

pre- to postvideo game play [Barlett and Rodeheffer, 2009; Barlett et al., 2007]. This effect stabilizes after the initial increase in aggression, thus Barlett and Rodeheffer [2009] concluded that once participants are aggressively primed, via violent video game play, there is no additional effect of continued violent video game play.

Overall, these findings can be explained by a number of theoretical frameworks, including Social Learning Theory [Bandura, 1983], Script Theory [Huesmann, 1998], Excitation Transfer Theory [Zillmann, 1983], Theory of Neo-Associative Networks [Berkowitz, 1993], and the integrative General Aggression Model [Anderson and Bushman, 2001]. Past research has found that violent video game play is related to aggressive thoughts, aggressive feelings, physiological arousal, and aggressive behavior [see Anderson, 2004], as suggested by these theories. Further, they suggest that aggressive thoughts, aggressive feelings, and physiological arousal mediate the relation between violent video game play and aggressive behavior [see Anderson and Bushman, 2001].

There has yet to be any empirical published study of how long the short-term effects of video game violence last. Certainly, longitudinal work has suggested that prolonged violent media exposure is related to trait aggression shifts as early as 5 months later [Anderson et al., 2007; Study 3] and can last as long as 15 years [Huesmann et al., 2003]. Although insightful and important, the results from such work cannot answer the question of how long do the short-term effects from media violence exposure last. Bushman and Huesmann [2006] argued that short-term effects of media violence exposure (in adults) are best explained by the priming of aggressive knowledge structures (scripts, schemas), which guide behavior. Once activated, these aggressive knowledge structures can also create feelings of hostility and general physiological arousal, owing to their theoretically predicted correlated relationships [see Anderson and Bushman, 2001]. However, it is unknown exactly how long these effects will last, but empirical evidence suggests that hostility and aggressive thoughts may dissipate very soon after video game play, as the former is an emotion [Larson, 2000], and the latter are primed nodes in memory. Arousal and aggressive behavior, on the other hand, may not dissipate immediately. Evidence has shown that more than 5 min is necessary to reduce arousal after exposure to violent stimuli to baseline [Zillmann et al., 1974], while it is unknown how long aggressive behavioral tendencies will last.

STUDY 1

Overview of this Study

The primary goal of this study was to answer the third research question and determine how long the effects of the heightened aggression and physiological arousal after violent, vs. non-violent, video game play last. Before this research question can be empirically tested, two conditions have to be met. First, the violent video game has to increase aggressive thoughts, feelings, and physiological arousal from baseline. Second, these aforementioned increases should not be observed for those who play a nonviolent video game. Once these conditions are met, the main research question will be tested by giving one group of participants a set of questionnaires to assess aggressive feelings, thoughts, and heart rate immediately after completion of an aggressive behavior task, and another group of participants will be given the same set of questionnaires 5 min after the completion of an aggressive behavior task.

We predict an increase in aggressive feelings, aggressive thoughts, and physiological arousal after violent video game play. Then those in the 4 min delay condition will have similar scores on all of the variables because very little time has elapsed since the previous questionnaire administration. We also predict a significant drop in the scores of all dependent variables for the 9 min condition.

The second objective was to test how many internal state variables (aggressive thoughts, aggressive feelings, and arousal) are necessary to fully mediate the relationship between video game content and aggressive behavior. To test this prediction, a series of mediation tests were conducted. We predicted that all three of the internal state variables are necessary to mediate the overall relationship, while analyzing one or two internal state variable(s) at a time will only partially mediate this relationship.

METHOD

Participants

Ninety-one (69 male) participants from a large Midwestern University participated in the current experiment for partial credit for their General Psychology class. The average age of this sample was 19.45 (SD = 1.90) years. The majority of participants were first year (62.6%), Caucasian (83.5%), undergraduate students.

Materials

Trait aggression. The Buss–Perry Aggression Questionnaire [Buss and Perry, 1992] was used to measure trait aggression. This is a 29-item scale that asks participants to respond on a 1 (*extremely uncharacteristic of me*) to 7 (*extremely characteristic of me*) Likert Scale about their aggressive tendencies. Certain items were reverse coded in order to have higher scores indicate higher trait aggression. The reliability for this scale for this study were acceptable ($\alpha = .92$).

Aggressive feelings. The State Hostility Scale [Anderson et al., 1995] was used to measure aggressive feelings, specifically state hostility. This is a 35-item scale that asks participants to respond on a 1 (*strongly disagree*) to 5 (*strongly agree*) Likert Scale about how they are feeling right now. Certain items were reverse coded in order to have higher scores indicate higher aggressive feelings. The reliabilities for this scale for this study were acceptable at all questionnaire administration periods (all α s $> .80$).

Aggressive thoughts. The Word Completion Task [Anderson et al., 2003] was used to measure aggressive thoughts. This measure consists of 98 incomplete word fragments. Participants are asked to quickly fill in the blanks to complete the word. For example, “K I _ _” could be completed as “KILL” or “KISS.” Aggressive responses were coded and counted, such that higher scores indicate higher aggressive thoughts activated in semantic memory, which is indicative of aggressive related priming.¹

Heart rate. To assess heart rate, a heart rate device (produced by Tanita) was used. This device instructed participants to place their right index finger atop a sensor to produce an output of the participant’s heart rate. In order to make this measurement more reliable, heart rate was measured three times, with the average of those three readings taken as the measure of heart rate, as was instructed

¹Typically, this questionnaire is scored by taking the number of aggressive responses divided by the total number of word fragments completed [Anderson et al., 2003], creating an aggressive to total word ratio. However, for this study the raw number of aggressive thoughts was used as the dependent variable. This was done because results showed that baseline measures of aggressive thoughts (computed using the aforementioned ratio) were significantly higher ($P < .05$) than Time 2 and 3. The reason for this was that participants had a hard time at baseline completing word stems ($M = 19.13$, $SD = 4.22$) than Time 2 ($M = 26.07$, $SD = 3.59$) and Time 3 ($M = 25.67$, $SD = 3.62$). Thus, the reason why the ratio measure did not work was because the denominator was too low, making the overall fraction too high for Time 1.

by the producers of this device [see Barlett et al., 2007].²

Aggressive behavior. In order to assess overt aggressive behavior, the Hot Sauce Paradigm [Lieberman et al., 1999] was used. In this paradigm participants are to give a cup of hot chili sauce to “another participant” who does not like hot/spicy foods. Thus, the amount of hot sauce in the cup is indicative of overt aggressive behavior. The current research will extend the Hot Sauce Paradigm by having two outcome variables [see Ritter and Eslea, 2005]. These outcomes are the amount of sauce in the cup and the degree of hotness of the sauce selected. These two variables will be combined into one outcome variable. The necessary materials for this consisted of a tray, the hot sauce, one cup to place the hot sauce into, a cup full of water, a spoon, and Popsicle sticks. The hot sauce was purchased from a local food establishment that had a ranked system of hotness for the sauces. For this study, the four hottest sauces were selected. The labels were removed and the sauces were assigned a number from one to four (higher numbers are indicative of degree of hotness). The summation of the standardized number of sauce selected and the amount of weight (in ounces) is indicative of aggressive behavior.

Demographics. A demographic questionnaire was given to assess age, gender, ethnicity, and year in school. This questionnaire also assessed postvideo game qualities of the video game experience. How violent, exciting, fun, and fast paced the video game was perceived to be was assessed on a 1 (*not at all*) to 5 (*extremely*) Likert scale [see Anderson and Dill, 2000]. Finally, the food preference of the participants was assessed. Six items assessed how much the participants enjoyed sweet, savory, spicy, hot, bland, and salty foods on a 1 (*not at all*) to 5 (*extremely*) scale.³

²Heart rate was actually measured four times. Once as soon as the participants arrived in the lab (the data point used in the study), once after baseline measures were completed, once after the video game was played, and once after the participant’s respective time delay condition was over. A paired-sample *t*-test revealed a nonsignificant difference in heart rate, $t(87) = -.62$, $P > .05$, between the first two times heart rate was measured for Study 1. Thus, the first arousal assessment was used.

³Linear regressions were conducted to determine whether the amount or degree of hot sauce given was not a function of the participant naturally liking hot sauce or feeling a great deal of distress from giving the hot sauce. Results indicate that the models did not account for a significant portion of variance in the amount of sauce given, $R^2 = .03$, $F(4,86) = 0.62$, $P > .05$, or the degree of hotness, $R^2 = .04$, $F(4,86) = 0.91$, $P > .05$, for Study 1. Results were similar for the

Suspiciousness. Owing to the highly publicized nature of video game effects, the fact that baseline measures of aggression were given, and the fact that deception was used, a suspiciousness questionnaire was given that assessed whether the participants knew the true purposes of the study before being debriefed, whether any other participant had told them about the study before completing the study, and whether they were aware of any deception. Analysis of this questionnaire showed that 12 (13.2%) of the sample did not believe another person was down the hallway to give the hot sauce too, and were, thus, deleted from the analyses with aggressive behavior. None of the participants reported being suspicious regarding media violence effects on aggression.

Video games and equipment. Two video games were used for this study. The first was the violent video game *Mortal Kombat: Deadly Alliance* for the PlayStation 2. This game was selected because of its violent content, excessive amount of blood, and because the controls are not difficult to learn. The nonviolent video game was *Hard Hitter Tennis* for the PlayStation 2. This is a nonviolent tennis video game. The objective is to beat the computer-controlled opponent at a standard game of tennis. This game was selected because it does not contain any violent content, and in fact, the two characters are not allowed to touch one another.

Procedure

Participants entered the lab one at a time for a study titled "Video Games and Food Preference." Upon completion of the informed consent and experimental credit cards, the participants were told that they would be participating in two unrelated experiments, with the first one being a video game study and the second being a study investigating the effects of personality on food preference, which would be completed in that order. Participants then had their heart rate measured three times (to assess baseline heart rate) and then were given the Aggression Questionnaire, State Hostility Scale and 1/3 of the Word Completion Task to complete. Then participants were given a brief tutorial on how to play the video game to which they were randomly assigned (35 male and 12 female in the violent condition, and 34 male and 10 female participants in the non-violent condition). This game was played for 15 minutes.

(footnote continued)

amount of sauce given, $R^2 = .02$, $F(2,74) = 0.81$, $P > .05$, and the degree of hotness, $R^2 = .05$, $F(2,74) = 1.88$, $P > .05$, for Study 2.

During the 15 min time period, the experimenter set out the materials for the food preference experiment. This included a tray with the four hot sauces, a plastic spoon, four small Popsicle sticks, and two plastic cups. The experimenter told the participant that while they were playing the video game the experimenter would have to leave because, "there should be another participant in the waiting area who would also take part in the food preference experiment." The experimenter took a packet of questionnaires and an empty plastic cup and left the room for exactly 5 min.

When the experimenter returned and the 15 min of video game play had expired, the video game was stopped and turned off, and the participants had their heart rate measured and were given the State Hostility Scale and a new 1/3 of the Word Completion Task to complete. When these questionnaires were completed, the participants sat down at another table that had the materials for the food preference experiment on it. The experimenter apologized for leaving and told the participant that in another room down the hall there was another participant who was with another research assistant completing the same questionnaires the participant's had just finished. The participant was given an already completed food preference questionnaire, and was told that the other participant down the hall had completed this questionnaire and, as indicated by this questionnaire, does not like hot or spicy foods.

Participants were informed that the job of the participant down the hall was to eat hot sauce that the actual participant would make. The purpose of the materials in front of the participant (i.e., the hot sauce, Popsicle sticks, cups, and spoon) was explained and two rules were explained to the participant. The first was that the participant could not mix sauces and the second was that the participant would have to try a little bit of the sauce before deciding to give that to the participant down the hall, so they knew how hot the sauce was. Participants were then instructed that after the cup was filled with the desired amount of sauce, the experimenter would take that cup to the participant who would "eat every drop of the given sauce."

After the participant completed this task, the researcher explained that he would return momentarily. For those assigned to the 4 min condition, the experimenter left the room, placed the cup of sauce on the floor in the hallway, and returned immediately stating that the cup was given to the other research assistant. At that point about 4 min had elapsed since the end of the video game. For those

assigned to the 9 min condition, the experimenter left the room with the cup of sauce and returned without the cup exactly 5 min later or about 9 min after the end of the video game. When the experimenter returned, all participants were instructed to complete a packet of questionnaires that were relevant to the food preference study, and, if the participants saw the same questionnaires as before, that was because the two studies were looking at similar variables. The participant's heart rate was measured three times, and the packet of questionnaires, which consisted of the State Hostility Scale, 1/3 of the Word Completion Task, a demographic questionnaire, and a food preference questionnaire was completed. Participants were thanked and fully debriefed. The entire experiment took between 45 and 50 min (depending on which delay condition they were assigned to) and the hot sauce procedure lasted approximately 4 min. Thus, we labeled the condition in which the researcher returned immediately to the room as the 4 min condition and the condition in which the researcher returned 5 min after the Hot Sauce paradigm procedure was completed as the 9 min condition.

RESULTS

Video Game Ratings

In order to ensure that the games were equivalent on several theoretically relevant variables, but differed on perceived violence, the ratings of how exciting, fun, and fast paced the game was perceived to be were summed together to create an Exciting Index (only one factor emerged from a principle components factor analysis, to confirm such a computation). A one-way analysis of variance was conducted with video game as the independent variable and the Exciting Index as the dependent variable. Results showed that the violent video game was significantly, $F(1,89) = 6.99$, $P < .02$, *partial* $\eta^2 = .07$, more exciting ($M = 12.66$, $SD = 3.91$) than the nonviolent video game ($M = 10.48$, $SD = 3.96$). The violent video game was also rated significantly higher, $F(1,89) = 197.14$, $P < .001$, *partial* $\eta^2 = .69$, on violence ($M = 4.85$, $SD = 1.63$) than the nonviolent video game ($M = 1.16$, $SD = 0.64$).

Video Game Content Effects on Aggression and Arousal

In order to determine whether violent video game play is related to an increase in aggressive feelings, aggressive thoughts, and physiological arousal,

change scores were computed between Time 2 and baseline measures of all the aforementioned dependent variables.⁴ One-way analyses of covariance (ANCOVAs) were conducted with video game content as the independent variable and trait aggression as the covariate. Results showed a significant main effect of content for aggressive feelings, $F(1,85) = 7.55$, $P < .01$, *partial* $\eta^2 = .08$, aggressive thoughts, $F(1,87) = 17.09$, $P < .001$, *partial* $\eta^2 = .16$, and physiological arousal, $F(1,85) = 12.00$, $P < .01$, *partial* $\eta^2 = .12$. Examination of Table I shows that these variables increased more after violent video game play relative to those who played the nonviolent game play. When gender was entered as a factor in the analyses, the results yielded nonsignificant main effects and interactions for gender on all of these dependent variables (all $F_s < 1.10$, all $P_s > .05$). Furthermore, when the Exciting Index was entered as a covariate, the results were similar to the aforementioned analyses.

A one-way ANCOVA was conducted with the summation of the standardized amount of sauce given and the standardized degree of hotness as the dependent variable, video game content as the independent variable, and trait aggression as the covariate. Results showed a significant main effect for content, $F(1,75) = 12.86$, $P < .001$, *partial* $\eta^2 = .15$. Examination of the means and standard deviations showed that those who played the violent video game gave more of a hotter sauce ($M = 0.56$, $SD = 1.39$) than those who played the nonviolent video game ($M = -0.66$, $SD = 1.56$). When gender was entered as a factor in the analyses, the results showed a nonsignificant main effect for gender or a significant gender by condition interaction. When the Exciting Index was entered as a covariate, the results were similar to the aforementioned analyses.

Delay and Content Effects on Aggressive Thoughts, Feelings, and Arousal (Time 3 to Time 2)

In order to determine how long the short-term increases in aggressive feelings, thoughts, and physiological arousal last, change scores were

⁴There are a number of statistical methods used to analyze multiple time point data. We elected to use change scores in order to account for any variability in the preassessment measures that may impact that postassessment measures. The main effect results reported were identical to a time \times condition interaction if we elected to use a repeated measures analyses of variance [2 (time: baseline, Time 2) \times 2 (content)]. Also, the results from these analyses were similar when we conducted a one-way ANCOVA with Time 2 as the dependent variable, video game content as the independent variable, and trait aggression and baseline scores as covariates.

TABLE I. Means and Standard Deviations for Aggressive Feelings, Aggressive Thoughts, Aggressive Behavior, and Heart Rate Change (T2–T1) for Violent and Nonviolent Video Game Play in Study 1

Variable	Content	T1	T2	Mean change
Aggressive feelings**	Violent	61.65 (10.21)	71.80 (15.62)	8.74 (12.54)
	Nonviolent	63.69 (10.98)	65.46 (13.45)	2.10 (9.68)
Aggressive thoughts**	Violent	4.93 (1.81)	6.41 (2.22)	1.60 (2.37)
	Nonviolent	5.76 (2.10)	4.63 (2.16)	-0.75 (2.91)
Heart rate**	Violent	76.76 (14.84)	86.80 (20.16)	8.24 (13.16)
	Nonviolent	78.15 (13.18)	77.93 (9.45)	-0.59 (10.35)
Aggressive behavior**	Violent	—	—	0.56 (1.39)
	Nonviolent	—	—	-0.66 (1.54)

** $P < .01$ (main effect for content). *Note:* Positive scores for the mean change column indicate an increase in the score of the dependent variable, whereas negative scores indicate a decrease in the score of the dependent variable. Aggressive behavior scores are standardized, and there are no change scores to report.

TABLE II. Means and Standard Deviations for Aggressive Feelings, Aggressive Thoughts, and Heart Rate Change (T3–T2) for Violent and Nonviolent Video Game Play across Delay Conditions in Study 1

Variable	Content	Delay	T2	T3	Mean change
Aggressive feelings*	Violent	4	69.33 (9.91)	62.77 (9.41)	-7.90 (9.69)
	Nonviolent	4	65.53 (15.18)	62.06 (12.93)	-3.47 (11.83)
	Violent	9	74.53 (20.11)	63.78 (16.28)	-9.94 (16.60)
	Nonviolent	9	65.40 (12.19)	62.50 (11.54)	-2.90 (8.67)
Aggressive thoughts**	Violent	4	6.09 (1.85)	5.09 (2.02)	-1.00 (2.53)
	Nonviolent	4	4.61 (1.79)	5.83 (2.03)	1.22 (1.93)
	Violent	9	6.79 (2.59)	5.63 (1.64)	-1.16 (2.71)
	Nonviolent	9	4.65 (2.50)	5.10 (2.00)	0.45 (3.56)
Heart rate*	Violent	4	82.25 (17.69)	82.31 (16.85)	-2.94 (11.73)
	Nonviolent	4	78.48 (10.07)	74.39 (9.51)	-4.09 (6.93)
	Violent	9	88.52 (22.94)	76.40 (12.74)	-12.11 (17.51)
	Non-Violent	9	77.44 (8.99)	79.63 (16.66)	2.19 (14.53)

** $P < .01$, * $P < .05$ (main effect for content). *Note:* Positive scores indicate an increase in the score of the dependent variable, while negative scores indicate a decrease in the score of the dependent variable.

computed between Time 3 and 2. Multiple 2 (content) \times 2 (delay) ANCOVAs were conducted for each of the aforementioned dependent variables with trait aggression as the covariate. Results showed a significant main effect of content, $F(1,73) = 8.20$, $P < .01$, *partial* $\eta^2 = .10$, for aggressive thoughts (see Table II). Examination of the means and standard deviations showed that those in the violent video game condition had a decrease in their aggressive thoughts ($M = -1.07$, $SD = 2.58$), whereas those in the nonviolent condition had a small increase in aggressive thoughts ($M = 0.68$, $SD = 2.80$). Analysis with the aggressive feelings variable also yielded a significant main effect for content, $F(1,70) = 4.23$, $P < .05$, *partial* $\eta^2 = .06$. Examination of the means and standard deviations showed that those in the violent condition had a higher decrease ($M = -8.85$, $SD = 13.18$) than those in the nonviolent condition ($M = -3.19$, $SD = 10.24$).

However, there was no significant interaction between delay and content for either aggressive feelings or aggressive thoughts indicating that there was no significant additional decrease in these variables between delays of 4 and 9 min. These results suggest that the effect of the violent games on aggressive thoughts and feelings lasts not more than 4 min.

In contrast, the results from the analysis on physiological arousal showed a significant main effect for content, $F(1,72) = 5.07$, $P < .03$, *partial* $\eta^2 = .07$, qualified by a significant content \times delay interaction, $F(1,72) = 6.78$, $P < .02$, *partial* $\eta^2 = .09$. A simple effects analysis was used to probe this significant interaction, and the results showed a nonsignificant main effect for video game content in the 4 min condition, $F(1,72) = 0.07$, ns, coupled with a significant main effect of content for those in the 9 min delay condition, $F(1, 72) = 11.27$, $P < .01$, *partial* $\eta^2 = .13$. Examination of the means and

standard deviations for the 9 min delay showed that those in the violent condition had a substantial decrease in their heart rate ($M = -12.11$, $SD = 17.52$) compared with right after the game (T2) whereas those in the nonviolent condition had a slight increase in their heart rate ($M = 2.64$, $SD = 14.79$). These results suggest that the arousal effect of violent video games lasts more than 4 min.

Delay and Content Effects on Aggressive Thoughts, Feelings, and Arousal (Time 3 to Time 1)

In order to further test the duration of the short-term effects of violent and nonviolent video game play, change scores were computed between Time 3 and 1. If the effects do not last even 4 min, then there should not be a significant change from baseline to Time 3 for any condition. However, if the effects last longer than 4 min, then we should see significant change from Time 1 to 3. Multiple 2 (content) \times 2 (delay) ANCOVAs with trait aggression as the covariate and with aggressive feelings, aggressive thoughts, and physiological arousal as the dependent variables were conducted. Results showed no significant main effects or interactions for the aggressive feeling or aggressive thought variables ($F_s < 2.95$, $P_s > .05$). This suggests that by the time the Hot Sauce paradigm procedure was completed no matter what delay, participant's levels of aggressive thoughts and feelings returned to baseline.

However, consistent with the results reported above, there was a significant delay \times content interaction for the arousal measure, $F(1,71) = 5.72$, $P < .02$, *partial* $\eta^2 = .08$. Examination of the means and standard deviations showed higher than baseline heart rate at the 4 min delay ($M = 7.59$, $SD = 14.29$), and slightly lower than baseline heart rate at the 1 min delay ($M = -1.94$, $SD = 9.54$) after violent video game play. Slightly lower heart rate was observed for those in the 4 min ($M = -2.90$, $SD = 7.57$) condition, compared with the slightly higher heart rate for those in the 9 min ($M = 1.03$, $SD = 15.38$) delay condition after nonviolent video game play.

Taken together with the observed differences between Time 2 and 3 reported above, these results all support the conclusion that the immediate effects of violent video game play on aggressive feelings and thoughts last less than 4 min, whereas the effects on arousal last more than 4 but less than 9 min.

Testing Direct and Indirect Effects

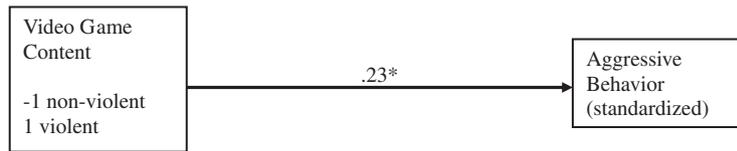
In order to test the direct effect of video game content on aggressive behavior and the indirect effect of video game content through aggressive thoughts, aggressive feelings, and physiological arousal, the raw scores of the

dependent variables were standardized and a multiple mediation test was conducted using Amos [Arbuckle, 2002]. Results indicated that the direct effect of video game content to aggressive behavior was significant, $\beta = .23$, $P < .05$. However, this effect was reduced to nonsignificance (though not to zero) with the presence of the three internal state variables (aggressive thoughts, aggressive feelings, and arousal) as mediators, $\beta = .12$. This suggests that at least one of the standardized⁵ internal state variables was a significant mediator. The standardized coefficients showed that aggressive thoughts were the only significant mediator, because only this mediating variable significantly predicted aggressive behavior $\beta = .22$, $P < .05$ (see Fig. 1). In order to test the number of internal state variables that are needed to render the direct effect of violent game playing on aggression insignificant, this model was run with only one internal state variable or combinations of two internal state variables. Results showed that all three were needed to render the direct effect of video game content to aggressive behavior nonsignificant. When each of the internal state variables were analyzed one at a time or in pairs (e.g., thoughts and feelings, thoughts and arousal, or feelings and arousal) in the mediator role, results showed that the link between video game content and aggressive behavior was still statistically significant (all $P_s < .05$).

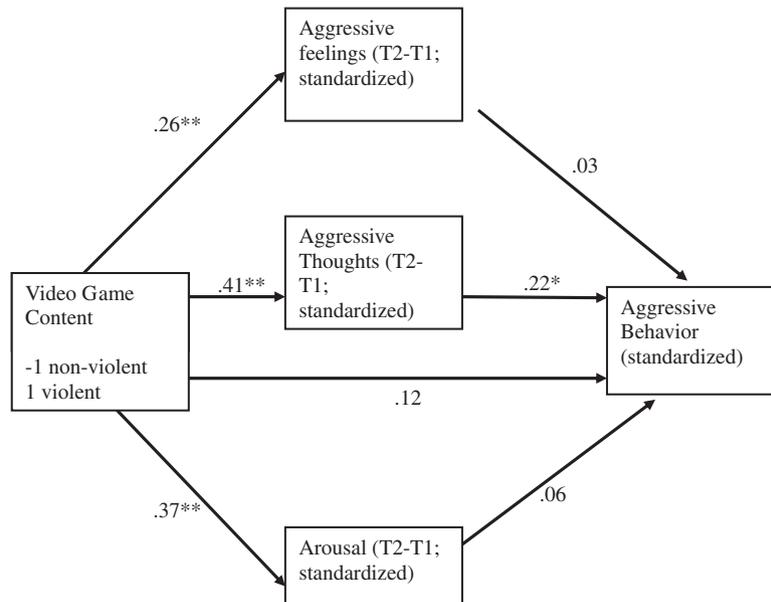
To further confirm these effects, we categorized each participant by whether or not they had a substantial change in the aggressive thoughts, aggressive feelings, and arousal. "Substantial" was defined as a change less than -2 or greater than 2 on any variable. Participants were called "increase only" if they increased by 2 on all three potential mediators ($n = 10$); called "decrease only" if they decreased by 2 on all three ($n = 1$); or called "mixed" if they increased by 2 on some and decreased by 2 on others (mixed

⁵The effect was similar when the data were not standardized. However, in order to calculate an appropriate aggressive behavior measure, the amount of hot sauce given was multiplied by the degree of hotness. The distribution of this new dependent variable had an extreme positive skew. In order to correct for this skew, the scores were log transformed (Tabachnick and Fidell, 2001). Using the log-transformed score as the aggressive behavior measure, the results were similar to the analysis using the standardized scores as the dependent variable and mediators. Specifically, the link between video game content was significant between aggressive feelings change ($\beta = .30$, $P < .001$), aggressive thoughts change ($\beta = .41$, $P < .001$), physiological arousal change ($\beta = .35$, $P < .001$), and aggressive behavior ($\beta = .25$, $P < .05$). Further, the link between aggressive thoughts change and aggressive behavior was statistically significant ($\beta = .22$, $P < .05$). Finally, when all three mediators were entered into the model, the results showed a nonsignificant relationship between video game content and aggressive behavior ($\beta = .13$, ns). The goodness-of-fit indices were also similar ($\chi^2 = 1.59$, $P > .05$, GFI = .99, AGFI = .97, CFI = .99, RMSEA = .001).

Direct effect of video game content on aggressive behavior



Indirect effect of video game content on aggressive behavior



* $p < .05$, ** $p < .01$

$\chi^2 = 1.27, p = .74, GFI = .99, AGFI = .97, CFI = .99, RMSEA = .001$

Fig. 1. Results of the Multiple Mediated Model in Study 1.

group; $n = 18$). If all the mediators play some role, then participants who increased on all three potential mediators should have higher aggressive behavior scores compared with the other two groups. This is exactly what we found, $F(2,26) = 5.14, P < .02, partial \eta^2 = .28$. Pairwise comparisons showed that those in the increase only group behaved significantly ($P < .027$) more aggressively ($M = 1.14, SD = 1.04$) than those in the mixed group ($M = -0.27, SD = 1.47$) and the person in the decrease only group ($M = -2.18$). The difference between the latter two groups did not approach significance ($P = 0.18$). The results were the same when we removed the decrease only group (owing to low sample size), $F(1,26) = 7.14, P < .02, partial \eta^2 = .22$ ($M_{increase} = 1.14, SD_{increase} = 1.04; M_{mixed} = -0.27, SD_{mixed} = 1.47$).

DISCUSSION

Results indicated that those who played a violent video game had a significant increase in aggressive

feelings, aggressive thoughts, physiological arousal, and overt aggressive behavior over baseline compared with those who played a nonviolent game. Also, the time delay analyses revealed the short-term increases in aggressive thoughts and aggressive feelings last less than 4 min, whereas heart rate after violent video game play may last more than 4 but less than 9 min. Finally, results show that, while all three internal state variables may play some role in mediating the relation between violent video game play and aggressive behavior, aggressive thoughts by far plays the most important role.

STUDY 2

Overview of the Current Study

Although Study 1 focused on determining how long violent video game effects last for aggressive feelings, aggressive thoughts, and heart rate, and showing that these internal state variables mediate

significant effects on aggressive behavior, Study 2 was designed to determine how long the effects of a violent video game last on overt aggressive behavior. To accomplish this objective, participants completed the hot sauce paradigm 0, 5, or 10 min after violent video game play. To simplify the procedure, no condition with a nonviolent game was included in this study as the comparison between violent and nonviolent games had already been done in Study 1.

METHOD

Participants

Ninety-one (48 male) participants from a large Midwestern University participated in the current experiment for partial credit for their General Psychology class. The average age of this sample was 18.60 (SD = 3.10) years. The majority of participants were first year (69.2%), Caucasian (76.9%) undergraduate students.

Materials

The same hot sauce and video game equipment that were used in Study 1 were used in this study. As the focus of this study was on the delay effects on aggressive behavior, the only questionnaires used were the Buss-Perry Aggression Questionnaire, demographic questionnaire, food preference questionnaire, and suspicious questionnaire. Study 1 showed that the violent video game condition was related to more aggression than the nonviolent video game condition, and hence, this study did not utilize a nonviolent video game.

Procedure

A similar procedure to Study 1 was used in this study, except for a few modifications. First, different participants completed the Hot Sauce paradigm at different times after playing the video game. Those in the 0 min condition completed the Hot Sauce paradigm immediately after video game play (19 male, 16 female). For those in the 5 min delay condition (14 male, 14 female), the researcher left the room after video game play to “get the other participant” to do the food preference experiment. Exactly 5 min later, the researcher came back, and participants completed the hot sauce paradigm. Finally, a 10 min condition (15 male, 13 female) was implemented that mirrored the procedure for the 5 min condition, except the researcher left the room for 10 min. All participants in all conditions then completed the demographic questionnaire,

food preference questionnaire, and suspiciousness questionnaire [analysis revealed that 14 (15.4%) of participants did not believe another was down the hall to give the hot sauce to] after the hot sauce procedure was completed. Finally, all participants were thanked and debriefed.

RESULTS

Delay Effects on Aggressive Behavior

A one-way ANCOVA was conducted with the delay period as the independent variable, aggressive behavior (defined identically as in Study 1) as the dependent variable, and trait aggression as the covariate. Results showed a significant main effect for delay condition, $F(2,72) = 5.43$, $P < .01$, *partial* $\eta^2 = .13$. Bonferroni corrected pairwise comparisons showed that those in the 0 min condition ($M = .39$, $SD = 1.90$) and the 5 min condition ($M = .56$, $SD = 1.44$) had significantly ($P < .01$) higher scores than those in the 10 min condition ($M = -.86$, $SD = 1.25$). There was a nonsignificant difference between the 0 and 5 min conditions (see Fig. 2). When gender was entered as a factor in the factorial design, there was a nonsignificant main effect for gender or a significant delay by gender interaction.

DISCUSSION

Analysis of the delay conditions showed that the effect on aggression of playing a violent video game lasted between 5 and 10 min. This finding

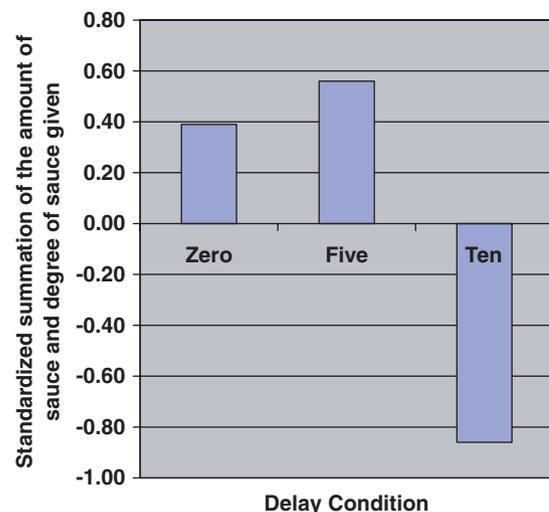


Fig. 2. Effect of Time Delay on Aggressive Behavior in Study 2. Positive scores indicate higher aggressive behavior, while negative scores represent lower aggressive behavior.

supplements the results of Study 1 by showing that 5–10 min are needed for the effects of aggressive behavior to dissipate.

GENERAL DISCUSSION

These two studies add to the existing literature that shows that violent video games increase aggressive behavior, aggressive feelings, aggressive thoughts, and arousal from baseline to postvideo game play. Taken together, the results of Studies 1 and 2 suggest that it takes approximately 4 min or less for the short-term increases in aggressive feelings and aggressive thoughts to return to baseline, whereas it takes approximately 5–10 min for heart rate and aggressive behavior to return to baseline. These results are consistent with what we know about the short-term effects of thoughts, feelings, and arousal. For instance, state hostility is an emotion, which is defined as short lived [Larson, 2000]; aggressive thoughts should dissipate once primed as soon as other thoughts, memories, or knowledge structures get primed (an idea similar to masking in the perception literature); and research has shown that physiological arousal after exposure to violent stimuli lasts longer than 5 min [Zillmann et al., 1974]. However, we are unaware of any literature that has attempted to determine how long the probability of using aggressive behavior lasts after violent media exposure.

Regarding the mediation analyses, results showed that aggressive thoughts were the lone predictor of aggressive behavior and the one significant mediator of the effect of violent video games on aggression. The lack of a significant correlation between physiological arousal or aggressive feelings and aggressive behavior does not suggest that these variables are unimportant to aggression. Only one violent and one nonviolent game were used in this study, and for these games the most important route (to use GAM terms, Anderson and Bushman, 2001) to aggressive behavior was aggressive thoughts. Other studies using other games might find that other routes (feelings, thoughts, and/or arousal) are the important mediators. More work is greatly needed to clarify this issue.

The results of the mediation analysis also raise an interesting theoretical issue: Primed aggressive thoughts were the primary mediator in the relation between video game content and aggressive behavior; however, aggressive thoughts seemed to be activated for only 4 min, whereas increases in aggressive behavior were detected at more than 5 min. This suggests that the longevity of aggressive

behavior involves other processes. Aggressive priming may be the primary route for initially increasing aggressive behavior. But, once the priming of aggressive thoughts dissipates, participants may continue to engage in a variety of cognitive or emotional processes, which may be a result of aggressive priming and directly influence aggressive behavior. Some of these processes may include the rumination of aggressive thoughts/feelings after aggressive priming [see Miller et al., 2003], the activation and maintenance of aggressive knowledge structures [scripts and schemas; Huesmann, 1998], increased hostile attribution bias [see Anderson et al., 2007], learned associations between aggressive thoughts and behaviors [Anderson et al., 2007], or attributional and other decision processes in whether or not people behave aggressively [Anderson and Bushman, 2001]. Theoretical models, such as GAM suggest that these (and other) processes may be activated after the initial aggressive priming. However, the literature does not make claims regarding how long these processes may last compared with aggressive priming. But, if these processes last longer than 4 min, they may describe why aggressive priming is the primary mediator but is shorter-lived than aggressive behavior. However, this is speculative and future research is needed to elaborate on these assumptions.

Putting a Time Frame on Video Game Effects

The results of the two studies suggest that the short-term effects of playing a violent video game on aggressive thoughts and feelings last less than 4 min, but the effects on arousal and aggressive behavior last 5–10 min. This is just one of many pieces of information that allows researchers to be able to put a time frame on short-term violent video game effects. Another piece is the research that has shown that playing a violent video game from anywhere from 10 to 20 min stimulates an increase in aggressive feelings, aggressive thoughts, and physiological arousal [e.g., Barlett et al., 2008; Carnagey and Anderson, 2005]. A third piece has been the finding of a stabilization effect, showing that once there is an initial increase in aggression, continued violent video game play does not continue to increase aggression [Barlett et al., 2007; Barlett and Rodeheffer, 2009]. In other words, the short-term increase in aggression and arousal will stay higher than baseline but remain stable. The final piece is how long the effects last, which was the focus of the current research. We believe these results to be an important first step in determining the duration of

time necessary for the short-term effects to drop. More work needs to be done to see whether these findings replicate across a variety of violent video games, different lengths of violent video game play time, and using different measures of aggressive thoughts, aggressive feelings, and arousal, and for different individuals. For instance, will these results replicate for a sample of heavy violent video game consumers?

It is important to note the time frame for the duration of the short-term increases in aggression and arousal to last. It can be speculated from the results that aggressive feelings and aggressive thoughts may last as few as 4 min. Critics, parents, teachers, and violent video game consumers should not interpret these results to suggest that the time frame is so miniscule that violent video game effects are unimportant. If one considers the course of how quickly people can be put in a situation where they perceive they are being provoked, then time frame for feeling hostile and thinking aggressively after violent video game play are very important. Furthermore, this study suggests that thoughts and feelings and arousal may start aggression promoting processes that last much longer than 4–9 min.

Limitations and Future Research

Like all psychological studies, there are potential limitations to the current research. The first is the order of the tasks in the procedure. Because the mediating role of all three internal state variables was very important to the current research and the existing literature, the Hot Sauce Paradigm procedure had to be completed before the time delay manipulation in Study 1. Thus, the 0 min condition, was actually a 4 min condition (which was the approximate length of time it took to complete the Hot Sauce Paradigm). This is a limitation because we were not able to precisely determine the length of time the short-term increase in aggressive feelings, aggressive thoughts, and heart rate last because there was no true 0 min or 5 min condition. Future research using a “pure” 0 and 5 min condition is needed to make such a comparison.

The second limitation was the generalizability of the video games in Studies 1 and 2 and the lack of a nonviolent video game in Study 2. Specific to the former, as only one exemplar of a violent and nonviolent game was used, we cannot accurately generalize our findings beyond the games we played [see Wells and Windschitl, 1999]. Future work

should attempt to replicate these studies using multiple games to see whether the results are consistent. Relating to the latter limitation, future work should use a nonviolent control game for Study 2. However, given the results of Study 1, it is unlikely that aggressive behavior would decrease substantially for those who play a nonviolent video game in Study 2, but future research is needed to empirically test this assumption. No nonviolent video games were used in Study 2 because the results from Study 1 clearly showed that playing this game had no effect on aggressive thoughts, aggressive feelings, aggressive behavior, or physiological arousal.

Third, we did not know what the participants in the delay conditions did while the experimenter was gone. All participants were told to wait until the experimenter returned, without telling them exactly when that would be. None of the participants played the video game. Thus, we believe that the participants just sat in their chair while the experimenter was gone, but we are unsure whether or not they played video games on their cell phones, text messaged their friends, or talked on their cell phone. Also, participants may have been thinking about the video game they just played, about how much sauce they gave the other person, or about their other classes, friends, family, or anything else. Future work should attempt to either control these variables by specifically asking participants what they did or thought about while the researcher was gone.

Finally, the results of Study 1 cannot disentangle the distinction between playing a violent video game or just a video game regarding the physiological arousal findings. Thus, we are unable to state with perfect precision that the arousal results are owing to playing a violent video game compared with any video game (independent of content). Although past research has shown that violent video game play is related to more arousal than nonviolent video game play [see Anderson, 2004], we cannot make such a distinction here.

ACKNOWLEDGMENTS

We thank Dr. Jerry Frieman, department head at Kansas State University, and Dr. Richard Harris for allowing this research to be conducted at Kansas State University. Thanks are also warranted to Dr. Craig Anderson for reading an earlier version of this paper and his countless suggestions for this paper. Finally, we are indebted to Dr. L. Rowell Huesmann for his suggestions and thorough editing.

REFERENCES

- Anderson CA. 2004. An update on the effects of playing violent video games. *J Adolesc* 27:113–122.
- Anderson CA, Bushman BJ. 2001. Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychol Sci* 12:353–359.
- Anderson CA, Dill KE. 2000. Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. *J Pers Soc Psychol* 78:772–790.
- Anderson CA, Murphy CR. 2003. Violent video games and aggressive behavior in young women. *Aggressive Behav* 29:423–429.
- Anderson CA, Deuser WE, DeNeve KM. 1995. Hot temperatures, hostile affect, hostile cognition, and arousal: Tests of a General Model of Affective Aggression. *Pers Soc Psychol Bull* 21:434–448.
- Anderson CA, Carnagey NL, Eubanks J. 2003. Exposure to violent media: The effects of songs with violent lyrics on aggressive thoughts and feelings. *J Pers Soc Psychol* 84:960–971.
- Anderson CA, Gentile DA, Buckley KE. 2007. *Violent Video Game Effects on Children and Adolescents: Theory, Research, and Public Policy*. Oxford: Oxford University Press.
- Arbuckle JL. 2002. Amos (Version 5) [Computer Program]. Chicago: SPSS.
- Ballard ME, Lineberger R. 1999. Video game violence and confederate gender: Effects on reward and punishment given by college males. *Sex Roles* 41:541–558.
- Ballard ME, Wiest JR. 1996. *Mortal Kombat™*: The effects of violent videogame play on males' hostility and cardiovascular responding. *J Appl Soc Psychol* 26:717–730.
- Bandura A. 1983. Psychological mechanism of aggression. In: Geen RG, Donnerstein EI (eds). *Aggression: Theoretical and Empirical Reviews*, Vol. 1. New York: Academic Press, pp 1–40.
- Barlett CP, Rodeheffer CD. 2009. Effects of extended violent and non-violent video game play on aggressive thoughts, feelings, behaviors, and physiological arousal. *Aggressive Behav*, in press.
- Barlett CP, Harris RJ, Baldassarro R. 2007. The longer you play the more hostile you feel: Examination of first person shooter video games and aggression during video game play. *Aggressive Behav* 33:486–497.
- Barlett CP, Harris RJ, Bruey C. 2008. The effect of the amount of blood in a violent video game on aggression, hostility, and arousal. *J Exp Soc Psychol* 44:539–546.
- Bartholow BD, Anderson CA. 2002. Effects of violent video games on aggressive behavior: Potential sex differences. *J Exp Soc Psychol* 38:283–290.
- Berkowitz L. 1993. *Aggression: Its Causes, Consequences, and Control*. Boston: McGraw Hill.
- Bushman BJ, Huesmann LR. 2006. Short-term and long-term effects of violent media on aggression in children and adults. *Arch Pediatr Adolesc Med* 160:348–352.
- Buss AH, Perry M. 1992. The Aggression Questionnaire. *J Pers Soc Psychol* 63:452–459.
- Carnagey NL, Anderson CA. 2005. The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychol Sci* 16:882–889.
- Huesmann LR. 1998. The role of social information processing and cognitive schema in the acquisition and maintenance of habitual aggressive behavior. In: Geen R, Donnerstein E (eds). *Human Aggression: Theories, Research, and Implications for Policy*. New York: Academic Press, pp 73–109.
- Huesmann LR, Moise-Titus J, Podolski C, Eron LD. 2003. Longitudinal relations between children's exposure to TV violence and their aggressive and violent behavior in young adulthood: 1977–1992. *Dev Psychol* 39:201–221.
- Larson RJ. 2000. Toward a science of mood regulation. *Psychol Inq* 11:129–141.
- Lieberman JD, Solomon S, Greenberg J, McGregor HA. 1999. A hot new way to measure aggression: Hot sauce allocation. *Aggressive Behav* 25:331–348.
- Miller N, Pedersen WC, Earleywine M, Pollock VE. 2003. A theoretical model of triggered displaced aggression. *Pers Soc Psychol Rev* 7:75–97.
- Panee CD, Ballard ME. 2002. High versus low aggressive priming during video-game training: Effects on violent action during game play, hostility, heart rate, and blood pressure. *J Appl Soc Psychol* 32:2458–2474.
- Ritter D, Eslea M. 2005. Hot sauce, toy guns, and graffiti: A critical account of current laboratory aggression paradigms. *Aggressive Behav* 31:407–419.
- Scott D. 1995. The effect of video games on feelings of aggression. *J Psychol* 129:121–132.
- Tabachnick BG, Fidell LS. 2001. *Using Multivariate Statistics*, 4th edition. Needham Heights, MA: Allyn & Bacon Publishers.
- Wells GL, Windschitl PD. 1999. Stimulus sampling in social psychological experimentation. *Pers Soc Psychol Bull* 25:1115–1125.
- Zillmann D. 1983. Arousal and aggression. In: Geen R, Donnerstein E (eds). *Aggression: Theoretical and Empirical Reviews*, Vol. 1. New York: Academic Press, pp 75–102.
- Zillmann D, Hoyt JL, Day KD. 1974. Strength and duration of the effect of aggressive and violent erotic communications on subsequent aggressive behavior. *Commun Res* 1:286–306.