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The effect of violence and competition within video games on aggression

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ABSTRACT

Since the release of video games numerous studies have assessed the impact of violence within video games on aggression, yet few have assessed the impact of competition. Initial studies that include competition indicate that competition within video games does impact aggression, and that it is the competitive nature of violent video games rather than the actual violence that has increased aggression. However, previous competitive video game studies have assumed levels of competition within video games or have used different games across conditions, both of which may have confounded results. As such, this study aimed to assess the impact of both competition and violence on aggression using a true experimental design and using the same game across conditions. Sixty-four participants played one of four versions of a video game (2 [Competitive] x 2 [Violent]) and it was found that competition, but not violence, impacted aggressive affect. In addition, participants who lost in the competitive version of the game had even higher levels of aggressive affect. Neither competition nor violence impacted aggressive behaviour. Possible limitations to this study included the poor validity of the Taylor Competitive Reaction Time Task (TCRTT) and the delay between participants finishing the game and then competing the TCRTT. Overall, these findings further support the notion that competition rather than violence within video games impacts aggression. Future research should assess ways to encourage fair play within video game communities to reduce the impact of competition on aggression.

1. Introduction

The impact of entertainment media on aggression has been discussed for centuries. Even in the gladiatorial era of the Roman Empire, Tertullian (200) theorized that Christians might be seduced into sinful bloodlust if they watched the gladiator games. In the early 1900s violent entertainment media began on new platforms such as movies and subsequently television (Trend, 2007). The rise of modern social science also began at this time and for several decades the impact of violent screen media on aggression was assessed (e.g., Bandura, Ross, & Ross, 1963). Then in the 1970s video games started to emerge (Ferguson, 2010) and gain popularity. Previous research on movies and television had concentrated on violence, thus research on video games followed suit. However, the focus on violence within video games led to other aspects of video games, which were not apparent in movies and television, being largely ignored in their relation to aggression, primarily competition.

Despite an early study of video games finding that a competitive version of a video game increased aggressive acts within the game (Anderson & Morrow, 1995), the impact of competition within video games on aggression was not assessed again until Eastin in 2007. Even after 2007 the number of competitive video game studies has been very limited compared to the hundreds that have been conducted regarding violence within video games (Dowsett, 2017). When competition was mentioned, it appeared only as a secondary factor (as seen in the following studies). Some studies assessed a competitive version of a video game to a cooperative version (e.g., Anderson & Morrow, 1995; Eastin, 2007; Eastin & Griffiths, 2009; Eden & Eshet-Alkalai, 2014; Schmierbach, 2010), but differences observed may be due to cooperation reducing aggression rather than competition increasing aggression (see Greitemeyer & Mugge, 2014). Some studies have compared a competitive multiplayer version of a video games to a single player version (e.g., Hollingdale & Greitemeyer, 2014; Mihan, Anisimowicz, & Nicki, 2015; Shafer, 2012; Velez, Greitemeyer, Whitaker, Ewoldsen, & Bushman, 2016). However, participants in the single player conditions still compete against the Artificial Intelligence within the game and thus it is not a true measure of the impact of competition.

Another area that has been assessed which is closely associated with competition is the impact of winning and losing video games. Studies have consistently found that participants who lost in a video game had higher levels of aggression and hostility post gameplay (Breuer, Scharkow, & Quandt, 2015; Griffiths, Eastin, & Cicchirillo, 2016;

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Shafer, 2012). This can be explained by the frustration-aggression hypothesis (Berkowitz, 1989). It should be noted with these studies that they assessed losing in what appeared to be highly competitive video games but losing can be a part of a non- or low-competitive video game. For example, it could be considered losing if a player fails to complete a task in a puzzle game, despite not actually competing against another entity.

While some studies have mentioned or been associated with competitive video games (i.e., cooperation, multiplayer, losing), only four papers have focused specifically on the competition within video games and how it may impact aggression (Adachi & Willoughby, 2011a, 2013, 2016; Lobel, Engels, Stone, & Granic, 2017). Adachi and Willoughby (2013) conducted a cross-lagged longitudinal study with high school students starting in Grade 9 until they were in Grade 12. They found that competitive video gameplay had a bi-directional relationship with aggression. One significant limitation of this study is that it relied solely on how often participants played sports or racing games. To address this limitation they re-analyzed their results to include violent games that were also competitive, i.e. action and fighting games (Adachi & Willoughby, 2016). In their 2016 paper they also included results from a longitudinal study with the same methodology but which assessed university students rather than high school students. After factoring out the violence within the competitive video games it was again found that competitive video game exposure had a bi-directional relationship with aggression for both high school students and university students.

Contrary to Adachi and Willoughby (2016), a study assessing children aged between 8 and 11 over a 1-year period found that competitive video game exposure reduced behaviors associated with conduct disorders (Lobel et al., 2017). The researchers argued that the difference in results was due to competitive play being fundamental to children's development. Children will learn to deal with winning and losing and the negative emotions associated, and competitive play can also involve cooperation with other team mates (Lobel et al., 2017). This is a very important and interesting differentiation; however, limitations in both Adachi and Willoughby (2013, 2016) and Lobel et al. (2017) also explain the inconsistent results.

All these longitudinal studies (Adachi & Willoughby, 2013, 2016; Lobel et al., 2017) did not get participants to rate how competitive the video games were. As such the competitiveness of the video games, as well as how competitively each participant played the video game, was assumed. Adachi and Willoughby (2016) even suggested that future studies should include participants' ratings of competition. Along with self-rating scales, future studies should use an experimental research design to support longitudinal studies.

Adachi and Willoughby (2011a) is the only true experimental study that has assessed the impact of competition on aggression, while not including cooperation or multiplayer conditions. Using a 2 (Violence) by 2 (Competitive) experimental design, with differences confirmed across conditions by participants' ratings, they found that competitive video gameplay increased aggression while violence did not. However, a critical limitation with this study was that different games were used across conditions and thus other aspects, such as differences in the goal of the game or the games' design, may have impacted aggression levels.

In a review of studies between 2005 and mid-2016 it was found that only eight of the 68 papers reviewed successfully used the same game across conditions while keeping all aspects of the game the same across conditions other than the aspect being studied, e.g. violence (Dowsett, 2017). This is a major concern as several other variables can influence aggression, for example Adachi and Willoughby (2011b) (who also found that previous studies had not controlled for competition) noted that competition, pace of action, and level of difficulty of the game varies across video games and could confound the results. Elson and Quandt (2014) also discussed the importance of using the same game across conditions, for example they suggested that as participants do not play both versions of the game they cannot accurately rate, and thus control for, perceived differences between the game (a lack of a "point of reference"). However, of particular importance to this study is that violent video games are generally more competitive than non-violent games, hence another confound (Dowsett, 2017). This means that meta-analyses will not factor out the confounding variable of competition as the majority of experimental studies in the meta-analyses would have had higher levels of competition in the violent condition. As such it brings into question whether violent video games impact aggression despite some meta-analyses suggesting that it does (Anderson et al., 2010; Greitemeyer & Mugge, 2014).

An analysis of all papers that controlled for competition (using the same game across conditions or using participants' ratings) (see Dowsett, 2017), only four (Anderson & Carnagey, 2009; Barlett, Harris, & Bruey, 2008; Bluemke, Friedrich, & Zumbach, 2010; Carnagey, 2006) of the 11 found that violence increased aggression, two found mixed results (Farrar, Krcmar, & Nowak, 2006; Krcmar & Farrar, 2009) and the remaining five found null results (Adachi & Willoughby, 2011a; Elson, Breuer, Van Looy, Kneer, & Quandt, 2015; Kneer, Elson, & Knapp, 2016; Przybylski, Deci, Rigby, & Ryan, 2014; Stermer, 2013). Therefore, when considering only studies that controlled for competition, the results regarding the impact of violence within video games on aggression are inconsistent and thus further research is needed.

1.1. Study overview

The primary aim of this study was to use the same video game across all conditions to assess the impact of both violence and competition on aggression. The secondary aim was to assess the impact of losing on aggression, in both a competitive and low-competitive video game. To address both these aims a 2 (Violence) x 2 (Competition) true experimental between-subjects design with an addition x 2 (Win/loss) quasi experimental between-subjects design was used. The first hypothesis was that competition within the video game would impact aggression. The second hypothesis was that violence within video games would impact aggression. This hypothesis was chosen because, despite the inconsistences and limitations listed above, most studies have found that violence does have an impact (Anderson et al., 2010; Greitemeyer & Mugge, 2014). The third hypothesis was that a combination of violence and competition would lead to higher levels of aggression over just one variable alone. The fourth hypothesis was that losing a video game would impact aggression. The fifth hypothesis was that losing in a competitive video game would have a greater impact on aggression compared to losing in a low-competitive video game.

2. Method

2.1. Participants

The sample consisted of 64 participants (40 male, 24 female) who were students from a major Australian metropolitan university. Participants' age ranged between 18 and 53, with a mean age of 21.58 (SD = 4.62), and had no knowledge of the true nature of the study beforehand. The study was approved by the RMIT ethics committee (HREC project number: 39/14).

2.2. Materials

2.2.1. Demographics

Participants were asked to rate on a 7-point Likert scale (1 = not at all, 7 = extremely) how experienced they were at video games overall and first-person shooting games. They also rated how skilled they were at first-person shooting games (which was used to set the difficulty of the video game).

2.2.2. Video game

The first-person shooter game *Unreal Tournament 3: Black Edition*$^{(TM)}$ was used for this study.

2.2.3. Violence modification/manipulation

In the high-violent condition participants used a weapon called the *Bio Rifle*, which shoots blobs of toxic waste, to kill their opponent. In addition, a modification called *Gibalicious* (Asvachin, 2008) was used to increase the amount of blood and gore in the game.

In the low-violent condition, a modification called *Battle Team/ Freezetag Arena* (De Vries, 2014) was used. This modification included an option to have players freeze in a light blue colour when they are defeated, rather than die and explode in blood and gore. In the low-violent condition, the "*Bio Rifle*" was described to participants as a paintball gun which would freeze the opponent when hit enough times. In addition, when a player hit their opponent a "ping" noise would be made rather than pain noises. Also, any text which stated that the player had "killed" their opponent was changed to "defeated" their opponent.

2.2.4. Competitive modification/manipulation

There are several aspects that can affect how competitive a video game is (see Dowsett, 2017). Two important aspects are score feedback and time pressure. The presence of an opponent's score has been demonstrated to increase competitive behaviour (McClintock & McNell, 1966; McClintock & Nuttin, 1969). In regard to time pressure, it has been demonstrated that when a task is close to being finished competitive behaviour increases (Ku, Malhotra, & Murnighan, 2005; Malhotra, 2010). Therefore, this study manipulated score board and time pressure to vary the levels of competition.

For the high-competitive condition, each time a player killed or froze their opponent they would get one point which was displayed on the scoreboard. Each time a player was killed or frozen a new round would begin with both players re-spawning. Participants won or lost after 10 min depending upon the points score. It was clearly stated to participants in this condition that the game would only last 10 min, but to create a more visible time-pressure, the game warned players when there was 30 s left and when there was 5 s left.

For the low-competitive condition, the game would still reset if a player was killed or frozen but no points were awarded. Therefore, no scoreboard was displayed and all messages of "you defeated your opponent" were removed. This meant that participants had no indication of whether they were winning or losing. In addition, before playing, participants in the low-competitive condition were informed that there was no winning or losing. No time pressure was displayed and the video game did not end after 10 min, rather the researcher came into the room and informed participants to stop.

2.2.5. Win/Lose result

To assess the effect of losing on aggression, the researcher took note at the end of the game what the final score was. This was done for both the competitive and low-competitive conditions.

2.2.6. Aggressive affect

The State Hostility Scale (SHS) (Anderson, Deuser, & DeNeve, 1995) was used to assess participants' aggressive affect post gameplay. This 35-item questionnaire comprises of mood statements, e.g. "I feel furious", and asks participants to rate if they are feeling this way on a 5-point Likert scale where 1 is strongly disagree and 5 is strongly agree. Questions that relate to positive or nice feelings, e.g. "I feel friendly", were reverse coded. The SHS has been used by several researchers and has been found to be a reliable measure (e.g., Anderson et al., 1995; Barlett, Branch, Rodeheffer, & Harris, 2009; Barlett et al., 2008). For this study, the initial reliability analysis had a high Cronbach's alpha of .91, although the questions, "I feel", "tender", "amiable", and "sympathetic"", were removed as all decreased the alpha and were either not significantly correlated or negatively correlated with the total SHS score. Therefore, only 32 items were used in this study with a Cronbach's alpha of .93.

2.2.7. Aggressive behaviour

The modified Taylor Competitive Reaction Time Task (TCRTT), originally constructed by Epstein and Taylor (1967) and later modified by other researchers (e.g., Anderson & Dill, 2000; Bushman, 1995), was used to assess post gameplay aggressive behaviour. This study used a procedure very similar to that which was used in the original studies (Anderson & Dill, 2000; Bushman, 1995). Firstly, the participants were informed that they were competing against a human opponent in another room, although it was actually a computer program. This minor deception was approved as part of the ethics application. The aim was to press the mouse button as quickly as possible when a visual cue was given. The loser of this reaction time task was then blasted with white noise set at an intensity and duration chosen by their opponent before each trial. Noise intensity was set on a scale of 0 (0 dB, no noise) to 10 (100 dB, very loud) and duration on a scale of 0 (0 s, thus no noise) to 10 (2 s of noise). The task involved 25 trials in which the computer program, in a semi random pattern, sets the intensity and duration to blast the participant with between 1 and 4 for the first nine trials. In the subsequent eight trials the computer program set the intensity and duration between 4 and 7, and for the last eight trials it was between 7 and 10. Participants always lost the first trial and then 50% of the subsequent trials spread evenly across the three blocks of eight trials. Participants could select any intensity and duration level to give to their opponent before each trial. The levels selected by the participant across the 25 trials gave a mean score for both intensity and duration. Higher mean scores indicated higher levels of aggressive behaviour. Intensity was recorded on the scale of 0–10, while duration was recorded by the number of seconds, from 0 to 2.

The TCRTT appears to be the most commonly used measure of aggressive behaviour and has been shown to have good external validity by some (e.g., Anderson & Bushman, 1997; Carnagey & Anderson, 2005; Giancola & Parrot, 2008; Giancola & Zeichner, 1995). However, there are still some concerns about its validity and standardisation (Elson, Mohseni, Breuer, Scharkow, & Quandt, 2014; Ferguson & Rueda, 2009).

2.2.8. Subjective gaming experience

Participants were also asked to rate how enjoyable, frustrating, fast-paced, exciting, and difficult the game was on a scale of 1 (not at all) to 7 (extremely). These questions were used to assess whether participants in different conditions had varied experiences outside the manipulated variables of violence and competition.

2.2.9. Video game manipulation assessment

A four-item scale (Elson et al., 2015) was used to assess if the violence manipulation was successful. The items are: "You had to use physical violence in this game", "The characters in this game were hurt", "Physical damage was inflicted on the characters in the game", "You had to kill humans in this game". Responses ranged on a 7-point Likert scale from 1 (not at all) to 7 (extremely) and then all four items were averaged to give an overall violence score. The internal reliability of the four-item scale was good ($\alpha = 0.86$).

The competitive manipulation was also assessed using four items that related to the competitiveness of the game (Anderson & Carnagey, 2009). These items are: "to what extent did you feel like you were competing with the other team", "how hard were you trying to win the game", "how competitive was this video game", and "to what extent did this video game involve competition". A 7-point Likert scale from 1 (not at all) to 7 (extremely) was used and the items were averaged to give an overall competitive rating. It was found to have good internal reliability ($\alpha = 0.87$).

2.3. Procedure

Participants were randomly allocated into one of the four video game conditions ($n = 16$ per condition), i.e. violent/competitive, low-

Table 1
Descriptive Statistics for Violent and Low-Violent condition, Competitive and Low-Competitive Condition.

	Violence				Competitive			
	High		Low		High		Low	
Variables	M	SD	M	SD	M	SD	M	SD
Overall Exp	4.31	1.64	4.78	1.66	4.41	1.68	4.69	1.64
FPS Exp	3.78	1.85	4.22	1.72	3.81	1.51	4.19	2.02
FPS Skill	3.47	1.74	3.81	1.60	3.59	1.64	3.69	1.71
Enjoying	5.03	1.20	4.97	1.60	5.03	1.43	4.97	1.40
Frustrating	3.31	1.40	3.00	1.46	3.34	1.45	2.97	1.40
Pace	4.91	1.75	4.91	1.63	4.94	1.70	4.88	1.68
Exciting	4.88	1.40	4.63	1.74	4.94	1.65	4.56	1.50
Difficult	3.56	1.48	3.66	1.66	3.91	1.53	3.31	1.55
Violence	4.81	1.60	2.87	1.44	3.46	1.27	3.96	1.84
Comp	5.28	1.10	5.52	1.13	5.46	1.27	5.34	.94
SHS	70.44	16.31	67.19	18.52	73.25	17.26	64.38	16.61
TCRTT Int	5.28	2.41	5.62	2.46	5.81	2.09	5.09	2.70
TCRTT Dur	1.16	.43	1.20	.49	1.26	.36	1.10	.50

Note. Exp = Experience, FPS = First-Person Shooter, Comp = Competition, SHS = State Hostility Scale, TCRTT = Taylor Competitive Reaction Time Task.

violent/competitive, violent/low-competitive, low-violent/low-competitive. The random allocation was done separately for males and females so that there was an equal number of males and females in every group. After completing the demographics and once they were confident with the tutorial version of the game, participants were left alone in a room to play the video game against the computer for 10 min. After playing the video game, participants were required to fill in the SHS, which took no longer than 5 min. Once the SHS was completed the participants engaged in the TCRTT which took approximately 10 min. Participants were then probed to see if they were aware of the true nature of the study or the deception involved in the TCRTT.

3. Results

Descriptive statistics for the 2 (violence) x 2 (competition) between subject design can be seen in Table 1. Means and standard deviations for the x 2 (win/loss) quasi experimental between-subject design are given in-text.

3.1. Manipulation checks

A MANOVA found that the violent condition had a significantly higher score on the four-item violence scale than the low-violent condition, F (1, 58) = 24.40, $p < .001$. Competition and subjective experience variables were successfully controlled for with no significant difference between the violent and low-violent condition.

Participants reported no significant difference between the competitive and low-competitive condition on the four-item competitiveness scale, F (1, 62) = 0.18, $p = .68$. Violence and subjective experience variables were successfully controlled for with no significant differences between the competitive and low-competitive condition.

While not part of the manipulation, it is also important to note that there were no significant differences between any groups on video game experience, first-person shooter experience, or first-person shooter skill.

3.2. Aggressive affect (SHS)

An ANOVA showed a significant main effect for competition, F (1, 60) = 4.56, $p = .037$, partial $\eta^2 = 0.07$, with participants in the competitive condition demonstrating greater aggressive affect. No significant main effect was found for violence, F (1, 60) = 0.61, $p = .44$, partial $\eta^2 = 0.01$. There was also no significant interaction between the competitive and violent condition, F (1, 60) = 3.83, $p = .055$, partial $\eta^2 = 0.06$.

An ANOVA indicated no significant main effect for losing (37 participants won, 26 lost), F (1, 61) = 3.71, $p = .059$, partial $\eta^2 = 0.06$ (Won $M = 65.35$, $SD = 16.23$; Lost $M = 73.81$, $SD = 18.41$). However, when analysing participants in the competitive group alone, losing did show a significant main effect, F (1, 30) = 4.87, $p = .035$, partial $\eta^2 = 0.14$, with participants who lost having a higher aggressive affect (Won $M = 68$, $SD = 14.33$; Lost $M = 80.92$, $SD = 18.82$). No significant main effect was found for participants in the low-competitive condition (Won $M = 62.56$, $SD = 18.01$; Lost $M = 66.69$, $SD = 15.56$).

3.3. Aggressive behaviour (TCRTT)

The results of four participants were removed for this part of the analysis due to their awareness of the deception related to the TCRTT. An ANOVA demonstrated that, in regard to intensity, there was no significant main effect for competition, F (1, 56) = 1.31, $p = .26$, partial $\eta^2 = 0.02$, or violence F (1, 56) = 0.29, $p = .59$, partial $\eta^2 = 0.01$. There was also no significant interaction between competition and violence, F (1, 56) = 0.06, $p = .81$, partial $\eta^2 = 0.001$.

For duration, there was no significant main effect for competition, F (1, 56) = 2.00, $p = .16$, partial $\eta^2 = 0.04$, or violence F (1, 56) = 0.19, $p = .74$, partial $\eta^2 = 0.002$. There was also no significant interaction between the competitive and violent condition, F (1, 56) = 0.48, $p = .49$, partial $\eta^2 = 0.01$.

Separate ANOVA's found that losing did not have a significant main effect with intensity, F (1, 57) = 1.74, $p = .19$, partial $\eta^2 = 0.03$ (Won $M = 5.11$, $SD = 2.64$; Lost $M = 5.96$, $SD = 2.07$), or duration, F (1, 57) = 3.45, $p = .067$, partial $\eta^2 = 0.06$ (Won $M = 1.09$, $SD = 0.48$; Lost $M = 1.30$, $SD = 0.36$). When assessing the competitive group alone, there was still no significant main effect for intensity (Won $M = 5.73$, $SD = 2.07$; Lost $M = 5.94$, $SD = 2.22$) and duration (Won $M = 1.23$, $SD = 0.34$; Lost $M = 1.29$, $SD = 0.39$).

3.4. Predictive validity and internal reliability of the TCRTT

To assess the predictive validity of the TCRTT a correlation between the SHS and TCRTT was conducted. There was no significant correlation between the SHS and TCRTT intensity, r (58) = 0.09, $p = .49$, or SHS and TCRTT duration r (58) = 0.12, $p = .37$.

Intensity and duration of the TCRTT were significantly correlated, r (58) = 0.95, $p < .001$. This indicates excellent internal reliability between the two measures of aggressive behaviour within the TCRTT.

4. Discussion

While numerous studies have assessed the impact of violence within video games, only a few have assessed the impact of competition. This study found that competition increased aggressive affect but not aggressive behaviour, and when participants lost in the competitive condition their aggressive affect increased even further. In contrast, violence within the video game had no effect on aggressive affect or behaviour. In addition, a combination of violence and competition did not increase aggression further than competition alone. This study provides further evidence that competition in video games plays a significant role in determining aggression and should be included in future studies.

This study supported Adachi and Willoughby's (2011a; 2013; 2016) research that competitive video games increased aggression. In addition, this experimental study is the first to demonstrate this effect by controlling for any confounding game effect variables by using the same game across all conditions. The results differed from the findings of Lobel et al. (2017) and this can be explained by the following refinements: this study assessed the level of competition within the games played by participants; it was an experimental study; and it studied

adults rather than children. A possible explanation to be evaluated in the future is the role of competitive video-game play in children (see Lobel et al., 2017). Children are often encouraged to play fair by caregivers and teachers who monitor their behaviour and this attitude may be carried over to video games. However, when adolescents and adults play online video games there is anonymity and no social pressure to behave appropriately. In fact, video game companies such as *Riot Games* have introduced a tribunal system and pre-game messages to encourage fair play and to reduce online toxic (aggressive) behaviour (Lin, 2015; Maher, 2016).

While previous studies have demonstrated that losing while playing video games increased aggression (Breuer et al., 2015; Griffiths et al., 2016; Shafer, 2012), this study showed that the increase only occurs when the game is highly competitive. Therefore, when the importance of winning a video game is reduced so too is the aggression associated with how the player performs within the game. This fits into the frustration-aggression model (Berkowitz, 1989) as it theorizes that if a goal is being thwarted, i.e. winning, then frustration and thus aggression is more likely. This is further supported by the results in this current study that showed that participants who lost in the low-competitive version of the video game (no goal to win, thus no goal could be blocked) did not show an increase in aggression.

Contrary to previous large meta-analyses (Anderson et al., 2010; Greitemeyer & Mugge, 2014) this study found that violence within the video game did not have an impact on aggression. Furthermore, there was no interaction between violence and competition with only competition having an influence on aggressive affect. However, these results do support studies that either used the same game or controlled for competition (see Dowsett, 2017). Currently, when competition is controlled for, the majority of studies have found that violent video games do not lead to an increase in aggression. Therefore, it is recommended that future research into violent video games continue to use the same game across all experimental conditions to control for confounding factors, such as competition.

It should be noted that in this study aggressive behaviour (assessed by the TCRTT) was unaffected by competition, losing, or violence. This contrary to the General Aggression Model (Anderson & Bushman, 2002) and the frustration-aggression model (Berkowitz, 1989) as both predict that an increase in aggressive affect (which was apparent for participants in the competitive condition) should lead to an increase in aggressive behaviour. There are two potential reasons for this null result. The first reason is that participants had a 5-min delay between playing the video game and completing the TCRTT (they were required to first complete the SHS) and this may have allowed time for the aggression to dissipate. Barlett et al. (2009) found that short term aggressive behaviour from violent video games only last somewhere between 4 and 9 min. The other reason may be the poor predictive validity of the TCRTT. In this study it did not correlate with the SHS. In addition, Ferguson and Rueda (2009) found that the TCRTT was not correlated with criminal behaviour, executive functioning related to aggression, or to an extent trait aggression or domestic violence. It is recommended that future research develops a new method to measure aggression in video game research (Ritter & Eslea, 2005).

Finally, it is interesting that participants did not rate the competitive version of the game as being more competitive even though the more competitive version increased aggressive affect. This may be due to participants not being consciously aware of the subtle cues (presence of a scoreboard and time pressure) or the fact that they had no "point of reference" because they only played one version of the game (Elson & Quandt, 2014). Given the usefulness of knowing the level of perceived level of competition for these games, future studies should consider getting participants to play the other version of the game so they can compare one version to another in terms of level of competition.

Despite some limitations there are potentially several real-world implications of this study. Firstly, the dimension of competition should be considered when rating the level of suitability of a video game for children. For example, *FIFA*$^{(TM)}$, which is seen as a low violence but a highly competitive game, is rated E by the Entertainment Software Rating Board which means it is available for anyone to play. However, given the impact of competition on aggression perhaps this should be rated higher, e.g. parental guidance required to alert parents to possibility of them helping their child deal with competition in a non-aggressive manner. A second implication is the potential impact on video game companies approach competitive videos games. The developers of *Riot Games* introduced a tribunal system and pre-game messages to encourage fair play (Lin, 2015; Maher, 2016). It has been reported that the tribunal system reduced verbal abuse by 40% while the pre-game messages reduced negative attitude by 8.3%, verbal abuse by 6.2%, and offensive language by 11% (Lin, 2015; Maher, 2016). Research from a sporting environment has also shown that when spectators and coaches display positive behaviour it increases the positive behaviour shown by children playing the game (Arthur-Banning, Wells, Baker, & Hegreness, 2009). Therefore, video game companies should continue to encourage and help model positive behaviour as this may help lead to a reduction of aggressive behaviour. In addition, the promotion of positive behaviour may help increase video game companies profits with a conference paper finding that new players are less likely to play and players spend less time in a gaming session when the behaviour by other players is "toxic" (Shores, He, Swanenburg, Kraut, & Riedl, 2014).

In summary, this study demonstrated that competition and losing in competitive games impacts aggressive affect, while violence within video games does not. Future studies need to continue to use the same game across conditions to control for confounding variables so that it becomes clearer exactly how video games impact aggression. With competition being shown to increase aggression affect, at least with adolescents and adults, researchers should now further investigate whether encouraging fair play reduces levels of aggression after competitive video gameplay.

References

Adachi, P. J. C., & 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. https://doi.org/10.1037/a0024908.

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

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*(7), 1090–1104. https://doi.org/10.1007/s10964-013-9952-2.

Adachi, P. J. C., & Willoughby, T. (2016). The longitudinal association between competitive video game play and aggression among adolescents and young adults. *Child Development, 87*(6), 1877–1892. https://doi.org/10.1111/cdev.12556.

Anderson, C. A., & Bushman, B. J. (1997). External validity of "true" experiments: The case of laboratory aggression. *Review of General Psychology, 1*(1), 19–41. https://doi.org/10.1037//1089-2680.1.1.19.

Anderson, C. A., & Bushman, B. J. (2002). Human aggression. *Annual Review of Psychology, 53*, 27–51. https://doi.org/10.1146/annurev.psych.53.100901.13523.

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. https://doi.org/10.1016/j.jesp.2009.04.019.

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*, 434–448.

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*(4), 772–790. https://doi.org/10.1037/0022-3514.78.4.772.

Anderson, C. A., & Morrow, M. (1995). Competitive aggression without interaction: Effect of competitive versus cooperative instructions on aggressive behaviour in video games. *Personality and Social Psychology Bulletin, 21*(10), 1020–1030. https://doi.org/10.1177/01461672952110003.

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. https://doi.org/10.1037/a0018251.

Arthur-Banning, S., Wells, M. S., Baker, B. L., & Hegreness, R. (2009). Parents behaving badly? The relationship between the sportsmanship behaviors of adults and athletes in youth basketball games. *Journal of Sport Behavior, 32*(1), 3–18.

Asvachin, M. (2008). *Unreal tournament 3: Gibalicious mutator v1.2.* [Unreal Tournament 3 modifier]. Retrieved from http://www.fileplanet.com/187994/180000/fileinfo/

Unreal-Tournament-3—Gibalicious-Mutator-v1.2.
Bandura, A., Ross, D., & Ross, S. A. (1963). Imitation of film-mediated aggressive models. *Journal of Abnormal and Social Psychology, 66*, 3–11. https://doi.org/10.1037/h0048687.
Barlett, C. P., Branch, O., Rodeheffer, C., & Harris, R. (2009). How long do the short-term violent video game effects last? *Aggressive Behavior, 35*(3), 225–236. https://doi.org/10.1002/ab.20301.
Barlett, C. P., Harris, R. J., & Bruey, C. (2008). The effect of the amount of blood in a violent video game on aggression, hostility, and arousal. *Journal of Experimental Social Psychology, 44*(3), 539–546. https://doi.org/10.1016/j.jesp.2007.10.003.
Berkowitz, L. (1989). Frustration-aggression hypothesis: Examination and reformulation. *Psychological Bulletin, 106*, 59–73. https://doi.org/10.1037/0033-2909.106.1.59.
Bluemke, M., Friedrich, M., & Zumbach, J. (2010). The influence of violent and non-violent computer games on implicit measures of aggressiveness. *Aggressive Behavior, 36*(1), 1–13. https://doi.org/10.1002/ab.20329.
Breuer, J., Scharkow, M., & Quandt, T. (2015). Sore losers? A reexamination of the frustration-aggression hypothesis for colocated video game play. *Psychology of Popular Media Culture, 4*(2), 126–137. https://doi.org/10.1037/ppm0000020.
Bushman, B. J. (1995). Moderating role of trait aggressiveness in the effects of violent media on aggression. *Journal of Personality and Social Psychology, 69*(5), 950–960. https://doi.org/10.1037//0022-3514.69.5.950.
Carnagey, N. L. (2006). *Is it competitiveness or violent content? The effects of violent sports video games on aggression* (Doctoral dissertation). *Available from ProQuest Dissertations and Theses Database* Order No. 3229055.
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. https://doi.org/10.1111/j.1467-9280.2005.01632.x.
De Vries, N. (2014). *Battle team freezetag arena v10.* [Unreal Tournament 3 modifier]. Retrieved from http://www.moddb.com/games/unreal-tournament-3/addons/battle-teamfreezetag-arena-v10.
Dowsett, A. C. (2017). The Effect of violent, competitive, and multiplayer video Games on aggression (Doctoral dissertation). Retreived from https://researchbank.rmit.edu.au/eserv/rmit:162079/Dowsett.pdf.
Eastin, M. S. (2007). The influence of competitive and cooperative group game play on state hostility. *Human Communication Research, 33*, 450–466. https://doi.org/10.1111/j.1468-2958.2007.00307.x.
Eastin, M. S., & Griffiths, R. P. (2009). Unreal: Hostile expectations from social gameplay. *New Media & Society, 11*(4), 509–532. https://doi.org/10.1177/1461444809102958.
Eden, S., & Eshet-Alkalai, Y. (2014). The effect of digital games and game strategies on young adolescents' aggression. *Journal of Educational Computing Research, 50*(4), 449–466. https://doi.org/10.2190/EC.50.4.a.
Elson, M., Breuer, J., Van Looy, J., Kneer, J., & Quandt, T. (2015). Comparing apples and oranges? Evidence for pace of action as a confound in research on digital games and aggression. *Psychology of Popular Media Culture, 4*(2), https://doi.org/10.1037/ppm0000010.
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. https://doi.org/10.1037/a0035569.
Elson, M., & Quandt, T. (2014). Digital games in laboratory experiments: Controlling a complex stimulus through modding. *Psychology of popular media culture*Advance online publicationhttps://doi.org/10.1037/ppm0000033.
Epstein, S., & Taylor, S. (1967). Instigation to aggression as a function of degree of defeat and perceived aggressive intent of the opponent. *Journal of Personality, 35*, 265–289.
Farrar, K. M., Krcmar, M., & Nowak, K. L. (2006). Contextual features of violent video games, mental models, and aggression. *Journal of Communication, 56*(2), 387–405. https://doi.org/10.1111/j.1460-2466.2006.00025.x.
Ferguson, C. J. (2010). Blazing angels or resident evil? Can violent video games be a force for good? *Review of General Psychology, 14*(2), 68–81. https://doi.org/10.1037/a0018941.
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. https://doi.org/10.1007/s11292-009-9069-5.
Giancola, P. R., & Parrot, D. J. (2008). Further evidence for the validity of the Taylor aggression paradigm. *Aggressive Behavior, 34*, 214–229. https://doi.org/10.1002/ab.20235.
Giancola, P. R., & Zeichner, A. (1995). Construct validity of competitive reaction-time aggression paradigm. *Aggressive Behavior, 21*, 199–204.
Greitemeyer, T., & Mugge, 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, 20*(5), 578–589. https://doi.org/10.1177/0146167213520459.
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. https://doi.org/10.1177/0093650214565895.
Hollingdale, J., & Greitemeyer, T. (2014). The effect of online violent video games on levels of aggression. *PLoS One, 9*(11), 1–5. https://doi.org/10.1371/journal.pone.0111790.
Kneer, J., Elson, M., & Knapp, F. (2016). Fight fire with rainbows: The effects of displayed violence, difficulty, and performance in digital games on affect, aggression, and physiological arousal. *Computers in Human Behavior, 54*, 142–148. https://doi.org/10.1016/j.chb.2015.07.034.
Krcmar, M., & Farrar, K. (2009). Retaliatory aggression and the effects of point of view and blood in violent video games. *Mass Communication & Society, 12*(1), 115–138. https://doi.org/10.1080/15205430802065268.
Ku, G., Malhotra, D., & Murnighan, J. K. (2005). Towards a competitive arousal model of decision-making: A study of auction fever in live and internet auctions. *Organizational Behavior and Human Decision Processes, 96*, 89–103. https://doi.org/10.1016/j.obhdp.2004.10.001.
Lin, J. (2015, July 7). *Doing something about the 'impossible problem' of abuse in online games. Recode*. Retrieved from http://www.recode.net.
Lobel, A., Engels, R. C. M. E., Stone, L. L., & Granic, I. (2017). Gaining a competitive edge: Longitudinal associations between children's competitive video game playing, conduct problems, peer relations, and prosocial behavior. *Psychology of popular media culture*Advance online publicationhttps://doi.org/10.1037/ppm0000159.
Maher, B. (2016). Can a video game company tame toxic behaviour? *Nature, 531*(7596), 568–571.
Malhotra, D. (2010). The desire to win: The effects of competitive arousal on motivation and behavior. *Organizational Behavior and Human Decision Processes, 111*, 139–146. https://doi.org/10.1016/j.obhdp.2009.11.005.
McClintock, C. G., & McNell, S. P. (1966). Reward and score feedback as determinants of cooperative and competitive game behavior. *Journal of Personality and Social Psychology, 4*(6), 606–613.
McClintock, C. G., & Nuttin, J. M. (1969). Development of competitive game behavior in children across two cultures. *Journal of Experimental Social Psychology, 5*, 203–218.
Mihan, R., Anisimowicz, Y., & Nicki, R. (2015). Safer with a partner: Exploring the emotional consequences of multiplayer video gaming. *Computers in Human Behavior, 44*, 299–304. https://doi.org/10.1016/j.chb.2014.11.053.
Przybylski, 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), 441–457. https://doi.org/10.1037/a0034820.
Ritter, D., & Eslea, M. (2005). Hot sauce, toy guns, and graffiti: A critical account of current laboratory aggression paradigms. *Aggressive Behavior, 31*(5), 407–419. https://doi.org/10.1002/ab.20066.
Schmierbach, M. (2010). "Killing Spree": Exploring the connection between competitive game play and aggressive cognition. *Communication Research, 37*, 256–274. https://doi.org/10.1177/0093650209356394.
Shafer, D. M. (2012). Causes of state hostility and enjoyment in player versus player and player versus environment video games. *Journal of Communication, 62*, 719–737. https://doi.org/10.1111/j.1460-2466.2012.01654.x.
Shores, K. B., He, Y., Swanenburg, K. L., Kraut, R., & Riedl, J. (2014). The identification of deviance and its impact on retention in a multiplayer game. *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 1356–1365. https://doi.org/10.1145/2531602.2531724.
Stermer, S. P. (2013). The effects of transportation into a video game world on aggressive cognitions and behaviors (Doctoral dissertation). *Available from ProQuest dissertation and theses global database* UMI No. 3588492.
Tertullian. (200). De spectaculis. Retrieved from: http://www.tertullian.org/lfc/LFC10–13_de_spectaculis.htm.
Trend, D. (2007). *The myth of media violence: A critical introduction.* Malden, MA: Blackwell.
Velez, J. A., Greitemeyer, T., Whitaker, J. L., Ewoldsen, D. R., & Bushman, B. J. (2016). Violent video games and reciprocity: The attenuating effects of cooperative game play on subsequent aggression. *Communication Research, 43*(4), 447–467. https://doi.org/10.1177/0093650214552519.