

Video Game Effects—Confirmed, Suspected, and Speculative

A Review of the Evidence

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This literature review focuses on the confirmed, suspected, and speculative effects of violent and non-violent video game exposure on negative and positive outcomes. Negative outcomes include aggressive feelings, aggressive thoughts, aggressive behavior, physiological arousal, and desensitization, whereas positive outcomes include various types of learning. Multiple theories predict, and empirical findings reveal, that violent video game exposure is causally related to a host of negative outcomes and a few positive outcomes. Some non-violent video games have been causally related to some specific positive learning effects as well as certain types of visual cognition (e.g., spatial rotation abilities) and may be associated with some negative effects on executive control and attention disorders.

Keywords: *aggression; computer games; desensitization; General Aggression Model; General Learning Model; learning; negative effects; positive effects; prosocial effects; video games; violence; visual cognition*

Recent statistics suggest that youth in the United States play video games an average of **R**9 hours per week (Gentile, Lynch, Linder, & Walsh, 2004). Survey research has found that approximately 21.4% of college freshmen played video games at least 6 hours per week during their senior year in high school (Cooperative Institutional Research Program, 2005), and approximately 70% of college students consider themselves avid gamers (Weaver, 2003). Statistics comparing males and females reveal that boys play violent video games more frequently than girls (Anderson, Gentile, & Buckley, 2007; Gentile et al., 2004). Any way you look at it, video games are very popular, which is reflected in the 17.9 billion dollar revenue that the video game industry grossed in 2007, a 43% increase from 2006 (Berardini, 2008).

In light of this massive exposure, it is important to understand the impact video games have on players. We discuss the relevant video game literature in terms of

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confirmed, suspected, and speculative findings for negative and positive outcomes. By *confirmed*, we mean effects that have received consistent empirical support using multiple research designs, paradigms, and populations, with appropriately large total samples of participants. In other words, effects are labeled confirmed when we believe that there is enough converging evidence to make causal claims regarding the effects of video game exposure on certain outcomes. *Suspected* effects are those for which there is substantial empirical support, but that support currently does not allow strong causal statements because of a combination of relatively few studies, few participants, or few research designs. For example, existing studies may have used only one specific of research design (e.g., only cross-sectional), making causal claims difficult. *Speculative* effects are those that have received only limited empirical attention and support.

The three labels (confirmed, suspected, or speculative) refer to the strength of the evidence that the video game effect is a causal one. Though all study types can vary in quality and diagnosticity of causality, in general experimental and longitudinal studies are more diagnostic of true causal effects than cross-sectional studies. Nonetheless, even cross-sectional studies are relevant to testing causal claims, especially cross-sectional studies that allow tests of alternative (i.e., noncausal) explanations (e.g., Anderson et al., 2007). However, in no case do we claim confirmed status on the basis of a set of cross-sectional studies without converging evidence from experimental and/or longitudinal studies.

Negative outcomes refer to video game effects that are harmful either to the individual or to society at large, such as aggressive and violent behavior. Positive outcomes refer to effects that are beneficial to the individual and to society, such as improved cognitive outcomes (e.g., visual perception). Of course, such judgments are subjective and value laden, but the guiding values are ones we believe are endorsed by most people. For example, effects that involve an improved ability to get along with other people or to perform well in school or on most jobs are considered positive effects. Conversely, effects that involve an increased likelihood of hurting other people, failing to get along with other people, or a decreased ability at school or job abilities are considered negative effects. Finally, it is important to note that some effects may be positive in one context but negative in most others. For example, ability and willingness to inflict harm on other people is necessary in combat soldiers *when they are in combat* but is generally not a positive trait in most other people or even in non-combat situations for soldiers.

Theory: How Video Games Cause Negative and Positive Outcomes

Multiple theoretical explanations have advanced our understanding of video game effects; however, most focus exclusively on just the positive and negative outcomes. One approach that can explain both negative and positive outcomes is the

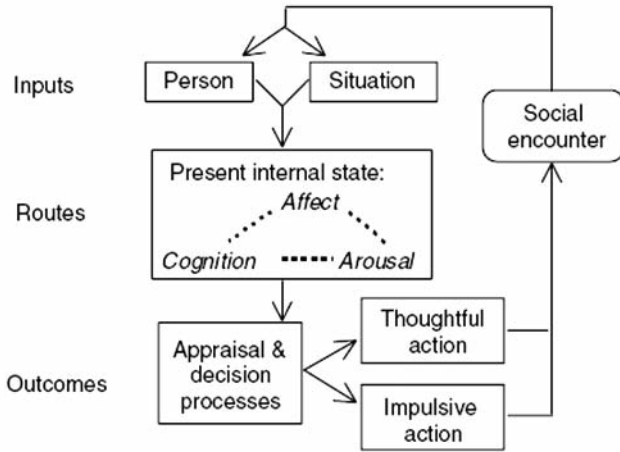
General Learning Model (GLM; see Buckley & Anderson, 2006). GLM describes how person and situational variables interact to either increase or inhibit various types of learning. This process is mediated by the internal state, which consists of one's physiological arousal, feelings, and cognitions. These three internal states vary as a function of the ongoing situational episode and traits, attitudes, skills, emotions, and beliefs that the individual brings to the situation. In this sense, each situational encounter constitutes another learning trial. The learning that may occur consists of factual learning, learning behaviors, perceptual learning, changes in attitudes, beliefs, and emotional reactions. In general, such learning-based changes can, in the long-term, change the video game player's personality traits and abilities.

GLM can also predict why video game play is related to learning negative outcomes. One specific type of GLM—in fact, the precursor—is the General Aggression Model (GAM; Anderson & Bushman, 2001; Anderson & Huesmann, 2003; Bushman & Anderson, 2000). GAM delineates how the causal link between any variable that increases aggressive behavior (such as media violence exposure) is mediated by one's thoughts, feelings, or physiological arousal. Some variables increase aggression primarily through the affective route (e.g., uncomfortably hot temperature; e.g., Anderson, Anderson, Dorr, DeNeve, & Flanagan, 2000). Others may directly influence more than one of the three internal states and, therefore, can increase aggression in multiple ways. For example, some violent video games may increase aggressive thinking, aggressive feeling, and physiological arousal (Anderson & Bushman, 2001). Because these three internal state variables are inter-correlated, it is difficult to disentangle the primary route through which a specific causal variable increases aggression. In any case, once an aggressive act has transpired, it feeds back into the situational input variable (see Figure 1).

One strength of GAM is that through the cyclical process described above, long-term effects of repeated media violence exposure are anticipated (see Carnagey & Anderson, 2003). The long-term effects from violent media exposure are related to aggressive beliefs and attitudes, aggressive perceptual schemata, aggressive expectation schemata, aggressive behavioral scripts, and desensitization to violence. These five types of relatively stable internal variables (and perhaps others) contribute to an "aggressive personality," which is related to the person factors in the episodic version of GAM (see Figure 2).

The use of these and other theoretical frameworks allows researchers to generate testable hypotheses regarding the effects of violent and non-violent video game exposure on various outcomes. Next, we review the literature on the confirmed effects (research findings that have been replicated many times with diverse methods), suspected effects (considerable empirical support, but not sufficient to warrant *strong* causal claims), and speculative effects (research findings that have received only limited empirical attention but that are becoming issues of interest to the research community).

Figure 1
The Episodic General Aggression Model



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Confirmed Video Game Effects

Negative Outcomes

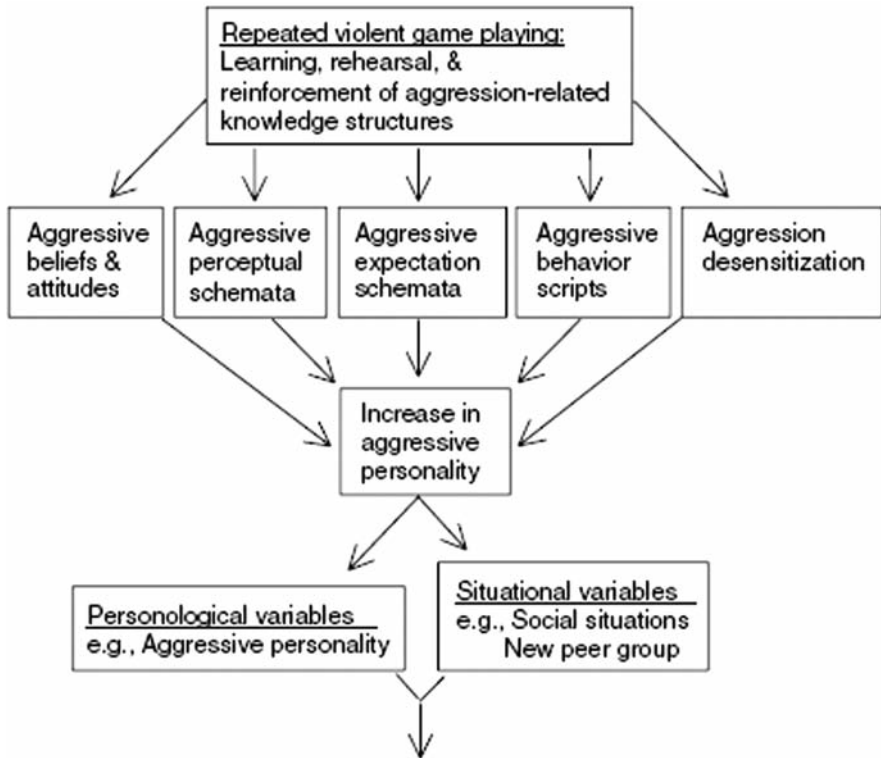
For decades now, there has been a great deal of interest in media violence effects (e.g., Potter, 2002). Violent video game exposure may shape the player’s behavior because constant playing reinforces the belief that hurting others is a successful way to resolve conflict.

Evidence

Multiple studies have found overwhelming evidence to suggest that exposure to violent video games is causally related to each of the internal state variables (aggressive feelings, aggressive thoughts, and physiological arousal) identified by GAM, to aggressive behavior, and other variables. Each will be briefly discussed.

Physiological arousal. Although heightened physiological arousal (e.g., heart rate, blood pressure, skin conductance) can be beneficial in certain situations, physiological arousal produced by violent media (or by other sources) can be related to an increase in aggressive behavior, especially when that arousal can be misattributed to another provoking event, rather than to the violent media. This rationale is why we view physiological arousal produced by violent media exposure as a negative outcome. Research

Figure 2
The Personality Process Long-Term General Aggression Model



General Aggression Model, as in Figure 1

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has shown that video games, regardless of content, can increase physiological arousal, probably as a function of the games being fun, challenging, and exciting (see Carnagey & Anderson, 2005). However, research has shown that violent video game exposure heightens heart rate (e.g., Fleming & Rickwood, 2001) and blood pressure (e.g., Ballard & Wiest, 1996) and that violent video games tend to produce more arousal than non-violent video games (Anderson & Bushman, 2001).

Aggressive feelings. Feelings of anger or hostility can be increased by violent video game exposure. Aggressive feelings are typically assessed using self-report questionnaires, such as the State Hostility Scale (Anderson, Deuser, & DeNeve,

1995) and the Multiple Affective Adjective Checklist (Zuckerman & Lubin, 1965). Research using such methods has found that violent video game exposure increases aggressive feelings, relative to non-violent video game play (e.g., Anderson & Bushman, 2001; Ballard & Wiest, 1996; Carnagey & Anderson, 2005).

Aggressive cognitions. Anderson and Huesmann (2003) argued that aggressive cognitions are the most influential route to long-term effects of violent video game exposure on aggressive behavior. Non-violent video games can increase physiological arousal (if the game is exciting) and aggressive feelings (if the game is too difficult) and, so, could indirectly prime aggressive cognitions and thereby influence long-term changes in the accessibility of aggression-related structures (see Anderson & Bushman, 2001, for review). But on the whole, violent video game play should more directly activate aggressive knowledge structures than non-violent game play (Anderson & Huesmann, 2003).

Although there are myriad methods to assess aggressive thoughts, the findings using different measures theoretically converge to suggest that violent video game exposure increases activation of aggressive thoughts and aggressive scripts in memory. Some of the most common methods used to assess aggressive cognitions include the Word Completion Task (Anderson, Carnagey, & Eubanks, 2003; Anderson, Carnagey, Flanagan, Benjamin, Eubanks, & Valentine, 2004), reaction times to aggressive and non-aggressive words (Anderson, Benjamin, & Bartholow, 1998), the Implicit Association Test (Uhlmann & Swanson, 2004), completion of ambiguous story stems (Anderson et al., 2007; Bushman & Anderson, 2002), and the face-emotional recognition task (Kirsh, Mounts, & Olczak, 2006). Overall, these methods have yielded consistent findings: Violent video game exposure leads to aggressive priming, activation of aggressive scripts and knowledge structures, and a hostile attribution bias compared to non-violent video game exposure.

Aggressive behavior. Many methods and tools are used to measure aggressive behavior (see Bushman & Anderson, 1998; Ritter & Eslea, 2005, for a review of laboratory-based methods). Methods used to assess aggressive behavior range from observations of children at play (e.g., Schutte, Malouff, Post-Gordon-Joan, & Rodasta, 1988) to reports by oneself, teachers, parents, and peers (e.g., Anderson et al., 2007, Studies 2 and 3), to standard laboratory paradigms (e.g., Konijn, Nije, & Bushman, 2007). Results using these and other measures show strong support for the causal relationship between violent video game exposure and aggressive behavior. Overall, experimental, cross-sectional, and longitudinal studies have all found that exposure to violent video games leads to increased physical aggression (for comprehensive reviews, see Anderson, Berkowitz, et al., 2003; Anderson & Bushman, 2001; Anderson et al., 2004; Anderson et al., 2007).

Prosocial behavior. Because violent video game exposure increases aggressive behavior, one might speculate that such games might also suppress or interfere with prosocial behavior, defined as helping or rewarding others, especially when no motives exist for why these acts occurred. Evidence for this has been shown in correlational and experimental research. A correlational study found that heavy violent video game players behaved less prosocially during free play (Wiegman & van Schie, 1998). Experimental research has found that exposure to violent video games is related to lower prosocial behavioral responding. Ballard and Lineberger (1999) found that participants gave less of a reward (jellybeans) to male confederates in a teacher/learner paradigm after violent video game play (MORTAL KOMBAT) compared to non-violent video game play (NBA JAM). Similar results have been found for donating to a charity box (Chambers & Ascione, 1987) and during free play (Silvern & Williamson, 1987). More recently, Bushman and Anderson (in press) found that college student participants who had just played a violent video game took longer to help a violence victim than those who had just played a non-violent game.

Moderator Variables

Baron and Kenny (1986) define a moderator as a variable which “partitions a focal independent variable into subgroups that establish its domains of maximal effectiveness in regard to a given dependent variable” (p. 1173). Although much experimental work has tested variables that might moderate the relationship between violent video game exposure and aggression, it appears as though this effect is fairly constant across video game systems, video game genre, socioeconomic status, age, and sex. This allowed for a number of media violence researchers to conclude that violent media effects (including video games) are a general effect—not limited to specific types of people (Anderson, Berkowitz, et al., 2003).

Although the previously mentioned variables do not appear to moderate the relationship between violent video game exposure and aggression, multiple aspects of the violent video game itself might moderate the effect on aggression (see Table 1). We focus on the research that has been the most consistent. One moderator is the presence of blood in a violent video game. Research has shown that blood in a violent video game can lead to higher levels of physiological arousal, aggressive feelings, and aggressive thoughts (e.g., Ballard & Wiest, 1996; Barlett, Harris, & Bruey, 2008), though this doesn’t always occur (Anderson et al., 2004, Experiment 3). It is believed that the blood in a video game acts as a strong prime to inform players that a violent act has just occurred, which should activate aggressive cognitions. Another moderating variable is whether or not the video game reinforces or punishes the player for violent acts. Carnagey and Anderson (2005) found that a driving game that rewarded the player for killing pedestrians produced higher levels of aggressive thoughts and aggressive behaviors than a version of the same game that punished players for killing pedestrians. To some extent, this appeared to occur because players performed less game violence when such violence was punished.

Table 1
Within-Game Moderators in the Relationship Between Violent Video Game Exposure and Aggressive Thoughts, Aggressive Behaviors, and Arousal

Moderator	Study	Outcome	Findings
Presence of blood in a violent video game	Ballard and Wiest (1996)	physiological arousal, aggressive feelings	Those who played a violent video game with blood had more aggressive feelings and systolic blood pressure compared to those who played a violent video game without blood. No effect was found for heart rate and diastolic blood pressure.
	Ballard and Lineberger (1999)	aggressive behavior, prosocial behavior	No difference between those who played a violent video game with or without blood on the outcome variables.
	Farrar, Krcmar, and Nowak (2006)	aggressive feelings, aggressive intentions	Those who played a violent game with blood had higher aggressive intentions than those who played a violent video game without blood. No effect of blood presence on aggressive feelings.
	Barlett, Harris, and Bruey (2008)	aggressive thoughts, aggressive feelings, physiological arousal, within-game violence	Those who played a violent video game with large amounts of blood had more state hostility, higher heart rate, and more aggressive thoughts compared to those who played a violent video game with little or no blood. Also, when blood levels were high, participants played the violent video game with a character's weapon more.
Rewarding violence	Camagey and Anderson (2005)	aggressive thoughts, aggressive feelings, aggressive behavior	Those who played a violent video game that rewarded the player for killing

(continued)

Table 1 (continued)

Moderator	Study	Outcome	Findings
Using an interactive light gun	Bartlett, Harris, and Baldassarro (2007)	aggressive scripts, aggressive feelings, heart rate	pedestrians had more aggressive thoughts and aggressive behavior compared to those who played a violent video game that punished killing pedestrians. There was no video game effect for aggressive feelings. Those who played a violent video game with an interactive light gun had more state hostility, heart rate, and aggressive scripts compared to those who played a violent video game with a standard controller.
Competitive vs. cooperative play	Anderson and Morrow (1995)	within-game violence, aggressive feelings	Those in the competitive video game condition used more violent methods to kill enemies compared to those in a cooperative video game condition. No difference was found for aggressive feelings.
Point of view (first- vs. third-person)	Eastin (2007) Farrar, Krcmar, and Nowak (2006)	aggressive feelings aggressive feelings, aggressive intentions	No difference between competitive or cooperative violent video game play on aggressive feelings. Those who played a violent video game in first-person point of view did not differ from those who played a violent video game in third-person point of view on the outcomes.

(continued)

Table 1 (continued)

Moderator	Study	Outcome	Findings
Sex of character	Eastin (2006)	aggressive thoughts	Those who played a violent video game with a character who was the same sex had more aggressive thoughts than those who played a violent video game with a character of the opposite sex.
	Anderson and Murphy (2003)	aggressive behavior	No difference between those who played a violent video game with a character of the same sex or opposite sex on aggressive behavior.
Game interface	Eastin and Griffiths (2006)	aggressive thoughts	Those who played a violent video game using virtual reality had more of a hostile attribution bias compared to those who played a violent video game on a standard console.
	Persky and Blascovich (2008)	aggressive feelings, within-game violence	Those who played a violent video game using virtual reality had more aggressive feelings and shot enemy characters in the head more often than those who played a violent video game on a standard console.
Video game realism	Anderson et al. (2004, Study 3)	aggressive behavior	Those who played a violent video game where the character's blood was red did not differ from those who played a violent video game where the character's blood was green on aggressive behavior.
Video game graphics quality	Ivory and Kalyanaram (2007)	physiological arousal, aggressive thoughts, aggressive feelings	Those who played a video game of higher graphics quality were more physiologically aroused compared to those who played a video game with poor graphics quality. No video game content effect was found for the outcomes measured.

Long-Term Effects

Only recently have longitudinal studies on violent video game exposure and aggression been reported. Such studies are useful at testing the effect of violent video game play on the same group of individuals over a specific portion of time (typically months or years). Anderson et al. (2007, Study 3) sampled third- through fifth-graders two times during the academic year and gathered reports of how often they played violent video games and of physical aggression. Results showed that violent video game play frequency at Time 1 predicted the frequency of aggressive behavior approximately 5 months later (Time 2), even after controlling for Time 1 aggressiveness and several other relevant variables. We believe that as more longitudinal research is conducted and longer time lags between questionnaire administration periods are used, the results will be similar or more dramatic.

There is some evidence that attractiveness of perpetrator and justification of violence moderate the long-term effects of violent video game play (Shibuya, Sakamoto, Ihori, & Yukawa, in press), but this finding comes from only one study on Japanese school children and varied by gender. In short, more work is needed to confirm this initial evidence. Three recent longitudinal studies have found similar longitudinal effects on aggressive behavior in Japan and the United States (Anderson, Sakamoto, Gentile, Ihori, & Shibuya, in press).

Meta-Analytic Work

There have been multiple meta-analyses on the effects that violent video game play has on aggression (Anderson, 2004; Anderson & Bushman, 2001; Anderson et al., 2004; Sherry, 2001). Properly conducted meta-analytic findings are especially important because they objectively summarize the results of all relevant studies. Results typically show a positive relationship between violent video game exposure and aggressive feelings ($r = .21$), aggressive thoughts ($r = .24$), aggressive behavior ($r = .26$), and physiological arousal ($r = .21$). The methodologically stronger studies tend to yield larger effect sizes than studies that have some methodological flaws (Anderson, 2004). To the average reader, these effect size estimates may appear small; however, we maintain that these effect sizes are large enough to be considered important. The magnitude of these effect sizes is similar to (even a bit larger than) many other public health issues, including the magnitude of the relationship between asbestos exposure and cancer, and between calcium intake and bone mass (see Gentile, Saleem, & Anderson, 2007). Therefore, these findings should not be taken lightly.

Positive Outcomes

Although the research findings presented have demonstrated that violent video game exposure is related to negative societal outcomes, some empirical work (and many advertisements) suggests that video game exposure independent of content is related to improvements in certain types of cognition and learning. In fact, the video

game industry has begun to produce video games that are marketed to make the player smarter. For instance, the games *BRAIN AGE*, *FLASH FOCUS: VISION TRAINING IN MINUTES A DAY*, *MY SPANISH COACH*, and *LEFT BRAIN RIGHT BRAIN* are commercially available video games that are designed to enhance learning, skills, vocabulary, and math. It is important to note that the majority of the games marketed to enhance such skills are non-violent. Interestingly, there is almost no research testing whether such games actually yield significant improvements. Furthermore, in those cases where there are at least some well-done studies of positive effects, the literature is too small for meta-analytic review, unlike the much larger (and more robust) literatures on negative effects of violent games on aggression-related outcomes. Nonetheless, some domains do yield convincing evidence of positive effects.

Visual Attention

In a series of correlational studies, Green and Bavelier (2003) found that playing video games was associated with superior performance on a variety of visual attention tasks. In a flanker task, participants identified a target visual stimulus in the presence of similar or different distractor stimuli. Video game players were influenced by the type of distractor stimuli (responding faster when distractors were similar and slower when they were different) even when the flanker task was so difficult that non-video game players lacked the attentional resources to process the distractors at all. Though this finding indicates greater visual attention capacity, the positive nature of this result is somewhat ambiguous. A greater tendency to process irrelevant flanker stimuli also indicates poorer executive control.

Other visual attention tasks revealed a more unambiguous association between video game playing and superior visual attention performance. Video game players outperformed non-video game players on an enumeration task (rapidly counting the number of squares presented on a computer screen), resulting from faster serial counting of the targets (rather than immediately perceiving the targets; Green & Bavelier, 2006). Further, video game players demonstrated greater useful field-of-view. In other words, video game players are better at searching for and identifying stimuli presented in the visual periphery. Video game players also showed a shorter attentional blink, meaning they were better able to process a second visual stimulus that was presented several hundred milliseconds after an initial stimulus.

Green and Bavelier (2003) assigned non-video game players to play either *MEDAL OF HONOR* (an action video game that involves rapidly shifting attention around the visual field) or *TETRIS* for 1 hour per day for 10 straight days. *TETRIS* served as the control because it would be expected to improve visuo-manual expertise but involves focusing on one target at a time. Those assigned to play the action video game later showed superior performance on the enumeration task, the useful field-of-view task, and the attentional blink task (see also Feng, Spence, & Pratt, 2007).

Spatial Abilities

The ability to mentally rotate or arrange objects is related to many general learning tests and paradigms, and research has shown that video game play is related to this ability. Playing TETRIS, a video game in which the player mentally rotates and fits a variety of shapes together to gain points, is related to heightened spatial abilities (De Lisi & Wolford, 2002; Okagaki & Frensch, 1994; Passig & Eden, 2001). Greenfield, Brannon, and Lohr (1994) had participants play a violent video game (THE EMPIRE STRIKES BACK) and complete a spatial rotation task (i.e., a paper folding task). Results showed that those who performed well at the video game also performed significantly better on the spatial ability task compared to those who did not perform well at the game.

Moderators of Visual Attention/Spatial Ability Effects

Theoretically, GLM predicts that some variables may moderate the relationship between video game exposure and learning. Most importantly, video game content does not seem to moderate this overall effect, such that both violent (Green & Bavelier, 2003; Greenfield et al., 1994) and non-violent video games (De Lisi & Wolford, 2002; Larose, Gagnon, Ferland, & Pepin, 1989; Okagaki & Frensch, 1994; Oyen & Bebko, 1996; Passig & Eden, 2001) are related to certain spatial-cognitive gains. This suggests that children do not need to use violent video games in order to gain the spatial-cognitive benefits of video game exposure; non-violent video games are capable of producing similar benefits. Therefore, one may be able to get the short-term positive benefits from game play without the negative consequences (i.e., aggression), if the game is non-violent and displays stimuli that elicit the cognitive gain. Conversely, a player may be able to cognitively benefit from certain computer games if the game requires mental effort and scanning, but if the video game is violent, then negative outcomes may also be heightened. Other possible moderators, such as the age of the participant, participant's mental status, and other theoretically relevant variables (e.g., time spent playing the game), need more empirical support before stronger, long-term causal claims can be made.

Educational Video Games

The use of video games to teach specific educational skills and knowledge is an intended positive consequence of educational video games. Gentile and Gentile (2008) argued that video games can serve as excellent instructors because, unlike traditional teaching methods, computer-based instruction reinforces the student often, emphasizes distributed practice (because children continue to play games on many separate occasions), offers clear objectives, and requires that the learner be actively involved. Educational video games are an effective teaching aid for certain school subjects for children and adolescents, including algebra (Corbett, Koedinger, & Hadley, 2001), biology (Ybarrondo, 1984), photography (Abrams, 1986), and computer programming (Kahn, 1999). Video games and simulators have been used

in a variety of applied settings to teach specific skills (see Swing & Anderson, 2008, for a brief review). For instance, flight simulators have been used by the Air Force and NASA for decades.

To test whether certain educational video games affect learning and behavior in a medical context, Lieberman (2001) randomly assigned diabetic youth to play a diabetes self-management video game or a non-health-related video game for 6 months. Results showed that those who played the diabetes-related video game had an increase in their self-knowledge about their disease, openly communicated about their diabetes to others more, and decreased their number of visits to the emergency room compared to those who played the control video game. These findings provide evidence that educational video games do have affective, communicative, and behavioral effects related to what these games intend to teach (see also Lieberman, 2006).

Suspected Video Game Effects

Negative Outcomes

Long-Term Aggressive Attitudes

Cross-sectional findings suggest that, after statistically controlling for gender and real-life violence exposure, there is a positive relationship between violent video game exposure and attitudes toward violence (Funk, Baldacci, Pasold, & Baumgardner, 2004). Research that has tested similar hypotheses and did not replicate these findings typically suffers from some methodological shortcomings. For example, Brady and Matthews (2006) compared the effects of playing a high violent video game (GRAND THEFT AUTO III) to a low violent video game (SIMPSON'S HIT AND RUN) on attitudes toward violence. However, this study did not include a truly non-violent video game; thus, their study does not allow a true test of the effect of violent versus non-violent video games on attitudes toward violence. Cross-sectional findings have also suggested that violent video game exposure is related to trait anger (Bartholow, Sestir, & Davis, 2005), trait hostility (Gentile, Lynch, Linder, & Walsh, 2004), and attitudes toward war (Anderson et al., 2007, Study 2). More work is needed in order to determine the long-term consequences of violent video game exposure on attitudes towards violence.

Desensitization/Empathy

Research has found that exposure to violent video games is related to desensitization, defined as "a reduction in emotion-related physiological reactivity to real violence" (Carnagey, Anderson, & Bushman, 2007, p. 490). The premise behind desensitization is that continued exposure to violence will lessen a person's normal negative emotional reaction to further violence exposure, indexed by various physiological indicators of emotion. Because negative emotional reactions to thoughts of

violence reduce the likelihood that such violent behavior scripts will be selected for use, this desensitization reduces the probability of real-life aggression (Huesmann, 1986). Experimental research has found that repeated exposure to violent video games is related to a decrease in cardiovascular indicators of negative emotional reactions to scenes of violence (Carnagey et al., 2007). Using brain wave indicators, Bartholow, Bushman, and Sestir (2006) found that high violent video game players were desensitized to violence, relative to low violent video game players. They also found that this brain indicator of desensitization mediated the relationship between video game violence exposure and aggressive behavior.

It has been argued that one can infer desensitization to violence when related emotional processes are affected (Eron, 2001; Funk et al., 2004), even when physiological indicators of desensitization are not assessed. Decreased empathy is one such process. In a correlational study of fourth- and fifth-grade children, participants completed measures of violent media exposure (television, Internet, and video games), attitudes toward violence, empathy, exposure to real-life violence, and relevant demographic variables. Results showed that after controlling for aggression-related variables (gender and exposure to real-life violence), violent video game exposure was negatively related to self-reported empathy (Funk et al., 2004). Bartholow, Sestir, and Davis (2005) found a similar negative correlation between video game violence exposure and empathy in a college-aged sample.

Attention Deficits

Another recent line of research has found evidence that exposure to electronic media, particularly in early childhood, is associated with attention disorder diagnosis or the symptoms of attention disorders such as attention deficit/hyperactivity disorder (ADHD; e.g., Acevedo-Polakovich, Lorch, & Milich, 2007; Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004). Much of the available television and video game content involves rapid shifts in attention as the viewer shifts focus from one target to another or reorients due to fast movement or a new angle of view. This rapid pacing seems to be an important element in the association between video game exposure and attention deficits. One recent study examined the possibility that the effects of media exposure in early childhood on attention deficits depend on the content of that media (Zimmerman & Christakis, 2007). This study found that violent media and non-violent non-educational media were both associated with a greater negative impact on attention deficits than educational media exposure.

The majority of this research has focused on the effect of television viewing, but Chan and Rabinowitz (2006) found that playing video games was associated with more self-reported inattention and symptoms of ADHD in a high school student sample. The effects of television on attention deficits have even been demonstrated in recent longitudinal studies that statistically controlled for earlier attention problems (Johnson, Cohen, Kasen, & Brook, 2007; Landhuis, Poulton, Welch, & Hancox, 2007). These provide some evidence that media exposure is exerting a

causal effect on attention problems, but the longitudinal findings have yet to be tested with video game exposure.

At first glance, these findings appear to be inconsistent with the research findings of video games related to visual-spatial attention. A closer examination of the findings reveals that these effects likely involve very different types of attention. The research on attention deficit outcomes measures symptoms relating to such challenges as sustaining attention on a single target (attention) or controlling stimulus-inspired impulses (hyperactivity). The research examining the effects of video game playing on visual-spatial attention focuses on ability to rapidly shift attention between targets and to orient attention to visual stimuli across a wide range of space. Not only are these attention processes distinct, in some cases they may be opposing processes. For example, in Green and Bavelier (2003), the finding of greater attention resources on the flanker task meant that the video game players were more likely to process the distractor stimuli. When the distractors on a flanker task are inconsistent with the target, this processing actually interferes with task performance. In other words, greater visual attention resources could lead to more interference by distractors in some tasks. Despite these interesting findings of video game effects on different aspects of attention, more research is clearly needed in these areas. The findings of a video game association with attention problems must be replicated and, if they are, future research should examine whether the changes in attention result from a single underlying process or multiple processes.

Executive Control

In daily life, people must often inhibit an automatic response in order to behave in ways consistent with their personal goals. This process is known as executive control. Given the association of media exposure and attention problems (in which staying on task and inhibiting task-irrelevant behaviors are problematic), a similar relationship should be found between video game playing and executive control. There is some research indicating that playing violent video games is associated with decreased ability to exert executive control. For example, one study found that those adolescents who play lots of violent video games showed greater interference on a Counting Stroop task assessing executive control, relative to a matched control group on non-gamers (Mathews et al., 2005). Furthermore, individuals diagnosed with disruptive behavior disorder (including aggressive symptoms) also showed greater interference on this task, suggesting a possible link between executive control and aggression. Similarly, Kirsh, Olczak, and Mounts (2005) found that participants assigned to play a violent video game (as well as those higher in trait hostility) showed greater interference for negatively valenced words (e.g., rage, murder) compared to neutral words (e.g., autumn, anchor) in an Emotional Stroop task that required naming the color of each word's text. These studies provide some evidence that playing violent video games decreases executive control, which may in turn increase aggressive behavior. More research is needed to make strong causal conclusions about these associations.

The conceptual similarity of attention disorders and executive functions suggests a possible common underlying effect of media exposure on each outcome, though further research is needed to test this prediction as well.

School Performance

One undesirable outcome of video game exposure is on overall school performance. Amount of time spent consuming screen media (television and video games) is negatively associated with school performance (Anderson et al., 2007; Gentile et al., 2004). Anderson and Dill (2000) also found that the amount of video game play was associated with lower college GPA. A longitudinal study of television viewing in adolescence found that viewing high amounts of television was associated with lower levels of educational achievement in early adulthood (Johnson et al., 2007).

Across studies, this association seems to be the result of the total time spent with such media, rather than exposure to a particular type of media content. This is consistent with the explanation that exposure to screen media hurts school performance by displacement. That is, every hour spent playing a video game is an hour that is not spent doing school work or other activities that might lead to better educational outcomes (e.g., reading for pleasure). More research is needed in this area to examine the possibility that mechanisms other than displacement (e.g., increased difficulty sustaining attention) might also be involved in the media exposure/school performance association. Furthermore, research should test the possibility that different forms of screen media exert different effects on school performance.

Positive Outcomes

Hand-Eye Coordination

Hand-eye coordination is important for a variety of behavioral tasks, such as performing surgery. Cross-sectional research (e.g., Griffith, Voloschin, Gibb, & Bailey, 1983) had video game players and non-players complete a variety of hand-eye coordination tasks (i.e., rotary pursuit tasks) and the results show that video game players performed better at these tasks. These findings are not surprising considering that playing a video game requires movement of a joystick or the push of a button in accordance with what is happening on the television screen. Rosser et al. (2007) found that past video game play and performance on one of three commercially available video games were both related to laparoscopic skills of residents and attending surgery physicians. Although this study did not specifically test hand-eye coordination, such skills are essential to perform successful laparoscopic surgeries.

Perceptual Accuracy/Speed

Reaction times to stimuli are sometimes important because many real-life behaviors require quick responding, and video game exposure may sharpen certain perceptual-cognitive skills, allowing faster reactions. Orosy-Fildes and Allan (1989) found that

those who played a video game (CENTIPEDE) had faster reaction times compared to those who did not play a video game. In a correlational design with kindergarten-aged children, Yuji (1996) found that video game players had faster reaction times to stimuli on a computer matching task compared to non-players. Interestingly, accuracy was not associated with the participant's gamer status. Finally, Goldstein et al. (1997) had elderly participants (mean age = 77.6 years) randomly assigned to one of two groups: the experimental group who played SUPER TETRIS for 5 or more hours a week for 5 weeks and a control group who did not play video games. Results from a pre- and post-experimental reaction time task (i.e., Sternberg Task) showed that participants in the experimental group had significantly faster reaction times compared to those in the control condition (Goldstein et al., 1997). More work is needed to determine how this increase in perceptual speed is related to skill transfer, memory, and attention.

Speculative Video Game Effects

Negative Effects

Narcissism

One moderating variable that has received little attention in the video game literature is narcissism, which is characterized by "self-serving interpretations, low empathy towards others, and an inflated sense of entitlement" (Bushman, Bonacci, van Dijk, & Baumeister, 2003, p. 1027). Research has shown that having a grandiose self-image, typical amongst narcissistic individuals, is related to higher aggressive behavioral responding relative to those who do not have such narcissistic self-images. Research also found that perceived threat to one's self-image significantly mediates the relationship between narcissism and aggressive behavior (Bushman & Baumeister, 1998). Given these findings, it may be that high narcissistic participants will behave relatively more aggressively after violent video game play, especially when their self-image is attacked, compared to those low on narcissism or when the self-image of narcissists is not attacked. Similarly, spending lots of time playing video games that reward violent responding to threats and that encourage narcissistic behavior and attitudes within the games may increase trait narcissism. More research is needed to test these possibilities.

Positive Effects

Communication

One area that needs empirical attention is the effect that certain games have on friendships, socialization skills, leadership, and team cooperative skills. Online gaming through computer or console-based platforms is becoming more available.

Nintendo Wii and PlayStation 3 both include a built-in wireless Internet card; thus, anybody can play video games with friends all over the world as long as the player has an Internet connection. PC-based massive multiplayer online role playing games (MMORPGs), such as WORLD OF WARCRAFT (WoW), are hugely popular. Statistics show that 9.3 million people pay to subscribe and play WoW (Schramm, 2007). These games allow players to control virtual characters that may interact with other virtual characters controlled by others all over the world.

Communication between players is possible with the use of headsets and microphones. Friendship creation is possible by playing such games repeatedly with the same people and maintaining a friendly dialogue. Williams, Caplan, and Xiong (2007) found that using a microphone to communicate to teammates in WoW was related to building stronger relationships and trust with teammates compared to those who used the standard text-based form of communication (i.e., typing on a keyboard). More work is needed on the effect that video games have on communication when one's teammate is across the world or right next to the player. The social interaction that can occur may be very different in these two contexts.

There may be other positive outcomes to online video game play that are advantageous for military training. Specifically, leadership and team cooperation skills are encouraged in certain military-based video games. For instance, some first-person-shooter video games allow players to create games with teams of other players. CALL OF DUTY 4: MODERN WARFARE and HALO 3, for example, have online team game modes that require teams of players to fight against enemies as a cohesive unit. With the use of headsets and other communication devices, certain players could assume the role of the leader of a commando force while talking to teammates. Finally, team building may be influenced by video game exposure if a team of game players communicates well to complete the video game's objectives. Given such communication abilities in some military-based commercially available video games, teamwork may be formed and maintained with repeated cooperative game play. Currently, it is unknown what effects playing these types of video games has on leadership skills, cooperativeness, team creation, or team longevity.

Subjective Well-Being

Video games, independent of content, are produced and played because they are fun. Video game play may enhance one's subjective well-being, defined as a positive evaluation of one's life that consists of a variety of factors including pleasant affect (Diener, Suh, & Oishi, 1997). There is a limited amount of empirical work that has examined the role that video game exposure has on positive affect; however, the work that has investigated video game play and positive affect has shown no statistical difference between playing a violent video game, a non-violent video game, or a pencil-and-paper game on positive mood (Fleming & Rickwood, 2001). However, this study only assessed post-game positive mood without considering baseline positive or negative affect. Due to the entertaining nature of video games, both violent

and non-violent games may have the potential to produce positive affect. Research accounting for baseline positive mood is needed to test for the degree of potential change in positive mood as a function of video game play. Experimental and longitudinal studies are particularly needed.

General Discussion

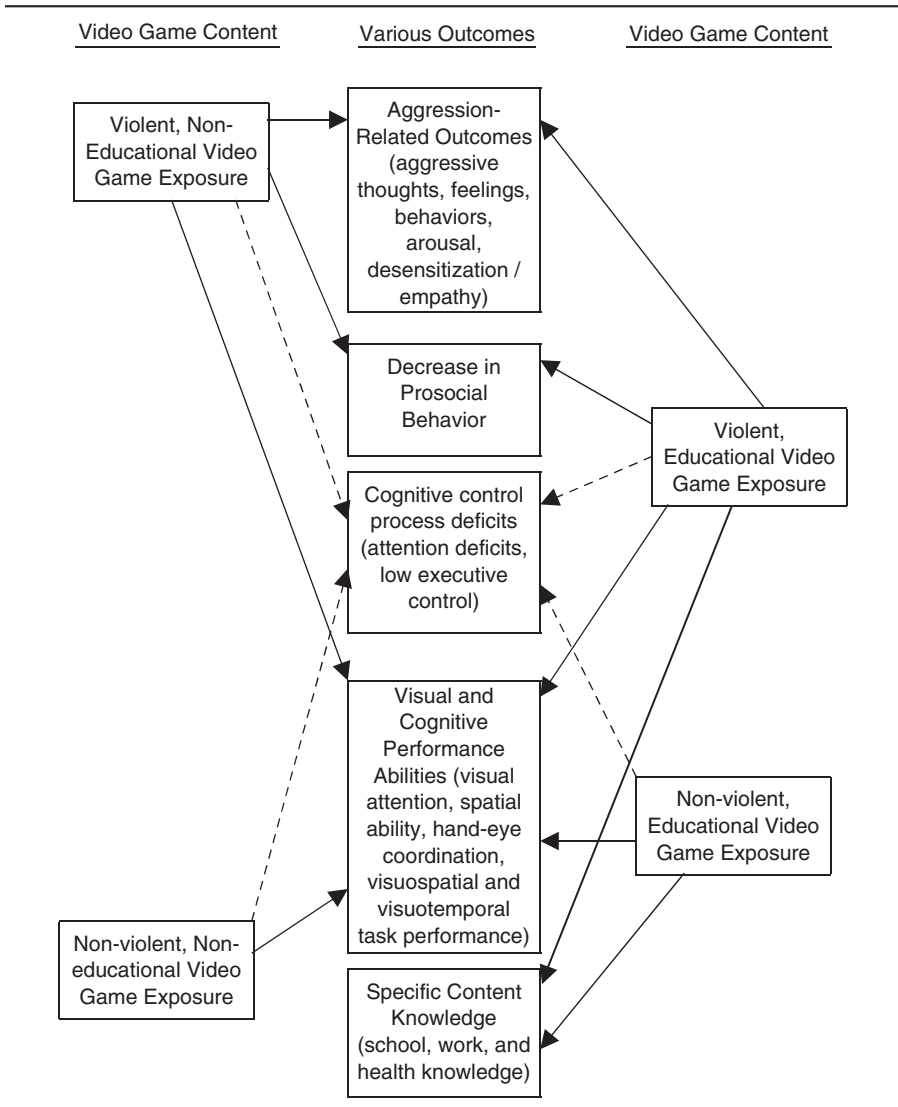
Overall, video games are played frequently and researchers are conducting empirical work to determine the psychological and behavioral effects that such play may have on players. Some video game effects have been confirmed by years of support, other effects are suspected findings that researchers are just now beginning to document, and still others are speculative effects that need much empirical attention. Some of the outcomes have negative societal implications; indeed, the effects of violent games on aggression-related variables are by far the most heavily researched and most clearly causal. Other effects are positive. Video games can be useful in aiding children and adults in learning educational content and visuospatial or visuotemporal skills, but the current literature suggests that these benefits do not depend on violent content. Thus, if schools or companies are going to use video games to aid in instruction, we suggest that those games do not contain violence. This should not distract from the fun or potential to learn classroom material from these games, because non-violent video games can be as fun and educational as violent video games. We also suggest caution in the amount of time spent using video games instructionally, because of the association between video game playing and attention deficit and school performance problems.

Figure 3 depicts the relationships between video game content and various outcomes, including aggression-related variables and cognition-related variables. This figure depicts four types of video game content: violent, non-educational (e.g., MORTAL KOMBAT), violent, educational (e.g., military-based simulators; AMERICA'S ARMY), non-violent, educational (e.g., BRAIN AGE), and non-violent, non-educational (e.g., SUPER MONKEYBALL). For the purposes of Figure 3, *educational* refers to games that are designed to teach specific content skills.

Note that we realize that many individual difference variables are related to a wide range of variables presented in Figure 3; however, such individual difference variables are not depicted for simplicity. We also realize that these four games are not completely orthogonal to each other. For instance, certain violent and non-violent video games are fast-paced; however, we did not draw all possible intercorrelations between the types of video game content, again, for the sake of simplicity.

Many different outcomes are related to playing video games. These variables are grouped according to their predicted interrelations. For instance, aggressive feelings, aggressive thoughts, aggressive behavior, physiological arousal, and desensitization/empathy are grouped together because they are all related theoretically and in past research. The outcomes include aggression-related variables (aggressive

Figure 3
Relationships between Video Game Content Exposure
and Various Outcomes



thoughts, aggressive feelings, aggressive behavior, physiological arousal, and desensitization/empathy), visual and cognitive performance variables (visual attention, hand-eye coordination, and spatial ability), specific content knowledge (school,

work, and health knowledge), cognitive control process deficits (executive control and attention deficits), and a decrease in prosocial behavior. Solid lines between the type of video game and the internal mediator variables denote confirmed effects, whereas the dashed lines denote speculative effects. Suspected effects are not included in the figure.

The left side of Figure 3 shows that violent video game exposure, independent of the degree of educational themes, is related to aggression-related variables, a decrease in prosocial behavior, and long-term cognitive deficits. Non-violent video game exposure is related to short-term cognitive-related variables and long-term cognitive deficits. The right side of Figure 3 differs from the left side by including educational themes in the content of the video game exposure. The depicted relationships between the video game content on the left and right sides of Figure 3 are conceptually similar to one another; however, educational video game exposure is related to specific content knowledge. Thus, educational video game exposure (independent of violent content) is related to cognitive-related variables and specific content knowledge is related to what the games are intended to teach.

We expect that there are complex interrelationships between certain outcomes that could not be fully depicted in Figure 3. In other words, some outcomes interact to influence certain behaviors. For instance, road rage requires a wide variety of cognitive skills to drive a car, but when a driver becomes aggressive after being provoked (e.g., somebody cutting off a driver), that driver is going to behave aggressively while also maintaining the cognitive skills required of driving. Another complex behavior is firing a weapon, which requires hand-eye coordination and visual attention, in addition to the heightened aggression from holding a firearm and pointing it at a living organism. Currently, it is unknown what effect video game content has on combinations of outcomes.

Future of Video Game Research

Now, more than ever, there is a need for well-conducted video game research. Anderson (2004) provided nine “best practice” methods in order to conduct rigorous scientific video game violence research. Such methodological rigor needs to be applied to the video game and aggression literature and adapted and utilized for the video game and cognition literature. Future research also needs to ask more theoretically relevant questions related to the variables that may moderate or mediate the relationship between the violent and/or educational content of the video game and aggressive thoughts, aggressive feelings, physiological arousal, attention, spatial abilities, hand-eye coordination, aggressive behavior, and other aggressive and non-aggressive outcomes.

Another area of future research involves the use of longitudinal designs to assess whether or not video games impact aggression and/or cognition over time. As previously stated, there have been only a few published reports on the longitudinal impact

of violent video game content on aggressive behavior (e.g., Anderson et al., 2007), but more work needs to be done that samples more children of different ages and other demographic variables over longer periods of time. More research is also needed on the various cognitive effects of violent and non-violent video game play over time.

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