competitive video games predicted aggression over time. They also found some support for the selection hypothesis, as there was evidence that adolescents who were more aggressive tended to play violent and competitive video games more frequently. Conversely, they found that non-violent and non-competitive games (e.g., puzzle games) did not predict increased aggression over time. However, because fighting and action video games are both violent and competitive, it was unclear whether the competitive or violent content was responsible for this long-term association. Thus, in order to isolate the longitudinal relationship between video game *competition* and aggression in the current study, it is necessary to examine individuals' video game play with competitive video games that are predominately non-violent, such as sports and racing games (again, in contrast to fighting and action games which are both competitive and violent). For instance, although a few sports games contain some aggressive (but not violent) content (e.g., sports games such as football), most do not (e.g., soccer, basketball, tennis, golf, baseball, skateboarding).

Similarly, while some racing games allow vehicles to come into contact with each other during a race, this behavior usually is not encouraged as it causes both vehicles to slow down or lose control, thereby hampering their goal of winning the race. Furthermore, sports and racing games do not contain the type of violent content that can be found in many fighting, action, and first-person shooter games, such as blood-soaked battles to the death with a variety of lethal weapons.

Gambling and aggression. Although many forms of gambling are illegal for adolescents in North America, gambling is prevalent among adolescents, as a nationally representative survey in the United States found that 68% of youth aged 14-21 reported gambling at least once in the past year (Barnes, Welte, Hoffman, & Tidwell, 2009). To date, there are only a few studies in which researchers have investigated a link between gambling and aggression (e.g., Parke & Griffiths, 2004, 2005), or between gambling and domestic violence (e.g., Griffiths, Parke, & Parke, 2003; Mulenman, Otter, Wadman, Tran, & Anderson, 2002). For example, Parke and Griffiths (2004) conducted an observational study of aggressive behavior in slot machine players. Specifically, they observed incidents of verbal aggression by the slot machine players towards staff members, other gamblers, and even towards the slot machines, and they concluded that this observed aggression appeared to be related to feelings of gambling-induced frustration. However, no researchers have examined the longitudinal association between gambling and aggression. Furthermore, no researchers have separated gambling activities in terms of competitive content and then compared the effect of competitive versus non-competitive gambling activities on aggression. Similar to competitive video games, gambling activities such as playing cards for money and betting on sports games involve

competition. For example, when playing poker, players must directly compete against each other during every hand, and in order to win, the other players must lose. In addition, people enter into a competition when betting on a sports game, in that in order to win their bet, the team that they bet on must defeat the opponent team (or beat the point spread, etc.). Because people who bet on sports games have a stake in the competition, they may experience similar elevations in arousal, frustration, hostility, and aggressive cognition as the athletes who are playing in the game. For instance, because a gambler's goal of winning his bet is constantly obstructed by the opponent team whose goal is to win the game, the gambler may experience elevations in frustration and hostility, and in turn may be more likely to behave aggressively. Hence, similar to competitive video games, competitive gambling activities may predict higher levels of aggression over time. In contrast, non-competitive gambling activities such as entering draws are based solely on luck and do not involve competition. Thus, unlike competitive gambling activities, non-competitive gambling activities may not be related to aggression over time.

The Present Study

Although experimental research has shown that competition in video games, not violence, has the greatest influence on aggression in the short-term (Adachi & Willoughby, 2011a), no researchers have examined the longitudinal relationship between competitive video game play and aggression. In addition, other competitive activities, such as competitive gambling, also may predict aggression over time. No studies, however, have been conducted in which competitive and non-competitive gambling activities are separated and their respective effects on aggression compared. Furthermore,

previous experimental work on the effect of competitive video games on aggression has focused solely on the unidirectional effect of competitive video games on aggression (i.e., the socialization hypothesis which represents the theory that competition causes people to be more aggressive), whereas selection effects have not been explored.

In the present study, we sought to address these questions by surveying adolescents about their video game play, gambling, and aggressive behaviors each year of high school (i.e., Grades 9 through 12). We then focused on three main goals. First, in order to examine whether competitive video game play predicts aggression over time, we used sports and racing games which are highly competitive but predominantly non-violent. Thus, if sports and racing games predict aggression over time, we can conclude that competition (not violence) may have been responsible. Consistent with experimental findings that video game competition was the game characteristic with the greatest influence on aggression in the short-term (Adachi & Willoughby, 2011a), we hypothesized that competitive video game play would predict higher levels of aggression over the four high school years. In addition, in order to conclude that it was competitive video game play and not simply video game play in general that predicted aggression over time, we also examined whether playing video games that were non-competitive and non-violent (e.g., puzzle games) predicted aggression over time. In contrast to competitive video games, we hypothesized that non-competitive and non-violent video games would not predict higher levels of aggression over the four high school years.

Second, if competitive video game play predicts aggression over time, then other competitive activities also may predict aggression. Thus, we examined whether competitive forms of gambling, specifically playing card games for money and betting on

sports games would predict aggression over time. Playing card games for money, such as euchre and poker, and betting on sports games, both involve entering into a competition. Therefore, similar to competitive video game play, we hypothesized that competitive gambling would predict higher levels of aggression over time. To conclude that it was competitive gambling in particular, and not gambling in general that was related to aggression, we also examined the longitudinal link between non-competitive gambling, such as entering draws, and aggression. We hypothesized that non-competitive gambling would not predict higher levels of aggression over time.

Third, in addition to assessing the socialization hypothesis, we simultaneously assessed the selection hypothesis between competitive and non-competitive video game play and aggression, as well as between competitive and non-competitive gambling and aggression. Considering that Willoughby et al. (2011) previously found some evidence in support of both hypotheses with competitive and violent games, we predicted that more aggressive people may be more likely to play competitive video games as well as engage in competitive gambling.

To test our hypotheses, we performed a 4-wave autoregressive cross-lagged path analyses which allowed us to simultaneously assess the socialization and selection hypotheses between each variable (i.e., competitive and non-competitive video game play, and competitive and non-competitive gambling) and aggression, while controlling for stability effects as well as covariances among all the variables within each grade. Three demographic variables (gender, parental education, and number of computers in the home) were included as covariates. In addition, because the measure of competitive video game play included sports video games, and the measure of competitive gambling

included betting on sports games, we wanted to rule out the possibility that adolescents who played sports video games and bet on sports games also played real sports, and that it was playing real sports that predicted higher levels of aggression over time. Thus, we included a measure of real sports involvement as a covariate at each time point to control for this potential third variable. It is important to note that real sports involvement was not a main variable of interest in our analyses because other factors besides the competition in sports may be positively related to aggression, such as physical contact (e.g., football or hockey), or negatively related to aggression, such as the fact that sports often are an organized activity that is supervised by adults.

Another possible concern may be that adolescents who play sports/racing video games also might play action/fighting (violent) video games, and thus it could be the participants' action/fighting video game play, and not their sports/racing video game play, that is driving the association with aggression. To address this issue, we examined whether the predictive effect of sports/racing games on aggression was moderated by whether participants played action/fighting games or not. If our hypothesis is correct, we would expect that the pattern of results would not differ between participants who played sports/racing games but not action/fighting games, and participants who played sports/racing games and action/fighting games. Finally, given that boys are more likely to play competitive video games than girls, we conducted an exploratory analysis to assess whether gender was a significant moderator of the results.

Method

Participants

Students from eight high schools encompassing a school district in Ontario, Canada took part in the study in grades 9, 10, 11, and 12 (*M* age in grade 9 = 13 years,10 months). This study was part of a larger cohort-sequential project. In the larger study, surveys were completed five times between 2003 and, 2008 (the time interval between each wave was one year) with some students starting the study in 2003 and others starting the study in 2004. The analyses for the present study are based on the cohort of students who entered the study in Grade 9 in 2004 and completed the survey in Grades 9, 10, 11, and 12. The overall participation rate ranged from 83% to 86% across the four waves; nonparticipation was due to student absenteeism (average of 13.5%), parental refusal (average of .06%), or student refusal (average of 1.4%). Student absenteeism from class was due to illness, a co-op placement, a free period, or involvement in another school activity. 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 2 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, *p*s > .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; e.g., 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 this data is missing at random (Little & Rubin, 2002; Schafer & Graham, 2002). Missing data were estimated using the expectation maximization (EM) estimation method in AMOS 19 (Arbuckle, 1995-2012).

Procedure

Active informed assent was obtained from the adolescent participants. Parents were provided with written correspondence mailed to each student's home prior to the survey administration outlining the study; this letter indicated that parents could request that their adolescent not participate in the study. An automated phone message about the study also was left at each student's home phone number. This procedure was approved by the participating school board and the University Research Ethics Board. At all time periods, the questionnaire was administered to students in classrooms by trained research staff. Students were informed that their responses were completely confidential.

Measures

Means and standard deviations for the measures are provided in Table 4. All measures were assessed across all four grades of high school (i.e., Grades 9 through 12)

except for gender, parental education, and number of computers in the home which were assessed in grade 9 only.

Demographic factors. Single-item questions were used to assess participant sex and the number of computers in the home. Parental education was an average of two items (one per parent, r = .58). Higher scores indicated female gender, more computers, and greater parental education (1= did not finish high school to 6= professional degree).

Sports involvement. Sports involvement was measured at each of the four time points 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 = *every day*). Higher composite scores indicated higher frequency of sports involvement.

Direct aggression. Direct aggression was assessed at each of the four time periods with a composite of two scales. One scale (Little, Jones, Henrich, & Hawley, 2003) assessed overt aggression with nine items (e.g., "If others have angered me, I often hit, kick, or punch them") based on a 4-point scale (1 = *not at all true of me* to 4 = *completely true of me*), with Cronbach's alphas ranging from .88 to .94 from Grades 9 to 12. The other scale (Marini, Spear, & Bombay, 1999) assessed overt aggression in the past year with four items (e.g., "How often have you pushed and shoved someone during the last school year?") based on a 5-point scale, recoded to fit a 4-point scale (1 = *never* to 4 = *every day*), with Cronbach's alphas ranging from .85 to .86 from Grades 9 to 12. An overall composite aggression score was formed by averaging the composite scores

Table 4

Means and Standard Deviations of Study 2 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)		
# of computers in home			3.09 (0.91)		
Sports involvement	1-5	2.47 (1.17)	2.38 (1.22)	2.21 (1.19)	2.18 (0.92)
Aggression	1-4	1.63 (0.51)	1.59 (0.51)	1.63 (0.50)	1.67 (0.48)
Competitive vg	1-2	1.31 (0.38)	1.30 (0.37)	1.29 (0.39)	1.34 (0.37)
Non-competitive vg	1-2	1.34 (0.47)	1.36 (0.48)	1.39 (0.49)	1.31 (0.46)
Freq competitive gambling	1-5	1.37 (0.60)	1.55 (.79)	1.48 (0.72)	1.41 (0.76)
Freq non-competitive gambling	1-5	1.36 (0.55)	1.31 (0.65)	1.34 (0.67)	1.30 (0.70)
Freq competitive vg	1-5			1.64 (0.67)	1.46 (0.50)
Freq non-competitive vg	1-5			1.32 (0.59)	1.27 (0.55)
Violent vg moderator	0-1		.65 (.48)		

Notes: vg = video game play; Freq = frequency; Competitive and non-competitive video game play was measured as 1=do no play, 2=play

on the two scales (correlations between the two measures were .53, .49, .49, and .44 in Grades 9 through 12, respectively). Higher composite scores indicated a higher frequency of aggression.

Competitive video game play. Prevalence of competitive video game play was assessed at each of the four time points with two items. Participants were asked to indicate *yes* or *no* to whether they played sports (e.g., *FIFA Soccer*) or racing (e.g., *NASCAR*) video games. When participants were in Grades 11 and 12 only, frequency of competitive video game play also was assessed, and computed as an average of two items: "On an average day, how often do you play sports games?" and "On an average day, how often do you play racing games?" (based on a 5-point scale: 1 = *not at all* to 5 = *5 or more hours*). Higher composite scores indicated a higher frequency of competitive video game play.

Non-competitive video game play. Prevalence of non-competitive video game play was assessed at each of the four time periods with four items. Participants were asked to indicate *yes* or *no* to whether they played puzzle (e.g., *Tetris*), art (e.g., *Printshop*), building model worlds (e.g., *Sims*), or quiz (e.g., Outburst) video games. In Grades 11and 12 only, frequency of nonviolent video game play also was assessed and computed as an average of four items: "On an average day, how often do you play puzzle, art, building model worlds, or quiz video games?" (based on a 5-point scale: 1 = *not at all* to 5 = *5 or more hours*). Higher composite scores indicated a higher frequency of nonviolent video game play.

Playing of violent video games over the four years (moderator variable). Participants were asked to indicate *yes* or *no* to whether they played action (e.g., *Call of*

Duty) or fighting (e.g., *Mortal Kombat*) video games at each time point. A dichotomous moderator variable was then created as 0 (did not play action or fighting games at any time point) and 1 (played action and fighting games during at least one time point).

Frequency of competitive gambling. Frequency of competitive gambling was assessed at each of the four time periods with two items. Participants were asked to indicate how often they played cards (poker, euchre) for money and bet on a sporting event (e.g., proline) based on a 5-point scale (1 = *never* to 5 = *every day*). Higher composite scores indicated higher frequency of competitive gambling.

Frequency of non-competitive gambling. Frequency of non-competitive gambling was assessed at each of the four time periods. Participants were asked to indicate how often they entered draws for charity based on a 5-point scale (1 = *never* to 5 = *every day*). Higher scores indicated higher frequency of non-competitive gambling.

Results

Preliminary Analyses

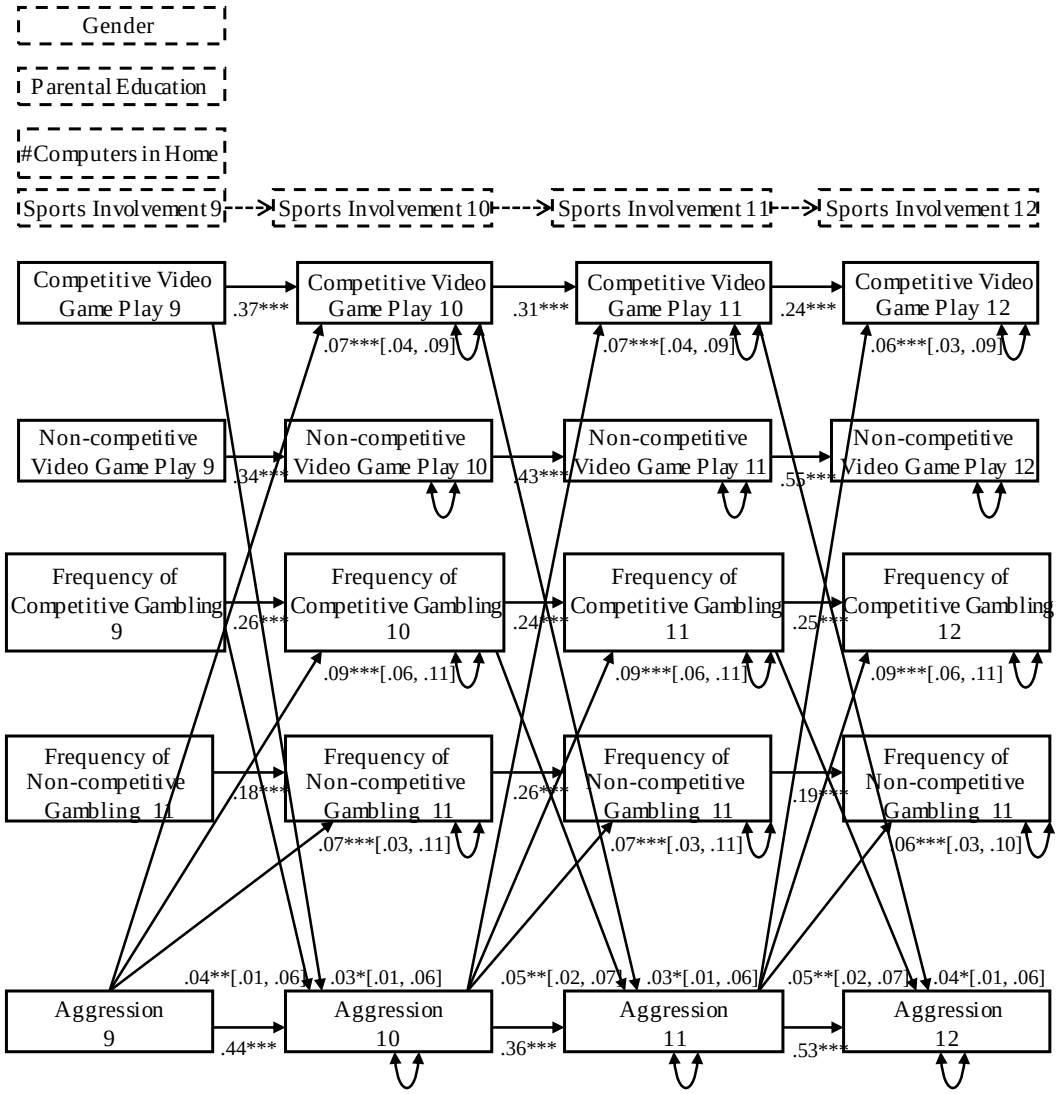
Table 4 outlines the means and standard deviations for the study variables (see Appendices R and S for bivariate correlations between the main study variables).
We also examined mean differences in the video game, gambling, and aggression measures as a function of gender. A significant multivariate main effect was found at each grade (all Wilks λs < .001, R^2 ranging from .27, 95% CI [.23, .31] in grade 9 to .35, 95% CI [.31, .39] in grade 11). Overall, boys reported more aggression, competitive video game play, competitive gambling, and non-competitive gambling than girls, while girls reported more non-competitive video game play than boys. All measures showed acceptable skewness and kurtosis, with the exception of the competitive and non-

competitive gambling measures, and the frequency of video game play measures in grades 11 and 12. To address this issue, we conducted a $\log^{10}$ transformation[4] for these video game play and gambling variable, which reduced skewness and kurtosis to acceptable levels (skewness < 2 and kurtosis < 3 for all variables). These transformed variables were used in the subsequent analyses. Please note that Table 4 reflects the means and standard deviations of the untransformed variables.

Assessment of the Socialization and Selection Hypotheses

Association between aggression, competitive video game play and frequency of competitive gambling from Grades 9 through 12. In order to simultaneously assess the socialization (playing competitive but not non-competitive video games/gambling predicts higher levels of aggression over time) and selection (aggression predicts higher levels of competitive but not non-competitive video game play/gambling over time) hypotheses, while controlling for gender, parental education, number of computers in the home, and sports involvement, we created a 4-wave (grade 9 to 12) autoregressive cross-lagged model in which bidirectional (cross-lagged) paths (i.e., paths from earlier video game play/gambling to later aggression as well as paths from earlier aggression to later video game play/gambling) were estimated across each adjacent grade (i.e., over 1-year time periods) between both competitive and non-competitive video game play and aggression, and between both competitive and non-competitive gambling and aggression (see Figure 2). Stability paths across grade within each variable also were specified, as

[4]Consistent with recommendations by Graham (2009) and Shafer and Graham (2002), we transformed these variables prior to imputation.



Notes. 9=grade 9; 10=grade 10; 11=grade 11; 12=grade 12. Covariates are indicated with dashed lines. Only significant paths are shown. Not shown are covariances among variables within each grade, or paths related to covariates. Standardized coefficients (95% confidence intervals are in brackets) are reported for significant paths. *<.05, **<.01, ***<.001. Results for covariates, covariances, and the 95% confidence intervals for the stability paths can be obtained from the first author.

Figure 2. Final model results for Study 2 analysis assessing the socialization versus selection hypotheses with dichotomous measures of competitive and non-competitive video game play

well as covariances among the variables within each grade to control for common method variance. Because we were not interested in the longitudinal associations between video game play and gambling, we did not include cross-lagged paths between the video game play and gambling variables.

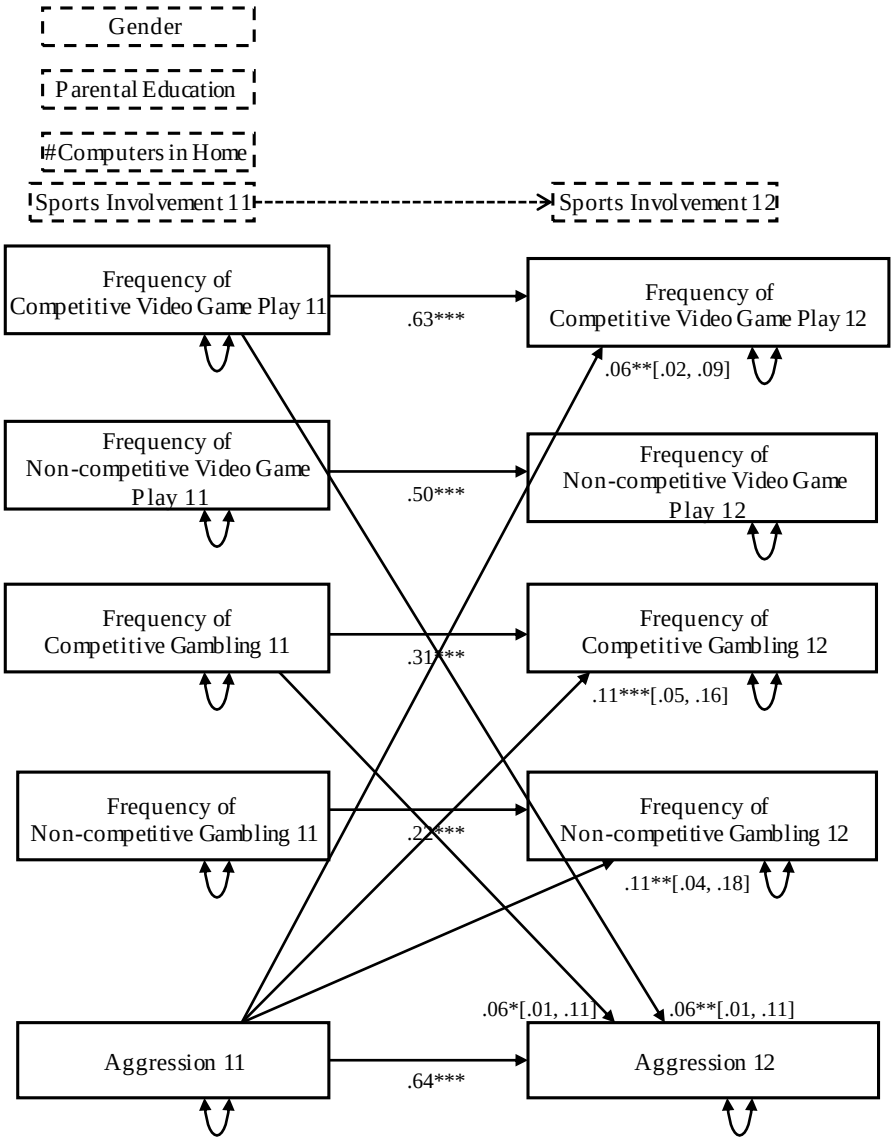
We first assessed whether the pattern of results was invariant across grade. Invariance was tested by comparing a model in which all cross-lagged paths were constrained to be equal across grade to the unconstrained model in which all structural paths were free to vary. The chi-square difference test of relative fit indicated that the unconstrained model was not a significantly better fit than the constrained model, 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, $\chi^2(110) = 191.63$ $p < .001$, CFI = .99, RMSEA = .022 (.017 - .028). Figure 2 summarizes the significant path estimates. In terms of the socialization hypothesis, competitive video game play significantly predicted higher aggression over time, after controlling for previous aggression. In contrast, non-competitive video game play did not significantly predict aggression over time, after controlling for previous aggression. Consistent with the relationship between competitive video games and aggression, frequency of competitive gambling also significantly predicted higher aggression over time, after controlling for previous aggression. Conversely, frequency of non-competitive gambling did not predict aggression over time, after controlling for previous aggression.

In terms of the selection hypothesis, higher levels of aggression significantly predicted competitive video game play over time, after controlling for previous

competitive video game play. In contrast, aggression did not significantly predict non-competitive video game play over time, after controlling for previous non-competitive video game play. In addition, higher levels of aggression significantly predicted higher frequency of competitive gambling, after controlling for previous frequency of competitive gambling. Interestingly, higher levels of aggression also significantly predicted higher frequency of non-competitive gambling, after controlling for previous frequency of non-competitive gambling. Furthermore, we tested whether the selection effects between competitive video game play and aggression as well as between competitive gambling and aggression were stronger than the socialization effects, by comparing a model in which the paths testing the socialization and selection effects were constrained to be equal between competitive video game play and aggression as well as between competitive gambling and aggression, to a model in which the socialization and selection effects were not constrained to be equal. For both video game play and gambling, the chi-square difference test of relative fit indicated that the constrained and unconstrained models did not differ, suggesting that the selection versus socialization effects between competitive video game play and aggression as well as between competitive gambling and aggression were not significantly different in magnitude, $p > .05$.

Association between aggression and frequency of competitive video game play and frequency of competitive gambling in Grades 11 and 12. Although the previous model assessed the bidirectional (cross-lagged) associations between dichotomous measures of video game play (yes/no) and aggression, it was important also to assess the bidirectional associations between *frequency* of competitive and non-

competitive video game play and aggression. We only had access to measures of the frequency of video game play when our participants were in grades 11 and 12. Thus, we created a 2-wave autoregressive cross-lagged model in which in which bidirectional (cross-lagged) paths were estimated across grades 11 and 12 (i.e., over 1-year time periods) between the frequency of both competitive and non-competitive video game play and aggression, and between both competitive and non-competitive gambling and aggression (see Figure 3). Stability paths across grade within each variable also were specified, as well as covariance among the variables within each grade. Gender, parental education, number of computers in the home, and sports involvement were included as covariates. Again, we did not include bidirectional paths between the video game play and gambling variables because we were not interested in the longitudinal predictive effects between video game play and gambling, Model fit was good, $\chi^2(16) = 61.19$ $p < .001$, CFI = .99, RMSEA = .044 (.032 - .055). Figure 3 summarizes the significant path estimates. In terms of the socialization hypothesis and consistent with the first model, frequency of competitive video game play significantly predicted higher aggression over time, after controlling for previous aggression. In contrast, frequency of non-competitive video game play did not significantly predict aggression over time, after controlling for previous aggression. Frequency of competitive gambling also significantly predicted higher aggression over time, after controlling for previous aggression. Conversely, frequency of non-competitive gambling did not predict aggression over time, after controlling for previous aggression.



Notes. 11=grade 11; 12=grade 12. Covariates are indicated with dashed lines. Only significant paths are shown. Not shown are covariances among variables within each grade, or paths related to covariates. Standardized coefficients (95% confidence intervals are in brackets) are reported for significant paths. *<.05, **<.01, ***<.001. Results for covariates, covariances, and 95% confidence intervals for the stability paths can be obtained from the first author.

Figure 3. Final model results for Study 2 analysis assessing the socialization versus selection hypotheses with frequency measures of competitive and non-competitive video game play

In terms of the selection hypothesis, higher levels of aggression significantly predicted higher frequency of competitive video game play over time, after controlling for previous competitive video game play. In contrast, aggression did not significantly predict frequency of non-competitive video game play over time, after controlling for previous non-competitive video game play. In addition, higher levels of aggression significantly predicted higher frequency of competitive gambling, after controlling for previous frequency of competitive gambling. Higher levels of aggression also significantly predicted higher frequency of non-competitive gambling, after controlling for previous frequency of non-competitive gambling. Furthermore, we tested whether the selection effects between frequency of competitive video game play and aggression as well as between frequency of competitive gambling and aggression were stronger than the socialization effects, by comparing a model in which the socialization and selection effects were constrained to be equal between competitive video game play and aggression as well as competitive gambling and aggression, to a model in which the socialization and selection effects were not constrained to be equal. The chi-square difference test of relative fit indicated that the model in which the selection and socialization effects were not constrained to be equal was not a significantly better fit than the constrained model, suggesting that the selection and socialization effects between frequency of competitive video game play and aggression as well as between frequency of competitive gambling and aggression were not significantly different in magnitude, $p > .05$.

Violent Video Game Play as a Moderator

Playing of action/fighting video games was included as a moderator to test whether playing sports/racing games was associated with aggression only for participants

who also played action/fighting (i.e., violent) games. Consistent with our hypotheses, there were no significant differences in the pattern of results as a function of playing action/fighting games ($p > .05$ in χ^2 *diff* tests between constrained and unconstrained models), suggesting that playing sports/racing games predicted aggression regardless of whether participants also played action/fighting games or not.

Gender as a Moderator

Gender also was included as a moderator and there were no significant differences in the pattern of findings as a function of gender ($p > .05$ in χ^2 *diff* tests between constrained and unconstrained models).

Discussion

The majority of research on the relationship between video games and aggression has confounded the effect of video game violence versus competition on aggression (see Anderson et al., 2010 for a review; see also Ferguson & Kilburn, 2010 for criticisms of this work). In contrast, recent experimental research suggests that it is video game competition, not violence, that has the greatest effect on aggression in the short-term (Adachi & Willoughby, 2011a). However, no researchers have examined the longitudinal relationship between competitive video game play and aggression. In addition, if competition in video games is a significant reason for the association between video game play and aggression, then other competitive activities, such as competitive gambling, also may predict aggression over time. The current study is the first to demonstrate a longitudinal, bidirectional association between competitive video game play and aggression, as well as between competitive gambling and aggression. Consistent with our hypotheses, the results revealed support for the socialization hypothesis in that

playing competitive video games (but not non-competitive video games) as well as higher frequency of competitive gambling (but not non-competitive gambling) predicted higher levels of aggression across the four high school years. In addition, higher frequency of competitive video game play (but not non-competitive video game play) in Grade 11 predicted higher levels of aggression in Grade 12. These findings suggest that adolescents who engage in competitive video game play and competitive gambling may be more likely to behave aggressively over time. We also found support for the selection hypothesis as higher levels of aggression predicted competitive video game play as well as higher frequency of competitive gambling from Grade 9 to Grade 12, and higher levels of aggression in grade 11 predicted higher frequency of competitive video game play in Grade 12, which suggests that adolescents who are more aggressive may be more likely to self-select into these competitive activities. Furthermore, the fact that we controlled for sports involvement at each time point rules out the potential third variable explanation that people who play sports video games and bet on sports games also play real sports, and that it is the playing of real sports that predicts aggression over time.

In addition, to address the possible concern that adolescents who play sports/racing video games also might play action/fighting (violent) video games, and thus, it could be the participants' action/fighting video game play, and not their sports/racing video game play, that is driving the association with aggression, we examined whether the predictive effect of sports/racing games on aggression was moderated by whether participants played action/fighting games or not. Consistent with our hypothesis, the pattern of results did not differ between participants who played sports/racing games but not action/fighting games, and participants who played

sports/racing games and action/fighting games. Thus, an important strength of the current study is that the longitudinal association between playing sports/racing games and aggression remained stable after controlling for action/fighting video game play.

The current findings are important as they elucidate a long-term relationship between competition and aggression among adolescents. First, the finding that competitive, but not non-competitive video game play predicted aggression over time after controlling for violent video game play suggests that in addition to having a short-term effect on aggression (Adachi & Willoughby, 2011a), video game competition also predicts higher levels of aggression in the long-term. Second, the finding that competitive, but not non-competitive gambling also predicted aggression over time suggests that competitive activities in general may predict later aggression. This finding is important because if competitive activities in general predict aggression, then this suggests that there may not be something unique about the association between violent video game play and aggression. Specifically, it suggests that the longitudinal link found between violent video games and aggression (see Willoughby et al., 2012) may be due to the competition in the games, rather than the violence, as violent video games in general tend to be more competitive than non-violent games (Adachi & Willoughby, 2011b; Carnagey & Anderson, 2005). Thus, violent video game play may be a long-term risk factor for aggression among adolescents for the same reason that competitive video game play and competitive gambling are risk factors: because they are all *competitive* activities.

Interestingly, we also found that higher levels of aggression predicted higher frequency of non-competitive gambling (i.e., entering draws). According to Steinberg (2007), the desire to take risks increases in adolescence, and thus many forms of risk

taking increase from childhood to adolescence. Considering that aggression and gambling are both forms of risk taking, it may be that adolescents who are more aggressive also are more likely to seek out other forms of risk taking such as gambling, than adolescents who are less aggressive. Furthermore, entering draws may be one of the most accessible forms of gambling for adolescents, as draws may not be restricted to adults unlike most forms of gambling (e.g., going to the casino, playing online poker). Conversely, adolescents who enter draws may not be more likely to behave aggressively because aggression often is a much riskier activity with more severe consequences than entering draws. Specifically, when someone behaves aggressively their victim may retaliate, and thus they are at risk for being the target of aggression. Furthermore, adolescents who behave aggressively may face negative consequences at school (e.g., suspension), at home (e.g., punishment from parents), or even with the law (e.g., assault charges). In contrast, adolescents who enter draws risk losing money, which may be considered as less of a risk compared to the potential negative consequences of behaving aggressively. Thus, adolescents who are willing to enter draws may not be willing to then take larger risks, such as behaving aggressively.

Given the longitudinal relationship found between competitive activities and aggression in the present study, future research should be aimed at identifying potential mediators of this association. In terms of socialization effects, consistent with excitation transfer theory (Zillmann, 1983) as well as the frustration-aggression hypothesis (Berkowitz, 1989; Dollard et al., 1939), it may be that repeated exposure to competitive activities may teach people that aggression is an appropriate way to deal with related increases in frustration and arousal. Thus, researchers should examine whether frustration

and arousal mediate the link between competitive activities and aggression, in that greater involvement in competitive activities may predict higher levels of frustration and arousal, and in turn, higher levels of frustration and arousal may predict higher levels of aggression over time. In addition, researchers should examine whether sustained participation in competitive activities over time may strengthen associative links between competition and aggression, consistent with Anderson and Carnagey (2009), and Anderson and Morrow (1995), which in turn may lead to higher levels of aggression. Using the implicit association test (IAT), researchers could examine whether people who report greater sustained participation in competitive activities tend to demonstrate stronger implicit associations between competition and aggression than people with less sustained participation in competitive activities, and in turn, whether these implicit associations mediate the predictive influence of competitive activity involvement on aggression. In terms of selection effects, it may be that more aggressive people are more likely to associate competitive activities with aggression, and thus are more likely to seek out competitive activities than less aggressive people. Hence, the IAT also could be used to examine whether more aggressive people tend to demonstrate stronger implicit associations between competition and aggression than less aggressive people, and in turn, whether these implicit associations mediate the predictive influence of aggression on competitive activity involvement.

An important limitation of the present study stems from the reliance on self-report measures. Reports of video game use, aggression, and gambling would benefit from corroboration from other informants (e.g., friends, parents). It is not clear, however, 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. Nonetheless, the inclusion of peer assessment may be a key factor in increasing our knowledge of how often adolescents play video games with friends and peers. Another limitation was that the structural paths that were significant in the present study were all small in magnitude. However, these effect sizes are common in longitudinal cross-lagged models when accounting for stability between adjacent waves of data and for concurrent associations among variables within each grade. Thus, small effects are not unexpected. Another possible concern may be that because a few sports and racing games might contain some aggressive content, it may be this aggressive content, rather than the competitive content that was associated with aggression in the present study. However, we think this is unlikely given that the competitive gambling activities also had a significant association with aggression that was similar in magnitude to competitive video game play, even though gambling does not involve violence or aggression. In addition, our findings are consistent with an experiment which demonstrated that it was the competitive content rather than the violent content that influenced aggression (Adachi & Willoughby, 2011a).

Furthermore, it is not clear whether the results are generalizable to developmental periods beyond the high school population. Indeed, the long-term relationship between competitive video game play and aggression may be different for adolescents (e.g., 12 to 19 years) and adults (e.g., 25 years and older), due to changes in the brain during adolescence and young adulthood. Specifically, according to Steinberg (2007), puberty-related maturation of brain regions linked to emotion and arousal may lead adolescents to

seek out arousing stimulation, such as risk-taking behavior. However, adolescents may have more difficulty than adults in regulating such arousal due to a still maturing prefrontal cortex (Giedd, 2008; Steinberg, 2010). Thus, adolescents may be more attracted to competitive video games than adults because competitive video games tend to be fast-paced, exciting, and arousing. In addition, adolescents may be more likely to behave aggressively after playing a competitive video game than adults, due in part to adolescents' greater difficulty in regulating their arousal in comparison to adults. In contrast, the long-term relationship between competitive gambling and aggression may be stronger for young adults (age 19 to 25 years) than adolescents, due to differences in gambling habits between the two age groups. Specifically, playing cards for money in a casino or regulated forms of sports betting (e.g., Proline) may be more prevalent among young adults than adolescents (Felsher, Derevensky, & Gupta, 2010; Shaffer & Hall, 2001) because these activities are illegal for adolescents in North America. Thus, if young adults engage in more competitive gambling than adolescents, then both socialization and selection effects on aggression may be stronger for young adults compared to adolescents. Future research would benefit from direct tests of these hypotheses by examining whether the link between competitive video games and aggression as well as between competitive gambling and aggression differ between age groups (e.g., adolescents and adults), as well as by conducting longitudinal studies over a longer time span (e.g., from childhood to adulthood). Finally, although the participants in the present study included a large sample of enrolled students from a school distinct, findings may not generalize to other geographic regions, including those with differing ethnic and/or demographic populations.

In summary, we found support for a bidirectional association between competitive video game play and aggression as well as between competitive gambling and aggression. In terms of the socialization hypothesis, we found that both competitive video game play and competitive gambling predicted higher levels of aggression over time. In terms of the selection hypothesis, we found that higher levels of aggression predicted higher levels of competitive video game play and competitive gambling over time. Overall, the results suggest that competitive activities in general may predict aggression over time among adolescents. The fact that millions of adolescents play competitive video games for several hours every day (Lenhart et al., 2008) and competitive gambling may increase as adolescents transition into adulthood, beckons the need for a greater understanding of the relationship between competition and aggression.

References

Adachi, P. J. C., & Willoughby, T. (2011)a. The effect of video game competition and violence on aggressive behavior: Which characteristic has the greatest influence? *Psychology of Violence, 1,* 259-274. doi:10.1037/a0024908

Adachi, P. J. C., & Willoughby, T. (2011)b. The effect of violent video games on aggression: Is it more than just the violence? *Aggression and Violent Behavior, 16,* 55-62. doi:10.1016/j.avb.2010.12.002

Anderson, C. A., & Carnagey, N. L. (2009). Causal effects of violent sports video games on aggression: Is it competitiveness or violent content? *Journal of Experimental Social Psychology, 45,* 731-739. doi:10.1016/j.jesp.2009.04.019

Anderson, C. A., Carnagey, N. L., Flanagan, M., Benjamin, A. J., Eubanks, J., & Valentine, J. C. (2004). Violent video games: Specific effects of violent content on aggressive thoughts and behavior. *Advances in Experimental Social Psychology, 36,* 199–249.

Anderson, C.A., & Dill, K.E. (2000). Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. *Journal of Personality and Social Psychology, 78,* 772-790. doi:10.1037//O022-3514.78.4.772

Anderson, C.A., Gentile, D.A., & Buckley, K.E. (2007). *Violent video game effects on children and adolescents.* New York: Oxford University Press.

Anderson, C. A., Ihori, N., Bushman, B. J., Rothsetin, H, R., Shibuya, A., Swing, E. L., Sakamoto, A., Saleem, M. (2010). Video Game effects on aggression, empathy, and prosocial behavior and eastern and western countries: A meta-analytic review. *Psychological Bulletin, 136,* 151-173. doi:10.1037/a0018251

Anderson, C. A., & Morrow, M. (1995). Competitive aggression without interaction: Effects of competitive versus cooperative instructions on aggressive behavior in video games. *Personality and Social Psychology Bulletin, 21,* 1020-1030.

Arbuckle, J. L. (1995-2010). *AMOS 19 User's Guide*. Crawford, FL: AMOS Development Corporation.

Barnes, G. M., Welte, J. W., Hoffman, J. H., & Tidwell, M. O. (2009) Gambling, alcohol, and other substance use among youth in the United States. *Journal of Studies on Alcohol and Drugs, 70,* 134-142.

Berkowitz, L. (1989). Frustration-aggression hypothesis: Examination and reformulation. *Psychological Bulletin, 106,* 59–73. doi:10.1037/0033-2909.106.1.59

Berkowitz, L. (1990). On the formation and regulation of anger and aggression: A cognitive-neoassociationistic analysis. *American Psychologist, 45,* 494-503. doi:10.1037/0003-066X.45.4.494

Biscotti, F., Blau, B., Lovelock, J-D., Nguyen, T. H., Erensen, J., Verma, S., Liu, V. (2011). *Market trends: Gaming ecosystem, 2011*. Retrieved from Gartner Newsroom: http://www.gartner.com/it/page.jsp?id=1737414.

Carnagey, L. N., & Anderson, C. A. (2005). The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychological Science, 16,* 882-889. doi:10.1111/j.1467-9280.2005.01632.x

Ciarrochi, J., Leeson, P., Heaven, P.C.L. (2009). A longitudinal study into the interplay between problem orientation and adolescent well-being. *Journal of* C*ounseling Psychology, 56,* 441-449. doi:10.1037/a0015765

Dodge, K. A., Coie, J. D., & Lynam, D. (2006). Aggression and antisocial behavior in youth. In N. Eisenberg, W. Damon, and R. M. Lerner (Eds.), *Handbook of child psychology* (6th ed.), vol. 3: *Social, emotional, and personality development* (pp. 719-788). New Jersey: John Wiley & Sons.

Dollard, J., Miller, N. E., Doob, L. W., Mowrer, O. H., & Sears, R. R. (1939). *Frustration and aggression.* New Haven, CT: Yale University Press.

Feldman B.J. & Masyn, K.E., Conger, R.D. (2009). New approaches to studying problem behaviors: A comparison of methods for modeling longitudinal, categorical adolescent drinking data. *Developmental Psychology, 45,* 652-676. doi:10.1037/a0014851

Ferguson, C. J., & Ivory, J. D. (2012). A futile game: On the prevalence and causes of misguided speculation about the role of violent video games in mass school shootings. In G.W. Muschert and J. Sumiala, (Eds.), *School Shootings: Mediated Violence in a Global Age* (pp 47-67). Bringley: Emerald Group Publishing Limited.

Ferguson, C. J., & Kilburn, J. (2010). Much ado about nothing: The misestimation and overinterpretation of violent video game effects in eastern and western nations: Comment on Anderson et al. (2010). *Psychological Bulletin, 136,* 174-178. doi:10.1037/a0018566

Ferguson, C. J., Rueda, S. M., Cruz, A. M., Ferguson, D. E., Fritz, S., & Smith, S. M. (2008). Violent video games and aggression: Byproduct of family violence and intrinsic violence motivation? *Criminal Justice and Behavior, 35,* 311-332. doi:10.1177/0093854807311719

Felsher, J. R., Derevensky, J. L., Gupta, R. (2010). Young adults with gambling problems: The impact of childhood maltreatment. *International Journal of Mental Health Addiction, 8*, 545-556. doi:10.1007/s11469-009-9230-4

Giedd, J.N. (2008). The teen brain: Insights from neuroimaging. *Journal of Adolescent Health, 42*(4), 335-343. doi:10.1016/j.jadohealth.2008.01.007

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology, 60*, 549-576. doi:10.1146/annurev.psych.58.110405.085530

Griffiths, M. D., Parke, A., & Parke, J. (2003). Violence in gambling environments: A cause for concern? *Justice of the Peace, 167*, 424–426.

Hyde, J.S., & Petersen, J.L. (2009). A longitudinal investigation of peer sexual harassment victimization in adolescence. *Journal of Adolescence, 32*, 1178-1188. doi:10.1016/j.adolescence.2009.01.011

Lenhart, A., Kahne, J., Middaugh, E., Macgill, A.R., Evans, C., & Vitak, J. (2008). *Teens, video games, and civics.* (Report No. 202-415-4500). Washington, DC: Pew Internet and American Life Project.

Little, T. D., Jones, S. M., Henrich, C. C., & Hawley, P. H. (2003). Disentangling the "whys" from the "whats" of aggressive behaviour. *International Journal of Behavioral Development, 27,* 122–133. doi: 10.1080/01650250244000128

Little, R. J. A., & Rubin, D.B. (2002). *Statistical analysis with missing data* (2nd ed). NJ: Wiley and Sons.

Marini, Z., Spear, S., & Bombay, K. (1999). Peer victimization in middle childhood: Characteristics, causes, and consequences of bullying. *Brock Education, 9,* 32–47.

Miller, G. A., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology, 110,* 40-48. doi:10.1037//0021-843X.110.1.40

Möller, I., & Krahé, B. (2009). Exposure to violent video games and aggression in German adolescents: A longitudinal analysis. *Aggressive Behavior, 35,* 75-89. doi:10.1002/ab.20290

Mulenman, R. L., Den Otter, T., Wadman, M. C., Tran, T. P., & Anderson, J. (2002). Problem gambling in the partner of the emergency department patient as a risk factor for intimate partner violence. *Journal of Emergency Medicine, 23,* 307–312. doi:10.1016/j.bbr.2011.03.031.

Parke, A., & Griffiths, M. D. (2004). Aggressive behavior in slot machine gamblers: A preliminary observational study. *Psychological Reports, 95,* 109–114. doi:10.2466/PR0.95.5.109-114

Parke, A., & Griffiths, M. D. (2005). Aggressive behavior in adult slot machine gamblers: An interpretative phenomenological analysis. *Journal of Community & Applied Social Psychology, 15,* 255-272. doi:10.1002/casp.824

Schafer, J.L., & Graham, J.W. (2002). Missing data: Our view of the state of the art. *Psychological Methods, 7,* 147-177. doi:10.1037/1082-989X.7.2.147

Schmierbach, M. (2010). "Killing spree": Exploring the connection between competitive game play and aggressive cognition. *Communication Research, 37,* 256-274. doi:10.1177/00 93650209356394

Shaffer, H. J., & Hall, M. N. (2001). Updating and refining prevalence estimates of disordered gambling behavior in the United States and Canada. *Canadian Journal of Public Health, 92,* 168-72. doi: 10.2105/AJPH.89.9.1369

Steinberg, L. (2007). Risk taking in adolescence. *Current Directions in Psychological Science, 16*(2), 55-59. doi:10.1111/j.1467-8721.2007.00475.x

Steinberg, L. (2010). A dual systems model of adolescent risk-taking. *Developmental Psychobiology, 52*(3), 216-224. doi 10.1002/dev.20445.

Wallenius, M., & Punamäki, R-L. (2008). Digital game violence and direct aggression in adolescence: A longitudinal study of the roles of sex, age, and parent-child communication. *Journal of Applied Developmental Psychology, 29*, 286-294. doi:10.1016/j.appdev.2008.04.010

Willoughby, T., Adachi, P. J. C., Good, T. (2011). A longitudinal study of the association between violent video game play and aggression among adolescents. *Developmental Psychology, 48*, 1044-1057. doi:10.1037/a0026046

Zillmann, D. (1983). Arousal and aggression. In R. G. Geen & E. Donnerstein (Eds.), *Aggression: Theoretical and empirical reviews: Vol. 1. Theoretical and methodological issues* (pp.75-101). New York: Academic.

Chapter 4 (Study 3): The Long-Term Associations between Competitive Video Game Play, Aggressive Affect, and Aggressive Behavior: Theoretical and Developmental Implications for Adolescents and Young Adults[5]

The long-term positive association found between video game play and aggression, which is defined as behavior that is intended to harm another individual (Dodge, Coie, & Lynam, 2006), is an important issue as video games have become the fastest growing form of entertainment in the world. Indeed, the global market value of the video game industry was $67 billion in 2010 and is predicted to be $112 billion by 2015 (Biscotti et al. 2011). The importance of this issue is further highlighted by U.S. President Barack Obama's recent request that Congress provide $10 million to fund research on the link between violent video game play and violent/aggressive behavior (Dinan, 2013). To date, the vast majority of video game and aggression research has been focused on the effect of *violent* video game content on elevating aggression (see Anderson et al., 2010; Ferguson, in press; Greitemeyer & Mügge, 2014 for reviews; also see Adachi & Willoughby, 2011a; Ferguson & Kilburn, 2010; Ferguson 2013 for critiques of this literature); however, recent research also has demonstrated effects of *non-violent* video game play on aggression (e.g., Adachi & Willoughby, 2011b; 2013a; Breuer, Scharkow, & Quandt, 2013; Przybylski, Deci, Rigby, & Ryan, 2014). Long-term longitudinal research on this topic, however, is still in its infancy, as only a small fraction of the research studies on the link between video game play and aggression have assessed long-term effects (e.g., Adachi & Willoughby, 2013a; Ferguson, San Miguel, Garza, & Jerabeck, 2012; Möller & Krahé, 2009). Importantly, there is a dearth of longitudinal

[5] A version of this chapter has been revised and resubmitted to *Developmental Psychology*.

research which has simultaneously examined the predictive effects of violent and *non-violent* video game play, on aggression. Thus, research is needed to investigate whether violent video game play and non-violent video game play each have unique long-term associations with aggression. In addition, researchers recently have demonstrated a link between video game *competition* (i.e., video games in which the player competes against other computer-generated characters such as in sports or racing games) and aggression, representing an important new direction in the video game and aggression literature (e.g., Adachi & Willoughby, 2011a, 2011b, 2013a; Breuer et al., 2013; Schmierbach, 2010).

The first goal of the present research, therefore, was to examine the fundamental question of whether violent video game play (i.e., action/fighting games) and non-violent video game play (i.e., sports/racing games) each have unique long-term associations with aggression. Next, given that action/fighting (violent) video games and sports/racing games (non-violent) video games are both highly competitive (e.g., Adachi & Willoughby, 2011b), the second goal was to examine the long-term predictive effect of the commonality (e.g., competitiveness) between action/fighting and sports/racing video game play on aggression. The third goal was to investigate a potential underlying mechanism of the long-term link between video game play and aggression, namely aggressive affect. Finally, the long-term association between video game play and aggression primarily has been examined among adolescents (e.g., Adachi & Willoughby, 2013a; Krahé & Möller, 2010; Möller & Krahé, 2009; Willoughby, Adachi, & Good, 2011), but not young adults. We examined whether video game play predicts aggression in the long-term, therefore, among young adults in addition to adolescents. Overall, the

current research significantly advances our understanding of the long-term link between video game play and aggression among adolescents and young adults.

The Long-Term Association between Video Game Play and Aggression among Adolescents and Young Adults

To date, research on the long-term association between video game play and aggression has been limited to adolescent samples (e.g., Adachi & Willoughby, 2013a; Möller & Krahé, 2009; Wallenius & Punamäki, 2008; Willoughby et al., 2012; see also Breuer et al., in press; and Ferguson et al., 2012 for null effects; and Anderson Gentile, & Buckley, 2007 for a short-term longitudinal study with elementary school students) and has been primarily focused on violent video game play, rather than *non-violent* video game play. For example, Möller and Krahé (2009) assessed the bidirectional link (i.e., both socialization and selection effects) between violent video game play and aggressive behavior in a 30-month longitudinal study of German adolescents. Specifically, Möller and Krahé examined whether violent video game play predicted higher levels of aggression over time (socialization effect) and whether aggression predicted higher levels of violent video game play over time (selection effect). Results indicated that exposure to violent video games at time 1 predicted physical aggression at time 2 (but not relational aggression), after controlling for aggression at time 1 (socialization effect). In contrast, there was no evidence of selection effects, as neither physical aggression nor relational aggression at time 1 predicted greater exposure to violent video games at time 2, after controlling for exposure to violent video games at time 1. In addition, because exposure to *non-violent* video game play (e.g., sports and racing games) was not included in the

model, it is unclear whether non-violent video game play also would have had a unique predictive effect on aggression.

The majority of experiments on the short-term effects of video game play on aggression have been conducted with young adults (e.g., Adachi & Willoughby, 2011b; Barlett, Branch, Rodeheffer, & Harris, 2009; Englehardt, Bartholow, & Saults, 2011; see also Ferguson & Rueda, 2010 for null effects), although no researchers have examined long-term predictive effects during this developmental period, even though 81% of 18-29 year old Americans play video games and half of these young adult video game players play games at least a few times a week (Lenhart, Jones, & Macgill, 2008). It is unclear, therefore, whether video game play has predictive effects on aggression over time among young adults. Video game play may have similar effects on behavior among adolescents and young adults, consistent with research on brain development during these two developmental periods. Specifically, according to the Dual Systems Model (Steinberg 2007; 2008), the cognitive control network, hypothesized to be led by the prefrontal cortex and responsible for planning, judgment, and inhibition, may not be fully mature until the mid-20s (Ernst, Pine, & Hardin, 2006). Neural connections among brain regions also continue to strengthen across adolescence into young adulthood (Dosenbach, Petersen, & Schlaggar, 2013; Eluvathingal, Hasan, Kramer, Fletcher, & Ewing-Cobbs, 2007; Paus, 2009). Thus, both adolescents and young adults sometimes may have difficulty in regulating their arousal and may be more likely to engage in risk-taking behaviors (Steinberg, 2007; 2010), such as aggression, than other age groups. Video game play may lead to elevations in aggression among young adults, therefore, similar to adolescents.

Research on the Effects of Video Game Violence versus Competition on Aggression

To date, the majority of research on the short-term link between video game play and aggression has been focused on the *violent* content in games (e.g., see meta-analytic reviews by Anderson et al., 2010; Ferguson, in press; Greitemeyer & Mügge, 2014; but also see Adachi & Willoughby, 2011b; Breuer, Vogelgesang, Quandt, & Festl, in press; Ferguson et al., 2008; Ferguson, Garza, Jerabeck, Ramos, & Galindo, 2013; Ferguson & Olsen, 2014; Ferguson & Reuda, 2010; Pryzbylski et al., 2014; Tear & Nelson, 2013; Williams & Skoric, 2005 for evidence of null effects of violent content); however, this work has been critiqued (e.g., Adachi & Willoughby, 2011a, 2011b; Ferguson et al., 2008; Ferguson & Kilburn, 2010). For example, researchers who have found that playing a violent video game produced more aggression than a non-violent game in an experimental study often did not match the games on competitiveness prior to testing. This is problematic, as violent video games in general tend to be more competitive than non-violent games (Carnagey & Anderson, 2005). Players compete in shooting battles with opponent characters in first-person shooter games (e.g., the *Call of Duty* series), for example, or in hand-to-hand combat in fighting games (e.g., the *Mortal Kombat* series). In contrast, many non-violent games do not involve competition. For example, the first-person perspective graphic adventure game, *Myst*, is a non-violent game in which the main character must explore virtual worlds and solve puzzles to advance through the game. In addition to being non-violent, *Myst* also contains no competition, as there are no other characters in the game with which to compete. Thus, in experimental studies in which researchers found that a violent and competitive video game produced elevations in aggression compared to a non-violent game that is also less competitive, such as *Myst*

(e.g., Anderson & Dill, 2001), it is unclear whether it was the violent or competitive content that produced the elevations in aggression.

To examine whether violent or competitive content in games has the greatest influence on aggressive behavior in the short-term, Adachi and Willoughby (2011b) matched video games on other characteristics that may be related to aggression beyond violent content in an experimental study. First, the violent content was isolated by matching a violent and a non-violent game on competitiveness, difficulty, and pace of action. No differences were then found between the two games in terms of their effect on aggressive behavior among undergraduate participants. Thus, Adachi and Willoughby concluded that video game violence alone was not sufficient to elevate aggression. Next, competitive content was isolated by matching competitive and non-competitive games in terms of difficulty and pace of action, and systemically controlling for violence. Adachi and Willoughby found that the competitive games produced more aggressive behavior than the non-competitive games irrespective of the amount of violent content. Therefore, they concluded that competition, not violence, is the video game characteristic that had the greatest influence on aggressive behavior in the short-term, suggesting that video game competition may be an alternative explanation for the effect of violent video game play on aggression.

To date, Anderson and Carnagey (2009) are the only other researchers to match a violent and a non-violent game on ratings of competitiveness; however, the violent game in their study contained a faster pace of action, was more difficult, and produced more frustration than the non-violent game. Anderson and Carnagey statistically controlled for these differences between the games using analysis of covariance, but this is invalid

according to Miller and Chapman (2001; see Adachi & Willoughby, 2011a for a more detailed discussion of these findings).

Similar to experimental research on short-term effects, most of the longitudinal research on video game play and aggression has been focused on *violent* video game play (e.g., Anderson, et al., 2007; Möller & Krahé, 2009; Wallenius & Punamäki, 2008; Willoughby et al., 2011; see also Breuer et al., in press; Ferguson et al., 2012 for null effects). In fact, the longitudinal association between video game *competition* and aggression only has been investigated in one study. Adachi and Willoughby (2013a) conducted a four-wave longitudinal study of adolescents in which they examined whether playing competitive video games that are predominately non-violent (e.g., sports and racing games) were associated with aggressive behavior over the four high school years. Adachi and Willoughby argued that sports and racing games are highly competitive but non-violent, because although a few sports games contain some aggressive content (e.g., football or boxing games), most do not (e.g., soccer, golf, basketball, snowboarding, tennis, baseball). Similarly, while some racing games allow vehicles to come into contact with each other during a race, this behavior usually is discouraged as it causes both vehicles to slow down and thus impedes the player's goal of winning the race. Furthermore, sports and racing games do not contain the more extreme violence that can be found in many fighting, action, and first-person shooter games, such as "blood-soaked battles to the death with a variety of lethal weapons" (Adachi & Willoughby, 2013a, p. 1093). These arguments have been supported by empirical evidence, as researchers have found that action and fighting video games are rated as more violent than sports and racing video games, but matched in terms of competitiveness (e.g., Adachi &

Willoughby, 2011b; Valadez & Ferguson, 2012). If playing sports and racing video games predict aggressive behavior over time, therefore, then this predictive effect on aggression may be driven by the competitive content, rather than by violent content.

In support of this hypothesis, Adachi and Willoughby (2013a) found that playing sports and racing video games predicted higher levels of aggressive behavior over time, after controlling for previous levels of aggressive behavior (socialization effect). There also was evidence of selection effects, as more aggressive adolescents were more likely to play sports and racing games over time than less aggressive adolescents. Adachi and Willoughby concluded that playing more competitive video games tends to be associated with higher levels of aggressive behavior, in comparison to less competitive video games, although they did not examine the link between violent video game play and aggression in this study. Thus, it is unclear whether sports/racing video game play would have uniquely predicted aggression if violent video game play (e.g., action/fighting games) also was included as a predictor of aggression.

The Frustration-Aggression Hypothesis

While recent findings have indicated a long-term association between competitive video game play and aggression, it is unclear *why* competitive video game play predicts aggression over time, as no researchers have examined the underlying mechanisms of this longitudinal link. The frustration-aggression hypothesis is particularly relevant for explaining the link between competition and aggression. This hypothesis, which first was proposed by Dollard, Doob, Miller, Mowrer, and Sears (1939) and then modified by Berkowitz (1989), holds that when an individual's goal is thwarted (or threatened), the individual may experience aggressive affect such as anger and hostility, which, in turn,

may make the individual more likely to behave aggressively. Researchers have found support for this effect even when the individual's goal is thwarted by another individual unintentionally.

Importantly, people are even more likely to become aggressive if they believe that their goal is deliberately blocked than if they believe that the goal thwarting is inadvertent (e.g., Berkowitz, 1989; Kulik & Brown, 1979). In addition to experiencing aggressive affect associated with the goal thwarting experience, when an individual's goal is deliberately blocked the individual may feel that he/she has been "attacked personally," which may further influence aggressive affect (Berkowitz, 1989, p. 68). The frustration-aggression hypothesis is especially pertinent for explaining the link between competition and aggression, therefore, as competitors deliberately block each other's goal of winning the competition during competitive encounters. For example, when competing against another player in a video game (either a human opponent or a computer-generated opponent), each player's goal of winning directly impedes the other player's goal of winning, as only one player can win. Thus, the fact that the players deliberately obstruct each other's goal of winning throughout the competition as well as threaten each other with a total loss may lead to anger and hostility, and, in turn, may influence aggression (Berkowitz, 1962). Furthermore, competition may lead to elevations in aggressive affect and aggressive behavior even among competitors who reach their goal of winning the competition (Berkowitz, 1989). For example, research with children has shown that although competitors who reached their goal of winning a competition behaved less aggressively than participants who lost the competition, winners still behaved more aggressively than participants in the control group who were not involved in competition

(e.g., Nelson, Gelfand, & Hartmann, 1969). Thus, elevations in aggression that are produced by a competitive experience (e.g., the deliberate obstruction or threat of obstruction of one's goals) may not be fully assuaged by reaching the end-goal of winning.

While competitive experiences may influence state-levels of aggressive affect in the short-term, long-term exposure to competition may lead to elevations in more stable, trait-levels of aggressive affect. For example, long-term exposure to competition may lead to more frequent and intense feelings of anger and hostility when faced with a potential competitive situation. As a result, people may have greater difficulty inhibiting the expression of this aggressive affect over time, which may facilitate the translation of aggressive affect into aggressive behavior. In terms of the longitudinal association between video game competition and aggression, therefore, exposure to video game competition may influence aggressive behavior over time through elevations in trait-levels of aggressive affect, consistent with the frustration-aggression hypothesis. Specifically, competitive video game play may lead to elevated trait-levels of aggressive affect, and, in turn, people with elevated trait-levels of aggressive affect may be more likely to behave aggressively.

Although no researchers have examined whether aggressive affect is a mechanism of the long-term association between competitive video game play and aggression, recent research has demonstrated support for this link in the short-term. Specifically, Breuer et al. (2013) had participants play a non-violent sports game competitively against a confederate, followed by measures of negative (aggressive) affect (i.e., anger, irritation, frustration) and aggressive behavior. Participants were randomly assigned to either win or

lose the video game competition. Breuer et al. found that participants who lost the competition behaved more aggressively than participants who won, and that this effect was fully mediated by elevations in negative affect, consistent with the frustration-aggression hypothesis.

It is important to note that non-competitive video games also involve the goal of "winning" (e.g., advancing through the levels in a puzzle game such as *Tetris*) and thus may involve the real threat of losing the game (e.g., failing to complete a level), which, in turn, may lead to elevations in anger and hostility. We suggest that competitive video games may be more likely to induce anger and hostility that non-competitive video games, however, because only competitive games involve the threat of *deliberate* goal-blocking from one's opponents (e.g., other vehicles trying to overtake the player in a race), which may feel like a personal attack (Berkowitz, 1989).

The Commonality between Action/Fighting (Violent) Video Game Play and Sports/Racing (Non-Violent) Video Game Play

As previously discussed in the review of the video game and aggression literature, competitiveness is a common element among action/fighting (violent) video game play and sports/racing (non-violent) video game play. In fact, both action/fighting and sports/racing video games have been shown to be matched in terms of participants' ratings of competitiveness (Adachi & Willoughby, 2011b; Valadez & Ferguson, 2013). Hence, an underlying tendency toward video game competitiveness is represented in the commonality (i.e., the association) between action/fighting and sports/racing video game play. Given that researchers have demonstrated a short-term effect of competitive video game play on aggression (e.g., Adachi & Willoughby, 2011b; Breuer et al., 2013;

Schmierbach, 2010), therefore, we hypothesize that video game competitiveness might be partially, if not fully responsible for an effect of the commonality between these two types of video game play on aggression.

Third Variable Framework

It is important to consider the possibility that a long-term link between video game play and aggression may be due to their common associations with other unmeasured or "third" variables, such as demographic characteristics (e.g., being male) and other risky behaviors (e.g., alcohol use). For example, Ferguson (2011) has argued for the importance of testing the third variable hypothesis in studies examining the link between media and aggression by including multiple risk factors in researchers' statistical models. Locating video game exposure among adolescents and young adults in a broader third variable framework, therefore, is critical. To address this issue, in the present research we included a diverse set of demographic variables (e.g., gender, parental education, age, living situation, born in Canada, ethnicity other than Canadian) as well as risk factors that have been found in past studies to be predictive of aggression and video game play (e.g., involvement in sports, online gambling, alcohol use; Adachi & Willoughby, 2013a; Maldonado- Molina, Jennings, & Komro, 2010; Wells, Graham, Speechly, & Koval, 2006). Our confidence in the robustness of the long-term association between video game play and aggression would be strengthened if analyses included these potential third variables as covariates and specifically assessed whether the link between competitive video game play and aggression holds up after controlling for these variables.

Study 3a

In Study 3a we surveyed a large longitudinal sample of young adults about their video game play, aggressive affect, and aggressive behaviors. We addressed four goals. The first goal was to investigate the fundamental question of whether violent video game play (i.e., action/fighting games) and non-violent video game play (i.e., sports/racing games) each have unique long-term associations with aggression. Consistent with longitudinal research demonstrating effects of action/fighting (violent) video game play on aggression (Willoughby et al., 2012), and recent research demonstrating effects of non-violent video games on aggression (e.g., Adachi & Willoughby, 2011b, 2013a, Breuer et al., 2013; Przybylski et al., 2014), we hypothesized that action/fighting (violent) and sports/racing (non-violent) video game play each would be uniquely associated with aggression over time.

Next, given that past research has shown that action/fighting (violent) and sports/racing (non-violent) video games tend to be matched in terms of competitiveness (Adachi & Willoughby, 2011b; Valadez & Ferguson, 2013), the second goal was to examine the long-term predictive effect of the commonality (e.g., competitiveness) between action/fighting video game play and sports/racing video game play on aggression. Consistent with research showing a link between video game competition and aggression (Adachi & Willoughby, 2011b; Adachi & Willoughby, 2013a; Breuer et al., 2013), we hypothesized that the commonality (e.g., competitiveness) between the two types of video game play would predict higher levels of aggression over time. Given that this is the first study to examine the predictive effect of the commonality between action/fighting and sports/racing video game play on aggression, however, it is not clear whether the two types of video game play also would have unique effects on aggression,

independent of the predictive effect of their commonality on aggression. For example, after controlling for the predictive effect of their commonality (e.g., competitiveness) on aggression, action/fighting and sports/racing video game play also may have unique associations with aggression, due to elements that are unique to each type of game (e.g., high levels of violence are unique to action/fighting games and may be linked with aggression). Thus, we did not have specific hypotheses regarding whether action/fighting or sports/racing video game play would be uniquely associated with aggression after controlling for the predictive effect of their commonality on aggression.

The third goal was to investigate whether aggressive affect (i.e., anger and hostility) is an underlying mechanism of the long-term link between video game play and aggression, consistent with the frustration-aggression hypothesis. Finally, the fourth goal was to examine these long-term associations among young adults in addition to adolescents, as the long-term link between video game play and aggression primarily has been studied among adolescents. Also, consistent with previous research that has found no moderating effects of gender on the link between video game play and aggression (Anderson et al., 2010), we hypothesized that gender would not moderate the associations between video game play and aggression.

Method

Participants. Participants were 1,132 undergraduate students (70.6% female) enrolled at a mid-sized university in southern Ontario, Canada, who were surveyed across 4 consecutive years. At the first assessment, all participants were in their first year of university (M = 19.06 years, SD = 0.92, range of 17 to 25 years). Data on socioeconomic status indicated that mean levels of education for mothers and fathers fell between “some

college, university, or apprenticeship program" and "completed a college/apprenticeship and/or technical diploma." Our sample was comprised predominantly of domestic-Canadian students (88%), and common ethnic backgrounds of these students other than Canadian were British (19%), Italian (16.8%), French (9.5%), and German (9%), consistent with the broader demographics for the region (Statistics Canada, 2006). Of the international students, the majority were from Asia (36.1%), European Union (15.7%), the Caribbean (10.2%) and Africa (10.2%). The overall retention rate of these students was excellent. Out of the original 1132 students that completed the survey in Year 1, 84% completed the survey in at least 2 of the 4 years, and 70% of the sample was still retained at Year 4. This long-term retention rate is very high. There were no significant differences between participants who completed the survey at all four time points or at less than four time points on any of the study measures. As missing data were not dependent on the values of the study measures, it is reasonable to assume that this data is missing at random (Little & Rubin, 2002; Schafer & Graham, 2002). Missing data were estimated using the expectation maximization (EM) estimation method. One of the main study variables (i.e., aggressive affect) was not assessed in wave 1; therefore we only used variables that were assessed at waves 2, 3, and 4 (hereafter referred to as time 1, 2, and 3) in our analyses.

Procedure. First-year university students from various academic disciplines were invited to complete a survey examining factors related to adjustment to university by way of posters, classroom announcements, website posting, and visits to on-campus student residences (wave 1). Participants were given monetary compensation for their participation at time 1 ($20), time 2 ($30), and time 3 ($40). At times 1, 2, and 3 all

students who participated in the first assessment (wave 1) were invited to participate again, by way of emails, posters, and classroom announcements. All assessments were conducted a year apart. The study was approved by the University Ethics board prior to survey administration at all assessments, and participants provided informed active consent prior to participation at each year. The survey was administered by trained research assistants.

Measures. The study measures were assessed at all of the time periods with the exception of the third variables which were assessed at time 1 (the demographics were assessed at wave 1).

***Aggressive behavior*.** Direct aggressive behavior was assessed with four items in the (e.g., How often have you pushed and shoved someone during the last year?) based on a 5-point scale (1 = *never* to 5 = *everyday*; Marini, Spear, & Bombay, 1999). Cronbach's alphas ranged from .74 to .77, and higher composite scores indicated a higher frequency of aggressive behavior.

Aggressive affect. Trait-levels of aggressive affect were assessed with a composite of the anger (3 items; e.g., "Sometimes I feel like a powder keg ready to explode") and hostility (3 items; e.g., "I wonder why sometimes I feel so bitter about things") subscales of the short-form of the Buss and Perry Aggression Questionnaire (1992; Diamond & Magaletta, 2006; Diamond, Wang, and Buffington-Vollum, 2005), based on a 5-point scale (1 = *very unlike me* to 5 = *very like me*). Cronbach's alpha was .87 at time 1, and .88 at time 2, with higher scores indicating higher levels of aggressive affect.

Competitive and non-violent (sports/racing) video game play. Frequency of playing video games that are competitive and non-violent was assessed with two items, by asking participants how frequently they played sports video games (e.g., *FIFA Soccer*) on an average day and how frequently they played racing video games (e.g., *Gran Turismo*) on an average day, based on a 5-point scale (1 = *not at* all, 2 = *less than 1 hour*, 3 = *1-2 hours*, 4 = *3-4 hours*, l to 5 = *5 or more hours*). Higher composite scores indicated a higher frequency of sports/racing video game play.

Competitive and violent (action/fighting) video game play. Frequency of playing video games that are competitive and violent was assessed with two items, by asking participants how frequently they played action video games (e.g., *God of War*) on an average day and how frequently they played fighting video games (e.g., *Mortal Kombat*) on an average day, based on a 5-point scale (1 = *not at all* to 5 = *5 or more hours*). Higher composite scores indicated a higher frequency of action/fighting video game play. Again, action/fighting video games have been shown to be rated as more violent than sports/racing video games, but matched in terms of ratings of competitiveness (e.g., Adachi & Willoughby, 2011a; Valadez & Ferguson, 2012).

Third variables that were controlled.

Demographics. Gender, age, born in Canada (*yes*/*no*), ethnicity other than Canadian (*yes*/*no*), living situation, and parental education (one item per parent, averaged for participants reporting on both parents, with a scale of 1 = *did not finish high school* to 6 = *professional degree*, r = .40) were used as covariates.

Involvement in sports. Involvement in sports was assessed at by asking participants how frequently they participated in sports clubs in the previous year on a 6-point scale (1 = *never* to 6 = *several times a week*).

Alcohol consumption. Alcohol consumption was assessed by asking participants how frequently they drink on an 8-point scale (1 = *never* to 8 = *every day*; recoded to a 6-point scale) and on average, how many drinks they consume when drinking alcohol on a 6-point scale (1 = *less than 1 drink* to 6 = *over 10 drinks*). The correlation between these two items was .65. Higher composite scores indicated higher alcohol consumption.

Online gambling. Online gambling was assessed by asking participants how frequently they go on the internet for online poker, sports betting, and online casinos on a 5-point scale (1 = *not at all* to 5 = *5 or more hours*).

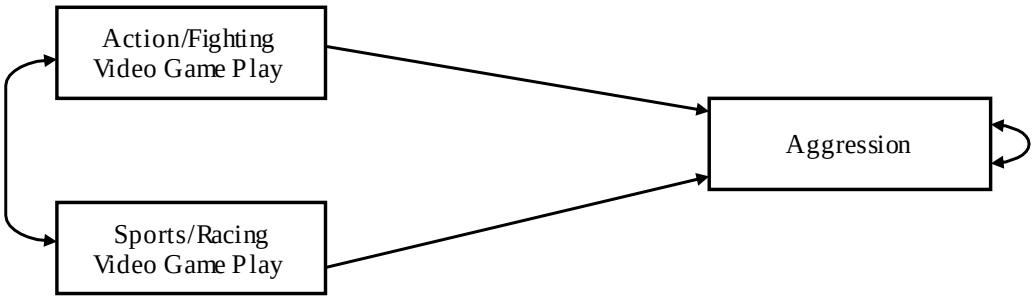
Plan of Analysis: General Overview of the Manifest and Latent Path Models

First, to examine the fundamental question of whether violent video game play (i.e., action/fighting games) and non-violent video game play (i.e., sports/racing games) each have unique long-term associations with aggression, we conducted an autoregressive cross-lagged path analysis in *AMOS 22* (Arbuckle, 1995-2013), in which action/fighting and sports/racing video game play (manifest variables) were tested as competing/unique predictors of aggression (Model 1; see Figure 4a for a simplified example of this model). Next, to examine the long-term predictive effect of the commonality (e.g., competitiveness) between action/fighting and sports/racing video game play on aggression, we created a latent factor to represent the commonality between both types of video game play (i.e., the common video game play factor), and then tested the predictive effect of this common video game play factor on aggression (Model 2; see

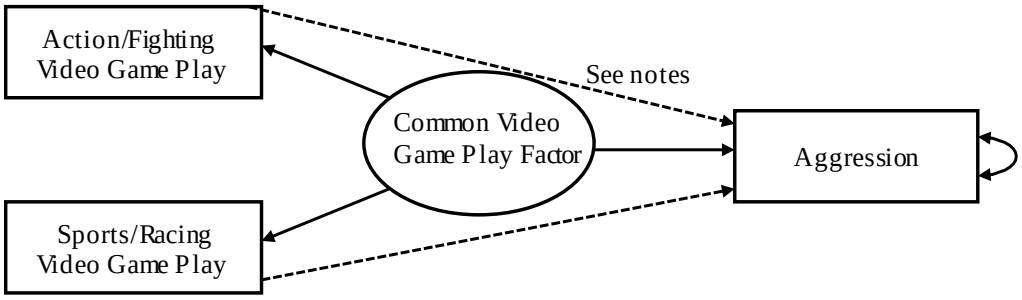
Figure 4b for a simplified example of this model). This latent factor model allowed us to simultaneously test the predictive effect of the common video game play factor (e.g., competitiveness) on aggression, as well as the unique effects of each type of video game play on aggression after controlling for the common video game play factor. The significance levels of the unique associations between each type of video game play and aggression are automatically calculated and reported in the standardized residual covariance matrix in the statistical output. Specifically, a value that is greater than |2| for either of these associations would mean that the association is statistically significant at $p < .05$. These paths cannot be specified in the model due to insufficient degrees of freedom.

The critical difference between these models is that there are three predictors of aggression in Model 2 (i.e., action/fighting video game play, sports/racing video game play, and the common video game play factor), and only two predictors of aggression in Model 1 (i.e., action/fighting video game play and sports/racing video game play). The unique associations between action/fighting video game play and aggression, and between sports/racing video game play and aggression, therefore, control for the predictive effect of the common video game play factor on aggression in Model 2, but not in Model 1. Thus, the magnitude of the unique effects of each type of video game play on aggression may be smaller in the Model 2 compared to Model 1, if there are strong factor loadings of the common video game play factor on the two video game play variables and a significant predictive effect of the common video game play factor on aggression. To further illustrate this difference between the two models, we have provided an example of a hypothetical model in which the path from the common video game play

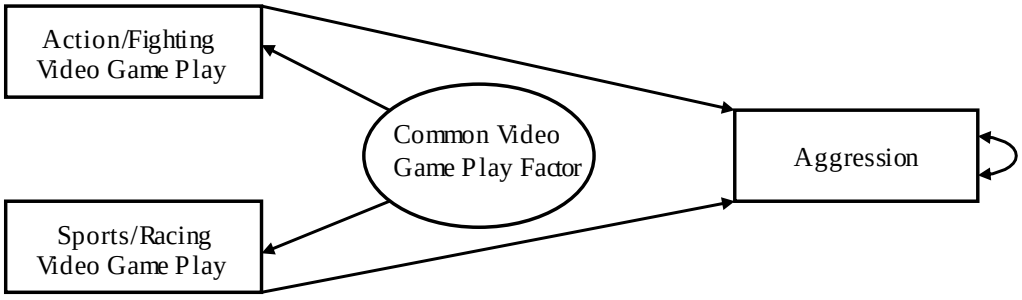
a) Model 1: The Manifest Video Game Play Variables as Predictors of Aggression



b) Model 2: The Common Video Game Play Latent Factor Included as a Predictor of Aggression



c) Model 3: The Latent Factor Model becomes Redundant with Model 1 if the Path from the Common Video Game Play Latent Factor to Aggression is Removed



Notes. In Model 2, the dashed lines indicate the unique associations between action/fighting video game play and aggression, and between sports/racing video game play and aggression, after controlling for the common video game play factor. The significance levels of these associations are automatically calculated and reported in the standardized residual covariance matrix in the statistical output. These paths cannot be specified in the model due to insufficient degrees of freedom.

Figure 4. Examples of the Manifest and Latent Path Models

factor to aggression is removed (Model 3; see Figure 4c). Importantly, the effects of each type of video game play on aggression in Model 3 would be identical to Model 1, because these paths do not control for the effect of the common video game play factor on aggression in either model.

Results and Discussion

Preliminary Analyses. Table 5 outlines the means and standard deviations for the study variables (see Appendices T and U for the bivariate correlations between the main study variables. We examined mean differences in the main study variables (i.e., video game play, aggressive behavior, and aggressive affect) as a function of gender. A significant multivariate main effect was found (Wilks $\lambda < .001$, partial $\eta^2 = .38$). Overall, males reported more aggressive behavior, aggressive affect, sports/racing video game play, and action/fighting video game play than females. All measures showed acceptable skewness and kurtosis with the exception of the video game variables, online gambling, living in residence and age. To address this issue of nonnormality, we used an inverse transformation[6] on the time 1, time 2, and time 3 video game variables, as well as the online gambling, living in residence, and age variables, which brought skewness and kurtosis to acceptable levels for each variable. These transformed variables were used in the subsequent analyses. Please note that Table 5 reflects the means and standard deviations of the untransformed variables.

[6] Consistent with recommendations by Graham (2009) and Shafter and Graham (2002), we transformed these variables prior to imputation.

Table 5

Means and Standard Deviations of the Study 3a Measures from the Young Adult Sample

Variable	*Scale Range*	*Time 1* *M (SD)*	*Time 2* *M (SD)*	*Time 3* *M (SD)*
Aggressive behavior	1-5	1.74 (0.56)	1.59 (0.52)	1.53 (0.48)
Sports/racing video game play	1-5	1.22 (0.43)	1.17 (0.38)	1.16 (0.36)
Action/fighting video game play	1-5	1.16 (0.38)	1.13 (0.34)	1.12 (0.32)
Aggressive affect	1-5	2.24 (0.73)	2.19 (0.73)	
Age			19 years, 1 month	
Parental education	1-6		3.65 (1.27)	
Gender	1-2		70.6% female	
Alcohol consumption	1-6	3.75 (1.14)		
Online gambling	1-5	1.12 (0.35)		
Born in Canada	1-2	1.12 (0.32)		
Ethnicity	1-2	1.36 (0.48)		
Living in residence	1-2	1.95 (0.22)		
Involvement in sports	1-6	2.24 (1.79)		

The long-term bidirectional (cross-lagged) associations between aggressive behavior and action/fighting video game play, and between aggressive behavior and sports/racing video game play, among young adults. In order to simultaneously assess the long-term bidirectional (cross-lagged) associations between aggression and sports/racing video game play, and between aggression and action/fighting video game play, we created a 3-time period (time 1 to time 3) autoregressive cross-lagged model in which bidirectional (cross-lagged) paths (i.e., paths from earlier video game play to later aggression as well as paths from earlier aggression to later video game play) were estimated across each adjacent time period (i.e., over 1-year time periods) between sports/racing video game play and aggression, and between action/fighting video game play and aggression. Stability paths across each time period within each variable also were specified, as well as covariances among the variables within each time point to control for common method variance. Because we were not interested in the longitudinal associations between the two types of video game play, we did not include bidirectional paths between the action/fighting and sports/racing variables.

We first assessed whether the pattern of results was invariant across time. Invariance was tested by comparing a model in which all cross-lagged paths were constrained to be equal across time to 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 was not a significantly better fit than the constrained model, suggesting that the patterns of associations among the measures were consistent across the three time points, $p > .05$. As the constrained model was the most parsimonious

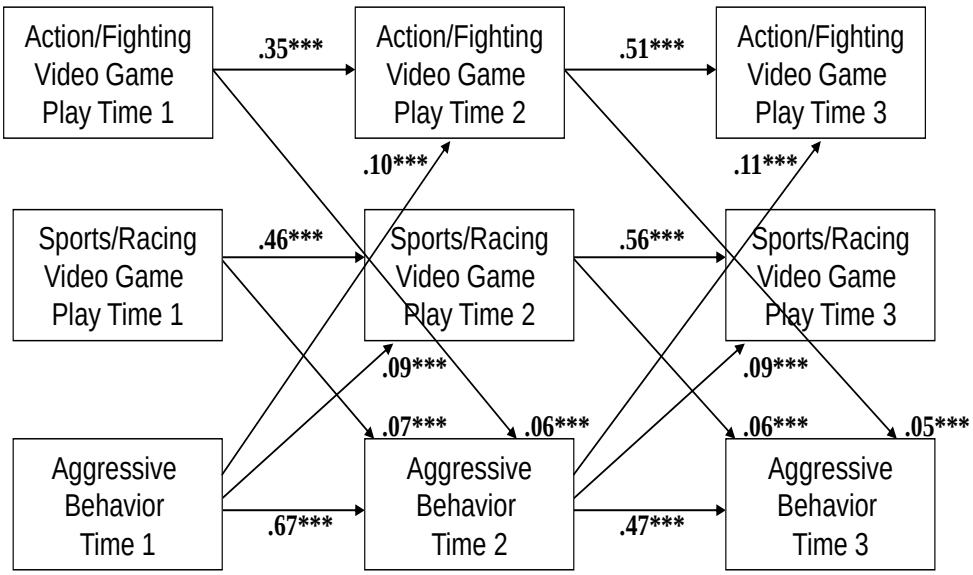
model, all further interpretations were based on the constrained model. Model fit was adequate, $\chi^2(14) = 86.19$ $p < .001$, CFI = .98, RMSEA = .068 (.054 - .082).

In terms of socialization effects, sports/racing video game play at time 1 predicted higher levels of aggressive behavior at time 2 (β = .08, 95% CI [.04, .12], $p < .001$), and sports/racing video game play at time 2 predicted higher levels of aggressive behavior at time 3 (β = .07, 95% CI [.03, .11], $p < .001$), after controlling for previous levels of aggressive behavior and action/fighting video game play. Similarly, action/fighting video game play at time 1 predicted higher levels of aggressive behavior at time 2 (β = .05, 95% CI [.01, .08], $p = .01$), and action/fighting video game play at time 2 predicted higher levels of aggressive behavior at time 3 (β = .04, 95% CI [.01, .07], $p = .01$), after controlling for previous levels of aggressive behavior and sports/racing video game play. In terms of selection effects, aggressive behavior at time 1 predicted higher levels of sports/racing video game play at time 2 (β = .10, 95% CI [.07, .14], $p < .001$), and aggressive behavior at time 2 predicted higher levels of sports/racing video game play at time 3 (β = .11, CI [.07, .15], $p < .001$), after controlling for previous levels of sports/racing video game play. In addition, aggressive behavior at time 1 predicted higher levels of action/fighting video game play at time 2 (β = .08, 95% CI [.05, .12], $p < .001$), and aggressive behavior at time 2 predicted higher levels of action/fighting video game play at time 3 (β = .09, 95% CI [.05, .13], $p < .001$), after controlling for previous levels of action/fighting video game play.

We then tested whether the magnitude of the socialization and selection effects between aggression and sport/racing video game play were significantly different from the magnitude of the socialization and selection effects between aggression and

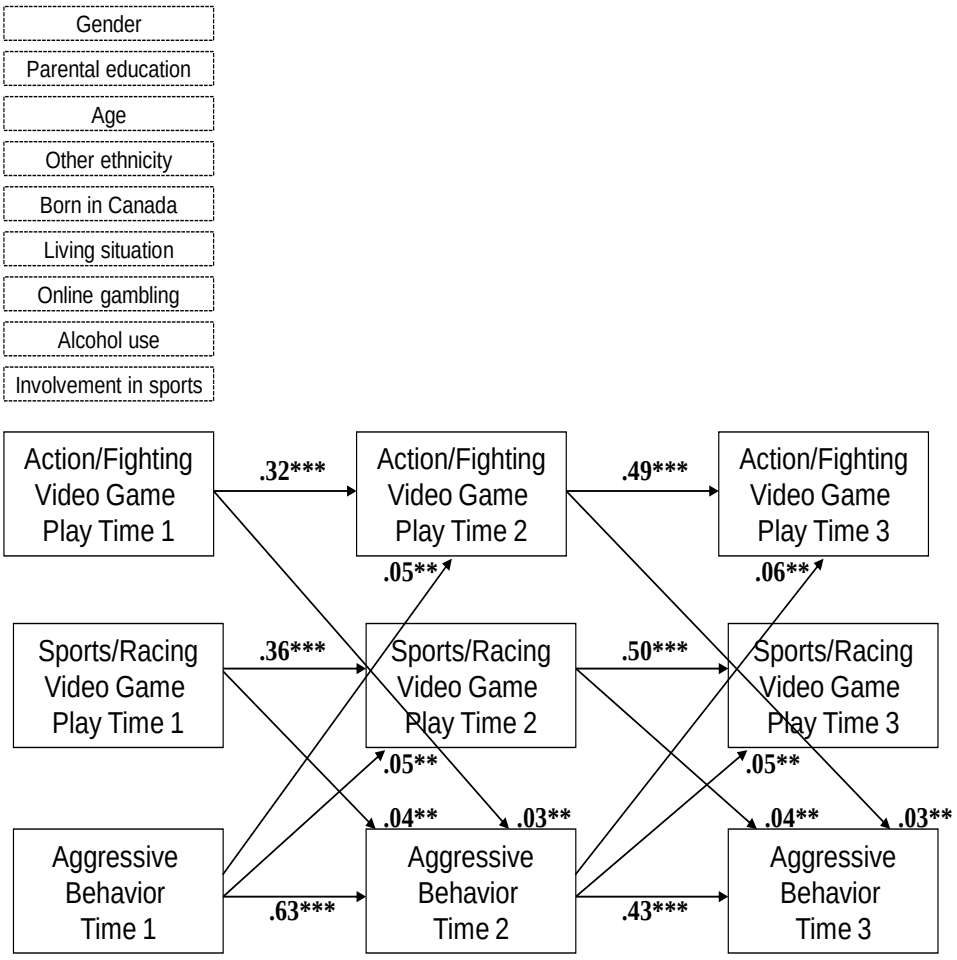
action/fighting video game play. Specifically, we compared a model in which the paths testing the effects of sports/racing video game play and action/fighting video game play on aggression over time were constrained to be equal, and the paths testing the effects of aggression on sports/racing video game play and on action/fighting video game play over time were constrained to be equal to the model in which these paths were unconstrained. The chi-square difference test of relative fit indicated that the constrained and unconstrained models did not significantly differ ($p > .05$). Hence, the socialization and selection effects between aggression and sport/racing video game play, and between aggression and action/fighting video game play, did not differ in magnitude, suggesting that violent video game play and non-violent video game play each had unique longitudinal associations with aggression, which were similar in size. Figure 5 summarizes the significant path estimates.

The long-term bidirectional (cross-lagged) associations between aggressive behavior and action/fighting video game play, and between aggressive behavior and sports/racing video game play, when adding third variables. Next, we tested whether the long-term bidirectional (cross-lagged) associations between aggression and sports/racing video game play, and between aggression and action/fighting video game play, were robust after controlling for the third variables (i.e., gender, parental education, age, born in Canada, ethnicity other than Canadian, living situation, alcohol consumption, involvement in sports, and online gambling). The bidirectional associations between aggression and sports/racing video game play, and between aggression and action/fighting video game play remained significant even after controlling for all of the third variables (see Figure 6).



Notes. Not shown are covariances among variables within each time point. Standardized coefficients are reported. *<.05, **<.01, ***<.001. Results for covariances and 95% CIs for standardized coefficients can be obtained from the first author.

Figure 5. Final model results for young adults for analysis assessing the long-term bidirectional associations between sports/racing video game play and aggressive behavior, and between action/fighting video game play and aggressive behavior.



Notes. Third variables are indicated with dashed lines. Not shown are covariances among variables within each time point or paths related to third variables. Standardized coefficients are reported. *<.05, **<.01, ***<.001. Results for third variables, covariances, and 95% CIs for standardized coefficients can be obtained from the first author.

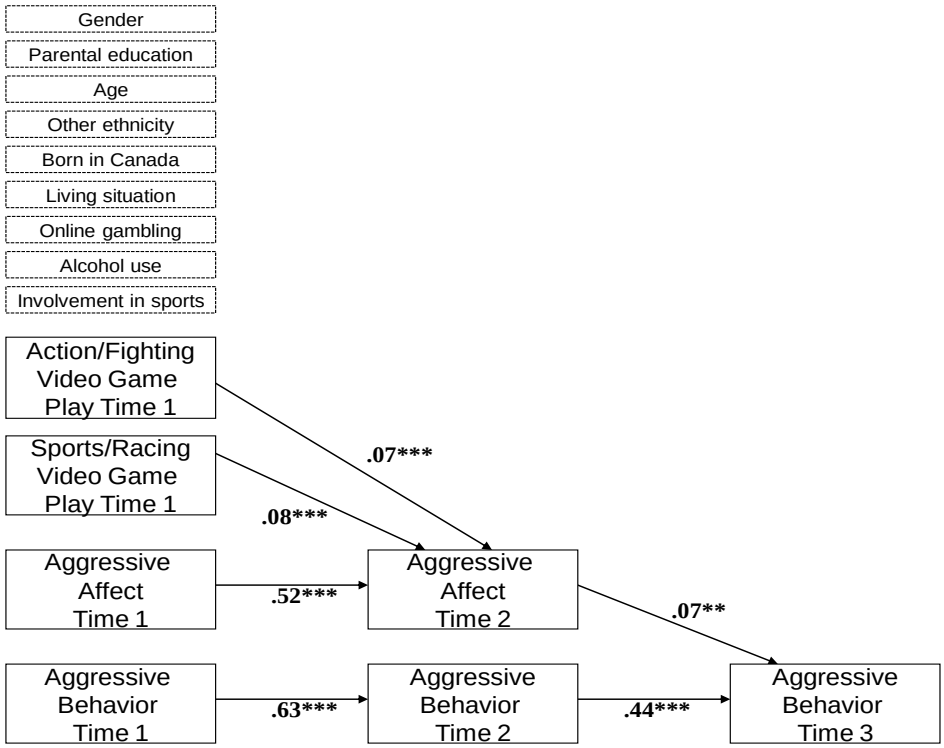
Figure 6. Final model results for young adults for analysis assessing the long-term bidirectional associations between sports/racing video game play and aggressive behavior, and between action/fighting video game play and aggressive behavior, controlling for the third variables.

Aggressive affect as an underlying mechanism of the long-term predictive effect of action/fighting video game play and sports/racing video game play on aggressive behavior among young adults. To examine whether sports/racing video game play and action/fighting video game play indirectly predicted aggressive behavior through aggressive affect, we added aggressive affect at time 1 and time 2 to the model. Paths were estimated from sports/racing video game play and action/fighting video game play at time 1 to aggressive affect at time 2, and from aggressive affect at time 2 to aggressive behavior at time 3, while simultaneously controlling for time 1 aggressive affect, time 1 and time 2 aggressive behavior, as well as all of the third variables. Because we specifically were interested in examining whether aggressive affect was a mechanism through which competitive video game play predicted elevations in aggressive behavior over time, sports/racing video game play and action/fighting video game play at time 2 and time 3 were not pertinent to this analysis, so we removed these variables from the model. In addition, given that AMOS only provides results for total indirect effects (i.e., AMOS does not provide separate results for multiple indirect effects when more than one mechanism is included in a model), we could not include more than one mechanism (i.e., time 2 aggressive affect) in the model. Thus, we removed the paths from the time 1 video game play variables to time 2 aggressive behavior. The total indirect effects of the time 1 video game play variables on time 3 aggressive behavior, therefore, pertained only to the mechanism of time 2 aggressive affect. Importantly, removing the paths from the time 1 video game play variables to time 2 aggressive behavior did not alter the effects of each type of video game play on time 2 aggressive affect. Model fit was good, $\chi 2(5)= 23.14$, $p < .001$, CFI = 1.00, RMSEA = .057 (.035 -

.081). Time 1 sports/racing video game play (β = .08, 95% CIs [.01, .15], *p* = .021) and time 1 action/fighting video game play (β = .08, 95% CIs [.01, .15], *p* = .020) each uniquely predicted higher levels of time 2 aggressive affect after controlling for previous levels of aggressive affect and the third variables, and, in turn, time 2 aggressive affect predicted higher levels of time 3 aggressive behavior (β = .07, 95% CIs [.01, .13], *p* = .004) after controlling for previous levels of aggressive behavior and the third variables.

We then tested whether the predictive effects of sport/racing video game play and action/fighting video game play on aggressive affect were significantly different by constraining these paths to be equal and then comparing this model to a model in which these paths were not constrained to be equal. The chi-square difference test of relative fit indicated that the constrained and unconstrained models did not significantly differ (*p* > .05). Thus, the magnitude of the predictive effect of sports/racing video game play on aggressive affect did not significantly differ from the predictive effect of action/fighting video game play on aggressive affect, suggesting that competitive video games that are violent have the same longitudinal associations with aggression as competitive video games that are non-violent, and thus both types of video game play may share this common underlying mechanism. Figure 7 summarizes the significant path estimates.

Given these significant direct predictive effects, we assessed the indirect predictive effects of time 1 sports/racing video game play on time 3 aggressive behavior through time 2 aggressive affect, and of time 1 action/fighting video game play on time 3 aggressive behavior through time 2 aggressive affect. Using bias-corrected bootstrapping (bootstrap samples = 2,000), we found a significant indirect predictive effects for

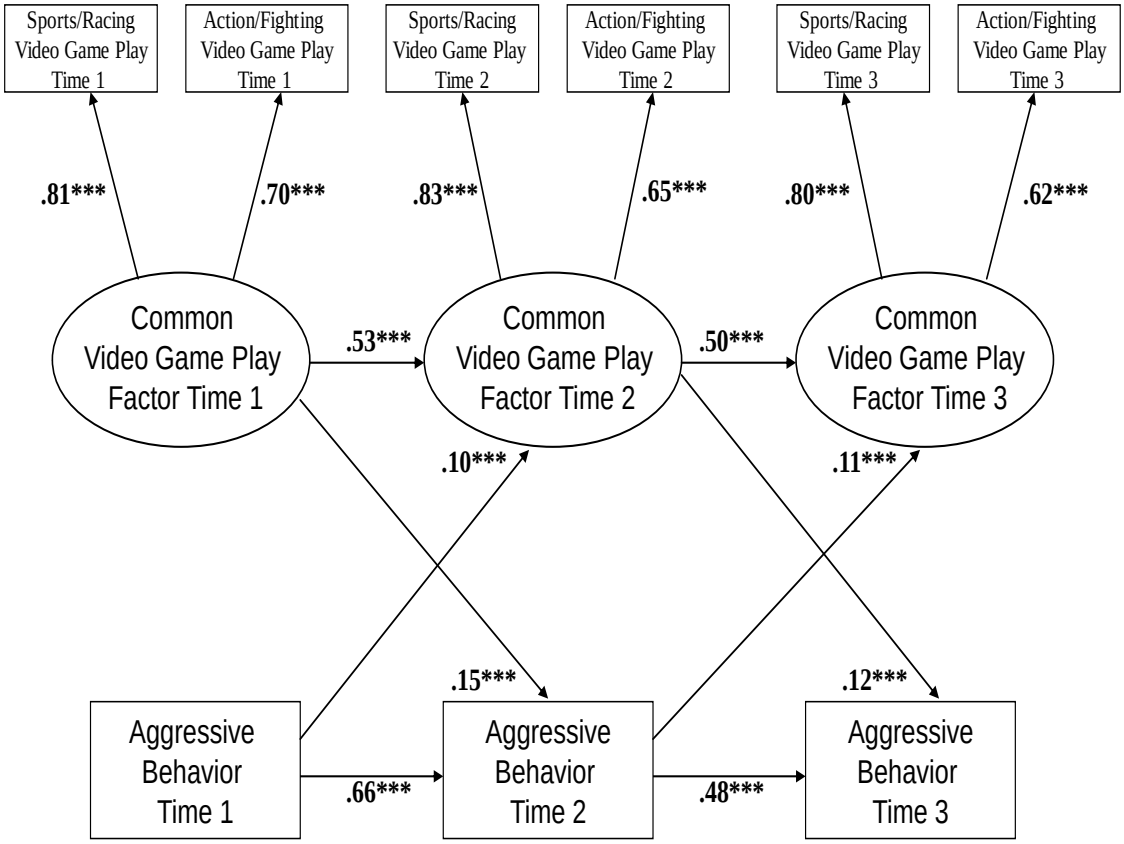


Notes. Third variables are indicated with dashed lines. Not shown are covariances among variables within each time point or paths related to third variables. Standardized coefficients are reported. *<.05, **<.01, ***<.001. Results for third variables, covariances, and 95% CIs for standardized coefficients can be obtained from the first author.

Figure 7. Final model results for young adults for analysis assessing the indirect predictive effects of sports/racing video game play as well as action/fighting video game play on aggressive behavior through aggressive affect, controlling for the third variables.

sports/racing video game play β = .01, 95% CI [.001, .013], p = .006 as well as for action/fighting video game play β = .01, 95% CI [.001, .013], p = .006. Thus, the results provide support for an indirect mediation model (MacKinnon, Fairchild, & Fritz, 2007; Zhao, Lynch, & Chen, 2010) in which playing sports/racing video game play or action/fighting video game play uniquely predicted higher aggressive affect, and in turn, aggressive affect predicted higher aggressive behavior.

The long-term bidirectional (cross-lagged) association between the commonality among action/fighting and sports/racing video game play (i.e., the latent factor), and aggressive behavior, among young adults. In order to simultaneously assess the long-term bidirectional (cross-lagged) association between aggression and the commonality (e.g., competitiveness) among action/fighting and sports/racing video game play, we modified the 3-time period (time 1 to time 3) autoregressive cross-lagged model (see Figure 8) by creating a latent factor (i.e., the common video game play factor) to represent the commonality between the two types of video game play at each time point. Bidirectional paths were estimated across each adjacent time period between the common video game play factor and aggression. Model fit was excellent, $\chi^2(13) = 17.65$ p = .171, CFI = 1.00, RMSEA = .018 (.000 - .037). All factor loadings were significant at $p < .001$. In terms of socialization effects, the common video game play factor at time 1 predicted higher levels of aggressive behavior at time 2, and the common video game play factor at time 2 predicted higher levels of aggressive behavior at time 3, after controlling for previous levels of aggressive behavior. In terms of selection effects, aggressive behavior at time 1 predicted higher levels of the common



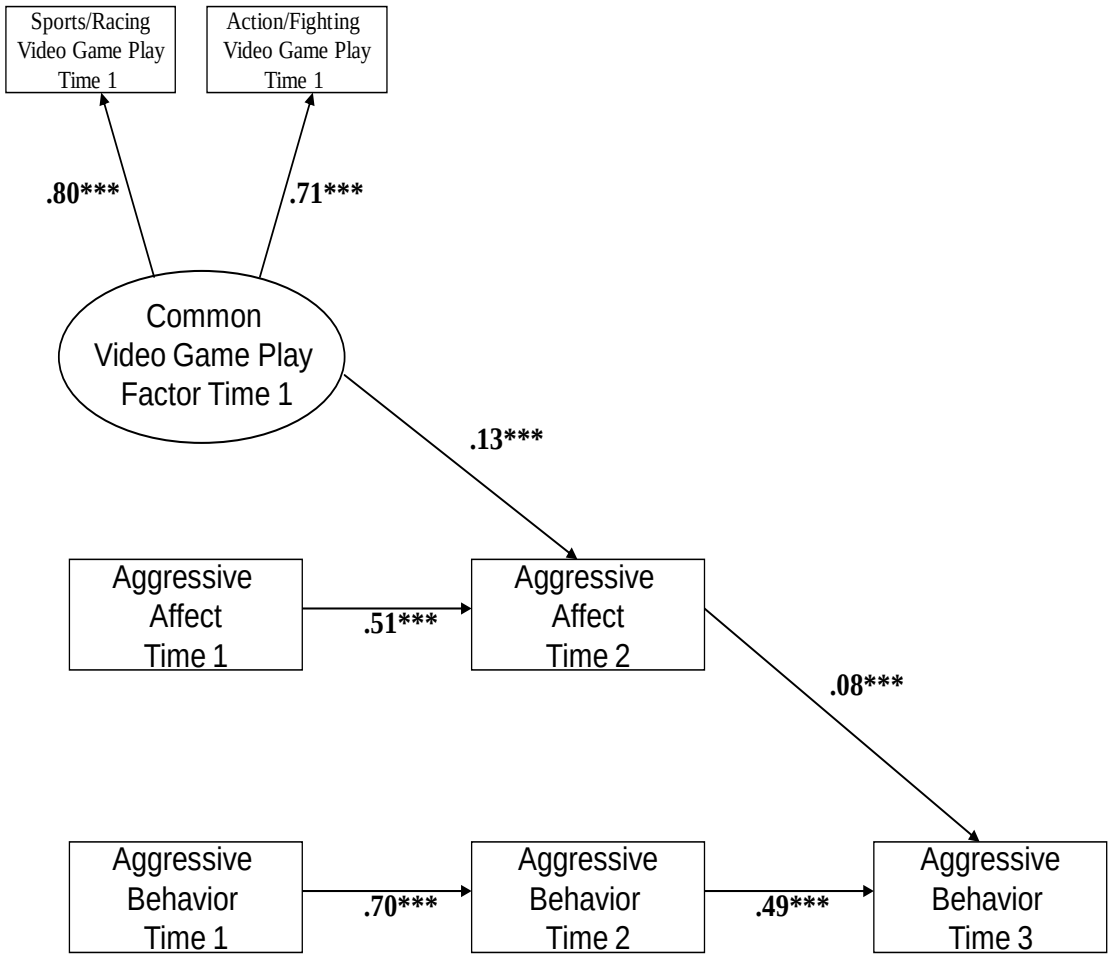
Notes. Not shown are covariances among variables within each time point. Standardized coefficients are reported. *<.05, **<.01, ***<.001. Results for covariances and 95% CIs for standardized coefficients can be obtained from the first author. The significance levels for the unique associations between action/fighting video game play and aggression, and between sports/racing video game play and aggression, after controlling for the common video game play factor, were automatically calculated and reported in the standardized residual covariance matrix in the statistical output. These paths were not specified in the model due to insufficient degrees of freedom.

Figure 8. Final model results for young adults for analysis assessing the long-term bidirectional associations between the common video game play factor and aggressive behavior, between sports/racing video game play and aggressive behavior, and between action/fighting video game play and aggressive behavior.

video game play factor at time 2, and aggressive behavior at time 2 predicted higher levels of the common video game play factor at time 3, after controlling for previous levels of the common video game play factor. Figure 8 summarizes the significant path estimates.

In contrast, the unique longitudinal associations between action/fighting video game play and aggression, and between sports/racing video game play and aggression were not significant (*p*s > .05; the significance levels of these associations were automatically calculated and reported in the standardized residual covariance matrix in the statistical output) after controlling for the association between the common video game play factor and aggression, and for previous levels of aggression. Consistent with the previous models, the pattern of results did not differ when adding the third variables into the model, so the more parsimonious model without the third variables is presented.

Aggressive affect as an underlying mechanism of the long-term predictive effect of the commonality among action/fighting and sports/racing video game play (i.e., the latent factor) on aggressive behavior among young adults. To examine whether the commonality among action/fighting and sports/racing video game play indirectly predicted aggressive behavior through aggressive affect, we modified the indirect effects model (see Figure 9) by including the common video game play factor at time 1 as a predictor of aggressive affect at time 2. Model fit was good, $\chi 2(7)= 39.90$, $p <$ .001, CFI = .99, RMSEA = .06 (.046 - .085). The time 1 common video game factor predicted higher levels of time 2 aggressive affect after controlling for previous levels of aggressive affect, and, in turn, time 2 aggressive affect predicted higher levels of time 3



Notes. Not shown are covariances among variables within each time point. Standardized coefficients are reported. *<.05, **<.01, ***<.001. Results for covariances and 95% CIs for standardized coefficients can be obtained from the first author. The significance levels for the unique associations between action/fighting video game play and aggressive affect, and between sports/racing video game play and aggressive affect, after controlling for the common video game play factor, were automatically calculated and reported in the standardized residual covariance matrix in the statistical output. These paths were not specified in the model due to insufficient degrees of freedom.

Figure 9. Final model results for young adults for analysis assessing the indirect predictive effects of the common video game play factor, sports/racing video game play, as well as action/fighting video game play on aggressive behavior through aggressive affect.

aggressive behavior after controlling for previous levels of aggressive behavior. Figure 9 summarizes the significant path estimates.

Given these significant direct predictive effects, we assessed the indirect predictive effects of the common video game play factor on time 3 aggressive behavior through time 2 aggressive affect. Using bias-corrected bootstrapping (bootstrap samples = 2,000), we found a significant indirect predictive effect for the common video game play factor $\beta = .01$, 95% CI [.001, .013], $p = .006$. Thus, the results provide support for an indirect mediation model (MacKinnon, Fairchild, & Fritz, 2007; Zhao, Lynch, & Chen, 2010) in which the common video game play variable uniquely predicted higher aggressive affect, and in turn, aggressive affect predicted higher aggressive behavior.

In contrast, the unique predictive effects of action/fighting video game play and sports/racing video game play on aggressive affect were not significant (*p*s > .05; the significance levels of these associations were automatically calculated and reported in the standardized residual covariance matrix in the statistical output) after controlling for the effect of the common video game play factor on aggressive affect, and for previous levels of aggressive affect. Consistent with the previous models, the pattern of results did not differ when adding the third variables into the model, so the more parsimonious model without the third variables is presented.

Gender as a moderator. Gender also was included as a moderator in each analysis and as predicted there were no significant differences in the pattern of findings as a function of gender (*p*s >.05 in χ^2_{diff} tests between constrained and unconstrained models).

Study 3b

In Study 3b we conducted a secondary longitudinal analysis of adolescents to address two main goals. First, we examined whether violent video game play (i.e., action/fighting games) and non-violent video game play (i.e., sports/racing games) each had unique long-term associations with aggression, and then compared the magnitude of these associations during this earlier developmental period. Second, we examined the long-term predictive effect of the commonality (e.g., competitiveness) between action/fighting video game play and sports/racing video game play on aggression. We re-analyzed data from Study 2 (Adachi and Willoughby, 2013a) in which a long-term bidirectional association between sports/racing video game play and aggression was demonstrated when action/fighting video game play was not directly included in the model. Consistent with longitudinal research demonstrating effects of action/fighting (violent) video game play on aggression (Willoughby et al., 2012), and recent research demonstrating effects of non-violent video games on aggression (e.g., Adachi & Willoughby, 2011b, 2013a, Breuer et al., 2013; Przybylski et al., 2014), we hypothesized that both sports/racing (non-violent) video game play as well as action/fighting (violent) video game play would be uniquely associated with aggression over time, and that the magnitude of these predictive effects would not significantly differ. In addition, we hypothesized that the commonality (e.g., competitiveness) among the two types of video game play would predict higher levels of aggression over time. Again, we did not have specific hypotheses regarding whether action/fighting video game play or sports/racing video game play would be uniquely associated with aggression after controlling for the predictive effect of their commonality on aggression. Also, consistent with previous research that has found no moderating effects of gender on the link between video game

play and aggression (Anderson et al., 2010), we hypothesized that gender would not moderate the associations between video game play and aggression.

Method

Participants. Students (N = 1,492; 50.8% female) from eight high schools encompassing a school district in Ontario, Canada took part in the study in grades 9, 10, 11, and 12 (M age in grade 9 = 13 years,10 months). This study was part of a larger cohort-sequential project. In the larger study, surveys were completed five times between 2003 and 2008, with some students starting the study in 2003 and others starting the study in 2004. The analyses for the present study are based on the cohort of students who entered the study in Grade 9 in 2004 and completed the survey in Grades 9, 10, 11, and 12. The overall participation rate ranged from 83% to 86% across the four time points; nonparticipation was due to student absenteeism (average of 13.5%), parental refusal (average of .06%), or student refusal (average of 1.4%). Student absenteeism from class was due to illness, a co-op placement, a free period, or involvement in another school activity. 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.). As missing data were not

dependent on the values of the study measures, it is reasonable to assume that this data is missing at random (Little & Rubin, 2002; Schafer & Graham, 2002). Missing data were estimated using the expectation maximization (EM) estimation method (see Adachi & Willoughby, 2013a for more information regarding the sample). Participants' frequency of video game play was not assessed in grade 9 or 10; therefore we used variables that were assessed in grades 11 and 12 in our analyses.

Procedure. Active informed assent was obtained from the adolescent participants. Parents were provided with written correspondence mailed to each student's home prior to the survey administration outlining the study; this letter indicated that parents could request that their adolescent not participate in the study. An automated phone message about the study also was left at each student's home phone number. This procedure was approved by the participating school board and the University Research Ethics Board. At all time periods, the questionnaire was administered to students in classrooms by trained research staff. Students were informed that their responses were completely confidential.

Measures. The study measures were assessed at all of the time periods with the exception of the demographics and the third variables which were assessed in grade 11.

***Aggressive behavior*.** Direct aggressive behavior was assessed with four items in the (e.g., How often have you pushed and shoved someone during the last year?) based on a 5-point scale (1 = *never* to 5 = *everyday*; Marini, Spear, & Bombay, 1999). Cronbach's alphas > .85, and higher composite scores indicated a higher frequency of aggressive behavior.

***Competitive and non-violent (sports/racing) video game play*.** Frequency of playing video games that are competitive and non-violent was assessed with two items, by asking participants how frequently they played sports video games (e.g., *FIFA Soccer*) on an average day and how frequently they played racing video games (e.g., *Gran Turismo*) on an average day, based on a 5-point scale (1 = *not at all* to 5 = *5 or more hours*). Higher composite scores indicated a higher frequency of sports/racing video game play.

***Competitive and violent (action/fighting) video game play*.** Frequency of playing video games that are competitive and violent was assessed with two items, by asking participants how frequently they played action video games (e.g., *God of War*) on an average day and how frequently they played fighting video games (e.g., *Mortal Kombat*) on an average day, based on a 5-point scale (1 = *not at all* to 5 = *5 or more hours*). Higher composite scores indicated a higher frequency of action/fighting video game play. Please note that in Study 2 we did not include these frequency variables of action/fighting video game play in the models, but instead we created a dichotomous moderator variable which assessed whether participants played action/fighting video games (yes/no) during any of the 4 high school years. Again, action/fighting video games have been shown to be rated as more violent than sports/racing video games, but matched in terms of ratings of competitiveness (e.g., Adachi & Willoughby, 2011a; Valadez & Ferguson, 2012).

***Third variables that were controlled*.**

Demographics. Gender, number of computers in the home, born in Canada (*yes*/*no*), ethnicity other than Canadian (*yes*/*no*), and parental education (one item per

parent, averaged for participants reporting on both parents, with a scale of 1 = *did not finish high school* to 6 = *professional degree, r* = .40) were used as covariates.

Involvement in sports. Involvement in sports was measured 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 = *every day*). The correlation between the two items was .50. Higher composite scores indicated higher frequency of involvement in sports.

Results and Discussion

Preliminary analyses. Table 6 outlines the means and standard deviations for the study variables. We examined mean differences in the main study variables (i.e., video game play and aggressive behavior) as a function of gender. A significant multivariate main effect was found (Wilks $\lambda < .001$, partial $\eta^2 = .40$). Overall, males reported more aggressive behavior, sports/racing video game play and action fighting video game play than females. All measures showed acceptable skewness and kurtosis with the exception of the video game variables. To address this issue of nonnormality, we used a log10[7] transformation on the grade 11 and grade 12 video game variables in the adolescent sample, which brought skewness and kurtosis to acceptable levels. These transformed variables were used in the subsequent analyses. Please note that Table 6 reflects the means and standard deviations of the untransformed variables.

The long-term bidirectional (cross-lagged) association between video game play and aggressive behavior among adolescents. In order to simultaneously assess the

[7] Consistent with recommendations by Graham (2009) and Shafter and Graham (2002), we transformed these variables prior to imputation.

Table 6

Means and Standard Deviations of the Study 3b Measures from the Adolescent Sample

Variable	*Scale Range*	*Grade 11* *M (SD)*	*Grade 12* *M (SD)*
Aggressive behavior	1-5	1.97 (0.89)	1.97 (0.95)
Sports/racing video game play	1-5	1.22 (0.43)	1.17 (0.38)
Action/fighting video game play	1-5	1.16 (0.38)	1.13 (0.34)
Gender	1-2	50.8% female	
Parental education	1-6	3.27 (1.03)	
# of computers in home		3.09 (.091)	
Involvement in sports	1-5	3.79 (1.19)	
Born in Canada	1-2	1.07 (.25)	
Ethnicity	1-2	1.15 (.36)	

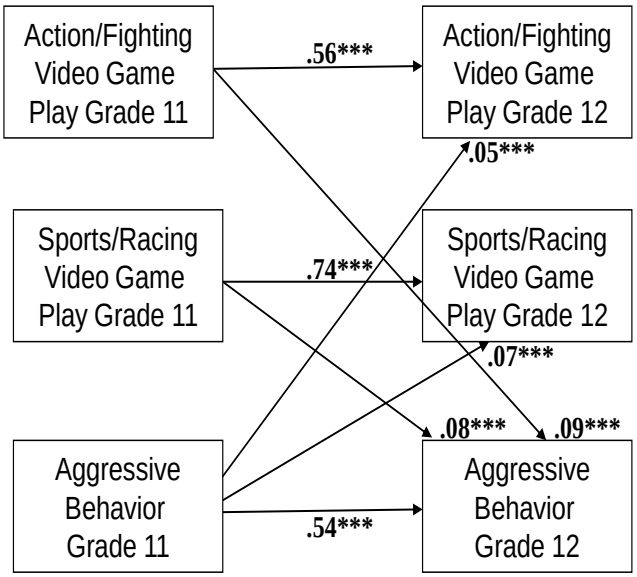
long-term bidirectional (cross-lagged) associations between sports/racing video game play and aggression, and between action/fighting video game play and aggression, among adolescents, we re-analyzed data from Adachi and Willoughby (2013a) in which a long-term bidirectional association between sports/racing video game play and aggression was demonstrated when action/fighting video game play was not directly included in the model. Specifically, we created a 2-time point autoregressive cross-lagged model in which paths were estimated from sports/racing video game play and action/fighting video game play in grade 11 to aggression in grade 12, and from aggression in grade 11 to sports/racing video game play and action/fighting video game play in grade 12. Stability paths within each variable also were specified, as well as covariances among the variables within each grade to control for common method variance. Because we were not interested in the longitudinal associations between the two types of video game play, we did not include bidirectional paths between the action/fighting and sports/racing variables. Model fit was adequate, $\chi^2(2) = 31.59$ $p < .001$, CFI = .99, RMSEA = .100 (.071 - .132).

In terms of socialization effects, sports/racing video game play in grade 11 predicted higher levels of aggressive behavior in grade 12 (β = .09, 95% CIs [.04, .14], p = .006) after controlling for aggressive behavior and action/fighting video game play in grade 11. Similarly, action/fighting video game play in grade 11 predicted higher levels of aggressive behavior in grade 12 (β = .08, 95% CIs [.03, .13], p = .017) after controlling for aggressive behavior and sports/racing video game play in grade 11. We also found evidence of selection effects, as aggressive behavior in grade 11 predicted higher levels

of sports/racing video game play in grade 12 (β = .08, 95% CIs [.04, .12], $p < .001$) after controlling for sports/racing video game play in grade 11.

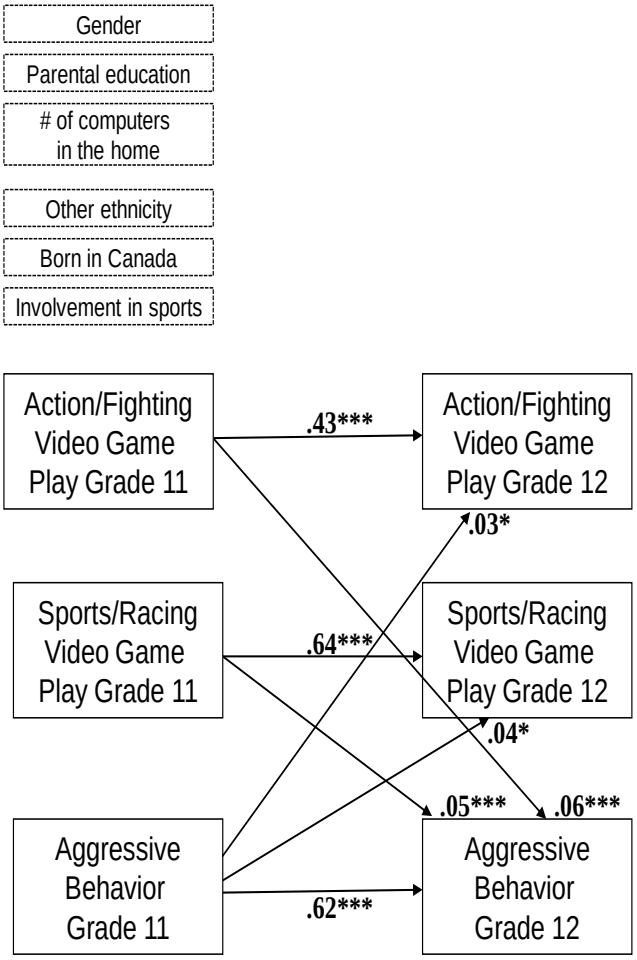
We then tested whether the socialization and selection effects between aggression and sports/racing video game play significantly differed in magnitude from the effects between aggression and action/fighting video game play (see Figure 10). Specifically, we compared a model in which the paths testing the effects of sports/racing video game play and action/fighting video game play on aggression over time were constrained to be equal, and the paths testing the effects of aggression on sports/racing video game play and on action/fighting video game play over time were constrained to be equal to the model in which these paths were unconstrained. The chi-square difference test of relative fit indicated that the constrained and unconstrained models did not significantly differ ($p > .05$). Similar to our analysis of young adults, therefore, the socialization and selection effects between aggression and sport/racing video game play, and between aggression and action/fighting video game play, did not differ in magnitude, suggesting that violent video game play and non-violent video game play each had unique longitudinal associations with aggression, which were similar in size. Figure 10 summarizes the significant path estimates.

The long-term bidirectional (cross-lagged) association between video game play and aggressive behavior among adolescents when adding third variables. Next, we tested whether the associations between aggression and sports/racing video game play, and between aggression and action/fighting video game play were robust after controlling for the third variables (i.e., gender, parental education, number of computers in the home, born in Canada, ethnicity other than Canadian, and involvement in sports in



Notes. Not shown are covariances among variables within each time point. Standardized coefficients are reported. *<.05, **<.01, ***<.001. Results for covariances and 95% CIs for standardized coefficients can be obtained from the first author.

Figure 10. Final model results for adolescents for analysis assessing the long-term bidirectional associations between sports/racing video game play and aggressive behavior, and between action/fighting video game play and aggressive behavior.



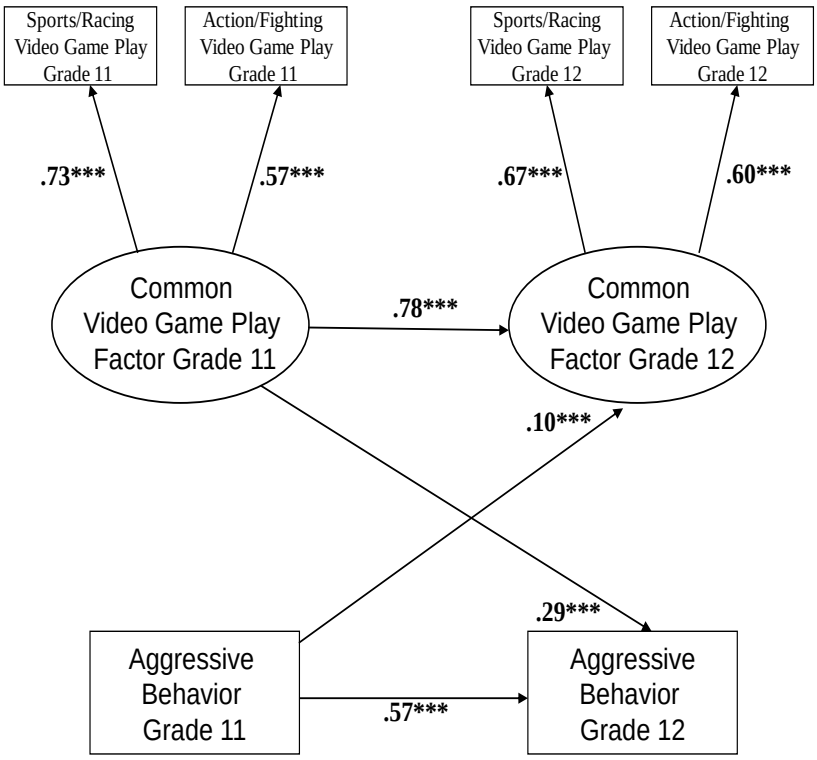
Notes. Third variables are indicated with dashed lines. Not shown are covariances among variables within each time point or paths related to third variables. Standardized coefficients are reported. *<.05, **<.01, ***<.001. Results for third variables, covariances, and 95% CIs for standardized coefficients can be obtained from the first author.

Figure 11. Final model results for adolescents for analysis assessing the long-term bidirectional associations between sports/racing video game play and aggressive behavior, and between action/fighting video game play and aggressive behavior, controlling for the third variables.

grade 11). The bidirectional associations between aggression and sports/racing video game play, and between aggression and action/fighting video game play remained significant even after controlling for all of the third variables, as well as stability in aggression (see Figure 11).

The long-term bidirectional (cross-lagged) association between the commonality among action/fighting and sports/racing video game play (i.e., the latent factor), and aggressive behavior. In order to simultaneously assess the long-term bidirectional (cross-lagged) association between aggression and the commonality (e.g., competitiveness) among action/fighting and sports/racing video game play, we modified the 2-time period autoregressive cross-lagged model by creating a latent factor to represent the commonality between the two types of video game play at each time point (i.e., the common video game play factor). Bidirectional paths were estimated across each adjacent grade between the latent factor and aggression. Model fit was adequate, $\chi^2(3) = 38.56$, $p < .001$, CFI = .99, RMSEA = .089 (.065 - .115). All factor loadings were significant at $p < .001$. In terms of socialization effects, the grade 11 common video game play factor predicted higher levels of aggressive behavior in grade 12, after controlling for previous levels of aggressive behavior. In terms of selection effects, grade 11 aggressive behavior predicted higher levels of the grade 12 common video game play factor, after controlling for previous levels of the common video game play factor. Figure 12 summarizes the significant path estimates.

In contrast, the unique longitudinal associations between action/fighting video game play and aggression, and between sports/racing video game play and aggression were not significant (*p*s > .05; the significance levels of these associations were



Notes. Not shown are covariances among variables within each time point. Standardized coefficients are reported. *<.05, **<.01, ***<.001. Results for covariances and 95% CIs for standardized coefficients can be obtained from the first author. The significance levels for the unique associations between action/fighting video game play and aggression, and between sports/racing video game play and aggression, after controlling for the common video game play factor, were automatically calculated and reported in the standardized residual covariance matrix in the statistical output. These paths were not specified in the model due to insufficient degrees of freedom.

Figure 12. Final model results for adolescents for analysis assessing the long-term bidirectional associations between the common video game play factor and aggressive behavior, between sports/racing video game play and aggressive behavior, and between action/fighting video game play and aggressive behavior.

automatically calculated and reported in the standardized residual covariance matrix in the statistical output) after controlling for the association between the common video game play factor and aggression, and for previous levels of aggression. Consistent with the previous models, the pattern of results did not differ when adding the third variables into the model, so the more parsimonious model without the third variables is presented.

Gender as a moderator. Gender also was included as a moderator in each analysis and as predicted there were no significant differences in the pattern of findings as a function of gender (*p*s >.05 in χ^2_{diff} tests between constrained and unconstrained models).

General Discussion

To date, the majority of research on the link between video game play and aggression has been focused on the violent content in games (e.g., see meta-analytic reviews by Anderson et al., 2010; Ferguson, in press; Greitemeyer & Mügge, 2014); however, recent research also has demonstrated effects of *non-violent* video game play on aggression (e.g., Adachi & Willoughby, 2011b; 2013a; Breuer, Scharkow, & Quandt, 2013; Przybylski, Deci, Rigby, & Ryan, 2014). In addition, researchers recently have demonstrated a link between video game *competition* and aggression, representing an important new direction in the video game and aggression literature (e.g., Adachi & Willoughby, 2011a, 2011b, 2013a; Breuer et al., 2013; Schmierbach, 2010). Longitudinal research on this topic is still in its infancy, however, and thus represents an exciting new area for discovery. Overall, the current research makes several important contributions to our understanding of the long-term association between video game play and aggression.

First, we addressed the fundamental question of whether violent video game play (i.e., action/fighting games) and non-violent video game play (i.e., sports/racing games) each have unique long-term associations with aggression. We found that action/fighting and sports/racing video game play each were uniquely associated with aggression over time among both young adults and adolescents, and that these associations did not differ in magnitude. Thus, these findings suggest that the long-term link between video game play and aggression is not limited to violent video games.

Second, we were interested in investigating the longitudinal association between video game competition and aggression. Given that past research has shown that action/fighting video games are more violent than sports/racing video games, but are matched in terms of competitiveness (e.g., Adachi & Willoughby, 2011b; Valadez & Ferguson, 2013), we examined the long-term predictive effect of the commonality (e.g., competitiveness) between action/fighting video game play and sports/racing video game play on aggression. In other words, by modeling the commonality between sports/racing video game play and action/fighting video game play in a latent video game play factor, we were able to separate the common elements (e.g., competitiveness) of these different types of video game play from the unique elements (e.g., violence in action/fighting games), and then examine the predictive effects of both the common elements and the unique elements on aggression over time. Importantly, we found that the commonality between the two types of video game play (i.e., the common video game play factor) was significantly associated with aggression over time among both young adults and adolescents. Thus, we hypothesized that the tendency toward video game competitiveness was at least partially, if not fully responsible for the effect of the common video game

play factor on aggression. In contrast, there were no significant unique associations between aggression and action/fighting video game play, and between aggression and sports/racing video game play, after controlling for the association between the common video game play factor and aggression. This finding suggests that the commonality between the two types of video game play is a more robust longitudinal predictor of aggression than the unique elements of each type of video game play (e.g., violence in action/fighting video games). Furthermore, this finding is consistent with an emerging literature on the link between competitive video game play and aggression (e.g., Adachi & Willoughby, 2011b, 2013a; Breuer, Scharkow, & Quandt, 2013; Schmierbach, 2010).

Third, we examined whether aggressive affect (i.e., anger and hostility) is an underlying mechanism of the long-term link between video game play and aggression. In our initial model which did not include the common video game play factor as a predictor of aggressive affect, we found that action/fighting and sports/racing video game play each uniquely predicted aggressive behavior through aggressive affect over time, suggesting that both violent and non-violent video game play may share this common mechanism. Furthermore, after including the common video game play factor into the model, we found that the common video game play factor significantly predicted aggressive behavior through aggressive affect over time, whereas neither action/fighting video game play or sports/racing video game play uniquely predicted aggressive affect. This finding suggests that aggressive affect may be an underlying mechanism of the predictive effect of the commonality between action/fighting and sports/racing video game play (e.g., competitiveness) on aggressive behavior, consistent with the frustration-aggression hypothesis.

It also is important to note that in addition to socialization effects (i.e., the predictive effect of the common video game play factor on aggression), we also found evidence of selection effects (e.g., the predictive effect of aggression on the common video game play factor). A possible explanation for why more aggressive adolescents and young adults may be more attracted to the common elements of action/fighting and sports/racing video games, such as competition, than less aggressive adolescents and young adults concerns how competitive situations are conceptualized. According to Anderson and Morrow (1995), competitive situations often are thought of as aggressive. For example, the goal of inflicting physical or psychological harm to an opponent in sports games and debates might be normative among competitors, as they often are encouraged to "demolish, destroy, or blow away their opponents" (Anderson & Morrow, 1995, p. 1021). Furthermore, Anderson and Morrow argue that as competitive situations occur early in life, the conceptualization of competitive situations as aggressive may occur at an early age. More aggressive adolescents and young adults, therefore, may self select into competitive situations to a greater degree than less aggressive adolescents and young adults.

Given that people can discern reality from fantasy at an early age and that this ability continues to improve over time (Ferguson & Dyck, 2012), it makes sense that video game competition may be a more robust long-term predictor of aggression than other fictional elements of video games, because video game competition involves the *real threat* of losing to an opponent. Indeed, the main goal of competitive video games (both violent and non-violent) is to win the competition (e.g., to win the violent shooting battle or to win the non-violent race) against either real opponents (i.e., a human

opponent) or fantasy opponents (i.e., a computer-generated opponent). Competitive video games, therefore, involve the real threat of losing to an opponent, and this real threat of intentional goal thwarting may trigger feelings of anger and hostility, and, in turn, aggressive behavior.

In addition, the present findings have important developmental implications for the long-term link between video game play and aggression. Specifically, we are the first to demonstrate that video game play has a long-term association with aggressive behavior among young adults, not just adolescents. This finding is consistent with the notion that young adults sometimes may have difficulty regulating their arousal due in part to the ongoing maturation of the prefrontal cortex (Giedd, 2008; Steinberg, 2010), and thus may be susceptible to the effects of competitive video game play on aggression, similar to adolescents. Long-term predictive effects of video games on aggression, therefore, are not limited to earlier periods of development. This is an important finding considering the high prevalence of video game play among young adults (Lenhart, 2008).

Links with a Motivational Theory of Aggression

While the current study was grounded in the frustration-aggression hypothesis (Dollard et al., 1939; Berkowtiz, 1989), the findings also are consistent with a prominent theory of human motivation, Self-Determination Theory (SDT; Deci & Ryan, 2000; Ryan & Deci, 2000), which has been applied to the link between video game play and aggression. SDT focuses primarily on the extent to which social contexts satisfy three universal human needs: competence (sense of efficacy), autonomy (personal agency), and relatedness (social connectedness). According to SDT, the satisfaction of these needs facilitates optimal functioning, intrinsic motivation, and well-being. In contrast, the

impedance (or threat of impedance) of these needs undermines intrinsic motivation and may promote human aggression (e.g., Ryan, Deci, Grolnick, & La Guardia, 2006; Ryan & Grolnick, 1986; Weinstein, Hodgins, & Ostvik-White, 2011).

Recently, researchers have applied an SDT-based approach to study the effect of video game play on aggression (see Pryzbylski, Rigby, & Ryan, 2010). Przybylski et al. (2014) demonstrated that competence impedance in video games produced elevations in aggressive thoughts, feelings, and behavior using both experimental and correlational methodology. For example, they found that more difficult video games impeded participants' competence satisfaction to a greater degree compared to less difficult video games, and, in turn, competence impedance predicted higher levels of aggression. Furthermore, violent content was not found to be a significant predictor of motivational or aggressive outcomes in these studies, suggesting that human need satisfaction/thwarting, but not violent content, had robust associations with attitudes and behaviour.

An SDT-based approach also could be applied to the link between competitive video game play and aggression. While the frustration-aggression hypothesis suggests that the impedance (or the threat of impedance) of one's goal of winning a video game competition may influence aggressive affect, and, in turn, aggressive behavior (Berkowitz, 1989), an SDT-based approach predicts that the critical impedance is at the fundamental level of need satisfaction (e.g., competence need impedance), which, in turn, may elevate aggression (Przybylski et al., 2014).

Directions for Future Research

The common video game play factor in our analyses represents the commonality between action/fighting and sports/racing video game play. As previously discussed, competitiveness is a common element of these games. Furthermore, research has demonstrated an association between competitive video game play and aggression (e.g., Adachi & Willoughby, 2011b, 2013; Breuer et al., 2013; Schmierbach, 2010). Thus, we hypothesized that the tendency toward video game competitiveness was at least partially, if not fully responsible for the effect of the common video game play factor on aggression. Yet, it is important to note that there may be other common elements between these two types of video game play that contribute to this effect. For example, researchers have found that action/fighting and sports/racing video game play also tend to be similar in terms of their pace of action (e.g., Adachi & Willoughby, 2011b; Valadez & Ferguson, 2013). It is less clear whether the pace of action in these games would contribute to this effect, however, given that recent research has failed to find a short-term effect of pace of action on aggression (Elson, Breuer, Van Looy, Kneer, & Quandt, 2013). In addition, the common video game play factor also may include personality elements such as surgency or sensation-seeking, which may contribute to the effect on aggression. Furthermore, the common video game play factor may tap into the extent to which individuals play a lot of video games in general (i.e., being a "gamer"). Specifically, individuals who frequently play a lot of video games in general likely would play both action/fighting and sports/racing video games frequently. Thus, it may be the high frequency of video game play in general that predicts aggression over time. However, given that previous research has failed to find a significant long-term link between the frequency of video game play in general and aggression (e.g., Willoughby et al., 2012), it is unclear whether being a

gamer is associated with aggression over time. Future research should aim to tease apart the specific common elements between action/fighting and sports/racing video game play, therefore, and elucidate which common elements are associated with aggression.

In addition, it is important to note that aggressive affect may not be the only long-term mechanism through which the commonality between action/fighting and sports/racing video game play predicts aggression over time. For example, competition may activate networks of aggressive thoughts through aggressive cues, such as the perception of threat, consistent with Berkowitz's (1990) cognitive neoassociation model (Adachi & Willoughby, 2013a). Furthermore, repeated exposure to competitive situations that result in aggressive outcomes may strengthen associative links between competition and aggression (Anderson & Carnagey 2009; Anderson & Morrow 1995), which, in turn, may make competitive video game players more likely to react aggressively to competitive experiences in general. Thus, cognitive routes such as aggressive perceptual and expectation schemata, also should be examined. To date, researchers (e.g., Anderson et al., 2007; Möller & Krahé, 2009) who have examined cognitive mechanisms (normative beliefs about aggression and hostile attribution bias) of the longitudinal link between video game play and aggression measured these potential mechanisms and aggression (the outcome variable) concurrently, and thus it is not clear whether cognitive mechanisms predict aggression over time.

There also are developmental questions regarding the link between video game play and aggression that should be addressed by future research. Specifically, after demonstrating a long-term predictive effect of video game play on aggression among adolescents and young adults, researchers should investigate whether these long-term

effects also are present during later developmental periods. For example, a large-scale study of American adults revealed that 60% of adults aged 30 to 49 years reported playing video games (Lenhart et al., 2008). It is unclear, however, whether video game play is associated with aggression among adults, as video game and aggression research with this older age group is scarce. Specifically, young adults may be more likely to behave aggressively after playing a video game than adults, due in part to the Dual Systems Model's hypothesis that young adults' sometimes may have greater difficulty in regulating their arousal in comparison to adults (Giedd, 2008; Steinberg, 2010).

In contrast, the link between video game play and aggression may be similar among adults, young adults, and adolescents, as researchers suggest that in the presence of strong emotions or high arousal, adults also engage in risky behaviors (e.g., Willoughby, Good, Adachi, Hamza, & Tavernier, 2013). For example, similar to the dual systems model (Steinberg, 2007;2008), the dual process models of decision making, which have been studied extensively with adult populations in the fields of social/cognitive psychology and behavioral economics (e.g., Evans & Stanovich, 2013; Hofmann, Friese, & Strack, 2009; Kahneman, 2011; Slovic, Finucane, Peters, & MacGregor, 2002; Strack & Deutsch, 2004), posit that there is a fast, intuitive, automatic system, which often is reliant on affect and current emotions for making decisions (''system 1''), versus a slow, controlled, and reflective system (''system 2''). Importantly, researchers have shown that adults also engage in many errors of judgment and choice and that system 1 often is the source of many of these errors (e.g., Kahneman, 2011; Slovic et al., 2002). Because video game play may elevate levels of aggressive affect such as anger and hostility, playing video games may activate adults' system 1,

making them more likely to act on their aggressive impulses. Future research would benefit from direct tests of these questions by examining whether the long-term link between video game play and aggression differs between young adults and adults, as well as by conducting longitudinal studies over a longer time span (e.g., from childhood to adulthood).

Limitations

An important limitation of the present research stems from the reliance on self-report measures. Reports of video game use and aggression would benefit from corroboration from other informants (e.g., friends). It is not clear, however, whether anyone other than the young adult 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. Nonetheless, the inclusion of peer assessment may be a key factor in increasing our knowledge of how often young adults play video games with friends and peers.

In addition, the structural paths that were significant in the autoregressive path analyses were small in magnitude. However, considering that aggressive affect and aggressive behavior were highly stable over time, controlling for these stability effects removed a large portion of variance in the aggressive affect and aggressive behavior outcome variables that was shared with the video game play predictor variables, and thus small predictive effects of change in levels of these variables were expected (Adachi & Willoughby, 2014). Indeed, these effect sizes are common in longitudinal models when controlling for stability between adjacent time points of data and accounting for

concurrent associations among variables within each time point[8] (e.g., Adachi & Willoughby, 2013a, 2013b, 2013c). Moreover, effect sizes often are smaller when there is considerable time between measurements (i.e., a year) versus shorter lags in time (e.g., a month). We may expect larger effects in future longitudinal research that employs shorter durations between measurements.

Another possible concern may be that, because a few sports and racing games might contain some aggressive content, it may be this aggressive content, rather than the competitive content, that was associated with aggression in the present research. However, we think this is unlikely given that previous research has demonstrated that competitive gambling activities also have a significant long-term association with aggression that is similar in magnitude to competitive video game play, even though gambling does not involve any violence or aggression (Adachi & Willoughby, 2013a). In addition, our findings are consistent with an experiment that demonstrated that it was the competitive content rather than the violent content that influenced aggression (Adachi & Willoughby, 2011a).

Also, although the types of video game play (action/fighting and sports/racing games) assessed in our study have been shown to be matched in terms of competitiveness but different in terms of violence (e.g., Adachi & Willoughby, 2011b; Valadez & Ferguson, 2013), our measures did not explicitly assess participants' ratings of the competitiveness and violence in these games. Future research could add to our findings

[8] It is important to note that we are not suggesting that small effects in autoregressive models are *always* important. The importance of these effects should be assessed individually on a case by case basis (see Adachi & Willoughby, 2014).

by having participants rate sports/racing and action/fighting video game genres in terms of violence and competitiveness, in addition to measuring frequency of play, in order to examine whether ratings of competitiveness and violence have unique long-term associations with aggression.

In addition, it is important to note that if the indicators of a latent factor are highly correlated (e.g., $r > .80$) , then there will be minimal residual variance in the indicators (e.g., action/fighting and sports/racing video game play) that could be associated with other variables in the model (e.g., aggression). However, given that the correlations between the indicators of the common video game play factor (i.e., sports/racing and action/fighting video game play) ranged from .35 to .57 in the current studies, the potential issue of minimal residual variance in the indicators is less of a concern. Finally, the present studies used samples of North American university students and high school students, and thus findings may not generalize to other geographic regions, including those with differing ethnic and/or demographic populations.

Conclusion

Overall, the present research represents an important advance in our understanding of the long-term link between video game play and aggression. First, we demonstrated that violent video game play (action/fighting games) and non-violent video game play (sports/racing games) each have similar long-term associations with aggression. Next, we found a long-term predictive effect of the common video game play factor (e.g., competitiveness) on aggression. Importantly, the unique associations between aggression and action/fighting video game play, and between aggression and sports/racing video game play, were no longer significant after controlling for the

association between aggression and the common video game play factor. In addition, we elucidated that aggressive affect is an underlying mechanism of this link, consistent with the frustration-aggression hypothesis. The current findings also have important developmental implications, as we are the first to find evidence of these long-term associations among young adults in addition to adolescents. The long-term predictive effect of video game play on aggressive behavior, therefore, is not limited to earlier periods of development. In addition, the fact that we had three time points of longitudinal data of young adults and two time points of longitudinal data of adolescents is an important strength of the current research, as it allowed us to examine the bidirectional associations between video game play and aggressive behavior over the long-term. Ultimately, our findings suggest that researchers should continue to critically examine elements of video game play, beyond the violent content, that are associated with aggression.

References

Adachi, P. J. C., & Willoughby, T. (2014). Interpreting effect sizes when controlling for stability effects in longitudinal autoregressive models: Implications for psychological science. *European Journal of Developmental Psychology*. doi:10.1080/17405629.2014.963549

Adachi, P. J. C., & Willoughby, T. (2011)a. The effect of violent video games on aggression: Is it more than just the violence? *Aggression and Violent Behavior, 16,* 55-62. doi:10.1016/j.avb.2010.12.002

Adachi, P. J. C., & Willoughby, T. (2011)b. The effect of video game competition and violence on aggressive behavior: Which characteristic has the greatest influence? *Psychology of Violence, 1,* 259-274. doi:10.1037/a0024908

Adachi, P. J. C., & Willoughby, T. (2013)a. Demolishing the competition: The longitudinal link between competitive video games, competitive gambling, and aggression. *Journal of Youth and Adolescence, 42,* 1090-1104. doi:10.1007/s10964-013-9952-2

Adachi, P. J. C., & Willoughby, T. (2013)b. It's not how much you play, but how much you enjoy the game: The longitudinal associations between adolescents' self-esteem and the frequency versus enjoyment of involvement in sports. *Journal of Youth and Adolescence*. doi: 10.1007/s10964-013-9988-3

Adachi, P. J. C., & Willoughby, T. (2013)c. More than just fun and games: The longitudinal relationships between strategic video games, self-reported problem solving skills, and academic grades. *Journal of Youth and Adolescence, 42,* 1041-1052. doi:10.1007/s10964-013-9913-9

Anderson, C. A., & Carnagey, N. L. (2009). Causal effects of violent sports video games on aggression: Is it competitiveness or violent content? *Journal of Experimental Social Psychology*, *45*, 731-739. doi:10.1016/j.jesp.2009.04.019

Anderson, C.A., & Dill, K.E. (2000). Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. *Journal of Personality and Social Psychology, 78,* 772-790. doi:10.1037//O022-3514.78.4.772

Anderson, C. A., Gentile, D. A., & Buckley, K. E. (2007). Violent video game effects on children and adolescents. New York: Oxford University Press.

Anderson, C. A., Ihori, N., Bushman, B. J., Rothsetin, H, R., Shibuya, A., Swing, E. L., Sakamoto, A., Saleem, M. (2010). Video Game effects on aggression, empathy, and prosocial behavior and eastern and western countries: A meta-analytic review. *Psychological Bulletin*, *136*, 151-173. doi:10.1037/a0018251

Anderson, C. A., & Morrow, M. (1995). Competitive aggression without interaction: Effects of competitive versus cooperative instructions on aggressive behavior in video games. *Personality and Social Psychology Bulletin*, *21*, 1020-1030.

Arbuckle, J. L. (1995–2013). AMOS 22 User's Guide. Crawford, FL: AMOS Development Corporation.

Barlett, C. P., Branch, O., Rodeheffer, C., & Harris, R. (2009). How long do the short-term violent video game effects last? *Aggressive Behavior*, *35*, 1−12. doi:10.1002/ab.20301

Berkowitz, L. (1989). Frustration-aggression hypothesis: Examination and reformulation. *Psychological Bulletin, 106,* 59–73. doi:10.1037/0033-2909.106.1.59

Berkowitz, L. (1990). On the formation and regulation of anger and aggression: A cognitive-neoassociationistic analysis. *American Psychologist, 45,* 494-503. doi:10.1037/0003-066X.45.4.494

Berkowitz, L. (1962). *Aggression: A social psychological analysis.* NewYork: McGraw-Hill.

Biscotti, F., Blau, B., Lovelock, J-D., Nguyen, T. H., Erensen, J., Verma, S., Liu, V. (2011). *Market trends: Gaming ecosystem, 2011*. Retrieved from Gartner Newsroom: http://www.gartner.com/it/page.jsp?id=1737414.

Boerger, E. A., Tullos, A., & Woolley, J. D. (2009). Return of the Candy Witch: Individual differences in acceptance and stability of belief in a novel fantastical being. *British Journal of Developmental Psychology, 27*, 953–970. doi:10.1348/026151008X398557

Breuer, J., Scharkow, M., & Quandt, T. (2013). Sore losers? A reexamination of the frustration-aggression hypothesis for collocated video game play. *Psychology of Popular Media Culture*. doi:10.1037/ppm0000020

Breuer, J. Vogelgesang, J., Quandt, T., Festl, R. (in press). Violent video games and physical aggression: Evidence for a selection effect among adolescents. *Psychology of Popular Media Culture*. doi:10.1037/ppm0000035

Buss, A. H., & Perry, M. (1992). The aggression questionnaire. *Journal of Personality and Social Psychology, 63,* 452–459. doi:10.1037/0022-3514.63.3.452

Carnagey, L. N., & Anderson, C. A. (2005). The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychological Science, 16,* 882-889. doi:10.1111/j.1467-9280.2005.01632.x

Corriveau, K. H., Kim, A. L., Schwalen, C. E., & Harris, P. L. (2009). Abraham Lincoln and Harry Potter: Children's differentiation between historical and fantasy characters. *Cognition*, *113*, 213–225. doi:10.1016/j.cognition.2009.08.007

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*, 227–268. doi:10.1207/S15327965PLI1104_01

Diamond, P. M., & Magaletta, P. R. (2006). The Short-Form Buss-Perry Aggression Questionnaire (BPAQ-SF): A validation study with federal offenders. *Assessment*, *13*, 227-240. doi:10.1177/1073191106287666

Diamond, P. M., Wang, E. W., & Buffington-Vollum, J. (2005). Factor structure of the Buss-Perry Aggression Questionnaire (BPAQ) with mentally ill male prisoners. *Criminal Justice and Behavior, 32*, 546-564. doi:10.1177/0093854805278416

Dinan, S. (2013, January 16). Critics of violent film, video games note the call for study, not controls. *The Washington Times*. Retrieved from http://www.washingtontimes.com

Dodge, K. A., Coie, J. D., & Lynam, D. (2006). Aggression and antisocial behavior in youth. In N. Eisenberg, W. Damon & R.M. Lerner (Eds.), Handbook of child psychology (6th ed.): Social, emotional, and personality development (Vol. 3, pp. 719–788). New Jersey: Wiley.

Dollard, J., Miller, N. E., Doob, L. W., Mowrer, O. H., & Sears, R. R. (1939). *Frustration and aggression.* New Haven, CT: Yale University Press.

Dosenbach, N. U. F., Petersen, S. E., & Schlaggar, B. L. (2013). The teenage brain: Functional connectivity. *Current Directions in Psychological Science, 22*(2), 101-107. doi:10.1177/0963721412474297

Elson, M., Breuer, J., Van Looy, J., Kneer, J., & Quandt, T. (2013). Comparing apples and oranges? Evidence for pace of action as a confound in research on digital game and aggression. *Psychology of Popular Media Culture*. doi:10.1037/ppm0000010

Eluvathingal, T., Hasan, K., Kramer, L., Fletcher, J., & Ewing-Cobbs, L. (2007). Quantitative diffusion tensor tractography of association and projection fibers in normally developing children and adolescents. *Cerebral Cortex, 17*, 2760-2768. doi:10.1093/cercor/bhm003

Engelhardt, C. R., Bartholow, B. D., Saults, J. S. (2011). Violent and nonviolent video games differentially affect physical aggression for individuals high vs. low in dispositional anger. *Aggressive Behavior*, *37*, 539-546. doi:10.1002/ab.20411

Ernst, M., Pine, D. S., & Hardin, M. (2006). Triadic model of the neurobiology of motivated behavior in adolescence. Psychological Medicine, 36(3), 299–312 doi:10.1017/S0033291705005891

Evans, J. St. B. T., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science*, *8*, 223–241. doi:10.1177/1745691612460685

Ferguson, C. J. (in press). Do angry birds make for angry children? A meta-analysis of video game influences on children's and adolescents' aggression, mental health,

prosocial behavior and academic performance. *Perspectives on Psychological Science*.

Ferguson, C. J. (2013). Violent video games and the Supreme Court: Lessons for the scientific community in the wake of Brown v EMA. *American Psychologist, 68*(2), 57-74. doi:10.1037/a0030597

Ferguson, C. J. (2011). Video games and youth violence: A prospective analysis in adolescents. *Journal of Youth and Adolescence, 40*, 377–391. doi:10.1007/s10964-010-9610-x

Ferguson, C. J., & Dyck, D. (2012). Paradigm change in aggression research: The time has come to retire the General Aggression Model. *Aggression and Violent Behavior, 17*, 220-228. doi:10.1016/j.avb.2012.02.007

Ferguson, C. J., Garza, A., Jerabeck, J., Ramos, R., & Galindo, M. (2013). Not worth the fuss after all? Cross-sectional and prospective data on violent video game influences on aggression, visuospatial cognition and mathematics ability in a sample of youth. *Journal of Youth and Adolescence, 42*(1), 109-122. doi:10.1007/s10964-012-9803-6

Ferguson, C. J., & Kilburn, J. (2010). Much ado about nothing: The misestimation and overinterpretation of violent video game effects in eastern and western nations: Comment on Anderson et al. (2010). *Psychological Bulletin*, *136*, 174-178. doi:10.1037/a0018566

Ferguson, C. J., & Olson, C. K. (2014). Video game violence use among “vulnerable” populations: The impact of violent games on delinquency and bullying among

children with clinically elevated depression or attention deficit symptoms. *Journal of Youth and Adolescence, 43*(1), 127-136. doi:10.1007/s10964-013-9986-5

Ferguson, C. J. & Rueda, S. M. (2010). The Hitman study: Violent video game exposure effects on aggressive behavior, hostile feelings and depression. *European Psychologist, 15*(2), 99-108. doi:10.1027/1016-9040/a000010

Ferguson, C. J., Rueda, S. M., Cruz, A. M., Ferguson, D. E., Fritz, S., & Smith, S. M. (2008). Violent video games and aggression: Byproduct of family violence and intrinsic violence motivation? *Criminal Justice and Behavior, 35*, 311-332. doi:10.1177/0093854807311719

Ferguson, C. J., San Miguel, C., Garza, A., & Jerabeck, J. (2012). A longitudinal test of video game violence effects on dating violence, aggression and bullying: A 3-year longitudinal study of adolescents. *Journal of Psychiatric Research, 46,* 141-146. doi:10.1016/j.jpsychires.2011.10.014

Giedd, J. N. (2008). The teen brain: Insights from neuroimaging. *Journal of Adolescent Health, 42*(4), 335-343. doi:10.1016/j.jadohealth.2008.01.007

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology, 60,* 549-576. doi:10.1146/annurev.psych.58.110405.085530

Greitemeyer, T., & Mügge, D. O. (2014). Video games do affect social outcomes: A meta-analytic review of the effects of violent and prosocial video game play. *Personality and Social Psychology Bulletin, 40,* 578-589. doi:10.1177/0146167213520459

Hofmann, W., Friese, M., & Strack, F. (2009). Impulse and self-control from a dual systems perspective. *Perspectives on Psychological Science, 4*, 162–176. doi:10.1111/j.1745-6924.2009.01116.x

Huesmann, L. R. (2010). Nailing the coffin shut on doubts that violent video games stimulate aggression: Comment on Anderson et al. (2010). *Psychological Bulletin, 136*, 179-181. doi:10.1037/a0018567

Kahneman, D. (2011). Thinking, fast and slow. NY: Farrar, Straus, and Giroux.

Krahé, B., & Möller, I. (2010). Longitudinal effects of media violence on aggression and empathy among german adolescents. *Journal of Applied Developmental Psychology, 31*, 401-409. doi:10.1016/j.appdev.2010.07.003

Kulik, J. A., & Brown, R. (1979). Frustration, attribution of blame, and aggression. *Journal of Experimental Social Psychology*, *15*, 183-194. doi:10.1016/0022-1031(79)90029-5

Lenhart, A., Jones, J., & Macgill, A. R. (2008). *Adults and video games*. Washington, DC: Pew Internet and American Life Project.

Loeber, R., Stoughamer-Loeber, M. (1998). Development of juvenile aggression and violence: Some common misconceptions and controversies. *American Psychologist, 53,* 242-259. doi:10.1037/0003-066X.53.2.242

MacKinnon, D. P., Fairchild, A. J., & Fritz, M. S. (2007). Mediation analysis. *Annual Review of Psychology, 58*, 593-614. doi: 10.1146/annurev.psych.58.110405.085542

Marini, Z., Spear, S., & Bombay, K. (1999). Peer victimization in middle childhood: Characteristics, causes, and consequences of bullying. *Brock Education, 9,* 32–47.

Miller, G. A., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology, 110,* 40-48. Doi:10.1037//0021-843X.110.1.40

Maldonado-Molina, M. M., Jennings, W. G., & Komro, K. A. (2010). Effects of alcohol on trajectories of physical aggression among urban youth: An application of latent trajectory modeling. *Journal Of Youth And Adolescence, 39*(9), 1012-1026. doi:10.1007/s10964-009-9484-y

Möller, I., & Krahé, B. (2009). Exposure to violent video games and aggression in German adolescents: A longitudinal analysis. *Aggressive Behavior, 35*, 75-89. doi:10.1002/ab.20290

Muthén, L. K., & Muthén, B. O. (1998 –2010). *Mplus user's guide* (6th ed.). Los Angeles, CA: Muthén & Muthén.

Paus, T. (2009). Brain development. In R. M. Lerner & L. Steinberg (Eds.), *Handbook of adolescent psychology: Individual bases of adolescent development.* Vol. 1, 3rd ed, pp. 95-115. NJ: Wiley.

Pryzbylski, A. K., Deci, E. L., Rigby, C. S., & Ryan, R. M. (2014). Competence-impeding electronic games and players' aggressive feelings, thoughts, and behaviors. *Journal of Personality and Social Psychology, 106*(3), 441-57. doi:10.1037/a0034820

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A motivational model of videogame engagement. *Review of General Psychology, 14*, 154-166. doi:10.1037/a0019440

Ryan, R. M., & Deci, E. L. (2000). Self-Determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78. doi:10.1037/0003-066X.55.1.68

Ryan, R. M., Deci, E. L., Grolnick, W. S., & LaGuardia, J. G. (2006). The significance of autonomy and autonomy support in psychological development and psychopathology. In D. Cicchetti & D. Cohen (Eds.), *Developmental psychopathology: Vol. 1. Theory and methods* (2nd ed., pp. 295–849). New York, NY: Wiley.

Ryan, R. M., & Grolnick, W. S. (1986). Origins and pawns in the classroom: Self-report and projective assessments of individual differences in children's perceptions. *Journal of Personality and Social Psychology, 50*, 550–558. doi:10.1037/0022-3514.50.3.550

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. Psychological Methods, 7, 147–177. doi:10.1037/1082-989X.7.2.147

Schmierbach, M. (2010). "Killing spree": Exploring the connection between competitive game play and aggressive cognition. *Communication Research, 37*, 256-274. doi:10.1177/00 93650209356394

Slovic, P., Finucane, M., Peters, E., & MacGregor, D.G. (2002). Rational actors or rational fools: Implications of the affect heuristic for behavioral economics. *Journal of Socio-Economics, 31,* 329-342. doi:10.1016/S1053-5357(02)00174-9

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking.*Developmental Review, 28,* 78–106. Doi:10.1016/j.dr.2007.08.002.

Steinberg, L. (2007). Risk taking in adolescence. *Current Directions in Psychological Science, 16*(2), 55-59. doi:10.1111/j.1467-8721.2007.00475.x

Steinberg, L. (2010). A dual systems model of adolescent risk-taking. *Developmental Psychobiology, 52*(3), 216-224. doi 10.1002/dev.20445

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of behavior. *Personality and Social Psychology Review, 8*, 22–247. doi:10.1207/s15327957pspr0803_1

Tear, M. J., Nielsen, M. (2013). Failure to demonstrate that playing violent video games diminishes prosocial behavior. *PLoS ONE, 8*, 1-7. doi:10.1371/journal.pone.0068382

Valadez, J. J., & Ferguson, C. J. (2012). Just a game after all: Violent video game exposure and time spent playing effects on hostile feelings, depression, and visuospatial cognition. *Computers in Human Behavior, 28*, 608-616. doi:10.1016/j.chb.2011.11.006

Wallenius, M., & Punamäki, R-L. (2008). Digital game violence and direct aggression in adolescence: A longitudinal study of the roles of sex, age, and parent-child communication. *Journal of Applied Developmental Psychology, 29*, 286-294. doi:10.1016/j.appdev.2008.04.010

Weinstein, N., Hodgins, H. S., & Ostvik-White, E. (2011). Humor as aggression: Effects of motivation and hostility on humor appreciation. *Journal of Personality and Social Psychology, 100*, 1043–1055. doi:10.1037/a0022495

Wells, S., Graham, K., Speechley, M., & Koval, J. J. (2006). Do predisposing and family background characteristics modify or confound the relationship between drinking

frequency and alcohol-related aggression? A study of late adolescent and young adult drinkers. *Addictive Behaviors, 31*(4), 661-675. doi:10.1016/j.addbeh.2005.05.046

Williams, D., & Skoric, M. (2005). Internet fantasy violence: A test of aggression in an online game. *Communication Monographs, 72,* 217–233. doi:10.1080/03637750500111781

Williams, K. D. (2009). The effects of frustration, violence, and trait hostility after playing a video game. *Mass Communication & Society, 12,* 291-310. doi:10.1080/15205430802461087

Willoughby, T., Adachi, P. J. C., Good, M. (2012). A longitudinal study of the association between violent video game play and aggression among adolescents. *Developmental Psychology, 48,* 1044-1057. doi:10.1037/a0026046

Willoughby, T., Good, M., Adachi, P. J. C., Hamza, C., Tavernier, R. (2013). Examining the link between adolescent brain development and risk taking from a social developmental perspective. *Brain and Cognition, 83,* 315-324. doi:10.1016/j.bandc.2013.09.008

Zhao, X., Lynch, J. G., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and Truths about mediation analysis. *Journal of Consumer Research, 37,* 197-206. doi:10.1086/651257

Zillmann, D. (1978). Attribution and misattribution of excitatory reactions. In J. H. Harvey, W. J. Ickes, & R. E Kidd (Eds.), *New directions in attribution research: Vol. 2.* Hillsdale, NJ Erlbaum.

Chapter 5: General Discussion and Conclusions

Over the past two decades, research on the association between video game play and aggression primarily has been focused on the violent content in games (see Anderson et al., 2010; Ferguson, in press; Greitemeyer & Mügge, 2014 for meta-analytic reviews of this work; but also see Adachi & Willoughby, 2011a; Ferguson & Kilburn, 2010; Ferguson, 2013 for critiques of this work). In recent critiques of this literature, however, researchers have drawn attention to an important confound in studies on the link between violent video game play and aggression. Specifically, violent video games in general tend to be more competitive than non-violent games (Carnagey & Anderson, 2005), yet video game competition has not been controlled in the vast majority of violent video game and aggression studies (see Adachi & Willoughby, 2011a). Thus, it is unclear whether video game *violence* or *competition* has a more robust association with aggression. The primary goal of the current dissertation research, therefore, was to address this confound by examining the link between competitive video game play and aggression. Taken together, my three dissertation studies significantly advance our understanding of the association between video game play and aggression among adolescents and young adults

In Study 1, I systematically matched video games on violence and competitiveness, in order to examine the short-term effects of video game violence versus competition on aggression among young adults. I found that video game violence was not sufficient to elevate aggressive behavior compared to a non-violent video game that was matched in terms of competition, and that more competitive video games produced greater levels of aggressive behavior, irrespective of the amount of violence in the games. These findings suggest that video game competition, rather than violence, may be the

main video game characteristic that impacts aggressive behavior in the short-term among young adults.

After demonstrating a short-term effect of video game competition on aggression among young adults in Study 1, I then examined the long-term associations between aggression and competitive/non-violent video game play (i.e., sports/racing games), and between aggression and competitive gambling among adolescents in Study 2. I found evidence of a long-term bidirectional association between aggression and competitive video game play, and between aggression and competitive gambling. Specifically, greater competitive video game play and competitive gambling each uniquely predicted higher levels of aggression over time, after controlling for previous levels of aggression, supporting the socialization hypothesis. The selection hypothesis also was supported, as aggression predicted greater competitive video game play and competitive gambling over time, after controlling for previous competitive video game play and competitive gambling. In contrast, there was no significant association between aggression and non-competitive video game play, or between aggression and non-competitive gambling. Overall, these findings suggest that competitive activities in general may predict aggression over time among adolescents.

In Study 3, I then built upon the finding of a long-term association between competitive/non-violent video game play (sports/racing games) and adolescent aggression in Study 2, by examining this association among young adults and by including competitive/violent (action/fighting video game play) in the model as a predictor of aggression. Specifically, I found that action/fighting (violent) video game play as well as sports/racing (non-violent) video game play were each uniquely

associated with aggression over time among young adults as well as adolescents, and that these associations did not differ in magnitude. This finding suggests that violent video game play and non-violent video game play each have unique long-term associations with aggression, which are similar in size.

Second, given that past research has shown that action/fighting video games and sports/racing video games are matched in terms of competitiveness (e.g., Adachi & Willoughby, 2011b; Valadez & Ferguson, 2013), I examined the long-term predictive effect of the commonality (e.g., competitiveness) between action/fighting video game play and sports/racing video game play on aggression. Importantly, I found that the commonality between the two types of video game play (i.e., the common video game play factor) was significantly associated with aggression over time among young adults and adolescents. In contrast, there were no significant unique associations between aggression and action/fighting video game play, and between aggression and sports/racing video game play, after controlling for the association between the common video game play factor and aggression. This finding suggests that the commonality between the two types of video game play (e.g., competitiveness) is a more *robust* longitudinal predictor of aggression than the unique elements of each type of video game play (e.g., violence in action/fighting video games). Furthermore, aggressive affect was an underlying mechanism of this long-term association among young adults, consistent with the frustration-aggression hypothesis. Study 3 also has important developmental implications, as this is the first study to find evidence of a long-term association between video game play and aggression among young adults.

Overall, the findings from my three dissertation studies are consistent with the frustration-aggression hypothesis (e.g., Dollard, Miller, Doob, Mowrer, & Sears,1939; Berkowitz 1989). Specifically, the deliberate blocking of the players' goals of winning the competition by their opponents in competitive video games may predict elevations in aggressive affect (anger and hostility), which, in turn, may predict elevations in aggressive behavior. In Study 3, we found direct support for this hypothesis, such that aggressive affect was an underlying mechanism of the long-term predictive effect of competitive video game play on aggressive behavior among young adults. The current findings also are consistent with SDT (e.g., Deci & Ryan, 2000; Ryan & Deci, 2000), which suggests that the critical blockage during competitive video game play may be at the fundamental level of need satisfaction (Przybylski, Deci, Rigby, & Ryan, 2014). Specifically, the deliberate blocking of players' goals of winning the competition may impede the satisfaction of their need for competence, which, in turn, may predict higher elevations in aggressive behavior.

In addition, it is important to clarify that my interpretation of the dissertation results as suggesting that video game competition, rather than violence, may be *driving* the association between video game play and aggression, was not intended to imply mediation (i.e., that competition *explains* the link between video game play and aggression), but instead to imply that competition may be the specific element of the predictor (video game play) that is linked with aggression. The key distinction, therefore, is between the terms "driving" versus "explaining." Specifically, whereas video game competitiveness, rather than violence, may be *driving* the association between video game play (violent or non-violent video games) and aggression, aggressive affect may

explain the link between video game competitiveness and aggression, given that aggressive affect was shown to be an underlying mechanism of this long-term association (Study 3b).

Implications

My dissertation research has important implications for the video game and aggression literature. Specifically, while the majority of research on the link between video game play and aggression has been focused on the violent content in games (e.g., see Anderson et al., 2010), the current findings suggest that the *competition* in video games, not the violence, may have a more robust association with aggression among adolescents and young adults. This finding represents a novel direction for research in this field, and should encourage researchers to continue to investigate aspects of video game play that may be associated with aggression, beyond the violent content in games.

In addition, the current research has important developmental implications for the long-term link between video game play and aggression. This is the first research to demonstrate that playing competitive video games has a long-term association with aggressive behavior among young adults. This finding suggests that the long-term predictive effects of video games on aggression are not limited to earlier periods of development such as childhood and adolescence. Furthermore, evidence of a long-term link between video game play and aggression among young adults may suggest that young adults sometimes may have difficulty regulating the aggressive affect that is associated with competitive video game play, which may be due in part to the ongoing maturation of the prefrontal cortex as hypothesized by the Dual Systems model of adolescent brain development (Giedd, 2008; Steinberg, 2010).

It also is important to investigate these long-term associations among older age groups. For example, 60% of American adults aged 30 to 49 years reported playing video games (Lenhart, Jones, & Macgill, 2008). Yet, research on the link between video game and aggression during this later period of developmental period is scarce. For example, adults sometimes may be better able to regulate their aggressive affect than young adults, due in part to the Dual Systems Model's hypothesis that adults may have a more mature prefrontal cortex than adolescents or young adults on average (Giedd, 2008; Steinberg, 2010). Adults, therefore, may be less likely to behave aggressively after playing a competitive video game than young adults.

In contrast, the link between competitive video game play and aggression may be similar among adults, young adults, and adolescents, as researchers have suggested that in the presence of strong emotions or high arousal, adults also engage in risky behaviors (e.g., Willoughby, Good, Adachi, Hamza, & Tavernier, 2013). Specifically, the dual process models of decision making, which have been studied extensively with adult populations in the fields of social/cognitive psychology and behavioral economics (e.g., Evans & Stanovich, 2013; Hofmann, Friese, & Strack, 2009; Kahneman, 2011; Slovic, Finucane, Peters, & MacGregor, 2002; Strack & Deutsch, 2004), posit that there is a fast, intuitive, automatic system, which often is reliant on affect and current emotions for making decisions (''system 1''), versus a slow, controlled, and reflective system (''system 2''). Importantly, researchers have shown that adults engage in many errors of judgment and choice and that system 1 often is the source of many of these errors (e.g., Kahneman, 2011; Slovic et al., 2002). Thus, elevations in adults' aggressive affect that is associated with competitive video game play may activate adults' system 1, which, in

turn, may facilitate the transition of this aggressive affect into aggressive behavior. In the future researchers should test these questions by comparing the long-term link between competitive video game play and aggression between young adults and adults, as well as by conducting longitudinal studies over a longer time span (e.g., from childhood to adulthood).

My dissertation research also has practical implications for social policy and intervention efforts to reduce aggression, which is particularly important given the current public concern about the effects of video games on aggression (e.g., Parents Television Council). For example, the current research may encourage vigilance among researchers when making statements regarding the link between video game violence and aggression to inform public policy (see Ferguson, 2013). In addition, this research helps to elucidate the specific elements of video game play that elevate aggression, which could inform intervention efforts such as the rating system used to determine the age groups for which video games are appropriate.

Yet, while the present research suggests that video game competition is associated with aggression in both the short- and long-term, it is important to note that there also may be many positive aspects related to competition in video games. For example, research has shown that there are elements of competition that are important for intrinsic motivation (e.g., Frederick-Recascino & Schuster-Smith, 2003; Reeve & Deci, 1996). In addition, there may be significant learning opportunities in competitive situations for developing emotion regulation, or becoming a gracious winner or loser. Thus, research on the effects of video game competition should not be restricted to aggressive outcomes,

but also should investigate positive outcomes (see Adachi & Willoughby, 2012; Granic, Lobel, & Engels, 2014 for discussions of positive effects of video game play).

Directions for Future Research

In the future, researchers should continue to investigate potential mechanisms of the link between competitive video game play and aggression. For example, consistent with SDT (e.g., Deci & Ryan, 2000; Ryan & Deci, 2000), the impedance of basic human needs (i.e., competence, autonomy, relatedness) may be a fundamental mechanism of the link between competitive video game play and aggression. Specifically, having players' goals of winning a video game competition deliberately blocked by their opponents may impede players' satisfaction of their need for competence, which, in turn, may predict higher levels of aggression. Thus, future research should examine whether competence impedance is an underlying mechanism of this association in both the short- and long-term.

In addition to studying underlying mechanisms of the link between competitive video game play and aggression, it is also important to investigate potential moderators of this association, such as adolescent temperament. For example, temperamental surgency is positively related to impulsivity, high activity levels, and high intensity pleasure, and is negatively related to shyness (Rothbart, Ahadi, Hershey, & Fisher, 2001). Furthermore, researchers have shown that surgency is positively associated with aggression among children (e.g., Berdian, Keane, & Calkins, 2008; Dollar & Stifter, 2012) and adolescents (e.g., Reker, 2010). Adolescents high in surgency, therefore, may experience more intense elevations in aggressive affect from competitive video game play and they may be more likely to act impulsively on these aggressive feelings than adolescents lower in

surgency. Thus, the link between competitive video game play and aggression may be stronger for adolescents higher in surgency than for adolescents lower in surgency. Future research is needed to examine this potential moderator.

Another important direction for future research is to examine the link between video game play and other forms of aggression. To date, video game research has focused mainly on traditional forms of physical and verbal aggression. In contrast, there is a dearth of research examining the link between video game play and cyber aggression, which refers to aggressive behavior through forms communication technology such as email, social networking sites, and instant messaging programs (Pornari & Wood, 2010; Wright & Li, 2013). The study of cyber aggression is critical, however, as the consequences of cyber aggression can be devastating for the victims (e.g., Mesch, 2009). For example, cyber aggression may be a quick and easy way to behave aggressively because it removes much of the trepidation associated with face-to-face physical and verbal aggression, such as the risk of immediate retaliation (Hinduja & Patchin, 2009; Wright & Li, 2013). In addition, given that cyber aggression often is anonymous and the aggressor usually cannot see the negative reaction of the victim, cyber aggressors may be more uninhibited in their aggression compared to face-to-face aggressors, resulting in particularly harsh acts of cyber aggression (Juvonen & Graham, 2014; Mesch, 2009). Furthermore, hurtful messages sent online can quickly spread to a large number of people beyond the target of the aggression (e.g., Juvonen & Graham, 2014). Taken together, these aspects of cyber aggression suggest that it can have devastating consequences for the victim, and thus elucidating predictors of cyber aggression is critical. Given that online video game play often provides players with platforms to communicate with other

players either verbally or through text, competitive video game play may be an important predictor of cyber aggression.

In addition, although the majority of the video game and aggression research to date has been focused on game content (e.g., violence), researchers recently have begun to examine video game *context* effects (Gentile, 2011), such as playing games competitively against other people. For example, Schmierbach (2010) found that compared to playing a violent video game solo (i.e., playing alone against computer-generated opponents), playing competitively against another participant led to higher aggressive cognition scores, whereas playing cooperatively with another participant led to lower aggressive cognition scores. In addition, Breuer, Scharkow, and Quandt (2013) found that participants who lost a non-violent video game competition against another player behaved more aggressively than participants who won. Furthermore, they found that this effect was mediated by elevations in aggressive affect, consistent with the frustration-aggression hypothesis (also see Jerabeck & Ferguson, 2013; Greitemeyer & Cox, 2013 for examples of studies examining cooperative video game context effects). Given that over a quarter of American adolescents play video games online with other people (Lenhart et al., 2008), it is important to further examine competitive video game context effects on aggression. For example, researchers should investigate why competing in video games against human opponents has a stronger effect on aggression than competing against computer-generated opponents. For example, competing against human opponents versus computer-generated opponents may induce greater ego threat among players, which, in turn, may predict higher levels of aggression.

Limitations

My dissertation work is not without limitations. For example, although I found a short-term effect of video game competition, rather than violence on aggression in Study 1, I used a small number of games (e.g., 2 highly competitive and highly violent games, 1 highly competitive and non-violent game, etc.). Thus, it is not clear whether these effects can be generalized to all competitive video games or whether there was something specific about the games used in Study 1, other than the competition, which was associated with aggression. Future research with a range of competitive and non-competitive video games is needed to further demonstrate the generalizability of this effect.

An important limitation of the correlational research in Study 2 and Study 3 stems from the reliance on self-report measures. Reports of video game use and aggression would benefit from corroboration from other informants (e.g., friends). It is not clear, however, whether anyone other than the young adult 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. Nonetheless, the inclusion of peer assessment may be a key factor in increasing our knowledge of how often young adults play video games with friends and peers.

In addition, the structural paths that were significant in the autoregressive path analyses in Study 2 and Study 3 were small in magnitude. However, considering that aggressive affect and aggressive behavior were highly stable over time, controlling for these stability effects removed a large portion of variance in the aggressive affect and aggressive behavior outcomes variables that was shared with the video game play

predictor variables, and thus small predictive effects of change in levels of these variables were expected (Adachi & Willoughby, 2014). Indeed, these effect sizes are common in longitudinal models when controlling for stability between adjacent time points of data and accounting for concurrent associations among variables within each time point[9] (e.g., Adachi & Willoughby, 2013a, 2013b, 2013c). Moreover, effect sizes often are smaller when there is considerable time between measurements (i.e., a year) versus shorter lags in time (e.g., a month). We may expect larger effects in future longitudinal research that employs shorter durations between measurements.

Another possible concern with Study 2 and Study 3 may involve the measures of playing video games that are competitive and non-violent (sports and racing games). Specifically, because a few sports and racing games might contain some aggressive content, it may be this aggressive content, rather than the competitive content, that was associated with aggression in the present research. However, I think this is unlikely given that previous research has demonstrated that competitive gambling activities also have a significant long-term association with aggression that was similar in magnitude to competitive video game play, even though gambling does not involve any violence or aggression (Adachi & Willoughby, 2013a).

In addition, although the types of violent video game play (action/fighting games) and non-violent video game play (sports/racing games) assessed in Study 3 have been shown to be matched in terms of competitiveness but different in terms of violence (e.g.,

---

[9] It is important to note that we are not suggesting that small effects in autoregressive models are *always* important. The importance of these effects should be assessed individually on a case by case basis (see Adachi & Willoughby, 2014).

Adachi & Willoughby, 2011b; Valadez & Ferguson, 2013), our measures did not explicitly assess participants' ratings of the competitiveness and violence in these games. Future research could extend our findings by having participants rate sports/racing and action/fighting video game genres in terms of violence and competitiveness, in addition to measuring frequency of play, in order to examine whether ratings of competitiveness and violence have unique long-term associations with aggression. Finally, the three dissertations studies used samples of North American university students and high school students, and thus the findings may not generalize to other geographic regions, including those with differing ethnic and/or demographic populations.

Strengths and Conclusion

Overall, my dissertation research significantly advances our understanding of the long-term link between video game play and aggression among adolescents and young adults. Importantly, the current findings consistently demonstrate that video game competition, rather than violence, is a more robust predictor of aggression in the short and long term. These findings represent a novel direction for research in this field. My dissertation work also has important developmental implications, as Study 3 provides the first evidence of a long-term association between video game play and aggression among young adults in addition to adolescents. The long-term predictive effect of competitive video game play on aggressive behavior, therefore, is not limited to earlier periods of development.

An important strength of Study 1 is that I conducted pilot studies to systematically match video games on violence and competition, in order to isolate the effects of violent and competitive content on aggression. In addition, the fact that I had access to four time

points of longitudinal data of adolescents and three time points of longitudinal data of young adults is an important strength of Study 2 and Study 3, as it allowed me to examine the bidirectional associations between competitive video game play and aggressive behavior over the long-term. Taken together, the findings from my three dissertation studies suggest that instead of "nailing the coffin shut on doubts that violent video games stimulate aggression" (e.g., Huesmann, 2010, p.179), researchers should continue to critically examine aspects of video games that may be associated with aggression, beyond the violence.

References

Adachi, P. J. C., & Willoughby, T. (2014). Interpreting effect sizes when controlling for stability effects in longitudinal autoregressive models: Implications for psychological science. *European Journal of Developmental Psychology*. doi:10.1080/17405629.2014.963549

Adachi, P. J. C., & Willoughby, T. (2013)a. Demolishing the competition: The longitudinal link between competitive video games, competitive gambling, and aggression. *Journal of Youth and Adolescence, 42*, 1090-1104. doi:10.1007/s10964-013-9952-2

Adachi, P. J. C., & Willoughby, T. (2013)b. It's not how much you play, but how much you enjoy the game: The longitudinal associations between adolescents' self-esteem and the frequency versus enjoyment of involvement in sports. *Journal of Youth and Adolescence*. doi: 10.1007/s10964-013-9988-3

Adachi, P. J. C., & Willoughby, T. (2013)c. More than just fun and games: The longitudinal relationships between strategic video games, self-reported problem solving skills, and academic grades. *Journal of Youth and Adolescence*, *42*, 1041-1052. doi:10.1007/s10964-013-9913-9

Adachi, P. J. C., & Willoughby, T. (2012). Do video games promote positive youth development? *Journal of Adolescent Research*, *28*, 155-165. doi:10.1177/0743558412464522

Adachi, P. J. C., & Willoughby, T. (2011a). The effect of violent video games on aggression: Is it more than just the violence? *Aggression and Violent Behavior*, *16*, 55-62. doi:10.1016/j.avb.2010.12.002

Adachi, P. J. C., & Willoughby, T. (2011)b. The effect of video game competition and violence on aggressive behavior: Which characteristic has the greatest influence? *Psychology of Violence, 1,* 259-274. doi:10.1037/a0024908

Anderson, C. A., Ihori, N., Bushman, B. J., Rothsetin, H, R., Shibuya, A., Swing, E. L., Sakamoto, A., Saleem, M. (2010). Video Game effects on aggression, empathy, and prosocial behavior and eastern and western countries: A meta-analytic review. *Psychological Bulletin, 136,* 151-173. doi:10.1037/a0018251

Berdan, L. E., Keane, S. P., & Calkins, S. D. (2008). Temperament and externalizing behavior: Social preference and perceived acceptance as protective factors. *Developmental Psychology, 44,* 957–968. Doi:10.1037/0012-1649.44.4.957

Berkowitz, L. (1989). Frustration-aggression hypothesis: Examination and reformulation. *Psychological Bulletin, 106,* 59–73. doi:10.1037/0033-2909.106.1.59

Breuer, J., Scharkow, M., & Quandt, T. (2013). Sore losers? A reexamination of the Frustration–Aggression Hypothesis for colocated video game play. *Psychology of Popular Media Culture*. doi:10.1037/ppm0000020

Carnagey, L. N., & Anderson, C. A. (2005). The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychological Science, 16,* 882-889. doi:10.1111/j.1467-9280.2005.01632.x

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11,* 227–268. doi:10.1207/S15327965PLI1104_01

Dollar, J. M., & Stifter, C. A. (2012). Temperamental surgency and emotion regulation as predictors of childhood social competence. *Journal of Experimental Child Psychology*. doi:10.1016/j.jecp.2012.02.004

Evans, J. St. B. T., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science*, *8*, 223–241. doi:10.1177/1745691612460685

Ferguson, C. J. (in press). Do angry birds make for angry children? A meta-analysis of video game influences on children's and adolescents' aggression, mental health, prosocial behavior and academic performance. *Perspectives on Psychological Science*.

Ferguson, C. J. (2013). Violent video games and the Supreme Court: Lessons for the scientific community in the wake of Brown v EMA. *American Psychologist, 68*(2), 57-74. doi:10.1037/a0030597

Ferguson, C. J., & Kilburn, J. (2010). Much ado about nothing: The misestimation and overinterpretation of violent video game effects in eastern and western nations: Comment on Anderson et al. (2010). *Psychological Bulletin, 136*, 174-178. doi:10.1037/a0018566

Frederick-Recascino, C. M., & Schuster-Smith, H. (2003). Competition and intrinsic motivation in physical activity: A comparison of two groups. *Journal of Sport Behavior*, *26*, 240-254.

Gentile, D. A. (2011). The multiple dimensions of video game effects. *Child Development Perspectives, 5*, 75-81. doi:10.1111/j.1750-8606.2011.00159.x

Giedd, J. N. (2008). The teen brain: Insights from neuroimaging. *Journal of Adolescent Health, 42*(4), 335-343. doi:10.1016/j.jadohealth.2008.01.007

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). The benefits of playing video games. *American Psychologist, 69*, 66-78. doi:10.1037/a0034857

Greitemeyer, T., & Cox, C. (2013). There's no "I" in team: Effects of cooperative video games on cooperative behavior. *European Journal of Social Psychology, 43*, 224-228. doi:10.1002/ejsp.1940

Greitemeyer, T., & Mügge, D. O. (2014). Video games do affect social outcomes: A meta-analytic review of the effects of violent and prosocial video game play. *Personality and Social Psychology Bulletin, 40*, 578-589. doi:10.1177/0146167213520459

Hinduja, S., & Patchin, J. (2009). Bullying beyond the schoolyard: Preventing and responding to cyberbullying. Thousand Oaks: Sage Publications.

Hofmann, W., Friese, M., & Strack, F. (2009). Impulse and self-control from a dual systems perspective. *Perspectives on Psychological Science, 4*, 162–176. doi:10.1111/j.1745-6924.2009.01116.x

Huesmann, L. R. (2010). Nailing the coffin shut on doubts that violent video games stimulate aggression: Comment on Anderson et al. (2010). *Psychological Bulletin, 136*, 179-181. doi:10.1037/a0018567

Jerabeck, J. M., & Ferguson, C. J. (2013). The influence of solitary and cooperative violent video game play on aggressive and prosocial behavior. *Computers in Human Behavior, 29*, 2573-2578. doi:10.1016/j.chb.2013.06.034

Juvonen, J., & Graham, S. (2014). Bullying in schools: The power of bullies and the plight of victims. *Annual Review of Psychology, 65,* 159-185. doi:10.1146/annurev-psych-010213-115030

Kahneman, D. (2011). Thinking, fast and slow. NY: Farrar, Straus, and Giroux.

Lenhart, A., Jones, J., & Macgill, A. R. (2008). *Adults and video games*. Washington, DC: Pew Internet and American Life Project.

Lenhart, A., Kahne, J., Middaugh, E., Macgill, A. R., Evans, C., & Vitak, J. (2008). *Teens, video games, and civics.* (Report No. 202-415-4500). Washington, DC: Pew Internet and American Life Project.

Mesch, G. S. (2009). Parental mediation, online activities, and cyberbullying. *Cyber Psychology & Behavior, 12,* 387–93. doi:10.1089/cpb.2009.0068

Parents Television Council. (2011). *PTC denounces Supreme Court ruling on CA video game law.* Retrieved 4/25/12 from https://www.parentstv.org/PTC/news/release/2011/0627a.asp.

Pornari, C. D., & Wood, J. (2010). Peer and cyber aggression in secondary school students: The role of moral disengagement, hostile attribution bias, and outcome expectancies. *Aggressive Behavior, 36,* 81–94. doi:10.1002/ab.20336

Pryzbylski, A. K., Deci, E. L., Rigby, C. S., & Ryan, R. M. (2014). Competence-impeding electronic games and players' aggressive feelings, thoughts, and behaviors. *Journal of Personality and Social Psychology, 106*(3), 441-57. doi:10.1037/a0034820

Reeve, J., Deci, E. L. (1996). Elements of the competitive situation that affect intrinsic motivation. *Personality and Social Psychology Bulletin, 22,* 24-44. doi: 10.1177/0146167296221003

Reker, D. L. (2010). Relation of temperament and authoritative parenting on subtypes of adolescent behaviour (Doctoral dissertation). Retrieved from https://dr.library.brocku.ca/bitstream/handle/10464/3183

Rothbart, M. K., Ahdi, S. A., Hersey, K. L., & Fisher, P. Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. Ch*ild Developmen*t, *72*, 1394-1408. doi:10.1111/1467-8624.00355

Ryan, R. M., & Deci, E. L. (2000). Self-Determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55,* 68–78. doi:10.1037/0003-066X.55.1.68

Schmierbach, M. (2010). "Killing spree": Exploring the connection between competitive game play and aggressive cognition. *Communication Research, 37,* 256-274. doi:10.1177/00 93650209356394

Slovic, P., Finucane, M., Peters, E., & MacGregor, D.G. (2002). Rational actors or rational fools: Implications of the affect heuristic for behavioral economics. *Journal of Socio-Economics, 31,* 329-342. doi:10.1016/S1053-5357(02)00174-9

Steinberg, L. (2010). A dual systems model of adolescent risk-taking. *Developmental Psychobiology*, *52*(3), 216-224. doi 10.1002/dev.20445

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of behavior. *Personality and Social Psychology Review, 8*, 22–247. doi:10.1207/s15327957pspr0803_1

Valadez, J. J., & Ferguson, C. J. (2012). Just a game after all: Violent video game exposure and time spent playing effects on hostile feelings, depression, and visuospatial cognition. *Computers in Human Behavior, 28*, 608-616. doi:10.1016/j.chb.2011.11.006

Willoughby, T., Good, M., Adachi, P. J. C., Hamza, C., Tavernier, R. (2013). Examining the link between adolescent brain development and risk taking from a social–developmental perspective. *Brain and Cognition, 83*, 315-324. doi:10.1016/j.bandc.2013.09.008

Wright, M. F., & Li, Y. (2013). The association between cyber victimization and subsequent cyber aggression: The moderating effect of peer rejection. *Journal of Youth & Adolescence, 42*, 662–674. doi:10.1007/s10964-012-9903-3

APPENDIX A

Ethics Approval for Study 1

Brock University
Office of Research Services
Research Ethics Office
St. Catharines, Ontario, Canada L2S 3A1
T: 905-688-5550, Ext. 3035/4876 F: 905-688-0748
www.brocku.ca

DATE: 11/18/2009

FROM: Michelle McGinn, Chair
Research Ethics Board (REB)

TO: Teena Willoughby, Paul Adachi Psychology

FILE: 09-060 WILLOUGHBY

TITLE: The Effect of Violent Video Games on Aggression: Is It More than Just the Violence?
The Brock University Research Ethics Board has reviewed the above research proposal.

DECISION: Accepted as clarified

This project has received ethics clearance for the period of November 18, 2009 to July 1, 2010 subject to full REB ratification at the Research Ethics Board's next scheduled meeting. The clearance period may be extended upon request. ***The study may now proceed.***

Please note that the Research Ethics Board (REB) requires that you adhere to the protocol as last reviewed and cleared by the REB. During the course of research no deviations from, or changes to, the protocol, recruitment, or consent form may be initiated without prior written clearance from the REB. The Board must provide clearance for any modifications before they can be implemented. If you wish to modify your research project, please refer to http://www.brocku.ca/research/policies-and-forms/forms to complete the appropriate form Revision or Modification to an Ongoing Application.

Adverse or unexpected events must be reported to the REB as soon as possible with an indication of how these events affect, in the view of the Principal Investigator, the safety of the participants and the continuation of the protocol.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of any research protocols.

The Tri-Council Policy Statement requires that ongoing research be monitored. A Final Report is required for all projects upon completion of the project. Researchers with projects lasting more than one year are required to submit a Continuing Review Report annually. The Office of Research Services will contact you when this form *Continuing Review/Final Report* is required.

Please quote your REB file number on all future correspondence.
MM/mb

APPENDIX B

Ethics Approval for Study 2 and Study 3b

Brock University

Senate Research Ethics Board **Extensions**
B205/4315, Room C315

FROM: David Butz, Chair
Senate Research Ethics Board (REB)

TO: Teena Willoughby, Child and Youth Studies

FILE: 00-116, WILLOUGHBY

The Brock University Research Ethics Board has reviewed the revised research proposal:

"Enhancement of youth resiliency and reduction of harmful behaviours leading to healthy lifestyle choices"

The Research Ethics Board finds that your revised proposal conforms to the Brock University guidelines set out for ethical research.

*** Accepted as clarified**

Please note: Any Changes or Modifications to this approved research must be reviewed and approved by the committee. If so, please complete form #5 - ***Request for Ethics Clearance of a Revision or Modification to an Ongoing application for Ethics Review of Research with Human Participants*** and submit it to the Chair of the Research Ethics Board. You can download this form from the Office of Research Services or visit the web site:
http://www.BrockU.CA/researchservices/mainethics/formpage.html

DB/dvo

APPENDIX C

Ethics Approval for Study 3a

Brock University
Research Ethics Office
Tel: 905-688-5550 ext. 3035
Email: reb@brocku.ca

Social Science Research Ethics Board

Certificate of Ethics Clearance for Human Participant Research

DATE: February 3, 2012

PRINCIPAL INVESTIGATOR: WILLOUGHBY, Teena - Psychology

FILE: 09-118 - WILLOUGHBY

TYPE: Faculty Research STUDENT:
SUPERVISOR: Teena Willoughby

TITLE: Stressed @ Brock?

ETHICS CLEARANCE GRANTED

Type of Clearance: MODIFICATION Expiry Date: 1/31/2013

The Brock University Social Sciences Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement. Clearance granted from **2/3/2012** to **1/31/2013**.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before **1/31/2013**. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved:

Jan Frijters, Chair
Social Sciences Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.

APPENDIX D

Demographic Questionnaire (Study 1)

Demographic Questionnaire
Participant ID:

Sex (please circle one): Male Female Age: _____

The following questions focus on your video game experience.

1. On the average WEEKDAY in the past six months, how many hours do you spend playing the following kinds of video/computer games?

Sports (e.g. FIFA soccer 2009, NHL 2009)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Strategy (e.g. Splinter Cell, Rainbow 6)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Role-playing (e.g. World of Warcraft, Final Fantasy)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Puzzles (e.g., Tetris, Solitaire)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Action (e.g. God of War 2, Grand Theft Auto 4)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

First-person Shooters (e.g. Halo, Call of Duty 4)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Racing (e.g. Gran Turismo 4, NASCAR)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Fighting (e.g. Mortal Kombat, Tekken 4)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Adventure (e.g. Harry Potter, Myst III)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Quiz/Board games (e.g. Monopoly, Risk)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

2. On the average WEEKEND in the past six months, how many hours to you spend playing the following kinds of video/computer games?

Sports (e.g. FIFA soccer 2009, NHL 2009)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Strategy (e.g. Splinter Cell, Rainbow 6)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Role-playing (e.g. World of Warcraft, Final Fantasy)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Puzzles (e.g. Tetris, Solitaire)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Action (e.g. God of War 2, Grand Theft Auto 4)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

First-person Shooters (e.g. Halo, Call of Duty 4)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Racing (e.g. Gran Turismo 4, NASCAR)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Fighting (e.g. Mortal Kombat, Tekken 4)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Adventure (e.g. Harry Potter, Myst III)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

Quiz/Board games (e.g. Monopoly, Risk)

1	2	3	4	5
Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours

3. How many year(s) have you played the following kinds of games?

Sports (e.g. FIFA soccer 2009, NHL 2009) _____ year(s)
Strategy (e.g. Splinter Cell, Rainbow 6) _____ year(s)
Role-playing (e.g. World of Warcraft, Final Fantasy) _____ year(s)
Puzzles (e.g. Tetris, Solitaire) _____ year(s)
Action (e.g. God of War 2, Grand Theft Auto 4) _____ year(s)
First-person Shooters (e.g. Halo, Call of Duty 4) _____ year(s)
Racing (e.g. Gran Turismo 4, NASCAR) _____ year(s)

Fighting (e.g. Mortal Kombat, Tekken 4) _____ year(s)
Adventure (e.g. Harry Potter, Myst III) _____ year(s)
Quiz/Board games (e.g. Monopoly, Risk) _____ year(s)

APPENDIX E

Ratings of Video Game Characteristics (Study 1)

Qualities of the Video Game Experience

Participant ID:

Without considering how much experience you have with this video game (pretend this was your first time playing this game)…

How was the pace of the action?

1	2	3	4	5	6	7
Very slow	Slow	Somewhat slow	Medium	Somewhat fast	Fast	Very fast

How difficult was the game?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

How violent was the game?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

To what extent did this video game involve competition (i.e., fighting or racing against opponents)?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

To what extent did you view the other characters in the game as opponents?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

To what extent did you feel like you were competing with your opponents (i.e., in a battle or in a race)?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

When you lost or failed, how close were you to winning or succeeding?

1	2	3	4	5	6	7
Very far	Far	Somewhat far	Medium	Somewhat close	Close	Very Close

How much confidence did you have that you would win or succeed?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

How competitive was this video game?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

How hard were you trying to win the game/match/contest?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

How intense was the competition?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

How frustrated were you when you failed or lost?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

How frustrated were you when you succeeded or won?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

How angry were you when you failed or lost?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

How angry were you when you succeeded or won?

1	2	3	4	5	6	7
Very low	Low	Somewhat low	Medium	Somewhat high	High	Very high

APPENDIX F

Food Preference Questionnaire (Study 1)

How much do you LIKE the following kinds of foods?

Sweet				
1	2	3	4	5
Not at all	Somewhat	Neither like nor dislike	Very much	Extremely
Savory				
1	2	3	4	5
Not at all	Somewhat	Neither like nor dislike	Very much	Extremely
Spicy				
1	2	3	4	5
Not at all	Somewhat	Neither like nor dislike	Very much	Extremely
Hot				
1	2	3	4	5
Not at all	Somewhat	Neither like nor dislike	Very much	Extremely
Bland				
1	2	3	4	5
Not at all	Somewhat	Neither like nor dislike	Very much	Extremely
Salty				
1	2	3	4	5
Not at all	Somewhat	Neither like nor dislike	Very much	Extremely

APPENDIX G

Suspiciousness Questionnaire (Study 1)

The next few questions focus on your perception of the study.

What do you think was the purpose of this study?

Did anyone tell you about this study before you came today? If so, what did they say?

Did you think anything you were told in the experiment was deceptive? If so, what do you think was deceptive?

APPENDIX H

Buss and Perry (1992) Trait Aggression Questionnaire (Study 1)

	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
Some of my friends think I am a hothead……	….O…..	….O…..	….O…..	….O…..	….O…..
If I have to resort to violence to protect my rights, I will……	….O…..	….O…..	….O…..	….O…..	….O…..
When people are especially nice to me, I wonder what they want……..	….O…..	….O…..	….O…..	….O…..	….O…..
I tell my friends openly when I disagree with them……..	….O…..	….O…..	….O…..	….O…..	….O…..
I have become so mad that I have broken things……..……	….O…..	….O…..	….O…..	….O…..	….O…..
I can't help getting into arguments when people disagree with me……	….O…..	….O…..	….O…..	….O…..	….O…..
I wonder why sometimes I feel so bitter about things……	….O…..	….O…..	….O…..	….O…..	….O…..
Once in a while, I can't control the urge to strike another person……	….O…..	….O…..	….O…..	….O…..	….O…..
I am an even-tempered person……	….O…..	….O…..	….O…..	….O…..	….O…..
I am suspicious of overly friendly strangers…….	….O…..	….O…..	….O…..	….O…..	….O…..
I have threatened people I know……..	….O…..	….O…..	….O…..	….O…..	….O…..
I flare up quickly but get over it quickly……..	….O…..	….O…..	….O…..	….O…..	….O…..
Given enough provocation, I may hit another person. …….	….O…..	….O…..	….O…..	….O…..	….O…..
When people annoy me, I may tell them what I think of them……	….O…..	….O…..	….O…..	….O…..	….O…..
I am sometimes eaten up with jealousy. ……	….O…..	….O…..	….O…..	….O…..	….O…..
I can think of no good reason for ever hitting a person. ……..	….O…..	….O…..	….O…..	….O…..	….O…..
At times I feel I have gotten a raw deal out of life……..	….O…..	….O…..	….O…..	….O…..	….O…..
I have trouble controlling my temper……	….O…..	….O…..	….O…..	….O…..	….O…..
When frustrated, I let my irritation show…….	….O…..	….O…..	….O…..	….O…..	….O…..
I sometimes feel that people are laughing at me behind my back…….	….O…..	….O…..	….O…..	….O…..	….O…..
I often find myself disagreeing with people……	….O…..	….O…..	….O…..	….O…..	….O…..
If somebody hits me, I hit back……	….O…..	….O…..	….O…..	….O…..	….O…..
I sometimes feel like a powder keg ready to explode……	….O…..	….O…..	….O…..	….O…..	….O…..
Other people always seem to get the breaks……..	….O…..	….O…..	….O…..	….O…..	….O…..
There are people who pushed me so far that we came to blows……..	….O…..	….O…..	….O…..	….O…..	….O…..
I know that "friends" talk about me behind my back……	….O…..	….O…..	….O…..	….O…..	….O…..
My friends say that I'm somewhat argumentative……..	….O…..	….O…..	….O…..	….O…..	….O…..
Sometimes I fly off the handle for no good reason……..	….O…..	….O…..	….O…..	….O…..	….O…..
I get into fights a little more than the average person……..	….O…..	….O…..	….O…..	….O…..	….O…..

APPENDIX I

Demographics/Covariates (Study 2)

1. Are you male or female? ○ Male ○ Female
2. What is the highest level of education that your MOTHER/STEPMOTHER (female guardian) whom you have lived with the MOST has completed? (If more than one mother, answer for one of them or if you have no contact with your mother/stepmother or female guardian please skip to Question 3 below)

○ Did not finish high school

○ Finished high school

○ Some college, university, or apprenticeship program

○ Completed a college/apprenticeship diploma (e.g., electrician) and/or technical diploma (i.e., graphic design, hair dressing)

○ Completed a university undergraduate degree

○ Completed a professional degree (e.g., masters, PhD, medical doctor, lawyer)

○ Still going to school

○ Don't know

3. What is the highest level of education that your FATHER/STEPFATHER (male guardian) whom you have lived with the MOST has completed? (If more than one father, answer for one of them or if you have no contact with your father/stepmother or male guardian please skip)

○ Did not finish high school

○ Finished high school

○ Some college, university, or apprenticeship program

○ Completed a college/apprenticeship diploma (e.g., electrician) and/or technical diploma (i.e., graphic design, hair dressing)

○ Completed a university undergraduate degree

○ Completed a professional degree (e.g., masters, PhD, medical doctor, lawyer)

○ Still going to school

○ Don't know

4. How many computers are in your home? _____

5. How often in the last month have you done the following?

	Never	Once or twice a month	Once a week	Several times a week	Everyday
a) Played organized sports in school?	○	○	○	○	○
b) Played organized sports outside of school?	○	○	○	○	○

APPENDIX J

Video Game Play (Study 2)

Dichotomous (yes/no) Measures

What kinds of video or computer games do you usually play? (Fill in all that apply)

○ Puzzle (e.g.,Tetris)
○ Sports (e.g., FIFA Soccer)
○ Art (e.g., Printshop)
○ Racing (e.g., NASCAR)
○ Quiz (e.g., Outburst)
○ Fighting (e.g., Mortal Kombat)
○ Action (e.g., Call of Duty)
○ Building model worlds (e.g., Sims)

Frequency Measures

On an average day, how often do you play the following types of video games?

	Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours
a) Puzzle (e.g.,Tetris)	○	○	○	○	○
b) Sports (e.g., FIFA Soccer)	○	○	○	○	○
c) Art (e.g., Printshop)	○	○	○	○	○
d) Racing (e.g., NASCAR)	○	○	○	○	○
e) Quiz (e.g., Outburst)	○	○	○	○	○
f) Building model worlds (e.g., Sims)	○	○	○	○	○

APPENDIX K

Gambling (Study 2)

How many times in the last month have you done the following?

	Never	Once or twice a month	Once a week	Several times a week	Everyday
a) Playing cards (poker, euchre) for money	○	○	○	○	○
b) Bet on a sporting event (i.e., Proline)	○	○	○	○	○
c) Entered draws for charity	○	○	○	○	○

APPENDIX L

Aggressive Behavior (Study 2)

Little, Jones, Henrich and Hawley (2003)

How true is each statement of you?

	Never	Once or twice a month	Once a week	Several times a week
a) I often threaten others to get what I want	○	○	○	○
b) When I'm threatened by someone, I often threaten back	○	○	○	○
c) I often kick, hit, punch others to get what I want	○	○	○	○
d)When I'm hurt by someone, I often fight back	○	○	○	○
e) If others have angered me, I often hit, kick, or punch them	○	○	○	○
f) If others make me mad or upset, I often hurt them	○	○	○	○
g) To get what I want, I often say mean things to others	○	○	○	○
h) To get what I want, I often hurt others	○	○	○	○
i) To get what I want, I often put others down	○	○	○	○

Marini, Spear, and Bombay (1999)

How often have you done these things during the last school year?

	Never	A few times a year	A few times a month	A few times a week	Everyday
a) Pushed and shoved someone	○	○	○	○	○
b) Swore at someone and called them names	○	○	○	○	○
c) Teased and ridiculed someone	○	○	○	○	○
d) Kicked and hit someone	○	○	○	○	○

APPENDIX M

Demographics/Covariates (Study 3a)

1. What is your birth date? _____year _____month _____day
2. Are you male or female? ○ Male ○ Female
3. What is the highest level of education that your MOTHER/STEPMOTHER (female guardian) whom you have lived with the MOST has completed? (If more than one mother, answer for one of them or if you have no contact with your mother/stepmother or female guardian please skip to Question 4 below)

○ Did not finish high school
○ Finished high school
○ Some college, university, or apprenticeship program
○ Completed a college/apprenticeship diploma (e.g., electrician) and/or technical diploma (i.e., graphic design, hair dressing)
○ Completed a university undergraduate degree
○ Completed a professional degree (e.g., masters, PhD, medical doctor, lawyer)
○ Still going to school
○ Don't know

4. What is the highest level of education that your FATHER/STEPFATHER (male guardian) whom you have lived with the MOST has completed? (If more than one father, answer for one of them or if you have no contact with your father/stepmother or male guardian please skip)

○ Did not finish high school
○ Finished high school
○ Some college, university, or apprenticeship program
○ Completed a college/apprenticeship diploma (e.g., electrician) and/or technical diploma (i.e., graphic design, hair dressing)
○ Completed a university undergraduate degree
○ Completed a professional degree (e.g., masters, PhD, medical doctor, lawyer)
○ Still going to school
○ Don't know

5. I live in residence. ○

6. Were you born in Canada? ○ yes ○ no

7. Other than Canadian, is there another culture or ethnic background that your family belongs to? ○ yes ○ no

8. In the previous year, how often have you done the following?

	Never	Seldom	About once a month	2-3 times a month	About once a week	Several times a week
a) Participated in sports clubs	○	○	○	○	○	○

9. How often do you go drinking or have a drink?

Never	Less than once a month	1-3 times a month	Once a week	2 times a week	3-4 times a week	5-6 times a week	Every day
○	○	○	○	○	○	○	○

10. On average, when you are drinking alcohol, about how many drinks do you have?

Less than 1 drink	1 drink	2-3 drinks	4-6 drinks	7-10 drinks	Over 10 drinks
○	○	○	○	○	○

11. On the average day, how many hours do you spend doing the following?

	Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours
a) Going on the Internet of online poker, sports betting, online casinos	○	○	○	○	○

APPENDIX N

Aggressive Affect (Study 3a)

Fill in the best answer that describes you.

	Very unlike me	Unlike me	Neither like me or unlike me	Like me	Very like me
a) At times I feel I have gotten a raw deal out of life	○	○	○	○	○
b) Sometimes I fly off the handle for no good reason	○	○	○	○	○
c) Other people always seem to get the breaks	○	○	○	○	○
d) I have trouble controlling my temper	○	○	○	○	○
e) I wonder why sometimes I feel so bitter about things	○	○	○	○	○
f) I sometimes feel like a powder keg ready to explode	○	○	○	○	○

APPENDIX O

Demographics/Covariates (Study 3b)

1. Are you male or female? ○ Male ○ Female
2. What is the highest level of education that your MOTHER/STEPMOTHER (female guardian) whom you have lived with the MOST has completed? (If more than one mother, answer for one of them or if you have no contact with your mother/stepmother or female guardian please skip to Question 4 below)

○ Did not finish high school

○ Finished high school

○ Some college, university, or apprenticeship program

○ Completed a college/apprenticeship diploma (e.g., electrician) and/or technical diploma (i.e., graphic design, hair dressing)

○ Completed a university undergraduate degree

○ Completed a professional degree (e.g., masters, PhD, medical doctor, lawyer)

○ Still going to school

○ Don't know

3. What is the highest level of education that your FATHER/STEPFATHER (male guardian) whom you have lived with the MOST has completed? (If more than one father, answer for one of them or if you have no contact with your father/stepmother or male guardian please skip)

○ Did not finish high school

○ Finished high school

○ Some college, university, or apprenticeship program

○ Completed a college/apprenticeship diploma (e.g., electrician) and/or technical diploma (i.e., graphic design, hair dressing)

○ Completed a university undergraduate degree

○ Completed a professional degree (e.g., masters, PhD, medical doctor, lawyer)

○ Still going to school

○ Don't know

4. I live in residence. ○ yes ○ no

5. Were you born in Canada? ○ yes ○ no

6. Other than Canadian, is there another culture or ethnic background that your family belongs to? ○ yes ○ no

7. How many computers are in your home? _____

8. How often in the last month have you done the following?

	Never	Once or twice a month	Once a week	Several times a week	Everyday
a) Played organized sports in school?	○	○	○	○	○
b) Played organized sports outside of school?	○	○	○	○	○

APPENDIX P

Video Game Play (Study 3a & Study 3b)

On an average day, how often do you play the following types of video games?

	Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours
a) Action (e.g., God of War)	○	○	○	○	○
b) Sports (e.g., FIFA Soccer)	○	○	○	○	○
c) Fighting (e.g., Mortal Kombat)	○	○	○	○	○
d) Racing (e.g., Gran Turismo)	○	○	○	○	○

APPENDIX Q

Aggressive Behavior (Study 3a & Study 3b)

How often have you done these things during the last school year?

	Never	A few times a year	A few times a month	A few times a week	Everyday
a) Pushed and shoved someone	○	○	○	○	○
b) Swore at someone and called them names	○	○	○	○	○
c) Teased and ridiculed someone	○	○	○	○	○
d) Kicked and hit someone	○	○	○	○	○

APPENDIX R

Correlation Table for Main Study 2 Variables from Grades 9 through 12

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Aggression 9	--																				
2. Aggression 10	.52	--																			
3. Aggression 11	.49	.56	--																		
4. Aggression 12	.51	.54	.72	--																	
5. Competitive vg 9	.20	.21	.20	.22	--																
6. Competitive vg 10	.21	.25	.24	.25	.49	--															
7. Competitive vg 11	.20	.27	.25	.28	.41	.51	--														
8. Competitive vg 12	.15	.19	.21	.26	.31	.34	.40	--													
9. Non-competitive vg 9	-.09	-.09	-.08	-.09	.12	-.02	-.04	-.03	--												
10. Non-competitive vg 10	-.06	-.06	-.08	-.08	-.01	.09	-.01	-.03	.35	--											
11. Non-competitive vg 11	-.01	-.01	-.03	-.04	.03	.07	.25	.06	.23	.45	--										
12. Non-competitive vg 12	.01	.02	.01	.04	.07	.10	.19	.13	.24	.41	.64	--									
13. Freq competitive gbl 9	.32	.25	.24	.25	.25	.22	.20	.16	-.06	-.07	-.02	.01	--								
14. Freq competitive gbl 10	.26	.36	.31	.37	.25	.35	.28	.19	-.09	-.11	-.03	.02	.40	--							
15. Freq competitive gbl 11	.23	.32	.38	.33	.24	.27	.30	.22	-.09	-.09	-.01	.04	.34	.47	--						
16. Freq competitive gbl 12	.23	.29	.33	.35	.23	.26	.26	.30	-.09	-.09	-.01	.06	.34	.44	.49	--					
17. Freq non-competitive gbl 9	.04	.03	.03	.02	.03	.02	.01	.01	.01	.00	.00	-.01	.24	.07	.05	.05	--				
18. Freq non-competitive gbl 10	.09	.22	.14	.13	.06	.08	.07	.05	-.01	.03	.01	.02	.10	.38	.15	.14	.18	--			
19. Freq non-competitive gbl 11	.09	.17	.19	.18	.09	.10	.16	.10	-.03	-.02	.05	.04	.11	.19	.49	.21	.14	.31	--		
20. Freq non-competitive gbl 12	.09	.12	.15	.18	.08	.09	.10	.14	-.03	-.02	.01	.08	.10	.14	.18	.54	.11	.17	.24	--	
21. Violent vg moderator	.18	.24	.20	.28	.31	.32	.40	.26	.00	.06	.16	.23	.20	.24	.27	.24	.04	.04	.09	.09	--

Notes. vg = video game play; gbl = gambling; Freq = frequency; 9 = grade 9; 10 = grade 10; 11 = grade 11; 12 = grade 12. r = .06 or higher is significant at $p < .05$.

APPENDIX S

Correlation Table for Main Study 2 Variables for Grade 11 and 12

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Aggression 11	--										
2. Aggression 12	.72	--									
3. Freq competitive vg 11	.36	.36	--								
4. Freq competitive vg 12	.35	.39	.77	--							
5. Freq non-competitive vg 11	.02	.05	.22	.13	--						
6. Freq non-competitive vg 12	.00	.06	.12	.26	.50	--					
7. Freq competitive gbl 11	.40	.39	.37	.36	.06	.04	--				
8. Freq competitive gbl 12	.33	.36	.31	.38	.04	.17	.50	--			
9. Freq non-competitive gbl 11	.21	.22	.17	.16	.11	.06	.50	.23	--		
10. Freq non-competitive gbl 12	.19	.22	.13	.19	.03	.22	.19	.54	.25	--	
11. Violent vg moderator	.20	.28	.28	.30	.22	.13	.09	.09	.27	.24	--

Notes. vg = video game play; gbl = gambling; Freq = frequency; 11 = grade 11; 12 = grade 12. r = .06 or higher is significant at $p < .05$.

APPENDIX T

Correlation Table for Main Study 3a Variables for the Young Adult Sample

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Aggressive behavior 1	--										
2. Aggressive behavior 2	.71	--									
3. Aggressive behavior 3	.59	.65	--								
4. Sports/racing vg 1	.27	.31	.23	--							
5. Sports/racing vg 2	.24	.25	.22	.51	--						
6. Sports/racing vg 3	.22	.24	.26	.50	.63	--					
7. Action/fighting vg 1	.24	.26	.20	.57	.33	.33	--				
8. Action/fighting vg 2	.19	.18	.18	.29	.55	.35	.40	--			
9. Action/fighting vg 3	.15	.17	.18	.32	.35	.50	.44	.58	--		
10. Aggressive affect 2	.35	.29	.27	.12	.14	.16	.16	.15	.20	--	
11. Aggressive affect 3	.26	.34	.26	.16	.12	.14	.18	.18	.18	.54	--

Notes. Vg = video game play; 1 = Time 1, 2 = Time 2; 3 = Time 3. r = .07 or higher is significant at $p < .05$.

APPENDIX U

Correlation Table for Main Study 3b Variables for the Adolescent Sample

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Aggressive behavior 11	--										
2. Aggressive behavior 12	.69	--									
3. Sports/racing vg 11	.33	.39	--								
4. Sports/racing vg 12	.33	.39	.77	--							
5. Action/fighting vg 11	.22	.27	.43	.35	--						
6. Action/fighting vg 12	.21	.38	.33	.39	.45	--					
7. Parental education	-.06	-.07	-.06	.04	-.03	-.05	--				
8. Gender	-.31	-.39	-.54	-.56	-.44	-.41	-.05	--			
9. Sports involvement	.14	.10	.25	.24	.00	-.04	.19	-.20	--		
10. Born in Canada	.01	.04	.07	.10	.04	.04	.13	-.03	.02	--	
11. Ethnicity	.00	-.02	-.02	.00	-.04	-.04	-.03	.03	.01	-.04	--

Notes. Vg = video game play; 11 = Grade 11; 12 = Grade 12. r = .06 or higher is significant at $p < .05$.