Psychology of Violence
2011, Vol. 1, No. 4, 259–274

2152-0828/11/$12.00 DOI: 10.1037/a0024908

The Effect of Video Game Competition and Violence on Aggressive Behavior: Which Characteristic Has the Greatest Influence?

Paul J. C. Adachi and Teena Willoughby
Brock University, Canada

Objective: This study is the first to our knowledge to isolate the effect of video game violence and competitiveness on aggressive behavior. ***Method:*** In Pilot Study 1, a violent and nonviolent video game were matched on competitiveness, difficulty, and pace of action, and the effect of each game on aggressive behavior was then compared using an unambiguous measure of aggressive behavior (i.e., the Hot Sauce Paradigm) in Experiment 1. In Pilot Study 2, competitiveness was isolated by matching games on difficulty and pace of action, and systematically controlling for violence. The effect of video game competition on aggressive behavior was then examined in Experiment 2. ***Results:*** We found that video game violence was not sufficient to elevate aggressive behavior compared with a nonviolent video game, and that more competitive games produced greater levels of aggressive behavior, irrespective of the amount of violence in the games. ***Conclusion:*** It appears that competition, not violence, may be the video game characteristic that has the greatest influence on aggressive behavior. Future research is needed to explore the mechanisms through which video game competitiveness influences aggressive behavior, as well as whether this relation holds in the long-term.

Keywords: violent video games, aggressive behavior, competitiveness, violence

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

This article was published Online First August 15, 2011.

Paul J. C. Adachi and Teena Willoughby, Department of Psychology, Brock University, Ontario, Canada.

Teena Willoughby received funding from the Social Sciences and Humanities Research Council of Canada and the Owl Children's Trust.

Correspondence concerning this article should be addressed to Paul J. C. Adachi, Department of Psychology, Brock University, St. Catharines, Ontario, Canada, L2S 3A1. E-mail: pa08fg@brocku.ca

measure of aggressive behavior, when both games were equated on competitiveness, difficulty, and pace of action. In addition, we tested whether a competitive video game produced more aggressive behavior than a less competitive video game when matched on violence, difficulty, and pace of action.

The General Aggression Model

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

Empirical Background

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

Differences Between Violent and Nonviolent Video Games Other Than Violence

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

Although researchers have attempted to equate games on competitiveness, difficulty, and pace of action, no one to date has equated a violent and nonviolent game on these characteristics simultaneously. For example, Carnagey and Anderson (2005) attempted to control for competition while examining the effect of video game violence on aggressive behavior by manipulating the game-play settings of the car-racing video game *Carmageddon 2*. Participants were randomly assigned to one of three conditions: (a) awarded points for destroying other vehicles during the race (violence rewarded), (b) deducted points for destroying other vehicles during the race (violence punished), or (c)

could not come into contact with other vehicles during the race (nonviolent). Because the same game was used in all three conditions, Carnagey and Anderson assumed that the level of competitiveness across the conditions was equal; however, without having participants rate each condition in terms of competitiveness, it is unclear whether they were actually equal. For instance, in the violence-punished and nonviolent conditions, there is only one competitive goal: defeat the other opponents in the race. However, in the violence-rewarded condition there are two competitive goals: defeat the other opponents in the race and defeat the other opponents in a battle for survival. Thus, the violence-rewarded condition contained more competition which may have caused participants to feel more competitive, and in turn, behave more aggressively than the participants in the violence-punished and nonviolent conditions.

Problems With Measures of Aggression

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

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

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

Aggression-Related Video Game Characteristics

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

pants were told that their goal was to get further in the game than the other participant, and the participants each used a different character (Mario or Luigi). In the cooperative condition, participants were told that their goal was to get as far in the game as possible together, and they took turns using the same character (Mario). Anderson and Morrow (1995) found that participants in the competitive condition killed significantly more enemy creatures than participants in the cooperative condition. Thus, they concluded that competition elevated aggressive behavior compared with cooperation (see also Williams & Clippinger, 2002).

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

The Current Studies

The purpose of Pilot Study 1 was to test whether two games chosen through pilot testing differed in terms of violence, but were matched in terms of competitiveness, difficulty, and pace of action. The two matched games were then used in Experiment 1 to test the effect of video game violence on aggressive behavior (the Hot Sauce Paradigm). Pilot Study 2 was conducted to test whether four video games chosen through pilot testing were matched on difficulty and pace of action, but differed on violence and competitiveness, such that two of the games were equally violent but one was more competitive than the other, while the other two games were equally nonviolent but one was more competitive than the other. These four games were then used in Experiment 2 to test the effect of video game competition on aggressive behavior, and whether there was an interaction between competition and violence.

Pilot Study 1

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

Fourteen introductory psychology students from a midsized university in Ontario, Canada (6 men, 8 women; *M* age = 20 years, 1 month) played the violent video game *Conan* and the nonviolent video game *Fuel* for 12 min each in a counterbalanced order. This study was approved by the University Ethics board, and all participants provided active consent before participation. The games were played on an XBOX 360 gaming system and 42-inch TV screen. In order to accurately compare participants' ratings of game characteristics, we controlled for their previous experience with the relevant video game genres of action (*Conan*) and racing (*Fuel*). Participants also completed a demographic questionnaire that assessed age and gender.

Participants rated each game in terms of the four video game characteristics. Violence was measured on a scale from 1 (*very low*) to 7 (*very high*) by asking "how violent was the game." Difficulty was measured by asking "how diffi-

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

Participants' experience with the two genres of games (action and racing) did not significantly differ, $F(1, 12) = 3.41$, $p > .05$, partial $\eta^2 = .22$. A repeated measures analysis of variance (ANOVA) was then conducted to compare the two video games on the four video game characteristics of violence, competitiveness, difficulty, and pace of action. Gender was included as a between-subjects variable, and experience with racing and action games were entered as covariates. Only the Type of game (i.e., *Conan* and *Fuel*) $\times$ Game characteristics (i.e., violence, competitiveness, difficulty, and pace of action) interaction was significant, $F(3, 30) = 7.59$, $p < .01$, partial $\eta^2 = .43$. To assess this interaction, follow-up analyses were conducted to compare each of the four video game characteristics between the two games (see Table 1 for mean ratings). *Conan* was rated as significantly more violent than *Fuel*. However, the two games did not differ on competitiveness, difficulty, or pace of action. Consequently, *Conan* and *Fuel* were used in Experiment 1 to test whether video game violence alone could produce elevations in aggressive behavior.

Experiment 1

The purpose of Experiment 1 was to test whether *Conan* and *Fuel* produced differences in aggressive behavior when using an unambiguous measure of aggressive behavior, the Hot Sauce Paradigm. Similar to Barlett et al. (2009), deception was used to disguise the purpose of the Hot Sauce Paradigm so that participants would not be aware that we were assessing the effect of violent video games on aggressive behavior. Specifically, participants were told that they were participating in two unrelated studies looking at (a) video game play and eye-gaze and (b) food preference and personality (the Hot Sauce Paradigm). In terms of expectations: (a) No specific hypothesis was made as to whether there would be a main effect of game. That is, it was not clear whether differences in hot sauce scores (i.e., standardized summation of the amount of sauce and the degree of hotness) would be found between the two video games, as this was the first study to match a violent and nonviolent game on competitiveness, difficulty, and pace of action; (b) We predicted a main effect for gender, with men expected to have higher hot sauce scores than women, consistent with past literature showing that men are more aggressive than women (e.g., Coie & Dodge, 1998); (c) We did not expect to find an interaction between game and gender as past research has shown that the relation between video game play and aggression does not

Table 1
Pilot Study 1 and Experiment 1 Mean Ratings of Video Game Characteristics for Conan and Fuel

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

Note. $N = 14$ for Pilot study, and $N = 42$ for Experiment 1. Means are unadjusted; *SD*s are in parentheses. Violent = *Conan*, Nonviolent = *Fuel*.
[a] $df = 1, 10$. [b] $df = 1, 34$.
** $p < .01$. *** $p < .001$.

differ for men and women (e.g., Anderson et al., 2010); and (d) We also included a measure of trait aggression at the end of the study to test the convergent validity of the Hot Sauce Paradigm. It was hypothesized that hot sauce scores would be moderately related to scores on a trait aggression questionnaire, consistent with past research (e.g., Lieberman et al., 1999, $r = .30$; Ferguson & Rueda, 2009, $r = .25$).

Method

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

Materials.

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

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

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

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

Food preference. Food preference was assessed by asking "how much do you LIKE the following kinds of foods" for six items (i.e., sweet, savory, spicy, hot, bland, and salty foods) on a 1 (*not at all*) to 5 (*extremely*) scale (Barlett et al., 2009). Consistent with Barlett et al., we confirmed that both the degree of hotness and the amount the hot sauce selected by participants was not a function of their liking hot food. Liking hot food did not account for a significant portion of the variability in the degree of hotness, $R^2 = .07$, $F(1, 40) = 2.78$, $p > .05$, or the amount of sauce $R^2 = .04$, $F(1, 40) = 1.44$, $p > .05$.

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

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

Procedure. Participants were tested one at a time by the first author. First, they were told that they were participating in two unrelated studies: a video game study examining video games and eye gaze and a study looking at

personality and food preference. For the food study, participants were told that they were randomly assigned to the role of "food administrator" and that when the time came their job would be to prepare a certain type of food for another participant who had been assigned to the role of "food taster." Participants were then given the demographic questionnaire followed by the food preference questionnaire.

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

The experimenter then provided the participant with the materials for the food preference study (i.e., the hot sauce, a cup, a cup of water, bread, and popsicle sticks) and explained that the participant could choose the intensity of hot sauce (ranging from 1 = *least hot* to 4 = *most hot*) and the amount, and that the food taster would have to drink whatever amount was in the cup. As in Barlett et al. (2009), participants were told that they could not mix sauces. Also, if they wished to know how hot the sauces were before choosing one, they could sample the sauces using the popsicle stick. The experimenter left the room and watched from behind a two-way mirror as the task was performed, and then returned to retrieve the cup of hot sauce to allegedly bring to the food taster. The time lapse between the video game play and hot sauce preparation was 2 to 3 min, well within the 5- to 10-min time frame in which the effect of violent video games on aggression has been shown to last (Barlett et al., 2009). Finally, participants completed the suspiciousness questionnaire to assess whether participants knew the true purpose of the study before being debriefed or whether they were aware of any deception. Furthermore, 26 participants (13 who played *Conan* and 13 who played *Fuel*) completed the Buss and Perry (1992) Trait Aggression Questionnaire to examine the convergent validity of the Hot Sauce Paradigm. The time lapse between the video game play and the completion of the trait aggression questionnaire was over 10 min ($M = 11$ min).

Results and Discussion

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

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

Video game ratings. A multivariate analysis of variance (MANOVA) was conducted to confirm that *Conan* and *Fuel* were equated on the three video game characteristics of competitiveness, difficulty, and pace of action, but differed on violence, and experience with racing and action games were included as covariates. There was a main effect for game, $F(4, 33) = 28.98$, $p < .01$, partial $\eta^2 = .78$. The video games differed only in ratings of violence, as *Conan* was rated as more violent than *Fuel* (see Table 1 for mean ratings). Thus, consistent with Pilot Study 1, participants rated *Conan* as more violent than *Fuel*, but not significantly different in terms of competitiveness, difficulty, and pace of action.

Aggressive behavior. A univariate ANOVA was conducted with the summation of the standardized amount of hot sauce given and the standardized degree of hotness as the dependent variable, video game condition (i.e., violent vs. nonviolent) and gender as the independent variables, and game experience for both genres of games as the covariates. Participants who played *Conan* did not differ in hot sauce scores ($M = .09$) compared with participants who played *Fuel* ($M = -.09$), $F(1, 36) = .00$, $p > .05$, partial $\eta^2 = .00$. As predicted, men

($M = .40$) had higher hot sauce scores than women ($M = -.59$), $F(1, 36) = 6.34$, $p < .05$, partial $\eta^2 = .15$, and the interaction between game and gender is not significant, $F(1, 36) = .23$, $p > .05$, partial $\eta^2 = .01$. The results suggest that the violent content alone was not sufficient to produce elevations in aggressive behavior compared with a nonviolent video game.

Convergent validity of the Hot Sauce Paradigm. We decided to test the convergent validity of the hot sauce paradigm after the study had begun, so only the final 26 participants completed the trait aggression questionnaire. As predicted, hot sauce scores were positively correlated with trait aggression ($r = .32$), although this correlation was not statistically significant because of the small sample size. However, the size of the moderate correlation is consistent with previous results (e.g., Ferguson & Rueda, 2009; Lieberman et al., 1999).

Experiment 1, therefore, demonstrated that video game violence alone is not sufficient to produce elevations in aggressive behavior in a lab setting. Using an unambiguous measure of aggressive behavior, participants did not have higher hot sauce scores after playing a violent game compared with a nonviolent game that was equated on competitiveness, difficulty and pace of action. This finding suggests that the level of violence in video games may be less influential in elevating aggression than previously believed. In addition, the present study provided support for the validity of the Hot Sauce Paradigm as a measure of aggressive behavior, because of its positive relation with a measure of trait aggression.

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

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

Pilot Study 2

The purpose of Pilot Study 2 was to isolate competitiveness by matching four games on difficulty and pace of action, and to systematically control for violence, so that we could use these games in Experiment 2 to examine the effect of competitiveness on aggressive behavior. After extensive testing by the first author, four games were selected that appeared to be matched on difficulty and pace of action. Two of the games appeared to be equally violent, and the other two games appeared to be equally nonviolent. Of the two violent games, one was

more competitive than the other, and of the two nonviolent games, one was more competitive than the other. The two violent games that were chosen were *Mortal Kombat versus DC Universe* (Midway Games, 2008) and *Left 4 Dead 2* (Valve, 2009). *Mortal Kombat versus DC Universe* is a fighting game in which the main character must battle another opponent character in hand-to-hand combat. The goal of the game is to defeat the opponent character in a 3-round fight so a new opponent can be faced. Because of the competitive nature of the game (i.e., three rounds of one-on-one combat), the competitive element of this game is quite salient. Thus, *Mortal Kombat versus DC Universe* was hypothesized to be the more competitive violent game. *Left 4 Dead 2* is a first-person shooter in which the main character must battle zombies using guns and other weapons. Although the main character must compete in a battle for survival with every other character in the game, *Left 4 Dead 2* was hypothesized to be less competitive than *Mortal Kombat versus DC Universe*. Unlike most other first-person shooters, the opponent characters in *Left 4 Dead 2* are zombies, and hence they do not possess weapons. Consequently, instead of engaging in a competitive shoot-out against other armed characters as in most first-person shooters, many scenarios in *Left 4 Dead 2* involve standing at a distance and shooting a barrage of charging zombies.

The two nonviolent games were *Fuel* (Codemasters, 2009) and *Marble Blast Ultra* (GarageGames, 2006). As previously described, *Fuel* is a racing game in which the main character must compete against other characters while in a series of races while driving a variety of vehicles such as motorcycles and ATVs. Because of the competitive nature of the game, *Fuel* was hypothesized to be the competitive nonviolent game. In contrast, *Marble Blast Ultra* involves controlling a marble through a series of labyrinth-like mazes as quickly as possible. As there are no other characters in the game with which to compete with, *Marble Blast Ultra* was hypothesized to be less competitive than *Fuel*. In terms of comparing the violent and nonviolent games, *Fuel* was hypothesized to be equally competitive to *Mortal Kombat versus DC Universe*, and more competitive than *Left 4 Dead 2*. *Marble Blast Ultra* was hypothesized to be less competitive than *Mortal Kombat versus DC Universe* and *Left 4 Dead 2* (because *Left 4 Dead 2* does contain some competition against opponent characters). The games were played on an XBOX 360 gaming system and 42-inch TV screen.

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

A repeated measures ANOVA revealed that participants' experience across the different genres did not significantly differ, $F(3, 51) = 1.32$, $p > .05$ partial $\eta^2 = .07$. A repeated measures ANOVA was conducted to compare the four video games on the four video game characteristics of violence, competitiveness, difficulty, and pace of action. Gender was included as a between-subjects variable, and experience with all game genres were entered as covariates. Only the Type of game (i.e., *Fuel*, *Left 4 Dead*, *Marble Blast Ultra*, *Mortal Kombat versus DC Universe*) × Game characteristics (i.e., violence, competitiveness, difficulty, and pace of action) interaction was significant, $F(9, 117) = 5.01$, $p < .01$, partial $\eta^2 = .28$ (see Table 2 for mean ratings of the video game characteristics for the four video games). Thus, participants' ratings of video game characteris-

Table 2
Pilot Study 2 and Experiment 2 Mean Ratings of Video Game Characteristics for the Four Video Games

Game rating	Pilot Study 2 video game				Experiment 2 video game			
	C, NV	C, V	LC, V	NC, NV	C, NV	C, V	LC, NV	NC, NV
Violence	1.52 $(0.70)_b$	5.37 $(0.90)_a$	6.42 $(0.84)_a$	1.00 $(0.00)_b$	1.33 $(0.82)_b$	5.20 $(0.86)_a$	5.87 $(1.13)_a$	1.07 $(0.26)_b$
Competitiveness	5.86 $(0.76)_a$	6.32 $(0.58)_a$	3.18 $(1.67)_b$	1.36 $(0.44)_c$	5.40 $(1.02)_a$	6.13 $(0.93)_a$	3.10 $(1.67)_b$	1.40 $(0.69)_c$
Difficulty	3.63 $(1.38)_a$	4.47 $(1.58)_a$	4.42 $(1.74)_a$	4.68 $(1.16)_a$	3.27 $(1.10)_a$	3.67 $(0.82)_a$	3.53 $(0.92)_a$	3.60 $(1.18)_a$
Pace of action	4.74 $(1.05)_a$	5.42 $(0.90)_a$	5.11 $(1.29)_a$	4.57 $(1.26)_a$	4.73 $(1.33)_a$	5.20 $(0.77)_a$	4.87 $(0.92)_a$	4.47 $(0.99)_a$

Note. $N = 19$ for Pilot Study 2 and $N = 60$ for Experiment 1. Means are unadjusted; cells within a row with common subscripts for the pilot study and experiment are not significantly different at the .05 level. *SD*s are in parentheses. C = competitive, NC = noncompetitive, LC = less competitive, V = violent, NV = nonviolent, C, NV = *Fuel*, C, V = *Mortal Kombat versus DC Universe*, LC, V = *Left 4 Dead 2*, NC, NV = *Marble Blast Ultra*.

tics differed between the four video games. Follow-up comparisons indicated that the four games did not significantly differ in their ratings of difficulty, $F(3, 42) = .17$, $p > .05$, partial $\eta^2 = .01$, or in pace of action, $F(3, 42) = .48$, $p > .05$, partial $\eta^2 = .03$. Thus, all four games were matched on difficulty and pace of action.

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

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

Experiment 2

The purpose of Experiment 2 was to examine the effect of video game competitiveness on aggressive behavior (using the Hot Sauce Paradigm), as well as test whether competitiveness interacts with violence to influence aggression, using the four video games from Pilot Study 2. Although previous research has attempted to equate video games on competitiveness (e.g., Anderson & Carnagey, 2009; Carnagey & Anderson, 2005), this was the first experiment to directly test the effect of video game competition on aggressive behavior. Moreover, as previously described, video game competitiveness may influence aggressive behavior through the mechanism of physiological arousal. In order to further examine the relation between competitiveness and aggressive behavior, we recorded participants' heart rate at baseline and during video game play to test whether video game competitiveness would produce elevations in heart rate from baseline.

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

Method

Participants. Participants consisted of 60 introductory psychology students from the same university as in Pilot Study 2 (32 men, 28 women; *M* age = 18 years 4 months). Participants were randomly assigned to play one of the four video games, and thus, each video game was played by 15 participants (8 men and 7 women). This study was approved by the University Ethics board and all participants provided active consent before participation. Students were recruited using the psychology participant pool and earned course credit in exchange for their participation.

Materials.

Demographics. See Experiment 1 for a Description.

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

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

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

Food preference. See Experiment 1 for a description. Consistent with Experiment 1, liking hot food did not account for a significant portion of the variability in the degree of hotness $R^2 = .00$, $F(1, 58) = 0.01$, $p > .05$, or the amount of sauce $R^2 = .00$, $F(1, 58) = 0.01$, $p > .05$.

Suspiciousness. See Experiment 1 for a description.

Trait aggression. See Experiment 1 for a description (in the current sample, $\alpha = .84$).

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

Procedure. The procedure was identical to Experiment 1, other than participants were told that in addition to assessing their eye-gaze, their heart rate would be monitored for 5 min at baseline as well as continuously during video game play.

Results and Discussion

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

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

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

Aggressive behavior. A univariate ANOVA was conducted with the summation of the standardized amount of hot sauce given and the standardized degree of hotness as the dependent variable, video game condition (four games) and gender as the independent variables, and experience with the four genres of games as the covariates. There was a main effect for game $F(3, 48) = 7.04$, $p < .01$, partial $\eta^2 = .31$. Follow-up analyses revealed that participants who played *Fuel* ($M = .79$) and *Mortal Kombat versus DC Universe* ($M = .90$) had significantly higher hot sauce scores (Figure 1) than participants who played *Marble Blast Ultra* ($M = -.91$) and *Left 4 Dead 2* ($M = -.78$). Hot sauce scores did not differ between *Fuel* and *Mortal Kombat versus DC Universe*, or between *Marble Blast Ultra* and *Left 4 Dead 2*. Although men ($M = .31$) had higher hot sauce scores than women ($M = -.35$), this difference did not reach significance $F(3, 48) = 1.49$, $p > .05$, partial $\eta^2 = .03$, and the interaction between game and gender also was not significant, $F(3, 48) = .41$, $p > .05$, partial $\eta^2 = .03$.

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

Heart rate. A repeated measures MANOVA was conducted to examine differences in heart rate between baseline and video game play among the four video game conditions. Game and gender were entered as the between-subjects variables, while heart rate (baseline and during video game) was entered

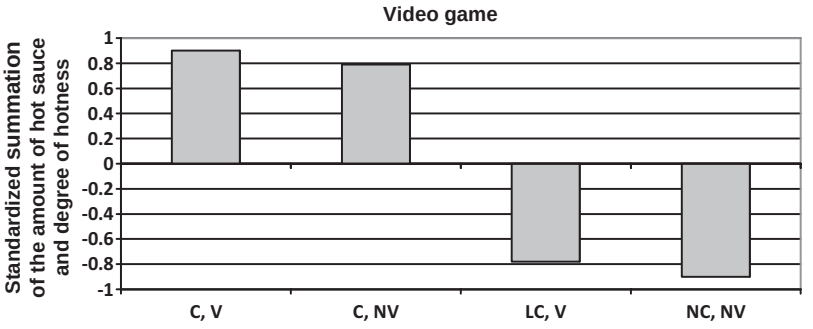

Figure 1. The effect of video game condition on aggressive behavior in Experiment 4. C = competitive, NC = noncompetitive, LC = Less competitive, V = violent, NV = nonviolent, C, V = *Mortal Kombat versus DC Universe*, C, NV = *Fuel*, LC, V = *Left 4 Dead 2*, NC, NV = *Marble Blast Ultra.*

as the within-subjects variable. A significant heart rate x video game interaction was found, $F(3, 48) = 12.76$, $p < .01$, partial $\eta^2 = .44$. Follow-up analyses were then conducted for each video game condition to see which video games produced elevations in heart rate from baseline (Table 3). *Fuel* and *Mortal Kombat versus DC Universe* both led to significant elevations in heart rate from baseline, while *Marble Blast Ultra* and *Left 4 Dead 2* did not.

In summary, Experiment 2 confirmed the hypothesis that the two most competitive games, *Fuel* and *Mortal Kombat versus DC Universe*, would produce greater aggressive behavior scores than the less competitive games, *Marble Blast Ultra* and *Left 4 Dead 2*. Also as expected, *Fuel* and *Mortal Kombat versus DC Universe* did not produce differences in aggressive behavior. In addition, we found that a moderately competitive, highly violent game (*Left 4 Dead 2*) was not sufficient to elevate aggressive behavior compared with a less competitive, nonviolent game (*Marble Blast Ultra*). These findings suggest that the level of competitiveness in video games is an important factor in the relation between video games and aggressive behavior, with highly competitive games leading to greater elevations in aggression than less competitive games. As expected, men gave more of a hotter sauce than women, although this difference did not reach significance. Also as expected, there was no interaction between game and gender when predicting aggressive behavior. Finally, we found that only the two highly competitive games, *Fuel* and *Mortal Kombat versus DC Universe*, elevated heart rate from baseline. This is consistent with the theory that physiological arousal may be one mechanism

Table 3
Experiment 2 Baseline and Heart Rate Scores for the Four Video Games

Video game	Heart rate		F^a	Partial η^2
	Baseline	Game		
Competitive, nonviolent	76.92 (10.18)	78.95 (11.25)	6.07*	0.32
Competitive, violent	74.89 (16.15)	86.36 (17.52)	31.00**	0.71
Less competitive, violent	78.85 (11.88)	77.32 (8.53)	0.78	0.06
Non-competitive, nonviolent	75.81 (11.88)	76.62 (12.25)	0.72	0.05

Note. *SD*s are in parentheses. $N = 60$; Means are unadjusted. Competitive, nonviolent = *Fuel*; competitive, violent = *Mortal Kombat versus DC Universe*; less competitive, violent = *Left 4 Dead 2*; noncompetitive, nonviolent = *Marble Blast Ultra.*
[a] $df = 1, 13$.
* $p < .05$. ** $p < .01$.

through which video game competitiveness may influence aggressive behavior.

General Discussion

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

After demonstrating that video game violence alone was not sufficient to elevate aggressive behavior, we examined the effect of video game competitiveness. The present study was the first to isolate video game competitiveness by matching two violent games, and two nonviolent games on violence, difficulty, and pace of action (Pilot Study 2). We found that video game competitiveness elevated aggressive behavior in the short-term, regardless of the level of violent content, as the two most competitive video games, *Mortal Kombat versus DC Universe* (violent) and *Fuel* (nonviolent), produced the greatest levels of aggressive behavior. We also found that a moderately competitive game (*Left 4 Dead 2*), even when paired with a high level of violence, was not sufficient to elevate aggressive behavior compared with a less competitive, nonviolent game (*Marble Blast Ultra*). In terms of mechanisms, according to the GAM, violent video games may influence aggressive behavior through aggressive thoughts, feelings, and physiological arousal. Consistent with the GAM, we demonstrated that physiological arousal may be a mechanism through which video game competitiveness influences aggressive behavior, as only *Mortal Kombat versus DC Universe* and *Fuel* produced elevations in heart rate from baseline.

Limitations

There were several limitations with this study. First, the present study only used samples of university students. Findings, however, may be different for other age groups. For example, the relation between video game competitiveness and aggression may be different for adolescents (e.g., 12 to 19 years) versus adults (e.g., 25 years and older), because of the hypothesis that some adolescents may experience a temporal gap between an early maturing socioemotional system (hypothesized to be a result of increases in dopaminergic activity, perhaps linked to puberty, leading to increases in reward seeking, need for novelty and stimulation), and a slower maturing self-regulatory system (hypothesized to be led by the prefrontal cortex, responsible for planning, judgment, and inhibition, which may not be fully mature until the mid 20s; Steinberg, 2010). Thus, adolescents on average may be more likely to behave aggressively than adults after playing a competitive video game because of their potentially greater difficulty (on average) in regulating their arousal than adults. Future research should compare the effect of video game competitiveness on aggression between these different age groups. Second, although this study addressed the short-term effect of video game competition on aggressive behavior, we did not examine long-term effects. Thus, longitudinal research examining the relation between video game competition and aggression is needed. Finally, findings may not generalize to other geographic regions, including those with differing ethnic and/or demographic mixes.

Research Implications

We have expanded on previous research that has found a relation between violent video games and aggression (see Anderson et al., 2010) by demonstrating that when isolating specific video game characteristics, competitiveness had a much larger impact on aggressive behavior than the violent content. At first glance, this finding may seem to contradict past research which has found that violent video games produced more aggression than nonviolent video games. However, because past studies have failed to equate the violent and nonviolent video games on competitiveness, difficulty, and pace of action simultaneously, researchers may have attributed too much of the variability in aggression to the violent content. For example, since violent video games are more competitive in general than nonviolent games, it was likely the competition, rather than the violence, that was responsible for the elevations in aggression in

past studies. Furthermore, in the only study that successfully matched a violent and nonviolent video game on competitiveness (Anderson & Carnagey, 2009), the violent game was rated higher in terms of difficulty and pace of action. Thus, it was unclear whether the violence, difficulty, pace of action, or a combination of the three influenced aggressive behavior. Future research should test the effect of both video game difficulty and pace of action on aggressive behavior, as well as how the four video game characteristics interact. For example, a competitive game that is more difficult, in that people lose more often and must exert considerable effort in order to succeed may be more likely to influence aggressive behavior. Thus, an interaction between competitiveness and difficulty may be related to elevated aggression.

Although we found that heart rate may be one mechanism through which video game competition influences aggressive behavior, future research is needed to examine other possible mechanisms. Consistent with Anderson and Morrow's (1995) finding that competition produces more aggressive thoughts than cooperation, it is likely that video game competitiveness influences aggressive thoughts. Similarly, Anderson and Morrow stated that competition usually leads to negative feelings as only one person can reach the desired goal of winning the game. Thus, video game competition likely produces feelings of frustration, as opponents continuously attempt to obstruct each other's goal of becoming victorious (Berkowitz, 1989).

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

Conclusion

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

References

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

Anderson, C. A., & Bushman, B. J. (2002). Human aggression. *Annual Review of Psychology, 53,* 27–51.

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

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

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

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

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

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

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

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

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

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

Buss, A. H., & Perry, M. (1992). The aggression questionnaire. *Journal of Personality and Social Psychology, 63,* 452–459.

Carnagey, L. N., & Anderson, C. A. (2005). The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychological Science, 16,* 882–889.

Coie, J. D., & Dodge, K. A. (1998). Aggression and antisocial behavior. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology* (5th ed., Vol. 3, pp. 779–862). New York, NY: Wiley.

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

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

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

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

Gentile, D. A. (2009). Pathological video-game use among youth ages 8 to 18: A national study. *Psychological Science, 20,* 594–602. doi:10.1111/j.1467-9280.2009.02340.x

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

Schmierbach, M. (2010). "Killing spree": Exploring the connection between competitive game play and aggressive cognition. *Communication Research, 37,* 256–274. doi:10.1177/0093650209356394

Steinberg, L. (2010). A dual systems model of adolescent risk taking. *Developmental Psychobiology, 52,* 216–224.

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

Williams, R. B., & Clippinger, C. A. (2002). Aggression, competition and computer games: Computer and human opponents. *Computer in Human Behavior, 18,* 495–506.

Received February 18, 2011
Revision received June 15, 2011
Accepted June 16, 2011 ■