Original Article

Is It Only the Violence?

The Effects of Violent Video Game Content, Difficulty, and Competition on Aggressive Behavior

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Abstract: The results of prior research investigating whether the violence in violent video games leads to increased subsequent aggression are mixed. Some observers question whether the difficulty and/or the competitive aspects of these games are important, but overlooked, factors that also affect aggression. In the present study, participants (N = 408) played a violent or nonviolent video game that was either difficult or easy and in which they competed and won, competed and lost, or did not compete against another player. Results revealed that participants became more aggressive only after playing a competitive, as opposed to a noncompetitive, game. Level of violence, winning or losing, and game difficulty did not have any significant effect. These results support the assertion that competition in video games has an independent and significant effect on subsequent aggression beyond violent content and game difficulty.

Keywords: violent media, aggression, competition

Several recent meta-analyses investigating the effects of playing violent video games (VVGs) suggest that playing these games causes people to think, feel, and behave more aggressively (e.g., Calvert et al., 2017; Prescott et al., 2018). However, other meta-analyses challenge these findings, suggesting that the effect sizes are both small and affected by publication bias (e.g., Ferguson et al., 2020; Hilgard et al., 2017). Nevertheless, despite the lament that meta-analyses often foment more debates than they resolve (de Vrieze, 2018), attempts to find common ground have been undertaken (Mathur & VanderWeele, 2019) and suggest that VVG effects may be less straightforward (e.g., Shao & Wang, 2019) and require more nuanced theorizing.

One question that merits serious attention is whether the violence in VVGs produces aggressive outcomes, or whether it is something else. Prior research has been primarily interested in whether or not there is an effect of game violence at the expense of potentially important underlying mechanisms (e.g., Adachi & Willoughby, 2011). A review of representative studies suggests that other factors may be partly, if not primarily, responsible for aggressive outcomes. Specifically, we draw attention to three factors typically ignored or uncontrolled in VVG research, namely: (a) the competition inherent in most VVGs; (b) the outcome of that competition (e.g., winning or losing); and (c) the difficulty of the video game being played.

Competition

Almost every VVG incorporates competition (e.g., kill or be killed), but the level and emphasis of this competition have not always been carefully considered. A thorough literature review found only three studies that specifically investigated competition as a potential causal factor for VVG aggression. Schmierbach (2010) found higher levels of aggressive cognition in participants who played VVGs competitively when compared with solo and cooperative players. Similarly, Adachi and Willoughby (2011) found higher levels of subsequent aggressive behavior after participants played a competitive game, regardless of violent content. Adachi and Willoughby (2013) further examined the long-term effects of playing competitive video games, irrespective of violence, and found that greater levels of competition predicted higher levels of future aggression. Although suggestive, one major drawback of these studies is that they never assessed winning or losing. Yet the outcome of the game may be as important as the strategy used to obtain the outcome.

Outcome

The simplest and most familiar example of game outcome would be that of a zero-sum game: The degree to which one party wins is equal to the degree that the other party loses

(Von Neumann & Morgenstern, 1944). This is the usual set-up for most violent and competitive video games and is what is meant by the term "outcome" in this research. A review of the literature yielded only three studies that examined competition outcomes in video games. Shafer (2012), as well as Breuer et al. (2015), found that participants who lost during video game play had significantly higher levels of affective and behavioral aggression than participants who won. Similarly, Griffiths et al. (2016) found that losers had significantly higher levels of hostility than winners. However, a drawback of these studies is that none employed a conventional VVG (i.e., video games involving violent actions, like killing). All three used athletic competitions, such as FIFA soccer or NCAA football. Thus, the effects of winning and losing in a VVG remains unexplored.

Difficulty

Difficulty refers to the in-game features involving the ease of gameplay. This can include inflicting more damage to kill enemies, using in-game resources more efficiently (e.g., healing packs, ammunition, etc.), or suffering less damage. Thus, difficulty is different from outcome. An exhaustive literature review returned only one study in which difficulty was a manipulated variable. Hilgard et al. (2019) found no significant effects of game difficulty on aggressive behavior. However, one suggestive study by McCarthy et al. (2016), in which difficulty happened to differ between the violent and nonviolent game, found a significant relationship between game difficulty and self-reported likelihood to aggress, in the expected direction.

Present Study

We conducted the following study to investigate the independent and interactive effects of video game violence, competition, outcome, and difficulty on aggressive and prosocial behavior. Previous research has expanded the universe of dependent variables (DVs) to include prosocial outcomes, in both original studies (e.g., Greitemeyer & Osswald, 2010) as well as meta-analyses (e.g., Ferguson, 2015), with DVs capable of being interpreted as examples of both aggression and helpfulness (see next section). Therefore, we generated hypotheses addressing both. Specifically, we had participants play a video game that varied in terms of violence, competition, outcome, and difficulty. On the basis of our review of the literature, we hypothesized the following.

Hypothesis 1 (H1): Participants in the violent game condition would exhibit higher levels of behavioral aggression (or lower levels of prosocial behavior) than participants in the nonviolent[1] game condition.

Hypothesis 2 (H2): Participants in the competition conditions would exhibit higher levels of behavioral aggression (or lower levels of prosocial behavior) than participants in the no-competition condition.

Hypothesis 3 (H3): Participants in the competition-lose condition would exhibit higher levels of behavioral aggression (or lower levels of prosocial behavior) than participants in the competition-win and no-competition conditions.

Hypothesis 4 (H4): Participants in the violent game and competition-lose condition would exhibit the highest levels of behavioral aggression (or lowest levels of prosocial behavior).

Method

To promote transparency, openness, and replicability, we report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. Additionally, we preregistered this study, with an analysis plan, before the data collection, and it is accessible at https://osf.io/t75f9.

Participants

We recruited 408 college-aged participants from a large university in the western United States. The sample size was based on comparable studies (e.g., Breuer et al., 2015; Schmierbach, 2010), while also considering the overall cost of compensation. The sample size allowed for about 30 participants per condition.

Only males were recruited for this study, as males usually have higher aggression levels in VVG studies (e.g., Bartholow & Anderson, 2002), and females, although often exhibiting lower levels of overall aggression, tend to vary in the same direction and in parallel with males (e.g., Archer, 2004). Additionally, Lapierre and Farrar (2018) found that males played significantly more VVGs than females. All participants self-identified as men, and ages ranged from 18 to 33 (M = 21.29, SD = 2.01). Participants were

[1] We use the term "nonviolent" because in contrast with the violent game condition, involving shooting to kill, the nonviolent condition involved capturing with a nonlethal weapon to return to prison. Thus, the nonviolent condition could be considered aggressive, but not of the extreme form that characterizes violence. Therefore, we choose to refer to this condition as a nonviolent condition, consistent with other research (Hilgard et al., 2019).

predominantly heterosexual (96.32%), not married (82.11%), Christian (97.79%), and White (89.46%). The study was approved by the university IRB, and all participants were treated per the ethical guidelines of the American Psychological Association. Participants received monetary compensation for participating.

Apparatus

A computer program was developed to advance participants through the study. The program contained all questionnaires, video game stimuli, dependent measures, and randomization algorithms for random assignment. The program was loaded onto USBs and administered in computer laboratories to as many as 18 participants simultaneously. All data were saved to each USB and compiled daily.

Video Game

Doom II: Hell on Earth (Doom 2; id Software, 1994) is a first-person shooter (FPS) game, in which the player (a space marine) fights against demons to close a portal from hell. Due to its widespread popularity and open-source code, Doom 2 allows for the creation of modifications (mods) to customize the play experience. Although Doom 2 is over 25 years old, it is still one of the most recognizable first-person shooter games (Dransfield, 2014), and it is still popular and selling (Gershgorn, 2018). Additionally, the Doom series of games, particularly Doom 2, has been used in previous, recent research on aggression (e.g., Hilgard et al., 2019).

The mod used in the present study was the Hilgard Modified Video Game Paradigm (Hilgard, 2014; Hilgard et al., 2019), in which two violence levels, violent and nonviolent, and two difficulties, easy and hard, were offered. The strengths of this paradigm are that participants played the same game, with the same number of computer-controlled opponents (bots) using similar attacks regardless of whether the participant was playing the violent, nonviolent, easy, or hard mod. Only the esthetics and damage dealt by attacks changed between mods. Thus, this paradigm offers greater control over the gaming experience and potential confounds than choosing and equating two different games (for a discussion of game modification, see Mohseni et al., 2015). Moreover, although not directly controlled for in the Hilgard paradigm, we reasonably assume that the pace of action between conditions was similar, if not the same, since pace of action can be a potential confound in video game research (Elson et al., 2015).

Study Design

The present study was a 2 (content: violent vs. nonviolent) × 2 (difficulty: easy vs. hard) × 3 (competition: no competition vs. competition win vs. competition lose) between-subjects factorial design while controlling for VVG exposure, trait aggression, and competitiveness.

Content

The violent condition had the participant playing as a space marine and, using sawed-off shotguns and miniguns, fighting and killing demons from hell. The violence was enhanced from the original game with extra blood splatter and screams. The nonviolent condition had the participant playing as a bounty hunter and, using various teleportation guns, capturing and returning escaped aliens to prison (without bloodshed) and not killing them. Participants encountered the same layout and number of opponents regardless of the content factor.

Difficulty

In the hard condition, the enemies fought back and could potentially kill the player, causing him to start over. In the easy condition, the enemies did not fight back or attack the player in any way.

Competition

The competition factor comprised three levels. For both the competition *win* and competition *lose* conditions, participants were told that to keep them engaged in the study, they would have the opportunity to enter into a drawing for one of five $100 gift cards upon achieving a higher score than another ostensible participant playing at the same time. In reality, we randomly assigned participants to the win or lose condition. The final level was *no competition*, with no mention of another player or a prize.[2] Pilot testing revealed that participants perceived the competition levels as significantly more competitive than the no-competition level. All participants were entered into the drawing, regardless of assigned condition.

Measures

Video Game Exposure

Prior video game exposure was measured using a modified version of the video game questionnaire (as detailed in Busching et al., 2015), developed by Anderson and Dill (2000) to control for differing levels of VVG exposure.

[2] Although it is true that playing against the computer is a form of competition, we were specifically interested in interpersonal competition in this study. Our no-competition level contained no interpersonal competition.

Trait Aggression

The short form of the Buss–Perry Aggression Questionnaire (BPAQ-SF), a reliable and valid measure of trait aggression (Bryant & Smith, 2001), was administered to control for differing levels of trait aggression. The 12 items were rated on a 6-point scale ranging from (1) *completely false for me* to (6) *completely true for me*. The items were averaged to get an overall trait aggression score (α = .82).

Competitiveness

Competitiveness was measured with a modified version of the competitiveness scale used by McGloin et al. (2016). The scale consists of 10 items rated on a 7-point scale ranging from (1) *strongly disagree* to (7) *strongly agree*. However, to better obscure the true nature of the study, the scale was measured using the same scale as the BPAQ-SF. All 10 items were averaged to get an overall competitiveness score (α = .87).

Distractors

To further obscure the true nature of the study, the Modified Rosenberg Self-Esteem Scale (10 items; Zimprich et al., 2005) and the Self-Monitoring Scale (25 items; Snyder, 1974) were included because the structure of the items was similar to that of the BPAQ-SF and competitiveness measure. All items from the BPAQ-SF, competitiveness scale, and both distractor scales were randomized for each participant.

Aggressive/Prosocial Behavior

Aggressive/prosocial behavior was measured using a digitized version of the tangram puzzle procedure (Saleem et al., 2015). Tangram puzzles consist of a large geometrical outline that must be recreated using smaller geometric shapes (e.g., triangles, squares, and trapezoids). Participants were shown 30 different tangram puzzles of varying difficulty (10 easy, 10 medium, and 10 hard). Easy tangram puzzles could be completed using three to four shapes, medium using five to six shapes, and hard using seven shapes. Participants chose 11 puzzles for another participant to complete. Participants were told that the other person would receive an additional $10 if he was able to complete all 11 tangrams in 10 min, and the other person was choosing the 11 tangram puzzles for the participant to attempt the same. In reality, the participant was not asked to complete any tangram puzzles.

If participants chose primarily easy tangram puzzles for the person, it was assumed that the participants were attempting to help the person (i.e., were acting prosocially). Conversely, by choosing primarily hard tangram puzzles, the participants would be hurting the person (i.e., acting aggressively). It is important to note, based on this study's manipulation, that there was no competitive component inherent in the tangram puzzle procedure. The participant was told to choose the puzzles for the other person at the same time the other person was ostensibly choosing puzzles for him, and both the participant and the fictitious other person would have 10 min to complete the puzzles and receive the reward regardless of the other's performance.

The literature reports two ways of computing the tangram choice variable. The preferred method (e.g., Saleem et al., 2015) is to take the number of hard tangrams chosen and subtract the number of easy tangrams chosen, ignoring the number of medium tangrams chosen (medium tangrams are considered neither hurtful nor helpful). The resulting difference score indicates the degree to which each participant intends to be aggressive or prosocial. The variable has a range of 21, from −10 to 10, with positive numbers indicating more aggressive behavior, negative numbers indicating more prosocial behavior, and zero indicating equal measures of aggressive and prosocial behavior.[3] In this measure, aggressive and prosocial behavior are viewed as endpoints on a continuum: an increase in one is a decrease in the other. Therefore, this measure is interpretable as higher and lower aggression or higher and lower prosocial behavior.

Finally, this measure appears to be both reliable and valid (Saleem et al., 2015); however, McCarthy and Elson (2018) raise valid concerns regarding several assumptions that must be met to correctly infer that the participant's motives were aggressive or prosocial in nature. To this end, supplemental questions were administered immediately after the present measure to directly assess these motives.

Supplemental Questions

Participants were asked a series of questions to better understand the intentions behind their choices. Specifically, they were asked to indicate their agreement, on a 5-point scale ranging from 1 = *not at all* to 5 = *a lot*, with the following five items: I wanted to (a) provide a range of tangrams; (b) help the other participant win some money; (c) make it difficult for the other participant to win the money; (d) hurt the other participant's chances of winning the money; (e) give the other participant harder puzzles to complete.

Manipulation Checks

Following the administration of the supplemental questions, participants were asked how violent and challenging the game they just played was on a 6-point scales ranging from 1 = *not at all* to 6 = *extremely*. For participants assigned to a

[3] The other, unused method is to count the number of easy tangrams chosen as a helping score and the number of difficult tangrams chosen as a separate hurting score. Effectively, a participant could have the same helping and hurting score with this method, if the participant chose the same number of easy and hard tangrams for the ostensible partner (e.g., Saleem et al., 2012).

competition condition, they were asked whether they won or lost (yes/no/unsure). These questions were used to determine whether our manipulations were successful.

Procedure

Arriving at the laboratory, participants sat at a computer carrel and were prompted to read and sign a digital consent form. Participants then read a cover story explaining that previous research shows that playing first-person and third-person perspective video games can affect spatial-reasoning and decision-making skills, and that they would be randomly assigned to play either a first-person or third-person perspective video game and then complete a task intended to measure their decision-making and spatial-reasoning abilities. In reality, all participants played a first-person video game, and the spatial-reasoning task (the tangram procedure) measured aggressive/prosocial behavior. Pilot testing revealed that the cover story was believable and obscured the true purpose of the study.[4]

Participants then filled out questionnaires detailing their levels of trait aggression, trait competitiveness, levels of VVG exposure, and general demographics. After completing the questionnaires, they were randomly assigned to one of 12 conditions and told to watch a short tutorial explaining the tangram procedure. Following the tutorial video, participants watched another tutorial video explaining the video game and controls. The videos were consistent with the assigned violent or nonviolent content condition. After the video concluded, if the participant was assigned to a competition condition – either win or lose – he was prompted with the possibility of winning a gift card and connected with an ostensible partner.

All participants played the video game for 15 min. Upon completion, they were immediately switched to the tangram paradigm to measure their levels of behavioral aggression. However, participants in the win or lose conditions were told first whether they had beaten or not beaten their partner, respectively. Participants were asked to pick the tangrams, as described above, for the same partner they had just played against, or a partner they were just matched with for participants in the no competition group. Participants were reminded that they were not competing with their partner in this second task, and they would never actually meet their partner. Once they had chosen 11 tangrams, they were shown a screen appearing to slowly load the tangrams for them to complete. On the loading screen, the participants were prompted to answer a few short manipulation checks. When finished, the participants did not complete any actual tangrams. Instead, they were shown a short debriefing video, in which they were told the true nature of the research. Then, all participants were paid $10, entered into the drawing for five $100 gift cards, and dismissed.

Results

A total of 408 participants took part in the study; however, due to missing data, three participants were dropped from the final analysis. Thus, all subsequent analyses utilized the 405 remaining participants. Additionally, the 12 different conditions had at least 30 participants each and no more than 42 (see Table 1 for sample size per condition, as well as means and standard deviations of the aggressive/prosocial measure). All analyses were conducted using Stata/IC 14.2 for Windows.

Manipulation Checks

To ensure participants perceived the stimulus materials as intended, we analyzed several manipulation checks. The content and difficulty conditions were perceived as intended, with the VVG ($M = 5.35$, $SD = 0.83$) rated as more violent than the nonviolent video game ($M = 2.93$, $SD = 1.22$), $t(402) = -23.26$, $p < .001$, 95% CI [−2.62, −2.21], $d = -2.31$, 95% CI [−2.57, −2.06], and the hard condition ($M = 2.71$, $SD = 1.31$) rated as harder than the easy condition ($M = 1.39$, $SD = 0.71$), $t(403) = -12.76$, $p < .001$, 95% CI [−1.53, −1.12], $d = -1.27$, 95% CI [−1.48, −1.05]. If participants were randomly assigned to a competition condition (e.g., win or lose), they were asked to indicate whether they won or lost. Comparing their perception with how they were assigned, 73.24% assigned to the win condition and 72.87% assigned to the lose condition reported correctly, with 24.65% and 20.93% being unsure, respectively. Very few believed they were assigned to a condition opposite of their actual assignment (3.10% assigned to lose and 0% assigned to win). All subsequent analyses were run both with and without the participants whose response did not match the condition they were assigned to with no change

[4] Pilot testing was iterative. Participants read the cover story and were asked what they believed the study was about. They then completed each stage of the procedure, responding to each questionnaire and viewing each video that explained the tangram procedure and the video game and controls. Random subsets of the sample responded to questions after each stage, reporting what the questionnaires seemed to be measuring, what suspicions, if any, they had, and their beliefs about what the research was really testing (if not what they had been told). Through this process, instructions and procedures were adjusted until no pilot participants could correctly guess the true purpose of the study. Study participants appear to have taken the experience at face value.

Table 1. Tangram score means, standard deviations, and sample sizes for each experimental condition

Comp	Violent				Nonviolent			
	Easy		Hard		Easy		Hard	
	M (SD)	*n*	*M (SD)*	*n*	*M (SD)*	*n*	*M (SD)*	*n*
No comp	−5.14 (5.83)	36	−7.75 (4.10)	32	−4.94 (5.43)	35	−6.81 (4.32)	31
Lose	−0.76 (7.18)	33	0.42 (6.21)	33	−2.43 (8.06)	30	−2.30 (7.87)	33
Win	0.72 (7.65)	36	−1.48 (7.38)	31	−3.88 (7.12)	42	−1.30 (6.24)	33

Note. Comp = competition condition; Lose = competition condition where the participant was randomly assigned to lose; Win = competition condition where the participant was randomly assigned to win. Sample size per condition was randomaly assigned via a computer algorithm, thus, the conditiones were not equal.

to the results. Therefore, all participants, not already excluded, were included in all subsequent analyses.

Confirmatory Analyses

Assumptions

The data for the dependent variable were not normally distributed (tested via Shapiro–Wilk test). Specifically, the distribution was in a "U" shape, with higher frequencies at the extremes and lower frequencies in the center. Although analysis of covariance (ANCOVA) is robust concerning violations of normality, severe violations may produce questionable results. Additionally, due to the non-normal distribution of the data, there was a violation of the assumption of homoscedasticity (tested via Levene's test of homogeneity), which also may be problematic. Since the dependent variable was discrete with clumping around a single integer (e.g., +10 or −10), no transformations would correct or help the issue of normality. Nevertheless, as ANCOVA is relatively robust concerning serious violations of assumptions (Schmider et al., 2010), it was employed here, and the results are interpreted cautiously.[5]

Main Analysis

A 2 (content: violent vs. nonviolent) × 2 (difficulty: easy vs. hard) × 3 (competition: no competition vs. competition win vs. competition lose) ANCOVA was conducted, with tangram score entered as the dependent variable and VVG exposure, trait aggression, and trait competitiveness entered as covariates. Results revealed a statistically significant main effect for competition, $F(2, 390) = 24.60$, $p < .001$, $\eta_p^2 = .11$, 95% CI [.06, .17]. A sensitivity analysis using G*Power (Faul et al., 2007) with $\alpha = .05$ revealed that we had 99% power to observe an effect as small as $\eta^2 = .05$, which is smaller than our observed effect. Tukey's post hoc test revealed that there was no difference between the winning ($M = -1.59$, $SD = 7.25$) and losing ($M = -1.23$, $SD = 7.40$) groups. However, there were significant differences between the no-competition ($M = -6.13$, $SD = 5.09$) and winning group, as well as between the no-competition and losing group, with those who competed, regardless of outcome, exhibiting higher levels of aggression than those who did not compete. No other significant main effects or two- or three-way interactions emerged (all $F \leq 2.95$, $p \geq .09$, $\eta_p^2 \leq .009$).

Exploratory Analyses

Examination of Histograms

As discussed earlier, the violations of normality in our dependent variable render these results tentative; nevertheless, an examination of the data is informative to help understand what participants were doing. As the only significant difference that emerged was competition versus no competition, we collapsed the competition factor across outcome (i.e., winning and losing) resulting in a dichotomous competition/no-competition variable. Figure 1 shows the histograms for participants who were competing and not competing while playing the game. In the no-competition condition 49.25% of the participants gave all easy tangrams to the other person, whereas only 2.24% gave all hard tangrams. Conversely, in the competition conditions, roughly half the number of participants (26.94%) gave all easy tangrams, whereas nearly six times as many (13.28%) gave all hard tangrams. If we include those who gave seven, eight, or nine hard tangrams to the other person, the percentage of aggressive behaviors increases to 20.66%, over nine times greater than the aggression exhibited in the no-competition condition (2.24%). These data strongly suggest that participants who competed behaved more aggressively than those who did not.

To verify this contention statistically, two chi-square tests of independence were conducted. The first tested for independence between competition assignment (competition or

[5] A robust regression (robust against violations of regression assumptions) was conducted to investigate the reliability of the results, with results emerging that were not significantly different from those presented here, $F(7, 397) = 7.36$, $p < .001$. The only significant predictors of aggression were the win versus no-competition condition ($b = 4.72$, $p < .001$) and lose versus no-competition condition ($b = 5.03$, $p < .001$), with violent versus nonviolent not being a significant predictor ($b = 1.26$, $p = .08$).

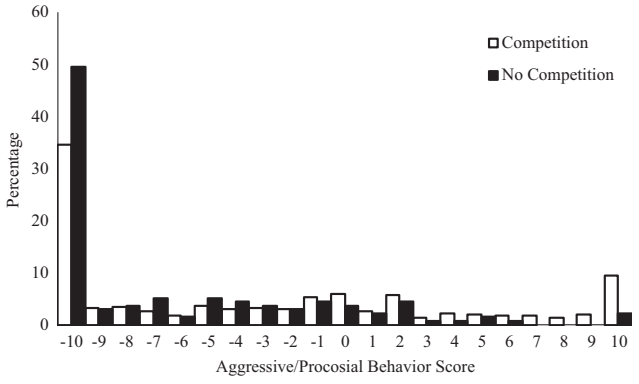

Figure 1. Histograms of aggressive/prosocial scores for competition/no-competition conditions. The histogram was collapsed across both content and difficulty conditions. The competition condition was collapsed across the winning and losing conditions, as those histograms are relatively identical, n = 273; No competition condition, n = 135. A score of −10 means that the participant gave their partner all easy tangrams (prosocial behavior), whereas a score of 10 means that the participant gave their partner all hard tangrams (aggressive behavior).

no competition) and whether the participant chose all easy tangrams (−10 as the tangram score) or all hard tangrams (10 as the tangram score). Participants who chose any other combination were excluded. Results revealed that the two were not independent, $\chi^2(1, N = 178) = 20.31$, $p < .001$, $\Phi = .34$, with more than the expected number of participants in the no-competition group selecting easy tangrams and more than the expected number of participants in the competition group selecting hard tangrams.

The second chi-square test of independence further verified the above result by testing for independence between competition assignment and whether the participant was generally prosocial (tangram score less than 0) or aggressive (tangram score greater than 0). Participants whose tangram score equaled 0 were excluded. Results revealed that the two were not independent, $\chi^2(1, N = 381) = 32.56$, $p < .001$, $\Phi = .29$, with participants in the no-competition condition exhibiting a greater propensity for prosociality than those in the competition condition and participants in the competition condition exhibiting a greater propensity for aggression than those in the no-competition condition.

Reasons for Choosing Tangrams

After choosing the tangrams for their ostensible partner, we asked participants a series of questions to better understand their intentions behind their choices. We employed Hotelling's T^2 to examine the overall difference between the five reasons for choosing the various tangrams. Results revealed that there was a significant difference at the multivariate level, $T^2 = 55.76$, $F(5, 398) = 11.04$, $p < .001$, $D^2 = 0.62$, indicating a medium effect (Stevens, 2009). Thus, we followed up with univariate t-tests using the Bonferroni correction to adjust for multiple comparisons ($\alpha = .01$).

Five independent-samples t-tests were conducted examining differences between the five reasons for choosing tangrams (see Table 2). There was no difference in the participant wanting to give a range of tangrams as a function of whether the participant competed ($M = 2.58$, $SD = 1.59$) or did not compete ($M = 2.26$, $SD = 1.51$). However, there were differences in the other items, with participants in the competition group agreeing more that they wanted to hurt, make it harder for, and give difficult tangrams to their partner than participants in the no-competition group. Finally, there was also a difference for participants who wanted to help their partner, with those in the no-competition group ($M = 4.14$, $SD = 1.28$) endorsing helping as the reason for giving the tangrams to a greater degree than those in the competition group ($M = 3.11$, $SD = 1.63$). A sensitivity analysis, using G*Power (Faul et al., 2007) two-tailed with $\alpha = .01$, revealed that we had 99% power to observe an effect as small as $d = |0.52|$, and our effects for hurt, make it harder for, give difficult, and help tests were all larger than $d = |0.52|$; however, the obtained effect for give a range of tangrams was smaller.

Discussion

We found evidence consistent with the assertion made by Adachi and Willoughby (2011), who argued that competition is a more powerful influence on subsequent aggression than the violence that is observed and carried out in VVGs. We observed no significant effects of game difficulty or of winning or losing in the competition, only whether or not the participants competed, with those competing exhibiting higher levels of behavioral aggression than those who did not compete. This suggests that competition should not be dismissed as a trivial construct or as an epiphenomenon. Rather, our results suggest that competition may be a legitimate risk factor for aggressive behavior following any video game play, violent or not.

That competition causes aggression should not be particularly surprising to scholars. Deutsch (1993) argues that competitive circumstances may contribute to arguments, anger, and aggression between individuals, and Nelson and Trainor (2007) flatly state that aggression developed as a response to competition. What may be surprising is the notion that competition in a VVG, rather than the violence itself, may be a more potent influence on aggression. After all, hundreds of studies and several meta-analyses (e.g., Anderson et al., 2010; Ferguson, 2015) have focused on violent content, largely ignoring or overlooking the effects of competition. Our research suggests that this

Table 2. Differences between competition and no-competition participants' reasons for choosing tangrams

Reason	No competition		Competition				95% CI for mean difference			95% CI for effect size	
	M	*SD*	*M*	*SD*	*t*(403)	*p*	LL	UL	*d*	LL	UL
Hurt	1.23	0.64	2.12	1.47	−6.71	> .001	−1.15	−0.63	−0.71	−0.92	−0.50
Difficult	1.49	0.89	2.52	1.55	−7.15	> .001	−1.31	−0.75	−0.76	−0.97	−0.54
Hard	1.66	1.03	2.61	1.57	−6.30*	> .001	−1.24	−0.65	−0.67	−0.88	−0.45
Range	2.26	1.51	2.58	1.59	−1.95	.052	−0.65	0.002	−0.21	−0.41	0.002
Help	4.14	1.28	3.11	1.63	6.44	> .001	0.72	1.35	0.68	0.47	0.89

Note. Reason refers to statements with which participants rated agreement; Hurt = "I wanted to hurt the other participants' chances of winning the money"; Difficult = "I wanted to make it difficult for the other participant to win the money"; Hard = "I wanted to give the other participant harder puzzles to complete"; Range = "I wanted to provide a range of tangrams"; Help = "I wanted to help the other participant win the money." Competition refers to both the winning and losing conditions collapsed together. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; *d* = Cohen's *d*. **df* = 402 due to one participant not responding to the item.

literature has ignored a potentially important risk factor for aggression resulting from VVG play. But what is the mechanism by which competition may cause a person to behave aggressively? We speculate on a few candidates.

The challenge hypothesis (Archer, 2006), based on evolutionary theory, proposes that males should experience a surge of testosterone when in competition with other males, which should then increase aggressiveness in competitive situations. To the extent that the men in our study regarded the video game competition as a challenge from another male player, they may have experienced an increase in testosterone that may have caused them to behave more aggressively in the tangram task. Such a biochemical-mediating mechanism would be predicted by the challenge hypothesis and is consistent with an evolutionary approach to aggression.

Another possibility is that affect mediates the relationship between competition and aggression. Berkowitz (1989) identifies competitive encounters as causal factors leading individuals to experience frustration as they inhibit each other's ability to obtain a goal. To the extent that the men in our study perceived themselves as competing with another participant to obtain a higher score and win a monetary prize, they may have experienced frustration when they attempted to defeat their opponent. To the extent that frustration is experienced as a negative emotion specifically resulting from competition (Anderson & Morrow, 1995), it may have contributed to our participants engaging in aggressive behavior.

A third possibility is that cognitive processes mediate the relationship between competition and aggression. Schmierbach (2010) found that participants playing a competitive video game experienced significantly more aggressive thoughts than those playing a cooperative game. To the extent that participants in our study experienced more aggressive thoughts when competing with another participant, these thoughts may have led them to behave more aggressively.

One or any combination of these mechanisms may have mediated the relationship between competition and aggression in the present study, and because they were not directly tested by us, they merit empirical scrutiny themselves. Regardless of the mechanism(s), it is clear that participants who had just competed in a video game intended to undermine their partners' ability to obtain a monetary reward after the competition ended, that is, they meant to harm their partners. This aggressive intent is revealed in the reasons why participants made their tangram choices. Participants in the competition conditions intended to hurt, make it difficult for, and make it harder for their partner to succeed at the tangram task, whereas participants in the no-competition condition intended to help their partner. Clearly, participants had more aggressive intentions when competing and more prosocial intentions when not competing.

Conclusion and Implications

With lawmakers and parents relying on the accumulated body of research to make important decisions about video game availability and consumption, especially among young people, it would be imprudent to not investigate all aspects of video game play that may be hazardous. Our results suggest that competition may be a factor contributing to video-game-induced aggression that has been underestimated and requires further research. Indeed, our results suggest that researchers should familiarize themselves with the literature on competition and aggression and make appropriate adjustments to their research designs, such as controlling for the competitive aspect of VVGs or investigating the competition as an independent variable. Such measures would add important nuance to the literature on the effects of playing VVGs.

Limitations and Future Research

Since no study is perfect, we would be remiss if we did not acknowledge some limitations in ours. As alluded to earlier, our sample comprised exclusively college-aged men. Even though females often exhibit levels of overall aggression that vary in the same direction and in parallel with males in many studies (e.g., Archer, 2004), and even though there is evidence that the challenge hypothesis applies to females as well as to males (Archer, 2006), future research must investigate the effects of competition on women. Moreover, research with younger participants is critical.

A second limitation is our use of a single measure of behavioral aggression: the tangram puzzle. Although this measure has been repeatedly employed in laboratory studies and is comparable to other accepted measures of behavioral aggression (Saleem et al., 2015), the specific form of aggression measured by the task is rather mild. However, the fact that we still found differences in aggression could suggest that this was a more conservative test of the effects of competition. Additionally, the measure has been criticized regarding the potential motives of the respondents, which is why we followed up the measure with questions regarding the participants motives. Finally, as mentioned, we treated prosocial behavior and aggression as two ends on a continuum; however, it should be noted that although this made sense in our specific case, this may not be appropriate for all forms of aggression and prosocial behavior. Future researchers may want to investigate the effects of competition in video games on aggression and prosocial behavior independently.

Finally, the competition aspect in our study is somewhat different from the common way competition works in most VVGs. While the participants were told they were competing against a partner, the competition was indirect. They were competing on the same task at the same time, with no indication of how the other was doing. A good illustrative analogy is that of the competition in football versus the competition in track. While both are zero-sum games (i.e., the winner causes the other to lose), the football teams compete to directly overcome and impede the other. The competition in track is only to see who can complete the task faster or better, with each individual or team on their own, unimpeded by others. Therefore, this could call into question the generalizability of our results. Nevertheless, to the extent that indirect competition represents a weaker manipulation of the construct than direct competition, it could be argued that the present study provided a stronger test of the hypothesis, as a significant finding would be harder to obtain. Therefore, there is reason to believe that the effect of competition on aggression could be even stronger when players directly compete with each other.

Additional research is needed to refine our understanding of the different effects of violence, competition, and outcome in video games on subsequent aggression. The preponderance of evidence for the assertion that it is primarily the violence in the video games is only beginning to be called into question, and more research is needed to address this important issue.

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Publication Ethics

The study was approved by the university IRB, and all participants were treated per the ethical guidelines of the American Psychological Association.

Open Data

The authors have posted all questionnaires and other materials, including analytic scripts, on OSF (https://osf.io/rha89/). Additionally, the Hilgard paradigm can be accessed at https://osf.io/3cb9m/. During the consent process, participants were not given an opportunity to consent to their anonymous data being freely available online; however, the authors are willing to share their data upon request.

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