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Video Games and Aggressive Thoughts, Feelings, and Behavior in the Laboratory and in Life

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Two studies examined violent video game effects on aggression-related variables. Study 1 found that real-life violent video game play was positively related to aggressive behavior and delinquency. The relation was stronger for individuals who are characteristically aggressive and for men. Academic achievement was negatively related to overall amount of time spent playing video games. In Study 2, laboratory exposure to a graphically violent video game increased aggressive thoughts and behavior. In both studies, men had a more hostile view of the world than did women. The results from both studies are consistent with the General Affective Aggression Model, which predicts that exposure to violent video games will increase aggressive behavior in both the short term (e.g., laboratory aggression) and the long term (e.g., delinquency).

On April 20, 1999, Eric Harris and Dylan Klebold launched an assault on Columbine High School in Littleton, Colorado, murdering 13 and wounding 23 before turning the guns on themselves. Although it is impossible to know exactly what caused these teens to attack their own classmates and teachers, a number of factors probably were involved. One possible contributing factor is violent video games. Harris and Klebold enjoyed playing the bloody, shoot-'em-up video game Doom, a game licensed by the U.S. military to train soldiers to effectively kill. The Simon Wiesenthal Center, which tracks Internet hate groups, found in its archives a copy of Harris' web site with a version of Doom that he had customized. In his version there are two shooters, each with extra weapons and unlimited ammunition, and the other people in the game can't fight back. For a class project, Harris and Klebold made a videotape that was similar to their customized version of Doom. In the video, Harris and Klebold dress in trench coats, carry guns, and kill school athletes. They acted out their videotaped performance in real life less than a year later. An investigator associated with the Wiesenthal Center said Harris and Klebold were "playing out their game in God mode" (Pooley, 1999, p. 32).

Entertainment media affects our lives. What behaviors children and adults consider appropriate comes, in part, from the lessons we learn from television and the movies (e.g., Huesmann & Miller, 1994). There are good theoretical reasons to expect that violent video games will have similar, and possibly larger, effects on aggression. The empirical literature on the effects of exposure to video game violence is sparse, however, in part because of its relatively recent emergence in modern U.S. society. About 25 years ago, when video games first appeared, popular games were simple and apparently harmless. In the 1970s, Atari introduced a game called Pong that was a simple video version of the game ping pong. In the 1980s, arcade games like Pac-Man became dominant. In Pac-Man, a yellow orb with a mouth raced around the screen chomping up ghosts and goblins. At this point, some eyebrows were raised questioning whether young people should play such "violent" games. In the 1990s the face of video games changed dramatically. The most popular video game of 1993 was Mortal Kombat (Elmer-Dewitt, 1993). This game features realistically rendered humanoid characters engaging in battle. As the name of the game implies, the goal of the player in Mortal Kombat is to kill any opponent he faces. Unfortunately, such violent games now dominate the market. Dietz (1998) sampled 33 popular Sega and Nintendo games and found that nearly 80% of the games were violent in nature. Interestingly, she also found that 21% of these games portrayed violence towards women.

The research to date on video game effects is sparse and weak in a number of ways. Indeed, one reviewer (and many video game creators) has espoused the belief that "video game playing may be a useful means of coping with pent-up and aggressive energies" (Emes, 1997, p. 413). In brief, what is needed is basic theory-guided research on the effects of playing violent video games. Such research would also contribute to the field's understanding of media violence effects in general.

THEORETICAL APPROACH

General Affective Aggression Model (GAAM): Short-Term Effects of Video Game Violence and Aggressive Personality

GAAM: Overview

There are several reasons for expecting exposure to violent video games to increase aggressive behavior in both the short run

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(i.e., within 20 minutes of game play) and over long periods of time (i.e., repeated exposure over a period of years). Our theoretical approach is the GAAM, which has emerged from our work on a variety of aggression-related domains (Anderson, Anderson, & Deuser, 1996; Anderson, Deuser, & DeNeve, 1995; Anderson, Anderson, Dill, & Deuser, 1998; Dill, Anderson, Anderson, & Deuser, 1997; Lindsay & Anderson, in press). The model integrates existing theory and data concerning the learning, development, instigation, and expression of human aggression. It does so by noting that the enactment of aggression is largely based on knowledge structures (e.g., scripts, schemas) created by social learning processes. Thus, GAAM incorporates the theoretical insights of much previous work, especially Bandura's social learning theory (e.g., Bandura, 1971, 1973; Bandura, Ross, & Ross, 1961, 1963), Berkowitz's Cognitive Neoassociationist Model (Berkowitz, 1984, 1990, 1993), the social information-processing model of Dodge and his colleagues (e.g., Dodge & Crick, 1990; Crick & Dodge, 1994), Geen's (1990) affective aggression model, Huesmann's social–cognitive model of media violence effects (Huesmann, 1986), and Zillmann's (1983) excitation transfer model.

Figure 1 presents the basic GAAM structure with examples relevant to this article. The focus of this version of GAAM is on short-term effects of video game violence. In brief, GAAM describes a multistage process by which personological (e.g., aggressive personality) and situational (e.g., video game play and provocation) input variables lead to aggressive behavior. They do so by influencing several related internal states and the outcomes of automatic and controlled appraisal (or decision) processes.

GAAM: Input Variables and Internal States

Both kinds of input variables—personological and situational—can influence the present internal state of the person—cognitive, affective, and arousal variables. For example, people who score high on measures of aggressive personality have highly accessible knowledge structures for aggression-related information. They think aggressive thoughts more frequently than do those individuals who score low on aggressive personality measures, and have social perception schemas that lead to hostile perception, expectation, and attributional biases (e.g., Anderson, 1997; Crick & Dodge, 1994; Dill, Anderson, Anderson, & Deuser, 1997).

Situational input variables can also influence the current accessibility of aggression-related knowledge structures. Being insulted may cause a person to think of how to return the insult in a harmful way (a behavioral script). More central to the present research, we believe that playing a violent video game also can increase the accessibility of aggressive cognitions by semantic priming processes. We know from related research that merely seeing a picture of a gun or other weapon can increase the accessibility of aggressive thoughts (e.g., Anderson et al., 1996; Anderson, Benjamin, & Bartholow, 1998). Presumedly, this process accounts for the "weapons effect" first reported by Berkowitz and LePage (1967), and reviewed by Carlson, Marcus-Newhall, and Miller (1990). However, there is presently no empirical evidence on whether playing a violent video game increases accessibility of aggressive thoughts.

Both kinds of input variables influence a person's current affective state, such as aggression-related feelings of anger or hostility. Some people feel angry a lot of the time. Some situations can

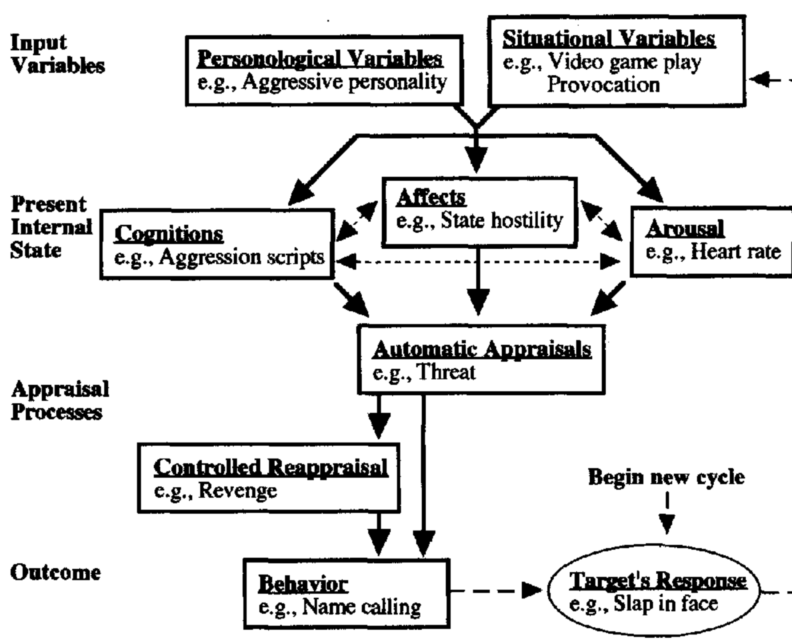

Figure 1. Single episode General Affective Aggression Model: Short-term effects of video game violence. Adapted from "Hot Temperatures, Hostile Affect, Hostile Cognition, and Arousal: Tests of a General Model of Affective Aggression," by C. A. Anderson, W. E. Deuser, and K. M. DeNeve, 1995, *Personality and Social Psychology Bulletin, 21,* p. 436.

make anybody angry. We do not, however, expect that playing violent video games will routinely increase feelings of anger, compared with playing a nonviolent game. To be sure, playing a frustrating game is likely to increase anger. Violent content by itself, however, in the absence of another provocation, is likely to have little direct impact on affect. We deliberately chose to use a pair of violent and nonviolent games that are equally well liked for Study 2. In effect, this choice closes off this particular route to aggression, allowing a cleaner test of the more critical hypothesis that violent content itself can increase aggression.

The present state of arousal can also be affected by both personological and situational variables. Some people are chronically aroused, and numerous situational variables, including playing certain video games, can temporarily increase arousal. As Zillmann (1983) and others have shown, unexplained arousal can lead to a search for environmental cues to which the arousal can be attributed. Salient cues, such as a provocateur, can lead to the misattribution of arousal that was actually caused by playing a violent video game (for instance) to anger at the salient provoking person, which in turn could increase the likelihood of an aggressive behavioral attack. As with the affect state, this arousal effect is not specific to violent video games, but could occur with any game that happens to be very exciting. For this reason, in Study 2 we chose to use violent and nonviolent video games that do not differentially increase physiological indicators of arousal, thus closing off this alternative route to aggression as well.

One additional aspect of GAAM deserves mention. In Figure 1 the three internal state variables are interconnected by dashed lines. This illustrates a key part of GAAM and the earlier models on which it is based, most obviously Berkowitz's (1984) CNA model. Cognition, affect, and arousal are seen as highly interrelated aspects of one's current internal state. Activating one tends to activate the other two. Such cross-modality priming helps explain how strong activation of one type of state (e.g., remembering a humiliating public insult received last week) can produce corresponding changes in the other states (e.g., reinstatement of anger and increased arousal).

In sum, short-term violent video game increases in aggression are expected by GAAM whenever exposure to violent media primes aggressive thoughts, increases hostile feelings, or increases arousal (all else being equal). However, because neither hostile feelings nor high arousal are specific effects of violent media, they must be controlled (experimentally or statistically) to allow an adequate test of the hypothesis that violent content per se can increase aggressive behavior in a short-term setting. For this reason, our experimental manipulation of type of video game in Study 2 used games chosen to differ primarily in violent content but to be similar in how well our participants would like them and in their likely effect on physiological indicators of arousal.

GAAM, Appraisal, and Aggressive Behavior

The appraisal processes of GAAM are not investigated in the present studies, so a brief summary of these processes will suffice. Automatic appraisals (called "immediate appraisal" in earlier versions of GAAM) are evaluations of the present environment and internal state that are made on-line, very quickly, with little or no awareness. When slapped in the face people will automatically "judge" that the present environment is threatening and that they are angry and/or scared, what is commonly referred to as the emotional part of the "fight or flight" response (e.g., Berkowitz, 1993). Berkowitz's (1993) CNA model also posits that such automatic appraisals include the behavioral aspects of fight or flight, a notion that is entirely consistent with GAAM.

Controlled reappraisals are somewhat slower and require more cognitive resources than do automatic appraisals. In some situations, in which there is little time for reappraisal for instance, a relevant behavior is chosen and performed before reappraisal takes place. However, reappraisal does often occur, as when one carefully considers why a provoking individual behaved in a particular way before deciding how to respond. Although we've presented appraisal and reappraisal as a dichotomy, in keeping with recent thinking in cognitive psychology it would be more accurate to view appraisal processes as existing along a continuum with *completely automatic* and *completely controlled* as the endpoints (e.g., Bargh, 1994).

Whether an aggressive behavior is emitted depends on what behavioral scripts have been activated by the various input variables and the appraisal processes. Well-learned scripts come to mind relatively easily and quickly and can be emitted fairly automatically. People who score high on aggressive personality have a relatively well-developed and easily accessible array of aggression scripts that are easily activated by relatively minor provocation (e.g., Anderson, Benjamin, & Bartholow, 1998). Furthermore, aggressive people have social perception schemata that bias the interpretation of observed events in aggression-enhancing ways. They perceive more violence than is really there, and they expect people to solve problems with aggressive means (e.g., Dill et al., 1997). We believe that video game violence also primes aggressive thought, including aggressive scripts. GAAM therefore explicitly predicts short-term effects of both aggressive personality and playing a violent video game on aggression after provocation.

GAAM: Long-Term Effects of Video Game Violence

Long-term media violence effects on aggression result from the development, overlearning, and reinforcement of aggression-related knowledge structures. Figure 2 illustrates this process and identifies five types of such knowledge structures that have received attention in other aggression-related contexts. Each time people play violent video games, they rehearse aggressive scripts that teach and reinforce vigilance for enemies (i.e., hostile perception bias), aggressive action against others, expectations that others will behave aggressively, positive attitudes toward use of violence, and beliefs that violent solutions are effective and appropriate. Furthermore, repeated exposure to graphic scenes of violence is likely to be desensitizing. In essence, the creation and automatization of these aggression-related knowledge structures and the desensitization effects change the individual's personality. Long-term video game players can become more aggressive in outlook, perceptual biases, attitudes, beliefs, and behavior than they were before the repeated exposure or would have become without such exposure.

Theoretically, these long-term changes in aggressive personality operate in the immediate situation through both types of input variables described in GAAM: person and situation variables. The link to person variables is obvious—the person is now more aggressive in outlook and propensity. Less obvious is how long-

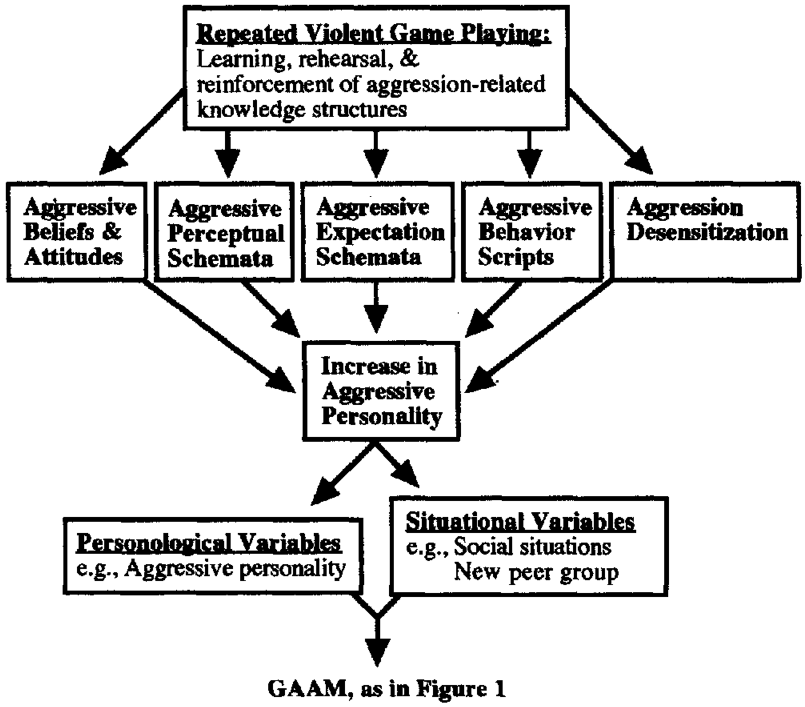

Figure 2. Multiple episode General Affective Aggression Model (GAAM): Long-term effects of video game violence.

term effects of repeated exposure to violent video games can change situational variables. However, Huesmann and colleagues (Huesmann, 1994) have developed a clear model of the social and academic effects of exposure to television violence. As a person becomes more aggressive, the social environment responds. The types of people who are willing to interact with them, the types of interactions that are held, and the types of situations made available to the person all change. Interactions with teachers, parents, and nonaggressive peers are likely to degenerate, whereas interactions with other "deviant" peers may well increase. For these reasons, we expect to find a positive correlation between a person's level of exposure to violent video games and their aggressive behavior. Study 1 was designed to test this notion.

RESEARCH ON VIDEO GAME VIOLENCE

Although much research has examined the effects of exposure to movie and television violence (see Huesmann, 1994, for a review), and although popular press commentaries about possible effects of video games abound, the empirical literature on video game violence is sparse (see Dill & Dill, 1998; Emes, 1997). To what extent do the existing video game studies support or contradict the GAAM-based predictions?

Video Games and Aggression: Correlational Work

Four correlational studies have examined the relation between video game playing habits and real-world aggressive behavior. Across the four studies, the ages of participants ranged from 4th graders to 12th graders. Measures of aggression included self, teacher, and peer reports. Three of the studies (Dominick, 1984; Fling et al., 1992; Lin & Lepper, 1987) yielded reliable positive correlations between video game playing and aggression. The fourth (Van Schie & Wiegman, 1997) correlation did not differ from zero. But, none of the studies distinguished between violent and nonviolent video games. Thus, none test the hypothesis that violent video games are uniquely associated with increased aggression.

Video Games and Aggression: Experimental Work

The extant experimental studies of video games and aggression have yielded weak evidence also. Four studies found at least some support for the hypothesis that violent video game content can increase aggression (Cooper & Mackie, 1986; Irwin & Gross, 1995; Schutte, Malouff, Post-Gorden, & Rodasta, 1988; Silvern & Williamson, 1987). However, none of these studies can rule out the possibility that key variables such as excitement, difficulty, or enjoyment created the observed increase in aggression. In our experience with video games and in the movie literature (Bushman, 1995), violent materials tend to be more exciting than nonviolent materials, so the observed effects could have been the result of higher excitement levels induced by the violent games.

Two additional experimental studies of violent video games and aggression found no effect of violence (Graybill, Strawniak, Hunter, & O'Leary, 1987; Winkel, Novak, & Hopson, 1987). Interestingly, of the six video game studies reviewed here, only the Graybill et al. (1987) study used games pretested and selected to be similar on a number of dimensions (e.g., difficulty, excitement, enjoyment). In sum, there is little experimental evidence that the violent content of video games can increase aggression in the immediate situation.

Video Games, Aggressive Affect, and Cognition

Two studies have examined the effect of video game violence on aggressive cognition. Calvert and Tan (1994) randomly assigned male and female undergraduates to a condition in which they either played or observed a violent virtual-reality game or to a no-game control condition. Postgame aggressive thoughts were assessed with a thought-listing procedure. Aggressive thoughts were highest for violent game players. Although this supports our GAAM view of video game effects, we hesitate to claim strong support because it is possible that this effect resulted from the greater excitement or arousal engendered by playing the game, rather than the violent content of the game. More recently, Kirsh (1998) showed that 3rd- and 4th-grade children assigned to play a violent video game gave more hostile interpretations for a subsequent ambiguous provocation story than did children assigned to play a nonviolent game. This also supports GAAM.

Five experiments have investigated the effects of video game violence on aggressive affect. One study showed increases in aggressive affect after violent video game play (Ballard & Weist, 1996). Another (Anderson & Ford, 1986) yielded mixed results. Three others (Nelson & Carlson, 1985; Scott, 1995; Calvert & Tan, 1994) showed little support for the hypothesis that short-term exposure to violent video games increases hostile affect. There are methodological shortcomings in many of these studies, which, when combined with the mixed results, suggest that there is little evidence that short-term exposure to violent video games increases aggression-related affect.

Summary

Four main hypotheses concerning video game violence and aggression emerge from a careful consideration of GAAM. First, consideration of social–cognitive learning processes and social dynamics leads to the prediction that exposure to violent video games over a long period of time should be positively correlated with aggression in naturalistic settings.

Second, GAAM predicts that short-term exposure to video game violence will lead to increases in aggressive behavior. Third, GAAM also predicts that people who score high on aggressive personality measures will behave more aggressively when provoked than will low trait aggression individuals. Fourth, GAAM predicts that short-term exposure to video game violence will lead to increases in aggressive cognition and that this effect mediates the short-term violent content/aggressive behavior relation, at least to some extent.

THE PRESENT RESEARCH

Our literature review revealed that the few published studies to date have not adequately tested the video game hypotheses. Thus, we conducted two studies of video game violence effects, one correlational, the other experimental. Our goal was to begin laying a firm empirical foundation for understanding video game violence effects, while at the same time providing further tests of the GAAM formulation and broadening our understanding of media violence effects in general. We chose two different methodologies that have strengths that complement each other and surmount each others' weaknesses—a correlational study and an experiment were conducted.

In Study 1, we measured both the amount of exposure to video game violence and the amount of time participants had played video games in prior time periods regardless of content. These video game measures and several individual difference measures were used as predictors of self-reported aggressive behavior and delinquency. We used a college student population, in part because they are old enough for long-term effects of playing violent video games to have had a measurable impact on real-world aggression. Study 1 also included a measure of academic achievement (grade point average [GPA]), mainly because prior longitudinal work on media violence effects on children has demonstrated a negative relation between exposure to violent media and later academic performance (e.g., Huesmann, 1986; Huesmann & Miller, 1994).

In Study 2 we randomly assigned participants to play either a violent or a nonviolent video game; the two games were matched (by means of pretesting) on several key dimensions. Subsequently, these participants played a competitive reaction time game in which they could punish their opponent by delivering a noxious blast of white noise. This constituted our laboratory measure of aggression. We also assessed the effects of the video games on both hostile thoughts and hostile feelings to see whether either (or both) served as mediators of the violent video game effect on aggressive behavior.

Both studies examined the additive and interactive effects of the individual difference variable of trait aggressiveness, one indicator of what we have called Aggressive Personality. This variable has yielded interesting effects in several media violence studies (e.g., Anderson, 1997; Bushman, 1995; Dill et al., 1997). Finally, both studies also included a measure of world view as a dependent variable (e.g., Gerbner, Gross, Morgan, & Signiorelli, 1980). These researchers posited that exposure to media violence creates an exaggerated picture of the world as a violent, unsafe place. As yet, this proposition has not been tested in the video game violence literature.

STUDY 1: CORRELATION TESTS OF VIDEO GAME VIOLENCE EFFECTS

Method

Participants

Two hundred twenty-seven (78 male, 149 female) undergraduates from introductory psychology courses at a large Midwestern university participated in small groups. All members of these classes were given the option of participating in psychological research or doing an alternative project for course credit. Students choosing to participate in research are recruited by means of a research participation sign-up board that lists ongoing research.

Design and Procedures

A correlational design was used to examine the relationship between long-term exposure to violent video games and several outcome variables, namely aggressive behavior, delinquency, academic achievement, and world view. We also collected data on two individual difference variables related to aggression (trait aggression, irritability) to examine the potential interactive effects of individual differences in aggression on the above outcomes. Gender of participant was also recorded so that we would be able to examine interactions with the aggression-related individual difference variables for each of the outcome variables. Data were collected in group questionnaire sessions, with the exception of the academic achievement variables, which were obtained from the university's registrar.

Materials

A self-report questionnaire was created to collect the individual difference data as well as the data on aggressive behavior, delinquency, and world view. There were six scales in total that made up the questionnaire. Each of these scales is described below. The two individual difference measures were the Caprara Irritability Scale (CIS; Caprara et al., 1985) and the Buss–Perry Aggression Questionnaire (AQ; Buss & Perry, 1992). The Delinquency Scale, which contained the aggressive behavior items, was also from a published scale (Elliot, Huizinga, & Ageton, 1985). The measures of world view and of violent video game play were created for this study. A balanced Latin square design was used to create a total of six different forms of the questionnaire. These different forms were used to control for potential order effects.

Irritability

The CIS measures aggressive impulsivity or the proclivity toward quick and impulsive reactions to what the individual perceives as provocation or frustration. Agreement with statements such as, "I easily fly off the handle with those who don't listen or understand" and "I don't think I am a very tolerant person," indicates irritability. Caprara (1982) found that irritability predicted aggressive behavior in provoked individuals. Caprara reported a coefficient alpha for the irritability scale at .81 and a test–retest reliability of .83 (Caprara et al., 1985). The CIS contains 20 items that Caprara et al. (1985) labeled "irritability" items and 10 additional control items that might be thought of as "friendliness" items. In past research in our laboratory (e.g., Dill et al., 1997) we have reverse scored the 10 "control" items and found these items to be a viable predictor of irritability in their own right. Thus, the irritability composites we report are an average of 30 items, the 20 irritability items and the 10 "friendliness" items (reverse scored).

Trait Aggression

In 1992 Buss and Perry revised the Buss–Durkee (Buss & Durkee, 1957) aggression questionnaire. Buss and Perry's AQ (Buss & Perry, 1992) measures trait aggressiveness through four distinct subtraits, each represented by a subscale on the AQ. These subtraits are Physical and Verbal Aggression, Anger, and Hostility. Items such as "If somebody hits me, I hit back" represent physical aggressiveness, and items such as "I can't help getting into arguments when people disagree with me" represent verbal aggressiveness. Likewise, items such as "Some of my friends think I'm a hothead" and "At times I feel I have gotten a raw deal out of life" measure anger and hostility, respectively. Buss and Perry (1992) demonstrated a significant relationship between peer nominations of aggressiveness and scores on these four aggression subscales for male college students. They report a coefficient alpha for the AQ at .89 and a test–retest reliability at .80 (Buss & Perry, 1992). More recently, Bushman and Wells (in press) reported a positive relation between the Physical Aggression subscale and minutes penalized for aggressive hockey violations in high school students.

Delinquency

In the late 1970s, first the National Institute of Mental Health and then the National Institute for Juvenile Justice and Delinquency Prevention funded research on the epidemiology of delinquent behavior. A series of longitudinal studies, which in part used a self-report measure of delinquency, were conducted, and these studies were collectively called the National Youth Survey (Elliot, Huizinga, & Ageton, 1985). The self-report delinquency measure that was created for the National Youth Survey is the one we use in the present study to measure delinquency. The format of the Delinquency Scale is a self-report of frequency of each of 45 specific behaviors over the last year. For example, an individual is asked to estimate how many times in the past year he or she has "purposely damaged or destroyed property belonging to a school." Of the 45 items, 7 pertain to illegal drug use (i.e., "How often in the last year have you used alcoholic beverages [beer, wine and hard liquor]?"). The multiple correlation ratio for the Delinquency Scale reported by Elliot et al. (1985) is .59. Using a model described in their book, *Explaining Delinquency and Drug Use* (Elliot et al., 1985), the authors demonstrated that their theoretical model explained 30–50% of the variance in the self-reported delinquency scores of males and 11–34% of the variance in the self-reported delinquency scores for females.

Aggressive behavior. The authors of the Delinquency Scale have sometimes analyzed their data by dividing the scale into subscales based on the severity of the delinquent crime (i.e., index offenses vs. minor delinquency) but not based on the type of delinquent act perpetrated (e.g., aggression vs. theft). However, for our purposes, we chose to form a subscale from the 10 items that were most clearly related to aggressive behavior. For example, participants were asked to estimate how many times in the past year they have "hit (or threatened to hit) other students" and "attacked someone with the idea of seriously hurting or killing him/her."

One of the 10 aggressive items was given a 0 by all participants (Item 27, "used force [strong-arm methods] to get money or things from other students") and was therefore dropped from the measure. Another item did not correlate well with the others (Item 20, "hit, or threatened to hit, one of your parents"), so it too was dropped. (Note that keeping these two items produces a few changes in higher order interactions but does not substantially change the main findings.) Furthermore, the standard deviations of the remaining items varied widely. To form a reliable index of aggressive behavior it was necessary to standardize each item before averaging across the eight items. Coefficient alpha for this index was .73. We hypothesized a positive relation between violent video game play and aggressive behavior.

Nonaggressive delinquency. Two of the remaining 35 items were also given 0s by all participants (items 4 and 13, "stolen [or tried to steal] a motor vehicle, such as a car or motorcycle" and "been paid for having sexual relations with someone") and were also dropped. The item standardization procedure as outlined for the aggressive delinquency behavior measure was used for this 33-item nonaggressive delinquency measure. It yielded an alpha coefficient of .89. We also hypothesized that violent video game play would be positively related to nonaggressive delinquency, though we expected it to be somewhat weaker than the video game link to aggressive delinquency. We expected this because many of these "nonaggressive" items have at least some aggression component to them, at least on occasion. For example, "purposely damaged or destroyed property belonging to your parents or other family members" may well be an indirect act of aggression, an attempt to harm someone by destroying something they value. In addition, some violent video games also model a total disregard for property rights of others or for other societal norms.

Video Game Questionnaire

We constructed our video game questionnaire to enable the creation of two composite indexes, one focusing on exposure to video game violence, and the other focusing on amount of time spent playing video games in general, regardless of type of content.

Video game violence. Participants were asked to name their five favorite video games. After naming each game, participants responded on scales anchored at 1 and 7, rating how often they played the game and how violent the content and graphics of the game were. Responses of 1 were labeled *rarely, little or no violent content,* and *little or no violent graphics,* respectively. Responses of 7 were labeled *often, extremely violent content,* and *extremely violent graphics,* respectively. The "how-often" scales also included the verbal anchor *occasionally* under the scale midpoint (4). For each participant, we computed a violence exposure score for each of their five favorite games by summing the violent content and violent graphics ratings and multiplying this by the how-often rating. These five video game violence exposure scores were averaged to provide an overall index of exposure to video game violence. Coefficient alpha was .86.

Participants were also asked, "Which of the following categories best describes this game?" for each of their five favorite games. The six categories were education, fighting with hands, sports, fighting with weapons, fantasy, and skill.

To help them remember their favorite games, participants were provided with a video game list. This list, which we compiled, contained the names of all video games that were currently for sale at a local computer store. It should be noted that participants were allowed to indicate that they had never played video games. Several individuals in our sample listed fewer than five favorite video games, but over 90% of our sample reported having at least one favorite video game.

Time spent on video games. After completing the questions relating to their favorite video games, participants were asked four questions regarding their general video game play across four different time periods. First they were asked to estimate the number of hours per week they have played video games "in recent months." They were not constrained as to the number of hours they could report. Next they were asked to estimate the number of hours per week they played video games "during the 11th and 12th grades," "during the 9th and 10th grades," and "during the 7th and 8th grades." A video game playing composite was formed by averaging the amount of time participants reported playing video games across the four time periods. Because participants were predominantly traditional-aged college underclassmen, this measure constituted a general video game playing estimate over approximately 5–6 years, from junior high to early college. The coefficient alpha for this general time spent playing video games variable was .84.

World View

Gerbner et al. (1980) were interested in the difference between light television viewers' and heavy television viewers' perceptions of the world. They asked participants to estimate the chance that they would be personally involved in crime and compared this with actual crime statistics. They also asked participants whether women are more likely to be victims of crime and whether neighborhoods are safe.

We chose to create our own World View Scale by making a set of questions that taps these general ideas. One reason for constructing a new measure was to not constrain the crime estimates to be compared with actual crime estimates at any one time. A comparison of the perceived likelihood of a crime can simply be made between those exposed to media violence and those not exposed, rather than to a continuously changing statistic. We constructed two sets of questions.

Crime likelihood. The first four questions on our Crime Opinion Survey, asked participants to estimate the percentage likelihood of a person experiencing each of four different crimes at least once in their lifetime. The questions read, "What do you think the chances are that any one person will be robbed by someone with a weapon in their lifetime? What do you think the chances are that any one person will be physically assaulted by a stranger in their lifetime? What do you think the chances are that any one woman will be raped in her lifetime? What do you think the chances are that any one person will be murdered?" Participants were asked to answer each of these four questions with a percentage and to assume that each question referred to current crime frequencies in the United States. Coefficient alpha for this "crime" perception measure was .86.

Safety feelings. In the last two questions participants were asked to indicate the extent to which they would feel safe walking alone in two different settings. These questions read, "How safe would you feel walking alone at night in an average suburban setting?" and "How safe would you feel walking alone at night on campus?" Participants responded on 7-point scales ranging from 1 (*not at all*) to 7 (*extremely*). Coefficient alpha for this "safety" measure was .82.

Academic Achievement

The academic achievement variable was the cumulative college GPA for each student. These were supplied by the university's registrar.

Results

Preliminary Analysis

Formation of Individual Difference Composites

Correlational analysis on the individual difference measures of aggression indicated no problem items (e.g., items that were negatively correlated with the scale) on either of the two scales. Coefficient alphas indicated that each of the two scales was internally reliable. Alphas were .88 for the CIS and .90 for the AQ. The CIS and AQ were strongly correlated ($r = .81$, $p < .001$). Past research in our lab has revealed that the CIS and the AQ load on the same latent Aggressive Personality factor (Dill et al., 1997). Therefore, we formed a single aggressive personality score by averaging the CIS and AQ scores.

Centering

When testing for interaction and main effects simultaneously in regression models with correlated predictors, it is recommended that continuous independent variables be centered to reduce multicollinearity problems (Aiken & West, 1991). We standardized all three continuous independent variables used in the various regression analyses to follow (i.e., video game violence, aggressive personality, and time in general spent on video games) to facilitate comparisons among them.

Descriptive Results

Most of the participants were traditional freshmen and sophomores. The mean age was 18.5 years. The oldest participants were two 25-year-olds and two 24-year-olds. Data from the video game questionnaire provided information about their playing habits. Overall, participants reported playing video games progressively less from junior high school to college. Participants reported playing video games an average of 5.45 hours per week while in junior high school, 3.69 hours per week in early high school, and 2.68 hours per week late in high school. Presently, the students reported playing video games an average of 2.14 hours per week.

Of the 227 students surveyed, 207 (91%) reported that they currently played video games. Of the 9% who do not play video games, 18 students, or 90% of the non-video game players, were women. Thus 88% of the female college students and 97% of the male college students surveyed were video game players. Participants were asked to list up to five favorite games. The mean number of games listed was 4.03. Over 69% listed five games, the maximum number allowed.

The most popular game listed was Super Mario Brothers, which was a favorite of 109 students or about 50% of the sample. The second most played game was Tetris, a favorite of 93 students or about 43% of the sample. The third favorite game among our college students was Mortal Kombat, which was named by 58 students or 27% of the sample.

Super Mario Brothers and Mortal Kombat both involve considerable violence in the sense that the player typically spends a considerable amount of time destroying other creatures. However, Super Mario Brothers is a cartoon-like game designed for kids, and is not classified as violent by many people. Mortal Kombat is one of the most graphically violent games available. Tetris is a totally nonviolent game. Super Mario Brothers was included free with purchase of the Nintendo system for some time, which may account for part of its popularity. So, one could see this list of the top three games as being fairly positive (if one views Super Mario Brothers as harmless) or as being not so positive.

Of the 911 game classifications made by the participants, 21% were in the fighting category. However, a number of classifications of clearly violent/aggressive games were to one of the other categories. For instance, one person who listed Mortal Kombat as a favorite game classified it as a "sports" game. If these suspect classifications are added to the fighting category, the percentage of violent/aggressive games jumped to almost 33%. If Super Mario Brothers is counted as an aggressive game (even when the participant put it in another category), the percentage jumps to 44%.

It is important to keep in mind that our participant population consisted of those who had been admitted to a large state university. The preferences of their junior high and high school peers who did not get into college might be quite different.

Main Analyses

Zero-Order Correlations

Table 1 presents the zero-order correlations between the key continuous independent and dependent variables. One male student failed to complete (or start) the AQ, so his data were dropped from all regression analyses. Table 1 reveals confirmation of both main hypotheses derived from GAAM: Aggressive delinquent behavior was positively related to both trait aggressiveness and exposure to video game violence (rs = .36 and .46, respectively). Nonaggressive delinquent behavior was also positively related to both trait aggressiveness and exposure to video game violence (rs = .33 and .31, respectively). Furthermore, exposure to video game violence was positively related to aggressive personality (r = .22).

It is interesting to note that exposure to video game violence was more strongly correlated with aggressive delinquent behavior than with nonaggressive delinquent behavior, $t(223) = 2.64$, $p < .05$. It is important to keep in mind that nonaggressive delinquent behavior includes some behaviors that are frequently (but not always) performed with the intent to harm another person.

Point biserial correlations involving gender of participant revealed that gender was strongly related to a number of the variables, especially perceived safety (r = .68), video game violence (r = .43), and time spent playing video games (r = .35). Males felt more safe, played more violent video games, and played more video games in general than did females.

Time spent playing video games in general was also positively related to both types of delinquent behaviors (rs = .20 and .15, respectively) but less strongly than was exposure to video game violence. Another interesting finding to emerge from data shown in Table 1 concerns GPA. Video game violence was negatively, but not significantly, related to GPA (r = −.08), but time spent playing video games in general was significantly and negatively correlated (r = −.20) with GPA. A number of additional interesting correlations can be seen in Table 1, but the overall patterns are best understood by the more complex analyses to follow.

Aggressive Behavior

Destructive testing. Our primary goal in Study 1 was to examine the relation between long-term exposure to violent video games and real-life aggressive behavior. Our first set of analyses used a destructive testing approach (Anderson & Anderson, 1996). In the destructive testing approach, one determines whether a specific predicted relation exists. If so, one enters competitive variables into the regression model to determine whether these competitors break the target relation or not. Of primary interest is

Table 1
Zero-Order Correlations and Alphas: Study 1

Variable	1	2	3	4	5	6	7	8	9
1. AB	(.73)	.54*	−.03	.24*	.46*	.36*	.20*	.20*	−.11
2. NAB	.54*	(.89)	−.08	.19*	.31*	.33*	.15*	.15*	−.15*
3. Crime	−.03	−.08	(.86)	−.27*	−.05	−.07	−.26*	−.09	−.05
4. Safety	.24*	.19*	−.27	(.82)	.35*	.23*	.68*	.25*	−.05
5. VGV	.46*	.31*	−.05	.35*	(.86)	.22*	.43*	.28*	−.08
6. AP	.36*	.33*	−.07	.23*	.22*	—[a]	.19*	.16*	−.15*
7. Gender	.20*	.15*	−.26	.68*	.43*	.19*	—	.35*	−.18*
8. Time	.20*	.15*	−.09	.25*	.28*	.16*	.35*	(.84)	−.20*
9. GPA	−.11	−.15*	−.05	−.05	−.08	−.15*	−.18*	−.20*	—

Note. N = 226 for all correlations. Alphas are shown in parentheses on the diagonal. Dashes indicate single-item measures. AB = aggressive delinquent behavior; NAB = nonaggressive delinquent behavior; Crime = perception of general crime chances; Safety = perception of personal safety; VGV = long-term exposure to video game violence; AP = aggressive personality; Gender = point biserial correlations with women coded as 0, men as 1; Time = time spent playing video games; GPA = grade point average.
[a] AP was the average of the CIS and AQ scores, which had alphas of .88 and .90, respectively.
* $p < .05$.

not whether the initial target link can be broken (i.e., made nonsignificant), because the assumption is that even strong causal links between measured variables can eventually be broken by adding more correlated competitors into the model. Rather, the focus is on how durable the link appears given the theoretical and empirical strength of the competitor variables used to test the target link.

Our first model predicted aggressive behavior with exposure to video game violence (VGV). In three subsequent regressions, we added general video game playing time (Time), aggressive personality (AP), and gender of participant as predictors, keeping all prior predictors in the model. For each of these four regressions, we report the slope relating VGV to aggressive behavior, the unique percentage of variance accounted for by the video game playing measure, and the t value testing the video game playing effect against 0. In Table 2 the results for the destructive testing of the links between VGV and three dependent variables are displayed, beginning with the one most relevant to this section—aggressive delinquent behavior.

As can be seen in the first three rows of Table 2, the VGV–aggressive behavior link was not broken in any of the destructive tests. In all cases, VGV was positively and significantly related to aggressive behavior, both statistically (all $ps < .001$) and in terms of percentage of total variance explained, which ranged from over 21% (when VGV was the only predictor) to 13% (when all three competitor variables were first partialed out). Thus, the link between VGV and aggressive behavior is quite strong indeed.

In the final destructive test, the only predictor other than VGV to attain statistical significance was AP ($b = .156$, $t(220) = 4.51$, $p < .001$). It accounted for about 7% of the total variance in aggressive behavior. The fact that Time did not "break" the VGV effect and that it didn't contribute significantly to the prediction of aggressive behavior in the final (or any) destructive tests suggests that violent video game play is the most important video game predictor of aggressive behavior.

Moderation by individual differences. Our second set of analyses was designed to examine the potential moderating effects of individual differences in aggression on aggressive behavior. Mixed-model hierarchical regression analyses tested a model in which self-reported aggressive delinquent behavior was predicted by violent video game play, AP, and gender of participant. Recall that the continuous variable predictors (VGV, AP) were standardized prior to these analyses.

All higher order interactions were tested. We used the conventional alpha of .05 for main and two-way interactions. However, because of the large number of unpredicted three-way interactions, we used a more conservative .01 alpha to help guard against Type I errors.

Results showed the predicted main effect of violent video game play on aggression, $F(1, 222) = 42.88$, $p < .0001$, $MSE = .252$. Greater exposure to violent video games predicted greater aggressive behavior, $b = .246$. There was also a main effect of AP on aggressive behavior, $F(1, 222) = 21.08$, $p < .0001$, $MSE = .252$, such that high trait aggressive individuals reported more instances of aggressive behavior than did low trait aggressive individuals, $b = .159$. The main effect of gender of participant did not approach significance ($F < 1$). The R^2 for this main effects model was .284.

One of the two-way interactions was significant. The VGV × AP interaction was quite large, accounting for 24% of the variance,

Table 2
Destructive Testing of Video Game Links to Aggressive Behavior, Nonaggressive Delinquency, Safety Feelings, and Grade Point Average: Slopes, Percentage Variance Accounted for, and t Tests of Links Between Video Game Playing and Key Dependent Variables

	Variables in the model			
Dependent variable/Target predictor	VGV	+Time	+AP	+Gender
Aggressive behavior/Video game violence				
Video game violence slopes	.274	.262	.232	.241
Percentage variance explained by video game play	21.61	18.18	13.77	12.99
t value	7.86*	7.21*	6.54*	6.34*
Nonaggressive delinquency/Video game violence				
Video game violence slopes	.155	.146	.120	.124
Percentage variance explained by video game play	9.92	8.07	5.28	5.97
t value	4.97*	4.48*	3.76*	3.64*
Safety feelings/Video game violence				
Video game violence slopes	.573	.495	.450	.094
Percentage variance explained by video game play	12.28	8.48	6.72	0.26
t value	5.60*	4.70*	4.24*	1.04
	Time	+VGV	+AP	+Gender
GPA/Time spent playing video games				
Time spent playing video games slopes	−.129	−.123	−.115	−.097
Percentage variance explained by video game play	3.85	3.25	2.80	1.84
t value	3.00*	2.75*	2.56*	2.09*
df	224	223	222	221

Note. VGV = video game violence; Time = time spent playing any type of video game; AP = aggressive personality; GPA = grade point average.
* $p < .05$.

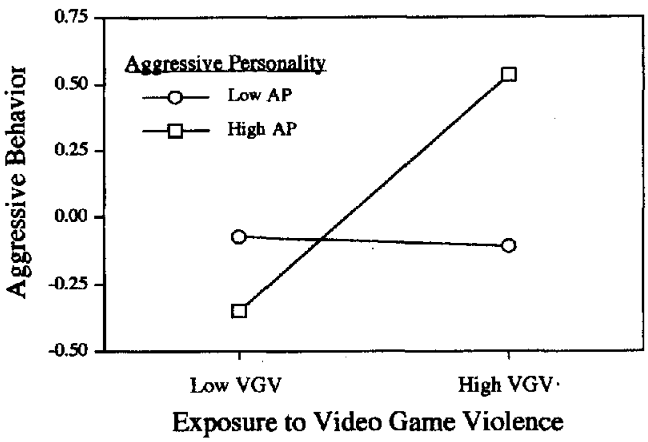

Figure 3. Effect of exposure to video game violence (VGV) on aggressive behavior as a function of aggressive personality (AP).

$F(1, 219) = 125.09$, $p < .0001$, $MSE = .147$. As can be seen in Figure 3, this huge interaction resulted from the fact that the VGV effect on aggression occurred primarily among participants with high AP scores. Neither of the other two-way interactions approached significance ($ps > .20$). The R^2 for this main effects and two-way interactions model was .588.

The three-way VGV × AP × Gender interaction was also significant and is illustrated in Figure 4, $F(1, 218) = 8.30$, $p < .005$, $MSE = .142$. It accounted for less than 2% of the variance in aggressive behavior, but is readily interpretable. For high AP participants there was a positive relation between VGV and aggression, but this was much stronger for men than women. For low AP people, however, there was little effect of VGV on aggression regardless of gender. (We created Figures 3 and 4 by doing a median split on AP then calculating the VGV–aggressive behavior regression lines for high and low AP participants separately.) The full model yielded an R^2 of .603.

Nonaggressive Delinquency

Destructive testing. Table 2 also contains the destructive testing results for the nonaggressive delinquency measure. As noted earlier, the VGV effect was considerably smaller on nonaggressive delinquency than on aggressive behavior (compare also the percentage variance results in Table 2). Nonetheless, VGV consistently accounted for a significant unique portion of variation in nonaggressive delinquency. Those who reported more VGV exposure also reported higher levels of nonaggressive delinquency, all $ps < .001$, even when all three competitor variables were in the model. The percentage variation uniquely attributable to VGV ranged from almost 10% (when VGV was the only predictor) to a bit over 5%.

As with aggressive behavior, in the final destructive test the only predictor other than VGV to attain statistical significance was AP, $b = .137$, $t(222) = 4.41$, $p < .001$. It accounted for about 7% of the total variance in nonaggressive delinquency. Once again, the fact that Time did not break the VGV effect and that it didn't contribute significantly to the prediction of aggressive behavior in the final (or any) destructive tests suggests that violent video game play is the most important video game predictor of both nonaggressive delinquency and aggressive behavior.

Moderation by individual differences. The hierarchical regression analyses on the full 3-factor model yielded similar results. The R^2 for the main effects model was .172. There were significant main effects of VGV, $F(1, 222) = 14.32$, $p < .001$, $MSE = .203$, and AP, $F(1, 222) = 19.46$, $p < .001$, $MSE = .203$. The gender main effect did not approach significance ($F < 1$). VGV and AP were both positively related to nonaggressive delinquency, $bs = .128$ and .137, respectively.

There was also a substantial VGV × AP interaction, $F(1, 219) = 33.27$, $p < .001$, $MSE = .176$, such that the VGV effect was stronger for participants high in AP than for participants low in AP. This effect accounted for over 10% of the variation in nonaggressive delinquency. This interaction is presented in Figure 5. None of the other interactions was significant. The R^2 for the full model with all main effects and two-way interactions was .297.

World View: Feeling Safe

Destructive testing. Data shown in Table 1 indicated that all four predictors—VGV, AP, Gender, and Time—were positively correlated with feelings of safety. Destructive testing revealed that the link between VGV and safety feelings survived the addition of the Time and AP factors, but did not survive the addition of Gender to the model (see Table 2).

Moderation by individual differences. The hierarchical regression results showed that gender differences accounted for a large portion of the variance in safety feelings. In the model containing VGV, AP, and gender, the only significant effect was the main effect of gender, $F(1, 222) = 135.92$, $p < .001$, $MSE = 1.43$. The R^2 for the main effect model was .471; for the full model it was .483.

In the model containing Time (instead of the VGV predictor) only the Gender and Time main effects were significant, $F(1, 222) = 153.25$ and 4.24, $ps < .001$ and .05, respectively, $MSE = 1.44$. The R^2 for the main effect model was .468; for the full model it was .481. As expected, women reported feeling

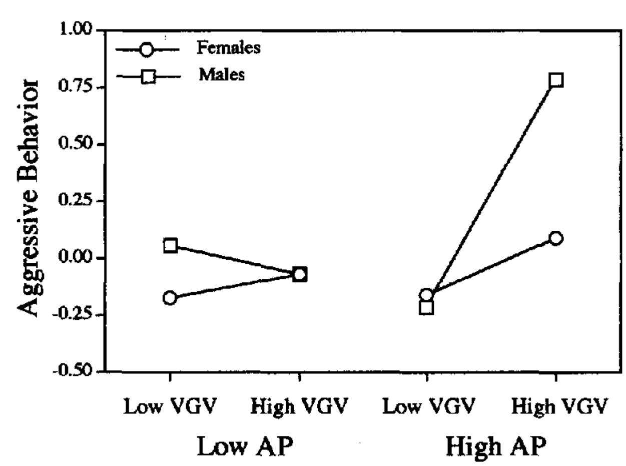

Figure 4. Effect of exposure to video game violence (VGV) on aggressive behavior as a function of aggressive personality (AP) and gender.

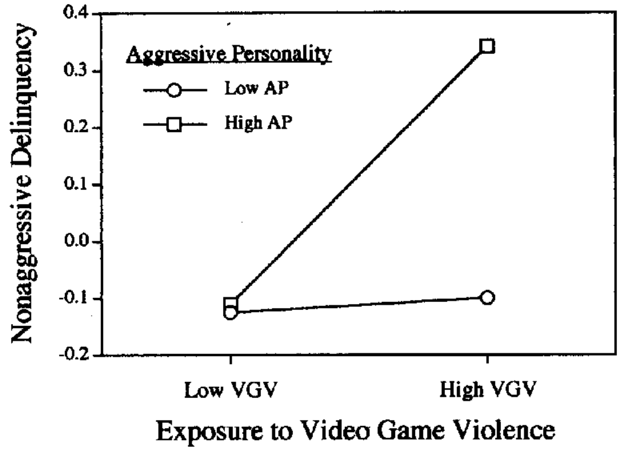

Figure 5. Effect of exposure to video game violence (VGV) on nonaggressive delinquency as a function of aggressive personality (AP).

significantly less safe than did men (e.g., adjusted means for the VGV model were 3.38 and 5.55 for female and male participants, respectively).

World View: Crime Opinions

The zero-order correlations (Table 1) showed that only gender of participant reliably correlated with crime likelihood estimates. Therefore, there was no link to video game playing experience to subject to destructive testing. Men gave lower estimates of crime than did women, r (point biserial) $= -.26$.

Hierarchical regression analyses with VGV, AP, and Gender as predictor variables were again used to further investigate the crime estimate variable. These analyses yielded only a main effect of gender, $F(1, 222) = 16.04$, $p < .01$, $MSE = 358.86$, such that women rated violent crimes as more likely to occur than did men (adjusted Ms $= 41.82$ and 30.01, respectively). The R^2 for the main effects model was .072. None of the other effects reached statistical significance. A similar set of hierarchical analyses using Time instead of VGV yielded almost identical results. The only significant effect was the main effect of gender, $F(1, 222) = 13.14$, $p < .001$, $MSE = 361.04$. The R^2 for the full model was .089.

Academic Achievement: GPA

Destructive testing. Results shown in Table 1 revealed a significant negative correlation between GPA and Time ($r = -.20$). Our destructive testing of this small relation consisted of adding VGV, AP, and Gender as competitor variables, in that order. The results are displayed in Table 2. Though the magnitude of the GPA–Time relation was weakened by the addition of these variables, the link did not break. By itself, Time accounted for nearly 4% of the variance in GPA, $b = -.13$, $t(224) = 3.00$, $p < .01$. With all three competitors in the model, Time accounted for nearly 2% of GPA variance, $b = -.10$, $t(221) = 2.09$, $p < .05$.

Moderation by individual differences. Hierarchical regression analyses yielded only one statistically significant effect. Time was significantly related to GPA, $F(1, 222) = 4.17$, $p < .05$, $MSE = .41$, such that more Time predicted lower GPAs ($b = -.093$). The R^2 for the main effects model was .063; for the full model it was .078.

Discussion

Taken together, these results paint an interesting picture. Violent video game play and aggressive personality separately and jointly accounted for major portions of both aggressive behavior and nonaggressive delinquency. Violent video game play was also shown to be a superior predictor of both types of delinquency compared with time spent playing all types of video games. This is also consistent with our GAAM formulation and suggests that future research (unlike most past work) needs to distinguish between these types of video games.

The positive association between violent video games and aggressive personality is consistent with a developmental model in which extensive exposure to violent video games (and other violent media) contributes to the creation of an aggressive personality. The cross-sectional nature of this study does not allow a strong test of this causal hypothesis, but a zero or negative correlation would have disconfirmed the hypothesis, so the test is a legitimate one.

We also found that for university students, total time spent in the recent past on video games has a potential detrimental effect on grades. Interestingly, Huesmann's (1986) theory and data on TV violence suggest that violent video game exposure should be related to decrements in academic achievement because of the disruption of progress in school that is associated with increases in aggressive behavior engendered by media violence exposure. One plausible reason why this relationship was not observed in the present data may involve the nature of our population. College students are preselected on the basis of high school achievement and standardized test scores. Those with serious decrements in intellectual functioning or serious aggressive behavior problems are not as frequently represented in college samples as would be the case in a high school sample. Future research should examine the relationship between violent video game play and academic achievement in a high-school-aged sample.

In sum, Study 1 indicates that concern about the deleterious effects of violent video games on delinquent behavior, aggressive and nonaggressive, is legitimate. Playing violent video games often may well cause increases in delinquent behaviors, both aggressive and nonaggressive. However, the correlational nature of Study 1 means that causal statements are risky at best. It could be that the obtained video game violence links to aggressive and nonaggressive delinquency are wholly due to the fact that highly aggressive individuals are especially attracted to violent video games. Longitudinal work along the lines of Eron and Huesmann's work on TV violence (e.g., Eron, Huesmann, Dubow, Romanoff, & Yarmel, 1987) would be very informative.

Study 1 was informative in that it measured video game experience, aggressive personality, and delinquent behavior in real life. Its focus was on potentially negative consequences of long-term exposure to video game violence. Study 2 focused on short-term effects of video game violence. An experimental methodology was also used to more clearly address the causality issue. If the GAAM view of video game effects is correct, then we should be able to detect violent video game effects on short-term aggression and on aggressive cognitions using an experimental design and games chosen to differ primarily in the amount of violent content.

STUDY 2: EXPERIMENTAL TEST OF VIDEO GAME VIOLENCE EFFECTS

Pilot Study

The pilot study was conducted to choose video games for use in the main experiment. Our goal was to control for possible differences between nonviolent and violent video games on other dimensions that may be relevant to aggressive behavior, most notably enjoyment, frustration level, and physiological arousal. The current pilot study addressed these issues.

Video Games

The video game Wolfenstein 3D was selected to be pilot tested because of its blatant violent content, realism, and human characters. In Wolfenstein 3D the human hero can choose from an array of weaponry including a revolver, a knife, automatic weapons, and a flame thrower. The hero's goal is to use these weapons to kill Nazi guards in Castle Wolfenstein to advance through a number of levels; the ultimate goal is to kill Adolph Hitler. The graphics of this game are very violent; a successful player will see multiple bloody murders and hear victims scream and groan. The play control is easy and intuitive and the 3D setting is realistic. We also chose the violent game Marathon for pilot testing. Marathon is set up in the same basic format as Wolfenstein 3D except that the locale is an alien spaceship and the enemies are humanoid aliens with green blood.[1]

The nonviolent games chosen for the pilot study were Myst and Tetrix. Myst is an award-winning interactive adventure game that was specifically designed to be nonviolent in nature. It shares the 3D "walk through" format of Wolfenstein 3D and Marathon. Tetrix (which is comparable to Tetris) is an engaging, fast-paced, thinking game in which players attempt to align colorful geometric figures as they fall down a computer screen.

Method

Thirty-two (18 female, 14 male) participants were recruited from the introductory psychology participant pool of a large Midwestern university and participated for partial course credit. Participants were run individually by a female experimenter. Participants were informed that we were choosing video games for use in a future study and that they would be asked a variety of questions about each of four games. We measured blood pressure and heart rate several times during the study. Games were presented in one of four counterbalanced orders to control for order effects.

After each game, the experimenter took the physiological measures, had the participant complete a "Video Game Rating Sheet" and asked the participant for any advice on changing the instructions or controls of the video game. On the Video Game Rating Sheet participants indicated, on 7-point unipolar scales, how difficult, enjoyable, frustrating, and exciting the games were as well as how fast the action was and how violent the content and graphics of the game were. These items were drawn from those used by Anderson and Ford (1986). After participating, participants were debriefed and given experimental credit.

Results

The goal of the pilot study was to select a pair of games that differed primarily in amount of violence. The goal was best achieved by pairing of Myst and Wolfenstein 3D. These two games did not produce differences in systolic blood pressure, diastolic blood pressure, heart rate, or mean arterial pressure (all $ps > .3$). There were also no differences on ratings of game difficulty, enjoyment, frustration, and action speed (all $ps > .05$). However, Wolfenstein 3D was rated as more exciting than Myst ($Ms = 4.81$ and 3.40, respectively), $F(1, 27) = 10.46$, $p < .01$. Further analyses revealed that this was true only for the male participants, $F(1, 10) = 12.08$, $p < .01$, and not for the female participants, $F(1, 14) = 2.50$, $p > .13$.

Myst and Wolfenstein 3D matched well, but because of the rated difference in excitement level, we decided to include the same Video Game Rating Sheet in the main experiment for use as a statistical control.

Main Experiment

Overview

Two hundred ten (104 female, 106 male) undergraduates from a large Midwestern university participated for partial credit in their introductory psychology course. In this experiment we examined the effects of violent video game play on aggressive thought, affect, and behavior and on world view. We also examined the interactive effects of gender and trait irritability on these variables. The design is thus a 2 (violent video game vs. nonviolent video game) × 2 (high irritability vs. low irritability) × 2 (male vs. female) between-subjects factorial design.

To give participants ample playing experience with the assigned video game, we arranged for them to come to the laboratory for two separate sessions. Each participant played the assigned video game a total of three times. In the first experimental session, participants played the game, completed the affective and world view measures, played the game again, then completed the cognitive measure. During the next session, participants played the game one last time and completed the behavioral measure. All participants had been preselected by their trait irritability score.

Method and Procedure

Preselection of Participants

The CIS (Caprara et al., 1985) was administered to the introductory psychology participant pool during mass testing questionnaire sessions several weeks before the experiment was begun. The full 30-item scale was used. Participants scoring in the bottom fourth of the distribution were considered to have low irritability and participants scoring in the top fourth of the distribution were considered to have high irritability. Participants both low and high in irritability were recruited by telephone and participated for course credit. Note that this Trait Irritability Scale was a part of what we called our Aggressive Personality index in Study 1 but that we will refer to it in Study 2 as Trait Irritability (TI).

Laboratory Session 1

All instructions for starting or stopping video game play or computerized dependent measures took place over an intercom. The main reason for the intercom-based instructions was so the participant was always reminded that there was another participant present. In fact, even in cases in which

[1] The data for study 2 were collected in 1997. Since then, video games have become even more graphically violent, and the graphics have become even more realistic.

the second cubicle was empty, the experimenter play-acted as if the second participant were actually there—entering the second cubicle and speaking the same instructions aloud to the nonexistent partner.

For the first session, participants were scheduled in pairs to come into the laboratory for 1 hour. Upon arriving at the laboratory, each participant was escorted to a cubicle that contained an intercom and a chair facing a color Macintosh computer equipped with a voice key (MacRecorder) and a pair of headphones. A female experimenter asked each participant to read and sign a consent form, to read a brief overview of the study, and to familiarize themselves with instructions that explained how to play the video game to which they were assigned (either Myst or Wolfenstein 3D). The experimenter then informed the participant that she would contact them when she was ready to begin and closed the door to the participant's cubicle.

Cover story. The overview informed participants that they would be taking part in a study called "The Learning Curve," which was purported to investigate how people learn and develop skills at motor tasks like video games and how these skills affect other tasks such as cognitive tasks and other motor tasks. Participants were also told that their video game play was being recorded to examine skill development. To make this believable, a VCR was set up near their computer, with wires running from the VCR to the computer. The two-session format was consistent with this motor skills development cover story as well.

Game play No. 1. After participants had read the cover story and had familiarized themselves with a written set of video game instructions, the experimenter entered the participant's cubicle and engaged the video game software. She reviewed the video game controls and asked for any questions about how to play the game. Then she asked the participant to wait until she gave the signal to begin, which would take place over the intercom system. At the appropriate time, the experimenter asked participants to put on a pair of headphones and play the video game. She informed them that she would stop them in 15 min.

Ratings. After 15 min of video game play, the experimenter stopped participants and saved their video game file on the computer. This was to keep up the cover story that the experimenters were interested in the player's video game performance. She then started a computer program that collected the affective data. The affective measure was the State Hostility Scale developed by Anderson and colleagues (Anderson, 1997; Anderson et al., 1995, 1996). In this scale participants are asked to indicate their level of agreement to 35 statements such as "I feel angry" and "I feel mean." Participants respond on 5-point scales anchored at 1 (*strongly disagree*), 2 (*disagree*), 3 (*neither agree nor disagree*), 4 (*agree*), and 5 (*strongly agree*). Some of the items are positive as stated (e.g., "I feel friendly") and thus were reverse scored for data analysis. Recent work by Anderson and colleagues (e.g., Anderson, 1997; Anderson et al., 1995, 1996) has shown that acute situational variables such as pain, provocation, violent movie clips, and uncomfortably cold and hot temperatures increase State Hostility scores.

Following the State Hostility Scale, the computer presented the same video game rating items that had been used in the pilot study, including the rating of how exciting the game was. Next, participants completed the same world view measure used in Study 1.

Game play No. 2. The computer program that collected the state hostility, video game, and world view data concluded with instructions for the participants to crack the door to their cubicle when they were finished. The experimenter then entered the participant's cubicle, stored the data on the computer, and restarted the video game software. The experimenter then asked the participant to wait until signaled to begin another 15-min video game playing session. When both participants were ready, the experimenter again signaled the participants by means of an intercom to put on their headphones and begin playing the video game. She informed them that she would stop them in 15 min. At that time, the experimenter returned and saved the participant's video game playing session. She then started the computer program that would collect the cognitive data.

The cognitive measure of aggressive thinking was the reading reaction time task used by Anderson and colleagues (Anderson, 1997; Anderson et al., 1996; Anderson, Benjamin, & Bartholow, 1998). This task presents aggressive words (e.g., murder) and three types of control words individually on a computer screen. The participant's task is to read each word aloud as quickly as possible. The three types of control words are anxiety words (e.g., humiliated), escape words (e.g., leave), and control words (e.g., consider). There are 24 words in each category. Each word is presented twice, for a total of 192 trials, with 48 trials for each word type. The four word lists have been equated for word length. The word "resign," which was used in previous studies as a control word, was later deemed an escape word. Thus, for this study, "resign" was replaced by "report."

Each word is presented on the computer screen in Times 12 font, with a period separating the letters of the word. The computer records the reaction time to each word. Words were presented in the same random order for each participant.

When participants finished, the experimenter reminded them of the time they were scheduled to return for the final portion of the study, thanked them for their time, and allowed them to leave. No debriefing information was given at this time.

Laboratory Session 2

Approximately 1 week later, participants returned to the laboratory to complete the final phases of the study. Participants came alone, but the procedures discussed earlier were carried out in this second session as well, so that participants would believe there was another participant in the second cubicle.

Video game play. The experimenter seated the participant in a cubicle, started the video game software, and asked if there were any questions about how to play the game. Then the experimenter asked the participant to wait until everyone was ready to begin. At that point, the experimenter said that she would give verbal instructions over the intercom for them to proceed with playing the game, as she had done in the first session.

Aggressive behavior. After 15 min, the experimenter entered the participant's cubicle, saved the video game file, and started the competitive reaction time task on the computer. In the competitive reaction time task, the participant's goal is to push a button faster than his or her opponent. If participants lose this race, they receive a noise blast at a level supposedly set by the opponent (actually set by the computer). Aggressive behavior is operationally defined as the intensity and duration of noise blasts the participant chooses to deliver to the opponent.

The competitive reaction time task used in this study was the same basic computer program used by Bushman (1995) and by Dorr and Anderson (1995). It is based on the Taylor Competitive Reaction Time task, which is a widely used and externally valid measure of aggressive behavior (see Anderson & Bushman, 1997; Anderson, Lindsay, & Bushman, 1999; Bushman & Anderson, 1998; Carlson, Marcus-Newhall, & Miller, 1989; Giancola & Chermack, 1998).

We used 25 competitive reaction time trials; the participant won 13 and lost 12. The pattern of wins and losses was the same for each participant. Prior to each trial the participant set noise intensity and duration levels. Intensity was set by clicking on a scale that ranged from 0 to 10. Duration was set by holding down a "Ready" button and was measured in milliseconds. After each trial the participants were shown on their computer screen the noise levels supposedly set by their opponent. For this experiment, the noise blast intensities supposedly set by the opponent were designed to appear in a random pattern. Specifically, three noise blasts of intensity Levels 2, 3, 4, 6, 7, 8, and 9, and four noise blasts of Level 5 were randomly assigned to the 25 trials. A noise blast at Level 1 corresponded to 55 decibels, a noise blast at Level 2 corresponded to 60 decibels, and the decibels increased by five for each subsequent noise blast level to a maximum of 100 decibels for a noise blast at Level 10. Similarly, the duration of noise blasts the participant received were determined by the computer, were in a random pattern, and were the same for each participant. The durations varied from 0.5 seconds to 1.75 seconds.

Pilot testing and prior use of this competitive reaction time game had revealed that participants frequently did not understand how to vary the duration of noise supposedly to be delivered to their opponent. We therefore modified this version and the instructions to highlight the noise duration aspects of the game.

As the competitive reaction time program begins, participants are asked to read a set of instructions from the computer screen. Because it was crucial to the validity of our results that participants understand the task, the experimenter also read participants a set of standardized instructions by means of an intercom. The instructions read,

> We are now ready to do the competitive reaction time task. You will set a noise level that your opponent will hear if they lose. You will do this by clicking on the noise level bar at your right. Where you click on the bar determines how loud the noise is. How long you hold down on the bar determines how long your opponent will hear the noise. (PAUSE.) After you set the noise level and duration, click the "Ready" button. (PAUSE.) Wait for the yellow box to appear. This is a warning that the tone is about to sound. As soon as you hear the tone, click your mouse as fast as you can. (PAUSE.) If you lose, you will hear the noise your opponent has set for you. If you win, your opponent will hear the noise you have set for them. Either way, you will see which noise level your opponent set for you. You will do this several times. (PAUSE.) If you have questions, please open your door now. (PAUSE.) We are now ready to begin. Please make sure you have your headphones on now and click on the arrow which says, "Begin Experiment" in the upper right hand corner of your screen. Please begin now, and open your door when you are finished.

Debriefing. When the participant opened the cubicle door, the experimenter entered the cubicle, gave the participant a debriefing statement that explained the procedures and hypotheses of the study and debunked the cover story, and gave the participant full experimental credit. After answering any questions, the experimenter thanked and dismissed the participant.

Results

Video Game Questions

Recall that pilot testing had revealed a significant difference in the excitement level of the game (based on self-report data but not on the physiological data) between Myst and Wolfenstein 3D. We included game excitement as a covariate in all the models that follow because of the pilot study results, but it was not a significant predictor in any of the models. We also measured game difficulty and frustration level. Game frustration was a significant covariate in the model with state hostility as the dependent variable. Game difficulty was a significant covariate in the model predicting reading reaction time. However, the addition of these covariates to the overall model did not appreciably alter the effects of most interest.

State Hostility

The 35 items on the State Hostility Scale (Anderson, 1997) were averaged into a composite. The coefficient alpha calculated for the entire scale was .96. Correlational analyses indicated that one item, "I feel willful," was slightly negatively correlated with the rest of the scale items. This was not surprising as this particular item had been problematic in past research. This item was deleted, although deleting the item did not appreciably alter the effects presented.

A 2 (game type) $\times$ 2 (gender) $\times$ 2 (trait irritability) between-subjects analysis of variance (ANOVA) was performed with State Hostility as the dependent variable and with Game Excitement as a covariate. The R^2 for this model was .17. Results indicated significant main effects of irritability, $F(1, 201) = 29.98$, $p < .0001$, $MSE = .40$, and of gender, $F(1, 201) = 4.73$, $p < .05$, $MSE = .40$. As expected, those higher in TI reported more state hostility ($M = 2.52$) than those lower in TI ($M = 2.05$). Women reported more hostility ($M = 2.38$) than men ($M = 2.19$). The game type effect as well as all two- and three-way interactions between the independent variables were nonsignificant (all $ps > .05$).

Crime and Safety Ratings

For both the crime and the safety rating indexes, the only significant effect was gender of participant. Women gave higher estimates of violent crime likelihood than did men ($Ms = 37.16$ and 25.82, respectively), $F(1, 200) = 21.75$, $p < .001$, $MSE = 313$, $R^2 = .14$. However, women reported lower feelings of safety than did men ($Ms = 3.63$ and 5.69, respectively), $F(1, 201) = 152.92$, $p < .001$, $MSE = 1.45$, $R^2 = .44$. None of the other effects approached significance.

Accessibility of Aggressive Thoughts

Data preparation. Each participant responded to a total of 192 reading reaction time trials. These 192 were made up of 2 sets of 24 trials for each of the four types of words (aggressive, control, escape, and anxiety). We followed the data cleaning procedure used by Anderson (1997), which involves identifying outliers according to Tukey's (1977) exploratory data techniques. Low and high outliers were changed to missing values. Low outliers (defined here as trials below 275 ms) may occur because of noise other than the participant's reading of the word, such as a door being slammed in an adjacent hallway. High outliers (defined here as trials above 875 ms) may occur because of a lack of attention by the participant or a failure to pronounce the word loud enough to trigger the voice key. Out of 40,320 data points, 2,391 (about 6%) were removed as outliers. In addition, three participants did not have reading reaction time data because of computer malfunctions. Thus, all the reading reaction time analyses are based on 207 participants.

Main analyses. Following the analysis procedure outlined by Anderson (1997), the first step was to see if reaction times to the three control word types (control, anxiety, and escape) were differentially affected by the video game manipulations. A repeated measures ANOVA on the three control word types did not produce a significant control word type by game type interaction, $F(2, 197) = 2.82$, $p > .05$. Therefore, reaction times to the three types of control words (control, anxiety, and escape) were combined into a composite. A new variable was then formed in which the average reaction time to aggressive words was subtracted from the average reaction time to control words. This new variable is the Aggression Accessibility Index. People with relatively high scores have relatively greater access to aggressive thoughts.

A 2 (game type) $\times$ 2 (gender) $\times$ 2 (trait irritability) between-subjects ANOVA was performed on Aggression Accessibility with

Game Excitement as a covariate. Results yielded the predicted main effect of game type, $F(1, 198) = 31.35$, $p < .0001$, $MSE = 246.05$. Aggression Accessibility scores were higher for those who had played the violent video game ($M = 5.54$) than for those who had played the nonviolent video game ($M = -6.69$). In other words, the violent video game primed aggressive thoughts. This result suggests one potential way in which playing violent video games might increase aggressive behavior—by priming aggressive knowledge structures.

There was also a main effect of gender, $F(1, 198) = 13.47$, $p < .001$, $MSE = 246.05$, such that Aggression Accessibility scores were higher for men ($M = 3.45$) than for women ($M = -4.60$). The TI effect, as well as the two- and three-way interactions were all nonsignificant ($ps > .05$). The R^2 for this model was .20.

The lack of a TI effect on aggression accessibility scores is puzzling. It has been found in several previous studies, with the same task as well as with a different lexical decision task (e.g., Anderson, 1997; Bushman, 1995; Lindsay & Anderson, in press). One possibility is that playing a highly violent versus a very mellow and nonviolent game for two 15-min periods of time was sufficient to temporarily override the usual differences between people high and low in irritability in relative accessibility of aggressive thoughts.

Aggressive Behavior

Prior to each trial in the competitive reaction time task, participants set the noise duration and intensity levels that supposedly would be delivered to their opponents if the participant won the trial. Data from three participants were lost because of computer failure. Eleven additional participants from Session 1 failed to show for this second session, leaving a total of 196 participants.

Data preparation. As is common with latency data, the duration settings were positively skewed and there was a systematic relation between group means and standard deviations. A log transformation was therefore applied to the duration data (Tukey, 1977).

Four aggression measures were constructed on the basis of the noise settings (duration or intensity) after both win and lose trials. We reasoned that retaliatory motives would be heightened after losing a trial (and therefore after receiving a noise blast from one's opponent), whereas winning a trial should reduce (at least temporarily) such motives. In other words, it may take both the cognitive priming of aggressive thoughts by violent video games and an immediate provocation (noise blast) by an opponent to trigger higher levels of aggression. Similarly, the emphasis placed in the instructions on how to control noise duration settings was expected to increase participants' use of this aggressive behavior, compared with what we've seen in previous work in our lab.

Both of these expectations were borne out. Indeed, our emphasis on the noise duration controls apparently interfered with participants' ability or willingness to use the intensity control. There were no statistically significant effects of any of the independent variables—gender, TI, video game type—on either the win or lose noise intensity settings. Therefore they will not be discussed further.

Duration: Aggression after "win" trials. For the trials after participants had just won and had not received but had supposedly delivered a noise blast, the only significant effect was a main effect of gender, $F(1, 187) = 8.17$, $p < .01$, $MSE = .28$. Women ($M = 6.89$) delivered longer noise blasts than men ($M = 6.65$). The R^2 for this model is .08.

Duration: Aggression after "lose" trials. Duration of noise settings after lose trials yielded significant main effects of gender, TI, and game type. Just as on win trials, women delivered longer noise blasts after loss trials than did men, $Ms = 6.86$ and 6.59, respectively, $F(1, 187) = 12.84$, $p < .001$, $MSE = .27$. High irritability participants delivered longer noise blasts than did low irritability participants, $Ms = 6.84$ and 6.65, respectively, $F(1, 187) = 4.43$, $p < .05$, $MSE = .27$.

Most importantly, participants who had played Wolfenstein 3D delivered significantly longer noise blasts after lose trials than those who had played the nonviolent game Myst ($Ms = 6.81$ and 6.65), $F(1, 187) = 4.82$, $p < .05$, $MSE = .27$. In other words, playing a violent video game increased the aggressiveness of participants after they had been provoked by their opponent's noise blast. In Figure 6 we illustrate both the irritability and the video game main effects. As can be seen, these two effects were about the same size, both were in the small to medium range.

There was also an Irritability × Gender interaction, $F(1, 187) = 7.04$, $p < .01$, $MSE = .27$, such that high trait irritability increased aggression by men ($Ms = 6.75$ and 6.47 for men high and low in irritability) but not by women ($Ms = 6.84$ and 6.85 for women high and low in irritability). The R^2 for this model is .14. Because this unexpected finding has not been reported previously in the literature we eschew speculation until it reappears in future studies.

Mediational Analyses

Playing the violent video game increased accessibility of aggressive thoughts and aggressive behavior but did not reliably increase state hostility. These findings suggest that VGV takes a cognitive and not an affective path to increasing aggressive behavior in short-term settings. To further test this idea we entered State Hostility as a covariate in the overall model relating video game violence to noise duration settings after the loss trials. The presence of State Hostility in the model did not eliminate the

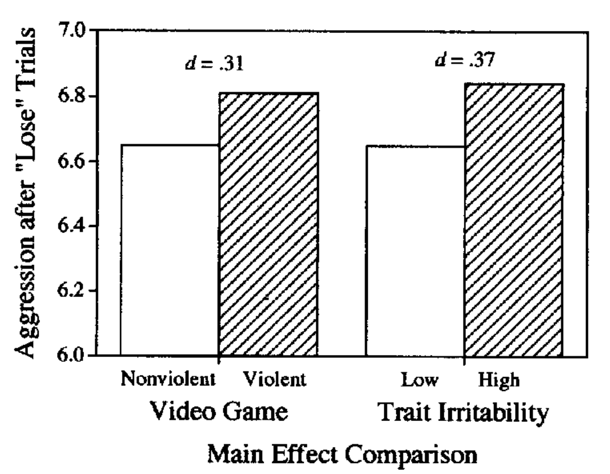

Figure 6. Main effects of video game and trait irritability on aggression (log duration) after "Lose" trials, Study 2.

significance of the video game effect, $F(1, 186) = 4.43$, $p < .05$, $MSE = .26$, $R^2 = .15$. We performed the same covariance analysis with Aggression Accessibility as the covariate instead of State Hostility. Consistent with a mediation hypothesis, the video game effect was reduced to marginal significance, $F(1, 186) = 3.08$, $p < .08$, $MSE = .26$, $R^2 = .15$.[2]

GENERAL DISCUSSION

Aggressive Behavior Effects

The present research demonstrated that in both a correlational investigation using self-reports of real-world aggressive behaviors and an experimental investigation using a standard, objective laboratory measure of aggression, violent video game play was positively related to increases in aggressive behavior. In the laboratory, college students who played a violent video game behaved more aggressively toward an opponent than did students who had played a nonviolent video game. Outside the laboratory, students who reported playing more violent video games over a period of years also engaged in more aggressive behavior in their own lives. Both types of studies—correlational–real delinquent behaviors and experimental–laboratory aggressive behaviors have their strengths and weaknesses. The convergence of findings across such disparate methods lends considerable strength to the main hypothesis that exposure to violent video games can increase aggressive behavior.

Though the existence of a violent video game effect cannot be unequivocally established on the basis of one pair of studies, this particular pair adds considerable support to prior work, both empirical and theoretical. When combined with what is known about other types of media violence effects, most notably TV violence (e.g., Eron et al., 1987; Huesmann & Miller, 1994), we believe that the present results confirm that parents, educators, and society in general should be concerned about the prevalence of violent video games in modern society, especially given recent advances in the realism of video game violence.

Trait Aggressiveness

One interesting difference between the results of the present two studies concerns the moderating effects of individual difference variables. The violent video game effect on aggressive behavior in Study 1 was moderated by individual differences in aggression such that the violent video game effect was stronger for those high in trait aggressiveness than for those low in trait aggressiveness. This moderating effect did not emerge in Study 2, though similar moderating effects have been found in other laboratory studies of media violence (e.g., Bushman, 1995). There are always several possible explanations for such discrepancies. One obvious possibility is that Study 1 used a composite of the CIS and the Buss-Perry AQ as the individual difference measure of aggressive personality, whereas Study 2 used only the CIS. To check on this possibility, we reanalyzed the Study 1 data using only the CIS, and found essentially the same results. For example, the Violent Video Game × CIS Score interaction in Study 1 was still highly significant, $F(1, 219) = 130.58$, $p < .001$, MSE $= .145$. It is also interesting to note that Irwin and Gross (1995) found no moderating effect of trait impulsivity on the violent video game effect they observed in their study of 7- and 8-year-old boys.

The fact that in Study 2 the video game effect and the trait irritability effect were of similar magnitude argues against the possibility that the video game manipulation simply overwhelmed individual differences in this setting. This suggests a third possibility: The AP × VGV interaction in Study 1 may reflect a long-term bidirectional causality effect in which frequent playing of violent video games increases aggressiveness, which in turn increases the desire and actual playing of even more violent video games. Such a cycle is not only plausible, but fits well with Huesmann's (1986) theorizing and data on TV violence effects.

Sex Differences

One additional behavioral result of Study 2 warrants comment: specifically, the finding that women displayed higher levels of state hostility and aggression than men. At first this result may seem very surprising given that men are generally seen as more aggressive than women. However, as Bettencourt and Miller's (1996) meta-analysis of provocation effects showed, gender differences vary considerably depending on setting and type of provocation. One possible explanation involves differences in liking for video games. In our participant population, men generally report playing more video games than women, as was seen in Study 1. Even a cursory examination of video game advertisements reveals a clearly male orientation. Thus, it is possible that both the higher reported level of state hostility and the higher level of aggression by women in Study 2 resulted from their being less familiar with video games or less happy at having to play them in this lab experiment. Furthermore, the ambiguous nature of the duration measure may well fit the aggressive style of women in our culture better than the style of men. In any case, what is most important to keep in mind is that exposure to the violent video game increased the aggression of both male and female participants.

Underlying Processes

The General Affective Aggression Model as well as the more domain-specific models on which it is based suggest that media violence effects occur through one of three routes: cognitive, affective, or arousal. In Study 2, games were selected to create equal arousal states as measured by heart rate and blood pressure. Furthermore, excitement ratings were used as a covariate to further ensure that this route was closed off in this investigation. The affective route was at least partially closed off by the selection of two games that were equally enjoyable and difficult. We then included measures of aggressive affect and cognition, and found that short-term VGV exposure increased the accessibility of aggression-related thoughts, but did not increase feelings of hostility. In the past, only one experimental investigation examined the effects of violent video game play on aggressive thoughts. Calvert and Tan (1994) found that participants listed more aggres-

[2] One procedural aspect of Study 2 may have reduced the effects of the video games on the dependent variables. Specifically, any time lag between video game play and the collection of the dependent measures may allow the effects of the video game to dissipate somewhat. This may be one explanation for the lack of state hostility changes due to video game. We thank an anonymous reviewer for pointing this out. Future research should attempt to speak to these concerns.

sive thoughts after playing a violent virtual-reality game. Thus, the current investigation supports and extends this very small literature on cognitive priming effects. This line of inquiry is especially important because it supports the various cognitive models of aggression on which GAAM is largely based (e.g., Anderson et al., 1995; Berkowitz, 1984, 1990, 1993; Huesmann, 1986).

Our findings do not rule out the possibility that under some circumstances violent video game effects on subsequent aggressive behavior might be mediated by increased feelings of hostility or by general arousal effects. Indeed, GAAM explicitly notes that thoughts, feelings, and arousal are intricately interconnected, sometimes to such an extent that they can't be disentangled.

The results of the current investigation suggest that short-term VGV effects may operate primarily through the cognitive, and not the affective, route to aggressive behavior (e.g., Anderson et al., 1995). This finding is consistent with Huesmann's (1986) social-cognitive theory of the development of aggressive reaction tendencies from media violence exposure. Thus, the danger in exposure to violent video games seems to be in the ideas they teach and not primarily in the emotions they incite in the player. The more realistic the violence, the more the player identifies with the aggressor. The more rewarding the video game, the greater potential for learning aggressive solutions to conflict situations.

Academic Achievement

We found that academic achievement (GPA) was not related to prior violent video game play in particular, but was related to long-term exposure to video games in general. Some past research has shown relations between video game play and decrements in academic achievement. For example, Harris and Williams (1985) reported a link between video game playing and lower English grades. However, other work has failed to find such a linkage. For example, Creasey and Myers (1986) found no long-term relationship between video game play and school activities, and Van Schie and Wiegman (1997) found a positive relation between general video game play and IQ.

As is the case in the video game literature in general, there is no definitive answer to the question of whether video games disrupt academic performance. There are enough hints of such an effect to warrant further investigation. That video game play in general, and not violent video game play, would produce decrements in academic achievement makes sense if the effect is based on time spent on such activities (rather than on academic activities) and not on a direct effect of the content of the games. Huesmann (1986) reasoned that the lessons taught by media violence can attenuate intellectual performance as well, through a series of inter- and intrapersonal processes, and has provided convincing evidence. However, the restricted range of academic achievement and of behavior problems in our college student sample raises the possibility that a less restricted sample may indeed show a unique violent video game effect on academic performance as well.

Unique Dangers of Violent Video Games

The present data indicate that concern about the potentially deleterious consequences of playing violent video games is not misplaced. Further consideration of some key characteristics of violent video games suggests that their dangers may well be greater than the dangers of violent television or violent movies. There are at least three reasons for this. The first concerns identification with the aggressor. When viewers are told to identify with a media aggressor, postviewing aggression is increased compared with measured aggression of those who were not instructed to identify with the aggressor (e.g., Leyens & Picus, 1973). In "first person" video games the player assumes the identity of the hero, and sometimes chooses a character whose persona the player then assumes. The player controls the action of this character and usually sees the video game world through that character's eyes. In other words, the main character is synonymous with the game player, potentially heightening the game's impact.

The second reason for concern involves the active participation involved in video games. Research on the catharsis hypothesis reveals that aggressive behavior usually increases later aggressive behavior (Bushman, Baumeister, & Stack, in press; Geen & Quanty, 1977; Geen, Stonner, & Shope, 1975). The active role of the video game player includes choosing to aggress and acting in an aggressive manner. This choice and action component of video games may well lead to the construction of a more complete aggressive script than would occur in the more passive role assumed in watching violent movies or TV shows.

A third reason to expect video games to have a bigger impact than TV or movies involves their addictive nature. The reinforcement characteristics of violent video games may also enhance the learning and performance of aggressive scripts. Braun and Giroux (1989) noted that video games are "the perfect paradigm for the induction of 'addictive' behavior" (p. 101). Griffiths and Hunt (1998) found that one in five adolescents can be classified as pathologically dependent on computer games. Video game "addiction" may stem, in part, from the rewards and punishments the game gives the player (Braun & Giroux, 1989; Dill & Dill, 1998; Klein, 1984), much like the reward structure of slot machines. When the choice and action components of video games (discussed above) is coupled with the games' reinforcing properties, a strong learning experience results. In a sense, violent video games provide a complete learning environment for aggression, with simultaneous exposure to modeling, reinforcement, and rehearsal of behaviors. This combination of learning strategies has been shown to be more powerful than any of these methods used singly (Barton, 1981; Chambers & Ascione, 1987; Loftus & Loftus, 1983).

Summary and Conclusions

Violent video games provide a forum for learning and practicing aggressive solutions to conflict situations. The effect of violent video games appears to be cognitive in nature. In the short term, playing a violent video game appears to affect aggression by priming aggressive thoughts. Longer-term effects are likely to be longer lasting as well, as the player learns and practices new aggression-related scripts that become more and more accessible for use when real-life conflict situations arise. If repeated exposure to violent video games does indeed lead to the creation and heightened accessibility of a variety of aggressive knowledge structures, thus effectively altering the person's basic personality structure, the consequent changes in everyday social interactions may also lead to consistent increases in aggressive affect. The active nature of the learning environment of the video game suggests that this medium is potentially more dangerous than the more heavily investigated TV and movie media. With the recent trend toward greater realism and more graphic violence in video games and the rising popularity of these games, consumers of violent video games (and parents of consumers) should be aware of these potential risks.

Recent events in the news, such as the link between teenage murderers in Colorado and violent video game play, have sparked public debate about video game violence effects. As the debate continues, video games are becoming more violent, more graphic, and more prevalent. As scientists, we should add new research to the currently small and imperfect literature on video game violence effects and clarify for society exactly what these risks entail. The General Affective Aggression Model has proved useful in organizing a wide array of research findings on human aggression and in generating testable propositions, including the present studies of video game violence. Additional short-term studies of the effects of violent video games are needed to further specify the characteristics of games and of game players that reduce and intensify the aggression-related outcomes. Longitudinal studies of exposure to violent video games are needed to test the proposition that such exposure can produce stable changes in personality, changes of the type seen in research on long-term exposure to other violent media.

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