Failure to demonstrate competitive video game play increases aggressive affect, cognition, or behavior.

Hannah Zimmerman¹, Chia-Wei Jao², Damian Scarf^{2*}

¹School of Psychology, Massey University, Palmerston North, New Zealand.

²Department of Psychology, University of Otago, Dunedin, New Zealand.

*Corresponding Author: Damian Scarf, PhD, 95a Union Place East, Goddard Laboratory Building, Department of Psychology, University of Otago, Dunedin, New Zealand. E-mail: damian@psy.otago.ac.nz. Office Phone: 6434797636. Cell Phone: 64201113040.

Background. Recent research suggests that the competitive aspects of video gameplay may increase aggression. Further, these effects are thought to be exacerbated when highly immersive forms of gameplay (e.g., Virtual Reality) are utilised.

Intervention. In order to test the effects of competition and immersion (i.e., telepresence) on aggression we had participants play a video game under one of four experimental conditions: non-competitive and non-immersive, competitive but non-immersive, non-competitive but immersive, and competitive and immersive.

Method. In this study, $N = 79$ university students were randomly assigned to one of the four experimental conditions. After gameplay, aggressive affect, aggressive cognition, and aggressive behaviour were measured. Immersion was manipulated by having participants play the game using a Virtual Reality headset.

Results. Competitive video gameplay did not increase aggressive affect, cognition, or behaviour, relative to the non-competitive video game. Similarly, immersion had no impact on aggressive affect, cognition, or behaviour.

Discussion. The current study failed to find any evidence that competitive video gameplay, or immersive technology (e.g., VR), enhanced aggressive affect, cognition, or behaviour. Given the small amount of research that has assessed the impact of competitive video gameplay and/or immersive technology on aggression, replications are key to identifying whether these aspects of video gameplay have reliable effects on thought and behaviour.

Keywords: video game play, competition, telepresence, immersive technology, aggression

Background

Video games are more popular than ever. In 2014, there were 1.82 billion video gamers across the world, and this number is expected to hit 2.7 billion by 2021 (Statistica, 2020b). Not surprisingly, action and shooter games are the most popular, capturing 26.9% and 20.9% of video game sales respectively (Statistica, 2020a). Looking to specific games, Call of Duty, Grand Theft Auto, and Fortnite were the most popular games in 2019 (Statistica, 2020a). For the uninitiated, all three of these games involve a high level of action and either first- or third-person shooter modes. As Markey and Ferguson (2017) note, the “...lust for virtual blood has grown exponentially” in recent years (p. 21).

Mirroring their market share, research on video games has focused almost exclusively on violent video games and their potential impact on aggression. The association between violent video games and aggression has a long history in politics and popular media. For example, in the 1980s, the US Surgeon General expressed his opinion that video games were one of the causes of family violence (Cooper & Mackie, 1986). The Columbine High School shooting in 1999 also generated a great deal of attention, with media focusing on the fact that the perpetrators were avid fans of the first-person shooter game *Doom* (Markey & Ferguson, 2017). More recently, following the mass shooting at Marjory Stoneman Douglas High School on the 14th of February 2018, Donald Trump blamed video games and other violent media for causing youth violence, stating that “...the level of violence in video games is really shaping young people’s thoughts” (Kain, 2018).

Despite decades of research and prognostications in the popular press, the relationship between violent video games and aggression is still a topic of heated academic debate (Anderson et al., 2010; Bushman, Rothstein, & Anderson, 2010; Ferguson & Kilburn, 2010; Hilgard, Engelhardt, & Rouder, 2017; Kepes, Bushman, & Anderson, 2017). Broadly

speaking, the debate can be distilled down to four points of contention. First, even if the various research groups agreed on the effect size derived from violent video game research, there is disagreement regarding whether small effect sizes are cause for concern when considered at the population level (Ferguson & Kilburn, 2010). Second, there is debate over the methods employed to measure aggression (Elson, Mohseni, Breuer, Scharkow, & Quandt, 2014; Ferguson, Smith, Miller-Stratton, Fritz, & Heinrich, 2008). For example, the Taylor Competitive Reaction Time Task (TCRTT) is perhaps the most popular measure of aggression in video game literature. Use of the TCRTT has been criticized due to a) variability in the aggression measure(s) extracted from the TCRTT and, b) issues regarding the validity of the TCRTT as a measure of aggression (Ferguson & Rueda, 2009; Ferguson et al., 2008). Third, studies that demonstrate a relationship between violent video gameplay and aggression are confounded by competition (Adachi & Willoughby, 2011a, 2011b; Hawk, 2018). That is, violent video games are inherently competitive (Adachi & Willoughby, 2011a, 2011b; Hawk, 2018). Finally, reflecting a wider issue in the social and behavioral sciences, there also appears to be a replication crisis in research on violent video games and aggression (Ferguson, 2020). For example, a series of preregistered experimental studies have reported null effects of video game violence (Ferguson et al., 2017; Ferguson et al., 2016; Hilgard, Engelhardt, Rouders, Segert, & Bartholow, 2019).

To address points two and three, a growing literature is employing validated measures of aggression and/or directly assessing whether competitive video gameplay leads to increases in aggression (Dowsett & Jackson, 2019; Griffiths, Eastin, & Cicchirillo, 2016; Hawk, 2018; Schmierbach, 2010). Theoretically, there is good reason to believe that competition will lead to aggression. Indeed, Berkowitz's (1989) frustration-aggression theory holds that when our path toward a goal is thwarted it causes frustration which, in turn, leads to aggression. Competitive games, by their very nature, involve the attempted thwarting of a goal (e.g.,

winning a battle) by an opponent and, as a consequence, should lead to aggression. Supporting this hypothesis, Adachi and Willoughby (2011a) had participants play one of four video games, which varied in terms of both violent content and competition. Aggressive behaviour was measured using the Hot Sauce Paradigm (HSP), which consists of selecting an intensity and amount of hot sauce to administer to an unknown third party (Barlett, Branch, Rodeheffer, & Harris, 2009; Lieberman, Solomon, Greenberg, & McGregor, 1999). Participants playing the two competitive games displayed higher levels of aggressive behaviour than those playing the non-competitive games. Critically, participants playing a competitive but non-violent game displayed higher levels of aggression than those playing a non-competitive but violent game, suggesting competition is the key factor in aggression following video gameplay (Adachi & Willoughby, 2011a).

In the context of competitive video game research, one factor that has not been investigated is the influence of technological advancement. Several researchers have argued that technological advancement will exacerbate the influence of video gameplay on thought and behavior (Bensley & Van Eenwyk, 2001; Calvert & Tan, 1994; Ivory & Kalyanaraman, 2007; Persky & Blascovich, 2007, 2008; Sherry, 2001; Tamborini, Eastin, Skalski, & Lachlan, 2004). The primary mechanism through which this is predicted to occur is *telepresence*. Although there is no single definition of telepresence, in the context of video games, it is thought to consist of increased feelings of involvement, immersion, and identification with characters in the game (Steuer, 1992; Tamborini, 2000; Tamborini et al., 2004). Beyond improvement in-game realism, Virtual Reality (VR) is one technological advancement that is thought to directly influence the degree to which players are ‘present’ in the game they are playing. Here, we combine VR technology with competitive video gameplay and investigate the degree to which they influence aggressive affect, cognition, and behaviour.

Intervention

The primary aim of the study was to investigate the impact of competition and telepresence on aggression. To achieve this aim, a 2 (Competition) by 2 (Telepresence) design was employed. Telepresence was manipulated by having participants play the video game on a standard television (non-telepresence) or using a VR headset (telepresence). Following Carnagey and Anderson (2005), we measured aggressive affect, cognition, and behavior.

Method

Hypotheses

H1: Competitive video gameplay will lead to increases in aggressive affect, cognition, and behavior.

H2: There will be an interaction between competitive video gameplay and telepresence, such that participants who play the competitive game with the VR headset will display greater increases in aggressive affect, cognition, and behavior relative to participants in the competitive but non-telepresence condition.

Sample

Seventy-nine people (52 females, 25 males, 2 other) participated in the current study (*Mean Age* = 23.41, *Range*: 18.00 to 39.00). Participants were recruited through the Department of Psychology's Experimental Participation Pool. Participants received either course credit or \$10 as compensation for participation. There were no inclusion criteria for participating in the current study. The current study was reviewed and approved by the University of Otago Human Ethics Committee.

Instruments

Before gameplay, following Persky and Blascovich (2007), video game experience was measured by simply asking participants how many hours/week they played video, computer,

and arcade games. Following gameplay, we used Persky and Blascovich's (2007) three-item enjoyment scale to assess whether participants across conditions experienced a comparable level of enjoyment when participating in the study (e.g., *"I would have liked the experiment to continue"*, Cronbach's $\alpha = .607$). Participants rated how competitive they found the game using Anderson and Carnagey's (2009) four-item scale (e.g., *"To what extent did this video game involve competition"*, Cronbach's $\alpha = .879$). To measure telepresence, participants completed Schneider, Lang, Shin, and Bradley's (2004) four-item character identification scale (e.g., *"I identified with the character I was playing in the game"*, Cronbach's $\alpha = .596$) and Ivory and Kalyanaraman's (2007) six-item involvement scale (e.g., *"I found myself responding strongly to this game"*, Cronbach's $\alpha = .768$).

Aggression Measures

Before gameplay, trait aggression was measured using a 12-item form of the Buss-Perry Aggression Questionnaire (Bryant & Smith, 2001; Diamond & Magaletta, 2006). The questionnaire includes items that measure physical (e.g., *"Given enough provocation, I may hit another person"*), verbal (e.g., *"My friends say that I'm somewhat argumentative"*), angry (e.g., *"Sometimes I fly off the handle for no good reason"*), and hostile aggression (e.g., *"I wonder why sometimes I feel so bitter about things"*). All questions were responded to on a five-point scale (Cronbach's $\alpha = .801$).

Following gameplay, aggressive affect was measured using the State Hostility Scale (SHS) (Anderson, Deuser, & DeNeve, 1995). The SHS consists of 35 items (e.g., *"I feel furious"*, *"I feel enraged"*, etc.) with participants' indicating their level of agreement on a 1 to 5 scale (Cronbach's $\alpha = .950$). Aggressive cognition was measured using Schmeibach's (2010) Word Completion Task (WCT). Each participant was given six two-letter stems on a piece of paper (i.e., KI, DE, BL, ST, RI and SL) and was asked to complete each stem such that it formed a word. The completed word stems were then coded by the experimenter and classified

as violent (e.g., KILL, DEATH, BLOOD, STAB, RIOT, SLAY) or non-violent (e.g., KITE, DEER, BLUE, STAND, RINSE, SLIME). An aggressive cognition score was then calculated as the proportion of words coded as violent. Finally, aggressive behaviour was measured using the Hot-Sauce Paradigm (HSP) (Adachi & Willoughby, 2011a; Lieberman et al., 1999). Specifically, participants were presented with four bottles of hot sauce, each labelled with a different level of heat/intensity (1 = low, 4 = high). Participants were first asked to select one of the four bottles and then place an amount of hot sauce into a plastic cup. Participants were told that the hot sauce would be given to an unknown third party, who was taking part in a food tasting study. The allocation was measured as the amount of hot sauce (in grams) participants poured into the cup. Following Adachi and Willoughby (2011a), the intensity and amount were converted to z-scores and summed.

Research Protocol

Participants were told they would be playing the game *Tekken 7*, a one-on-one fighting game, and given a brief description of what each of the buttons on the controller did (e.g., kick, punch, etc.). Participants were then randomly assigned to one of four conditions. In the two non-immersive conditions, participants were assigned a character to play as and played the game on a Samsung 55" Ultra HD 4K Smart LED Television. In the two immersive conditions, participants selected their own character to play as and played the game using a PlayStation Virtual Reality (CUH-ZVR2 Series) headset with a field of view of approximately 100 degrees. For the non-immersive and immersive conditions, participants played either a non-competitive or competitive version of the game. The non-competitive version was simply the game placed in practice mode (i.e., with the opponent not fighting back). The competitive version involved them playing against an opponent that fought back. Participants were told the opponent in each condition was controlled by the console. Participants in all conditions played the game for 3 minutes.

Statistical Analysis

We assessed each measure for normality. Measures that were normally distributed were analysed using Analysis of Variance (ANOVA). For variables that were not normally distributed, Kruskal-Wallis tests were employed. Video game experience and trait aggression were analysed to determine if there were any baseline differences between groups. Manipulation checks were then carried out, assessing whether the competition and immersion manipulation were effective. Finally, the aggression measures were submitted to separate between-group analyses.

Results

Baseline Measures and Manipulation Checks

First, we assessed whether participants in each condition differed in terms of game experience or trait aggression (Adachi & Willoughby, 2011a). A Kruskal-Wallis test revealed that participants in each condition did not differ in terms of video game experience, $H(3) = 5.075, p = .166$. Further, a one-way Analysis of Variance (ANOVA) revealed participants did not differ in terms of trait aggression, $F(3, 78) = 1.258, p = .295$. Second, we compared the conditions in terms of enjoyment, competition, identification, and immersion. Importantly, given we did not aim to manipulate enjoyment, a one-way ANOVA revealed no difference in the degree to which participants in each condition enjoyed playing the game, $F(3, 78) = .889, p = .451$ (Figure 1). With respect to competition, a one-way ANOVA revealed a significant effect of condition, $F(3, 78) = 40.323, p < .001$ (Figure 1). Consistent with our manipulation, Tukey post-hoc tests revealed that participants in the competitive conditions rated the games as more competitive than those in the non-competitive conditions. With respect to telepresence, separate one-way ANOVAs revealed a significant effect of condition on identification, $F(3, 78) = 3.154, p = .030$, and involvement, $F(3, 78) = 40.323, p < .001$ (Figure 1). Partially consistent with our manipulation, Tukey post-hoc tests revealed that participants in the telepresence conditions, and those in the non-telepresence competitive condition, tended to

report higher levels of identification and immersion than those in the non-telepresence, non-competitive condition.

Aggression Measures

None of the aggression measures were normally distributed and, therefore, Kruskal-Wallis Tests were used to compare conditions. There was no effect of condition for aggressive affect, $H(3) = 5.035$, $p = .169$, *Bayes Factor* = .032, aggressive cognition, $H(3) = 5.920$, $p = .116$, *Bayes Factor* = .030, or aggressive behavior, $H(3) = 4.225$, $p = .238$, *Bayes Factor* = .051 (Figure 2). Thus, despite participants in the competitive condition rating the game as more competitive, there was no evidence that this led to higher aggressive affect, cognition, or behavior. Similarly, the absence of a main effect suggests that playing an immersive version of the game has no influence on aggressive behavior.

Discussion

The current study had two hypotheses. The first was that participants who played the competitive version of *Tekken* would display more aggressive affect, cognition, and behaviour than participants who played the non-competitive version. The second hypothesis was that participants who played the competitive version of *Tekken* with the VR headset would display the highest level of aggressive affect, cognition, and behaviour, relative to the other three conditions. Neither hypothesis was supported. Participants that played the competitive version of *Tekken* displayed comparable levels of aggressive affect, cognition, and behaviour to participants that played the non-competitive version. Similarly, participants that played the competitive version of *Tekken* with VR did not display higher levels of aggressive affect, cognition, and behavior than participants in the other three conditions. Critically, the null effect for competition occurred despite participants playing the competitive version of *Tekken* rating it as more competitive than participants that played the non-competitive version.

The current study is not consistent with previous studies reporting a link between competitive video gameplay and aggression (Adachi & Willoughby, 2011a; Dowsett & Jackson, 2019; Griffiths et al., 2016; Schmierbach, 2010). This discrepancy cannot be attributed to the methods used to measure aggression, as previous studies have demonstrated the SHS (Griffiths et al., 2016), WCT (Schmierbach, 2010), and HSP (Adachi & Willoughby, 2011a) are impacted by competitive video gameplay. The current study is, however, the first to use the video game *Tekken*. Previous studies that have manipulated levels of competition *within* the same game, rather than using different games (e.g., Adachi & Willoughby, 2011a), have tended to use first- or third-person shooter games, such as *Unreal Tournament* (Dowsett & Jackson, 2019), *Halo* (Schmierbach, 2010), and *Doom II: Hell on Earth* (Hawk, 2018). *Tekken* involves no weapons and it is possible the presence of weapons plays a role in priming the aggressive behavior observed in the studies noted above (Benjamin Jr, Kepes, & Bushman, 2018). Finally, manipulating the level of competition within a game naturally changes the nature of the game and this may contribute to the null effects observed in the current study. In the non-competitive version of the game, participants played the game in practise mode, with an opponent that did not fight back. Although the level of enjoyment participants reported was comparable across conditions, it is possible that participants found playing a character that did not fight back frustrating, potentially overshadowing any potential effects of competition on aggression.

With respect to telepresence, few studies have assessed the impact of VR on aggression (Persky & Blascovich, 2007; Tamborini et al., 2004). Tamborini et al. (2004) failed to find any evidence that VR increased aggressive thoughts and behaviour following violent video gameplay, relative to participants that played the game on a 14-inch colour computer monitor. In contrast, Persky and Blascovich (2007) reported that playing a violent video game with VR led participants to report more aggressive feelings after playing the game, relative to

participants that played the game on a 17-inch computer monitor. An important distinction between these studies and the current study, is that the non-telepresence condition in the current study played the game on a Samsung 55" Ultra HD 4K television, providing a vastly different experience to playing the game on a 14- (Tamborini et al., 2004) or 17-inch computer monitor (Persky & Blascovich, 2007). Consistent with the mixed findings for the self-report measures of telepresence, it is possible that playing the game on a large and high definition television leads to similar levels of telepresence as playing the game in VR.

It is important to acknowledge that the current study is not without limitations. First, while typical of studies in this area, we used a relatively small sample size. Although the Bayes Factors support our conclusion, providing moderate evidence for the null hypothesis, a higher powered study would allow a stronger conclusion to be drawn. Second, it is clear from participants' responses to the enjoyment questions that they had fun playing the game. The high level of enjoyment has the potential to mitigate any effect of playing the competitive and/or immersive game. It is important to remember, however, that this limitation is true for all studies that investigate the impact of video games on aggression. Finally, the majority of participants in the current study were female. Females tend to score lower than males on aggression measures such as the HSP (Adachi & Willoughby, 2011a). Adachi and Willoughby (2011a), however, have demonstrated that both males and females are impacted by competition.

The current study failed to find any evidence that competitive video gameplay, or immersive technology (VR), enhanced aggressive affect, thought, or behaviour. It is important to note that the null findings are not uncommon in video game research (Ferguson, 2020) or social science research more generally (OSC, 2015). Given the small amount of research that has assessed the impact of competitive video gameplay and/or immersive technology (e.g., VR)

on aggression, replication will be key to identifying whether these aspects of video gameplay have reliable effects on thought and behaviour.

References

Adachi, P. J., & Willoughby, T. (2011a). The effect of video game competition and violence on aggressive behavior: Which characteristic has the greatest influence? *Psychology of Violence, 1*(4), 259-274.

Adachi, P. J., & Willoughby, T. (2011b). The effect of violent video games on aggression: Is it more than just the violence? *Aggression and Violent Behavior, 16*(1), 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*(4), 731-739.

Anderson, C. A., Deuser, W. E., & DeNeve, K. M. (1995). Hot temperatures, hostile affect, hostile cognition, and arousal: Tests of a general model of affective aggression. *Personality and Social Psychology Bulletin, 21*(5), 434-448.
doi:10.1177/0146167295215002

Anderson, C. A., Shibuya, A., Ihori, N., Swing, E. L., Bushman, B. J., Sakamoto, A., . . . Saleem, M. (2010). Violent video game effects on aggression, empathy, and prosocial behavior in eastern and western countries: a meta-analytic review. *Psychological Bulletin, 136*(2), 151-173.

Barlett, C., Branch, O., Rodeheffer, C., & Harris, R. (2009). How long do the short-term violent video game effects last? *Aggressive Behavior, 35*(3), 225-236.
doi:10.1002/ab.20301

Benjamin Jr, A. J., Kepes, S., & Bushman, B. J. (2018). Effects of weapons on aggressive thoughts, angry feelings, hostile appraisals, and aggressive behavior: A meta-analytic

- review of the weapons effect literature. *Personality and Social Psychology Review*, 22(4), 347-377. doi:10.1177/1088868317725419
- Bensley, L., & Van Eenwyk, J. (2001). Video games and real-life aggression: Review of the literature. *Journal of Adolescent Health*, 29(4), 244-257. doi:10.1016/S1054-139X(01)00239-7
- Berkowitz, L. (1989). Frustration-aggression hypothesis: examination and reformulation. *Psychological Bulletin*, 106(1), 59-73. doi:10.1037/0033-2909.106.1.59
- Bryant, F. B., & Smith, B. D. (2001). Refining the architecture of aggression: A measurement model for the Buss-Perry Aggression Questionnaire. *Journal of Research in Personality*, 35(2), 138-167. doi:10.1006/jrpe.2000.2302
- Bushman, B. J., Rothstein, H. R., & Anderson, C. A. (2010). Much ado about something: Violent video game effects and a school of red herring: Reply to Ferguson and Kilburn (2010). *Psychological bulletin*, 136(2), 182-187.
- Calvert, S. L., & Tan, S.-L. (1994). Impact of virtual reality on young adults' physiological arousal and aggressive thoughts: Interaction versus observation. *Journal of Applied Developmental Psychology*, 15(1), 125-139. doi:10.1016/0193-3973(94)90009-4
- Carnagey, N. L., & Anderson, C. A. (2005). The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychological Science*, 16(11), 882-889.
- Cooper, J., & Mackie, D. (1986). Video games and aggression in children. *Journal of Applied Social Psychology*, 16(8), 726-744. doi:10.1111/j.1559-1816.1986.tb01755.x
- Diamond, P. M., & Magaletta, P. R. (2006). The short-form Buss-Perry Aggression questionnaire (BPAQ-SF) a validation study with federal offenders. *Assessment*, 13(3), 227-240. doi:10.1177/1073191106287666

- Dowsett, A., & Jackson, M. (2019). The effect of violence and competition within video games on aggression. *Computers in Human Behavior*, 99, 22-27.
doi:10.1016/j.chb.2019.05.002
- Elson, M., Mohseni, M. R., Breuer, J., Scharkow, M., & Quandt, T. (2014). Press CRTT to measure aggressive behavior: The unstandardized use of the competitive reaction time task in aggression research. *Psychological Assessment*, 26(2), 419-432.
doi:10.1037/a0035569
- Ferguson, C. J. (2020). Aggressive video games research emerges from its replication crisis (sort of). *Current Opinion in Psychology*, 36, 1-6. doi:10.1016/j.copsyc.2020.01.002
- Ferguson, C. J., Colon-Motas, K., Esser, C., Lanie, C., Purvis, S., & Williams, M. (2017). The (not so) evil within? Agency in video game choice and the impact of violent content. *Simulation & Gaming*, 48(3), 329-337. doi:10.1177/1046878116683521
- 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(2), 174-178.
- 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(2), 121-137. doi:10.1007/s11292-009-9069-5
- Ferguson, C. J., Smith, S., Miller-Stratton, H., Fritz, S., & Heinrich, E. (2008). Aggression in the laboratory: Problems with the validity of the modified Taylor Competitive Reaction Time Test as a measure of aggression in media violence studies. *Journal of Aggression, Maltreatment & Trauma*, 17(1), 118-132.
doi:10.1080/10926770802250678

- Ferguson, C. J., Trigan, B., Pilato, S., Miller, S., Foley, K., & Barr, H. (2016). Violent video games don't increase hostility in teens, but they do stress girls out. *Psychiatric Quarterly*, 87(1), 49-56. doi:10.1007/s11126-015-9361-7
- Griffiths, R. P., Eastin, M. S., & Cicchirillo, V. (2016). Competitive video game play: An investigation of identification and competition. *Communication Research*, 43(4), 468-486. doi:10.1177/0093650214565895
- Hawk, C. E. (2018). *Effects of Competition in Violent and Nonviolent Video Games on Aggressive/Prosocial Behavior*. Brigham Young University.
- Hilgard, J., Engelhardt, C. R., & Rouder, J. N. (2017). Overstated Evidence for Short-Term Effects of Violent Games on Affect and Behavior: A Reanalysis of Anderson et al. (2010). *Psychological Bulletin*, 143, 757-774. doi:10.1037/bul0000074
- Hilgard, J., Engelhardt, C. R., Rouder, J. N., Segert, I. L., & Bartholow, B. D. (2019). Null effects of game violence, game difficulty, and 2D: 4D digit ratio on aggressive behavior. *Psychological Science*, 30(4), 606-616. doi:10.1177/0956797619829688
- Ivory, J. D., & Kalyanaraman, S. (2007). The effects of technological advancement and violent content in video games on players' feelings of presence, involvement, physiological arousal, and aggression. *Journal of Communication*, 57(3), 532-555. doi:10.1111/j.1460-2466.2007.00356.x
- Kain, E. (2018). Trump Blames Violent Video Games For School Shootings - Here's Why He's Wrong. Retrieved from <https://www.forbes.com/sites/erikkain/2018/02/22/trump-blames-violent-video-games-for-school-shootings-heres-why-hes-wrong/#3f8527cd67f3>
- Kepes, S., Bushman, B. J., & Anderson, C. A. (2017). Violent video game effects remain a societal concern: Reply to Hilgard, Engelhardt, and Rouder (2017). *Psychological Bulletin*, 143, 775-782. doi:10.1037/bul0000112

- Lieberman, J. D., Solomon, S., Greenberg, J., & McGregor, H. A. (1999). A hot new way to measure aggression: Hot sauce allocation. *Aggressive Behavior*, 25(5), 331-348.
doi:10.1002/(SICI)1098-2337(1999)25:5<331::AID-AB2>3.0.CO;2-1
- Markey, P. M., & Ferguson, C. J. (2017). *Moral combat: Why the war on video games is wrong*. Dallas, TX: BenBella Books.
- OSC. (2015). Estimating the reproducibility of psychological science. *Science*, 349(6251), 943-951. doi:10.1126/science.aac4716
- Persky, S., & Blascovich, J. (2007). Immersive virtual environments versus traditional platforms: Effects of violent and nonviolent video game play. *Media Psychology*, 10(1), 135-156. doi:10.108/15213260701301236
- Persky, S., & Blascovich, J. (2008). Immersive virtual video game play and presence: Influences on aggressive feelings and behavior. *Presence*, 17(1), 57-72.
doi:10.1162/pres.17.1.57
- Schmierbach, M. (2010). "Killing spree": Exploring the connection between competitive game play and aggressive cognition. *Communication Research*, 37(2), 256-274.
doi:10.1177/0093650209356394
- Schneider, E. F., Lang, A., Shin, M., & Bradley, S. D. (2004). Death with a story: How story impacts emotional, motivational, and physiological responses to first-person shooter video games. *Human Communication Research*, 30(3), 361-375. doi:10.1111/j.1468-2958.2004.tb00736.x
- Sherry, J. L. (2001). The effects of violent video games on aggression: A meta-analysis. *Human Communication Research*, 27(3), 409-431. doi:10.1111/j.1468-2958.2001.tb00787.x

Statistica. (2020a). Genre breakdown of video game sales in the United States in 2018.

Retrieved from <https://www.statista.com/statistics/189592/breakdown-of-us-video-game-sales-2009-by-genre/>

Statistica. (2020b). Number of video gamers worldwide 2014-2021. Retrieved from

<https://www.statista.com/statistics/748044/number-video-gamers-world/#statisticContainer>

Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication*, 42(4), 73-93. doi:10.1111/j.1460-2466.1992.tb00812.x

Tamborini, R. (2000). *The experience of telepresence in violent video games*. Paper presented at the 86th annual convention of the National Communication Association, Seattle, WA.

Tamborini, R., Eastin, M. S., Skalski, P., & Lachlan, K. (2004). Violent virtual video games and hostile thoughts. *Journal of Broadcasting & Electronic Media*, 48, 335-357.

Figure 1. Game ratings for the four experimental conditions: non-competitive and non-immersive (C-/T-), competitive but non-immersive (C+/T-), non-competitive but immersive (C-/T+), and competitive and immersive (C+/T+).

Figure 2. Aggression measures for the four experimental conditions: non-competitive and non-immersive (C-/T-), competitive but non-immersive (C+/T-), non-competitive but immersive (C-/T+), and competitive and immersive (C+/T+).