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Violent video game effects on children and adolescents

A review of the literature

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Studies of violent video games on children and adolescents were reviewed to: 1) determine the multiple effects; 2) to offer critical observations about common strengths and weaknesses in the literature; 3) to provide a broader perspective to understand the research on the effects of video games. The review includes general theoretical and methodological considerations of media violence, and description of the general aggression model (GAM). The literature was evaluated in relation to the GAM. Published literature, including meta-analyses, are reviewed, as well as relevant unpublished material, such as conference papers and dissertations. Overall, the evidence supports hypotheses that violent video game play is related to aggressive affect, physiological arousal, aggressive cognitions, and aggressive behaviours. The effects of video game play on school performance are also evaluated, and the review concludes with a dimensional approach to video game effects. The dimensional approach evaluates video game effects in terms of amount, content, form, and mechanics, and appears to have many advantages for understanding and predicting the multiple types of effects demonstrated in the literature.

Key words: **Video games - Child - Violence.**

"Lead has been recognized as a poison…and has been the focus of public health regulation in much of the developed world for the better part of the past century. The nature of regulation has evolved in response to increasing information provided by vigorous scientific investigation of lead's effects. In recognition of the particular sensitivity of the developing brain to lead's pernicious effects, much of this legislation has been addressed to the prevention of childhood lead poisoning".

The quote above is from a review article titled "Lead neurotoxicity in children: basic mechanisms and clinical correlates".[1] There have been more studies on the effects of media violence than on lead exposure. What if we replaced the word "lead" above with "media violence"? In contrast, although media violence has been recognized as a risk factor for healthy child development since at least 1972, there does not seem to have been a corresponding serious focus on the public policy implications in most countries. Perhaps a direct comparison between lead exposure and media violence is unfair, but consider the conclusions of meta-analyses on each.

Needleman *et al.*[2] conducted a meta-analy-

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sis of research comparing lead exposure and the intelligence quotients (IQs) of children. They found 24 studies that used proper controls which they included in the meta-analysis. Partial correlations ranged from -0.27 to -0.003. These numbers may seem small, but they are large enough that few doubt the effect of lead on child IQ and they are significant when considering the number of children. As a result of such research documenting the health risks of lead exposure, legislation strongly enforces limits on the amount of lead in the environment.

Anderson *et al.*[3] conducted a meta-analysis of research comparing media violence exposure and aggressive behavior. They found 284 studies with 51 597 participants using proper measures. Correlations between media violence and subsequent aggression from meta-analytic reviews ranged from 0.11 to 0.31. These results are stronger than those on lead exposure, and the number of children who are exposed to media violence is greater. Yet, public policy debates continue to question whether any actions should be taken. Indeed, publicly the issue is so contentious that although almost no one would consider the validity of the introductory quote with respect to the effects of lead, many would find it laughable to use such language when discussing the effects of violent media.

The Anderson *et al.*[3] meta-analysis focused primarily on studies of television and film violence. However, in the past 15 years, interactive video games have become increasingly violent. At the same time, greater numbers of children have begun playing video games for increasing amounts of time. Although several excellent narrative and meta-analytic reviews of violent video game studies exist, this review will primarily focus on studies including children and adolescents. This paper has 3 goals: 1) to summarize the literature on the multiple effects violent video games have on younger players; 2) to offer critical observations about common strengths and weaknesses in the literature; 3) to provide a broader perspective within which to understand the research on the effects of video games.

Theoretical and methodological considerations

Several criticisms of the media violence and violent video game literatures exist.[4, 5] Some of these criticisms are legitimate, and many are illegitimate. Due to space constraints, only some will be discussed here.[6, 7] One of the most serious of the illegitimate criticisms is that critics often consider studies "in a theoretical vacuum".[7] No single study is perfect, and each type of study design has strengths and weaknesses. Critics often attempt to document the relative flaws in studies without referring to the broader theoretical framework within which the studies were conducted. This is like pointing out that a particular car model made by Ford has a flaw, and therefore all internal combustion engines must not work. Just because one car has a flaw we cannot ignore that the theory of engine mechanics is sound, and many other cars with different flaws also work. Therefore, it is important to understand the broader theories that guide research on media violence effects.

Many theoretical models have been advanced to describe, explain, and predict aggressive behavior. Most of these models have been specific to one domain or to a particular level of analysis. For example, some look at the level of neural networks (*e.g.*, Berkowitz's cognitive-neoassociation theory), some focus on arousal processes (*e.g.*, Zillman's excitation transfer theory), and some focus on cognitive processes (*e.g.*, Huesmann's script theory). Each of these domain-specific theories has received empirical support.[8] Research has shown that media violence exposure does lead to priming of aggressive thoughts, increased physiological arousal, and the development of aggressive scripts and beliefs. Recently Anderson *et al.* created the general aggression model (GAM) to help unify the many more specialized theories into one broad model.[9]

The GAM is designed to describe and predict likelihood of aggressive behavior in both the short term (or episode) and long-term. Aggressive behavior is usually defined by researchers as behavior that is intended to harm another person. Repeated interactions with violent video games are hypothesized to have several effects over the long term. Figure 1 displays how single interactions can lead to long term changes. Any given interaction can be social (*e.g.*, an argument with another person) or individual (*e.g.*, playing a violent video game by oneself), and is considered an "episode." An episode is influenced both by person variables and by situation variables. The person variables include a person's personality characteristics, their existing attitudes, beliefs, scripts, biological predispositions, etc. The situation variables include specific proximal characteristics such as whether the individual was just insulted, whether there are onlookers, whether the individual just played a violent video game, etc. The person and situation variables combine to affect the individual's present internal state. There are at least 3 routes by which a person's internal state could be influenced, including arousal, affect, and cognition (although these are not typically wholly independent of each other). The individual then has an opportunity to decide on how to respond and takes some action, which yields some result. The results of this episode feed directly into the next episode, affecting both the situation variables as well as the internal state of the individual (please note that this is an oversimplification of the episodic and decision processes in the model; for details see Anderson *et al.*[9, 10] and Anderson, Gentile, Buckley, in press).

If the results of an episode are rewarding or punishing, it is certainly likely that the individual may learn something, leading to some change. For example, if you insult someone else and get hit in response, hopefully you will learn to be more careful with your insults. This leads to some change in the person, although in any single episode it is likely to be very little change – most personality traits are highly stable over the short term. However, it is possible that people may learn even when there is no decision-action-result process. Consider playing a violent video game in which one is rewarded for successful violent actions. The violent game is likely to increase physiological arousal, prime aggressive thoughts, and lead to changes in emotional states. Because these all happen together as a result of the game, they can become associated with each other.

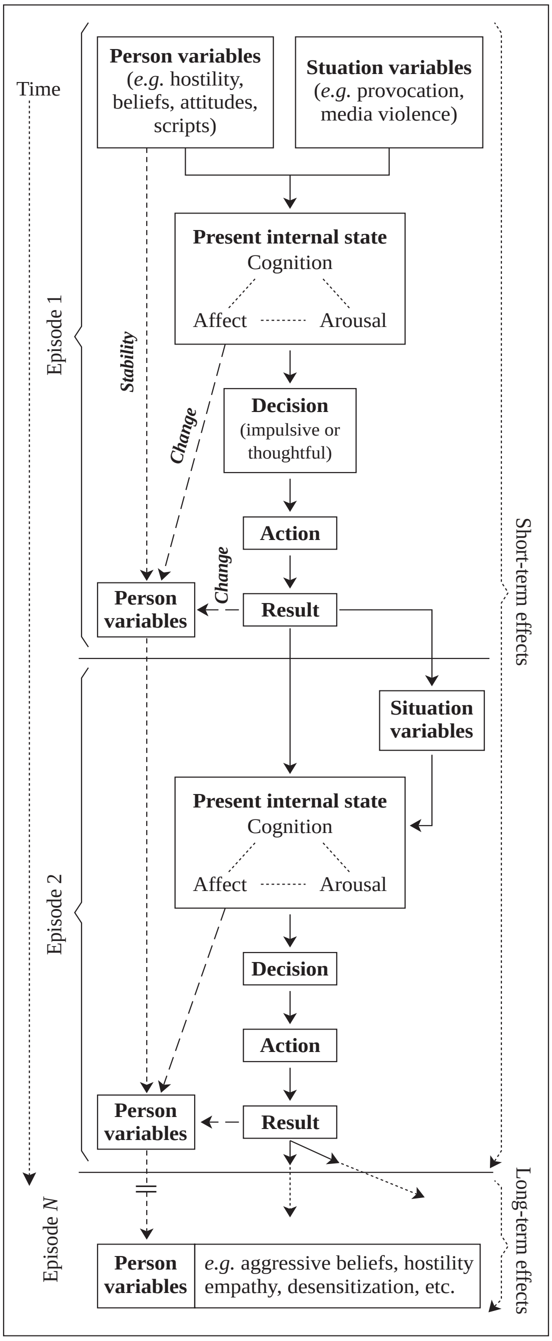

Figure 1.—The general aggression model: episodic processes leading to long-term change.

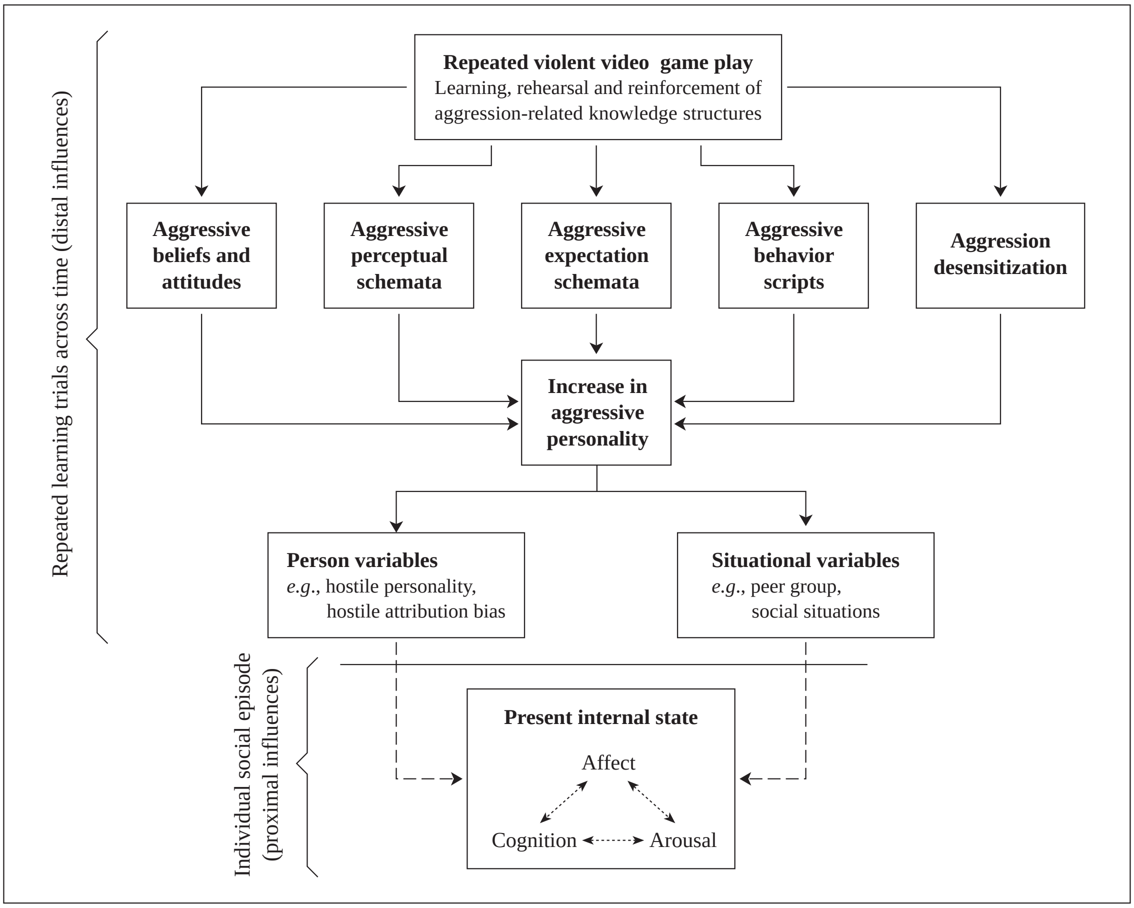

Figure 2.—The general aggression model: developmental processes.

Because game playing is generally considered to be fun, relaxing, and rewarding, these links between aggressive thoughts, feelings, and arousal are rewarded, and may, therefore, also lead to some change in the person (although again, the short-term change is likely to be small). However, repeated exposure over time provides multiple learning trials, leading to changes that are likely to be larger and measurable. Figure 2 displays some of the personality variables believed to be influenced by an individual's ongoing bio-social interactions. What is learned across time depends on the experiences an individual has, including interactions with biological factors (such as biological predispositions to learn certain types of associations through rewards and punishments). Violent video games may affect individuals by having influences on their aggressive beliefs, schemata, scripts, and by desensitizing them to aggression.

Understanding the theory helps to organize the many types of studies that are conducted. It helps researchers and others understand the types of effects they should expect, as well as which effects they should not expect. This allows researchers to answer the often-heard criticism, "I've played violent video games for years and never shot anyone". As Figures 1 and 2 show, no researcher would expect to see a simple and extreme effect such as playing a violent game and then picking up a gun and shooting someone. We would expect that years of violent video game exposure would be related to increased personality trait hostility; however, we would not expect that a single episode of playing a violent video game would change trait hostility – personality traits by definition are stable over the short term. But we would expect that playing a violent video game might lead to increased arousal, aggressive affect, or aggressive cognitions in the short-term, and maybe they would lead to aggressive behaviors immediately post-play (but note that behavior is farther removed from the situational event of playing the video game than arousal, affect, and cognition, so it would have to be a pretty strong effect to influence behavior).

Several legitimate criticisms of video game research have been raised, 4 of which will be described here.[6]

1) Some studies claiming to measure aggressive behavior use dependent variables that are not true aggressive behavior. A surprising number of studies claim to measure the short-term effects of playing a violent game on aggressive behavior, but use trait or personality aggression scales as measures of aggressive behavior. As mentioned above, there is no reason to expect that playing a video game for 20 min would change a trait. Some studies have also used hitting inanimate objects as a measure of aggressive behavior. Most modern aggression researchers define aggression as behavior intended to harm another person [10, 11], and would therefore not consider hitting objects to be true aggressive behavior.

2) Many studies use sample sizes that are too small to detect an effect. Meta-analyses [12] have suggested that the average effect size is about r=0.20. Therefore, the number of study participants (N) should be at least 200 for power of 0.80 (power is the likelihood of being able to find a legitimate difference between groups). Studies that use sample sizes under 200 are unlikely to find effects of violent video games – not because there is no effect, but because there is not enough statistical power to find it.

3) Many studies use "violent" and "nonviolent" games that are not particularly different from each other. This was especially a concern for studies conducted in the 1980s and early 1990s. Several studies used games such as Missile Command as a violent game, which included no aggression at all toward people. Some studies have used games that included violence in the alleged non-violent condition. If the games are not sufficiently distinct from each other in terms of violence (or if the "violent" game is not particularly violent), then we should not expect to find much of a difference in their effects.

4) Many studies do not match the violent and nonviolent games on potentially confounding dimensions such as frustration, difficulty, or excitement. An experimenter may have done everything else correctly—selected violent and nonviolent games that are clearly distinct, had a sample size over 200, and measured appropriate dependent variables—but still find no result or even a non-intuitive result if the games were not matched. For example, if the nonviolent game was more boring or frustrating than the violent game, then participants may be more aggressive after playing the nonviolent game than the violent game! Therefore, the highest quality studies tend to match violent and non-violent games on several dimensions in order to ensure that any differences are due to violent content and not to other unrelated dimensions.

In general, there are 3 dominant types of study designs, and each has distinct strengths and weaknesses. They are experimental, correlational (or cross-sectional), and longitudinal. The are several taxonomies under which one could classify the different type of research designs. The 3 types discussed here are not exhaustive, but are the most typical and comprise the majority of media effects studies. The major strength of experimental studies is that causality can be determined. This is done by randomly assigning participants to different groups, and treating each group identically except for one variable (the "independent variable"). If the groups are shown to differ in some measurable way (the "dependent variable") at the end of the study, the most probable explanation is that the independent variable caused the changes in the dependent variable. Experimental studies are usually used to measure short-term effects, although experimental studies could be designed to test long-term effects. High quality experimental studies share at least 4 characteristics: they have sample sizes of at least 200, they use games that are equated on potentially confounding dimensions, they use violent and nonviolent games that are truly violent and nonviolent, and have valid measures of aggression or aggression-related variables (Anderson, Gentile, Buckley, in press). Over 30 experimental tests of the effects of violent video games have been conducted with children and adults, but very few share all 4 of these characteristics.

The major weakness of experimental studies is that researchers cannot measure "real life" aggression. For example, it is unethical to allow participants to hit each other as a measure of aggressive behavior. Thus, researchers use other means such as the noise-blast paradigm.[13-15] It is then incumbent upon researchers to demonstrate that their laboratory measures have real-world validity. With the noise-blast paradigm, specifically, several studies have shown that people who give higher blasts in the laboratory are also more likely to physically aggress in the real world.[16-20] Therefore, the noise-blast paradigm is a valid measure of aggressive behavior.

Correlational (or cross-sectional) studies allow researchers to overcome the primary weakness of experimental studies because they can use a wide range of "real world" measures of aggression. Thus, researchers can study the relations between violent game exposure and several types and severities of aggression. Correlational studies are usually used to measure long-term effects (although short-term correlational studies can be designed). Correlational studies can also incorporate multiple informants (*e.g.*, self, peers, parents, teachers), thereby gaining additional levels of ecological validity. High quality correlational studies also share several characteristics: adequate sample size (at least 200); a reliable measure of exposure to violent video games; and a reliable measure of aggression or of an aggression-related variable (Anderson *et al.*, in press).

The major weakness of correlational studies is that causality cannot be determined. However, correlational studies are important in that they can support, refine, or refute causal theories. More importantly, correlational studies are strong where experimental studies are weak—that is, they can find relations between media violence and real-world aggression. Conversely, experimental studies are strong where correlational studies are weak—that is, they can document causal relations.

Longitudinal studies allow researchers to overcome some of the weaknesses of both experimental and correlational studies. In a longitudinal study, researchers study the same people over a period of time. They can thus observe patterns of behavior and document both short-term and long-term effects. Longitudinal studies can be either experimental or correlational in design, but even correlational designs can provide some causal information, as it is possible to determine what precedes what over time. High quality longitudinal studies should share the same characteristics of high quality experimental and correlational studies.

Violent video game effects studies

Researchers using the GAM would predict 4 main types of short-term effects of violent video games: increased aggressive affect, increased physiological arousal, increase aggressive cognitions, and increased aggressive behaviors. Although few of the studies reviewed here have relied on the GAM as their theoretical basis, most fit with it very well.

Aggressive affect

The GAM predicts that violent video games might cause both short-term and long-term increases in aggression-related feelings, such as state anger, anxiety, or trait hostility. At the time of this writing, there have been 6 experimental (Hind,[21] Funk *et al.*,[22] Fleming *et al.*,[23] Ballard *et al.*,[20] Cohn and Brooks unpublished), 2 correlational (Durkin *et al.*,[24] Anderson *et al.* in press), and 2 longitudinal studies [20, 25] of video games and aggres-

TABLE I.—*Studies of violent video games on affect.*

Study	N	Age	Major findings
Experimental studies on affect			
Cohn (1995 - unpublished)	124	6^{th}-8^{th} graders	Higher, but non-significant, hostile and anxious feelings after V game compared to NV game
Hind (1995) [21]	102	15-18 years	Incarcerated adolescents preferred playing games with aggressive actions more than NV games and more than a non-incarcerated control group
Funk *et al.* (1999) [22]	35	3^{rd}-5^{th} graders and parents	Higher, but non-significant, frustration levels after V game
Brooks (1999 - unpublished)	120	6^{th}-7^{th} graders	Higher frustration and negative affect levels after V game compared to NV game, watching V and NV games, or watching V or NV television programs
Fleming *et al.* (2001) [23]	71	8-12 years	V game increased state anger marginally significantly (P = 0.052), while simultaneously improving overall mood compared to a paper-and-pencil task
Ballard *et al.* (2001) [20]	41	12-18 years	V games increased frustration (but were harder to play than NV game)
Correlational studies on affect			
Durkin *et al.* (2002) [24]	1 304	10^{th} graders	High computer game use correlated with greater depressed mood compared to low computer game use
Anderson *et al.* (in press)	189	14-19 years	V game play correlated with trait hostility and trait anger
Longitudinal studies on affect			
Ballard *et al.* (2001) [20]	41	12-18 years	Repeated play of V games (3 times over 3 weeks) resulted in lower facial displays of disgust and smiling
Ihori *et al.* (2003) [25]	807	5^{th} and 6^{th} grade	Increased amount of video game play (all play, not specifically V games) related to later hostility

V = violent, NV = non-violent; VR = virtual reality.

sion-related affect conducted with children and adolescents (Table I). None of these studies meets all of the criteria for high quality studies described above. Several have small sample sizes,[20, 22, 23] which may be related to many failing to find statistically significant effects. It should be noted, however, that all studies including those with non-significant results showed trends in the predicted direction (*e.g.*, higher hostile feelings after playing a violent game). This is perhaps surprising given the wide range of theoretically relevant dependent measures. Some studies measured hostility, frustration, anger, or anxious feelings—all clearly aggression—related emotions. Others, however, measured depressed mood,[24] preferences for playing violent or non-violent games,[21] and emotional desensitization to playing violent games.[25]

The 2 studies with large sample sizes both suffer from the problem that neither measured violent game play, but only total amount of game play.[24, 25] Amount of game play per se is not theoretically predicted to increase aggressive emotions, only amount of violence exposure. However, there is a strong correlation between amount of play and violence exposure;[26] children who spend more time playing video games also tend to play more violent games. This probably accounts for the relation found in these 2 studies – amount is effectively a proxy for violence exposure.

None of the studies on affect with children can be considered to be definitive. In addition to the problems already described, none of

TABLE II.—*Studies of violent video games on physiological arousal.*

Study	N	Age	Major findings
Experimental studies on affect			
Winkel *et al.* (1987) [28]	56	8th graders	No effect of V or NV games on HR
Segal *et al.* (1991)29	32	16-25 years	Increased HR, BP, and oxygen consumption when playing Ms. Pac Man compared to standing but inactive
Irwin *et al.* (1995)30	60	2nd graders	No effect of V or NV games on HR
Cohn (1995 - unpublished)	124	6th-8th graders	Higher, but non-significant, HR after V game compared to NV game
Lynch (1999)31	40	9th-12th grade	V game play increased stress hormones (epinephrine and nor-epinephrine) among hostile adolescents
Brooks (1999 - unpublished)	120	6th-7th graders	Higher HR after V game compared to NV game, watching V and NV games, or watching V or NV television programs
Fleming *et al.* (2001)23	71	8-12 years	V game increased HR and self-reported arousal compared to NV game or pencil-and-paper game
Ballard *et al.* (2001)20	41	Adolescents	"Horror" genre VG increased arousal (HR and BP?) more than other sports or fighting genres; across games, HR initially decreased and then increased throughout game play; SBP decreased in anticipation of playing, remained low during play, but increased immediate after playing
Matsuda *et al.* (2003-unpublished)	?	Unknown	Playing a V game (and some NV games) decreases prefrontal cortex activation (indicating attention and less self monitoring) compared to other NV games and to just watching the games

V = violent, NV = non-violent; VR = virtual reality; HR = heart rate, BP = blood pressure, SBP = systolic blood pressure, DBP = diastolic blood pressure.

the experimental studies used matched violent and non-violent video games. However, regardless of the various methodological problems and various approaches to measuring aggression-related affect, they converge on the finding that violent game play is related to aggressive affect.

Although the focus of this review is on children and adolescents, it is important to note that these results also converge with the preponderance of results from studies of college students and adults. In a recent meta-analysis of studies of violent video games and aggressive affect, no differences in effect sizes were found between child and adult samples.[27] Combining all samples, the meta-analysis [27] revealed a significant average effect size of approximately r=0.17.

Physiological arousal

The GAM predicts that violent video games might cause short-term increases in physiological arousal, such as heart rate, blood pressure, or the so-called "stress" hormones. At the time of this writing, there have been 9 experimental studies of video games and physiological arousal conducted with children and adolescents (Table II [20, 23, 28-31] and Cohn, Brooks and Matsuda *et al.*, unpublished). As a group, the results from these studies appear to be relatively weak, but there is evidence that both violent and non-violent games can increase physiological arousal [20, 23, 29] (Brooks MC, unpublished data, 1999). This fact increases the importance of matching the violent and non-violent games on dimensions other than violence; unfortunately, none of the studies matched the violent and non-violent games.

Winkel *et al.*[28] created 3 games on an Apple IIe computer varying in terms of "aggressiveness." They tested appropriately whether the 3 versions were different from each other (which they were) and from a no-game condition. However, it is unclear whether any of the versions would be considered truly aggressive (meeting the definition of intentional harm to another person, rather than shooting at shapes). Their design included 8 conditions, but with 56 participants total, each cell only included 7 participants. This sample size leaves little power for finding differences in highly variable data such as heart rate.

One of the more interesting findings is reported by Lynch.[31] In this study, stress hormones (epinephrine, nor-epinephrine, testosterone, and cortisol) were measured in urine following 45 min of violent game play compared to 45 min of quiet resting. Overall there appeared to be no effect of playing violent games. However, there was an interaction with personality trait hostility. High hostile adolescents showed significant increases in epinephrine and nor-epinephrine (and a marginally significant increase in testosterone) compared to low hostile adolescents. Lynch recruited his participants from science and math classes in high school. It is likely that if asked, all participants would have reported that it was more relaxing to play video games than to stay in class. However, hostile adolescents were physically unable to relax in the presence of the aggressive stimulus. Although this study did not include a non-violent control game, it suggests that the effects of violent games on physiological arousal may not be as straightforward as researchers might hope, but may interact in important ways with personality or other variables (such as amount of previous violent game play).

In contrast to these studies, the literature with adult participants seems somewhat stronger. Combining child and adult samples, a recent meta-analysis [27] again reveals a significant average effect size of approximately r=0.17.

Aggressive cognition

The GAM predicts that violent video games are likely to cause both short-term and long-term increases in aggressive cognitions, such as aggressive priming, hostile attribution bias, and pro-violence attitudes. At the time of this writing, there have been 5 experimental studies,[32-36] 8 correlational studies (Dominick,[37] Colwell *et al.*,[38] Funk *et al.*,[35] Funk *et al.*,[36] Funk *et al.*,[39] Krahé *et al.*,[40] Gentile *et al.*,[26] Anderson *et al.* in press), and 1 longitudinal study of video games and aggressive cognition (Anderson *et al.* submitted) conducted with children and adolescents (Table III). Some of the correlational studies fit our criteria for high quality studies,[26, 40] but most of the experimental studies have serious methodological problems. For example, Graybill *et al.*[32] found that playing a violent game increased assertive fantasies more than playing a non-violent game, but they also report that the violent game was more frustrating to play than the non-violent game. Without the games being matched on confounding dimensions such as this, it is impossible to know whether it was the violent content that accounts for any observed differences. Funk *et al.*[36] use both a correlational and an experimental approach to test whether violent video games affect empathy in children. Because empathy is typically considered to be a trait rather than a state, it is unlikely that measures would be sensitive enough to find changes in empathy after playing a video game for 15 min. The authors found a significant long-term relationship in the correlational study (habitual violent video game playing was correlated with lower empathy scores), but no significant short-term relationship in the experimental study. The experimental studies also use small sample sizes – indeed, Funk *et al.*[36] note that their observed statistical power is only 0.05. This is not a complete list of methodological flaws. For example, Graybill *et al.*[33] title their article “Effects of playing *versus* observing violent *versus* nonviolent video games on children’s aggression,” but they then combine observers and players for data analysis. There is less theoretical reason to believe that observers would be affected in the same way or to the same extent as players.

As a group, the correlational studies on aggressive cognitions are methodologically stronger than the experimental studies. Krahé *et al.*[40] gathered survey data from 231 German

TABLE III.—*Studies of violent video games on aggressive cognition.*

Study	N	Age	Major findings
Experimental studies on aggressive cognitions			
Graybill *et al.* (1985) [32]	116	2nd, 4th, and 6th grade	V game increased assertive fantasies and decreased defensive fantasies compared to NV game
Graybill *et al.* (1987) [33]	79	7-11 years	V games increased aggressive thought accessibility and liking compared to NV games
Kirsh (1998) [34]	52	3rd-4th grade	V game increased hostile attribution bias compared to NV game
Funk *et al.* (2000) [35]	35	8-12 years	V game increased aggressive thoughts and decreased empathic thoughts, but not significantly
Funk *et al.* (2003) [36]	31 35	5-7 years and 8-12 years	No effect of V game on aggressive story completions or empathy
Correlational studies on aggressive cognitions			
Dominick (1984) [37]	250	10th-11th grade	Arcade game playing (but not home game playing) correlated with aggressive cognitions
Colwell *et al.* (2000) [38]	204	12-14 years	Game exposure correlated with aggressive cognitions
Funk *et al.* (2000) [35]	35	8-12 years	Naming a V game as favorite correlated with aggressive thoughts
Funk *et al.* (2003) [36]	31 35	5-7 years and 8-12 years	History of V game play correlated with lower empathy
Funk *et al.* (2004) [39]	150	4th and 5th grade	Greater V game play positively correlated with proviolence attitudes and negatively correlated with empathy
Krahé *et al.* (2004) [40]	231	8th grade	Greater V game play positively correlated with acceptance of physical aggression and indirectly with hostile attribution bias
Gentile *et al.* (2004) [26]	607	8th and 9th grade	Greater V game play positively correlated with trait hostility
Anderson *et al.* (in press)	189	14-19 years	V game play correlated with positive attitudes to violence in war, attitudes toward intimate partner violence, and normative aggression beliefs
Longitudinal studies on aggressive cognitions			
Anderson *et al.* (in press)	430	3rd-5th grade	V VG play early in a school year related to later increases in hostile attribution bias after controlling for sex, race, total screen time, parental involvement, and earlier hostile attribution bias

V = violent, NV = non-violent; VR = virtual reality.

8th graders. They found that children who play violent games more frequently and who were likely to recommend violent games to friends were more likely to endorse normative beliefs about the acceptability of aggressive behavior. These beliefs in turn mediated a significant relationship with hostile attribution bias. Hostile attribution bias is a perceptual/cognitive bias related to aggressive behavior that has been validated in many studies.[41-43] It refers to how one views the world when ambiguous negative events occur. For example, if a child is bumped in the hallway, does he assume it was accidental or was intentionally hostile. If the child has a bias to attributing hostility to others' actions, that child is very likely to respond aggressively to others. In an experimental study, Kirsh [34] found that playing a violent video game can cause increased hostile attribution bias in the short term.

In a study of 607 adolescents, violent game

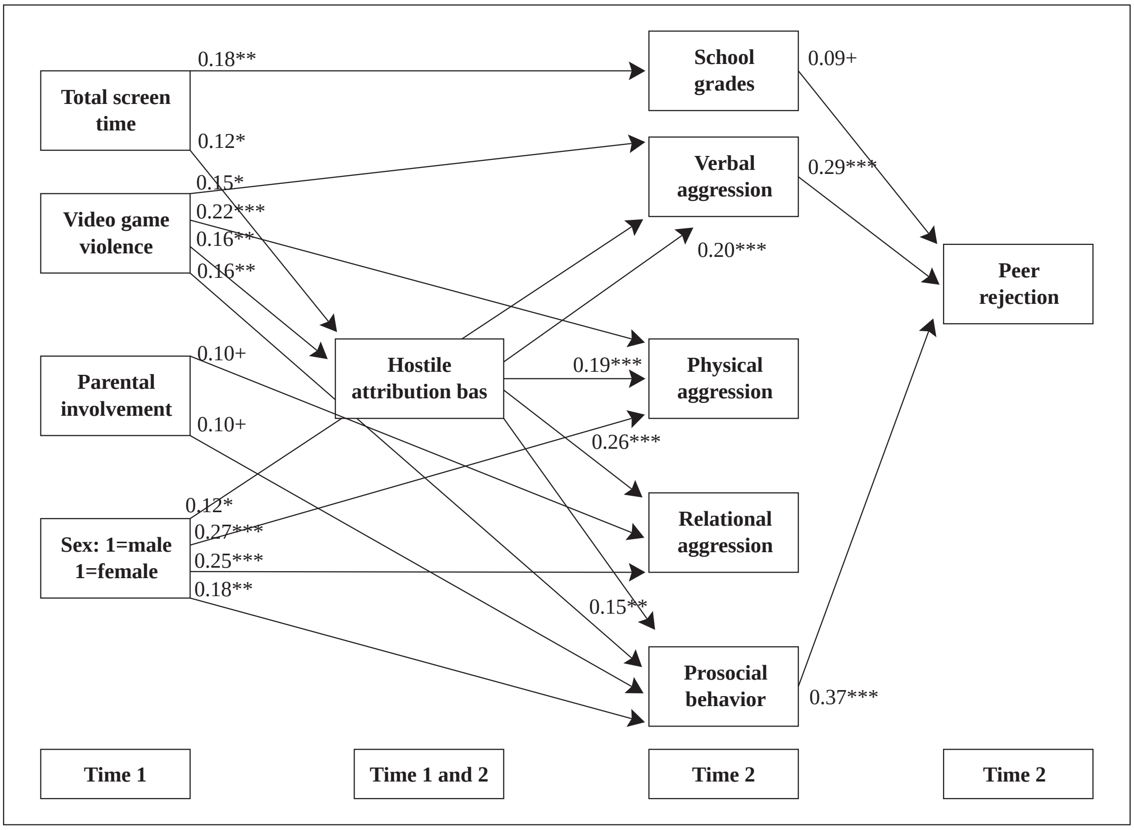

Figure 3.—Longitudinal path analysis of 430 elementary school children documenting different effects of amount and content on school performance and aggressive/prosocial behaviors. +) P=0.10. *) P=0.05. **) P=0.01. ***) P=0.001.

play, personality trait hostility (aggressive cognitions/beliefs/attitudes), and antisocial and aggressive behaviors were measured.[26] Violent game exposure predicted antisocial and aggressive behaviors, but these relationships were also mediated by increased hostility. Therefore, as predicted by theory, long-term exposure to violent video games may affect aggressive behavior by first affecting beliefs and attitudes about aggression, which later change one's likelihood of behaving aggressively. However, these studies are correlational and it is unclear whether video games are the causes of increased aggressive cognitions.

In the only longitudinal study conducted to date, 430 3rd-5th graders were surveyed at 2 points during the school year (Anderson, Gentile, Buckley, in press). Measures of violent video game exposure, hostile attribution bias, and aggressive behaviors were taken, including gathering information about behaviors from multiple informants (self-report, peer-nominations, and teacher reports). Violent video game play early in the school year was significantly related to changes in hostile attribution bias later in the school year, even after controlling for several potentially confounding variables (sex, race, total screen time, and parental involvement in children's media habits). As predicted, changes in hostile attribution bias mediated children's later aggressive behaviors (Figure 3).

These results are consistent with the studies of violent video games and aggressive cognition with adults. Because of the larger number of studies using children and adolescents, Anderson [44] was able to conduct a meta-analysis of studies with just child participants. Across studies, the average effect size was significant

TABLE IV.—*Studies of violent video games on aggressive behavior.*

Study	N	Age	Major findings
Experimental studies on aggressive behavior			
Cooper *et al.* (1986) [45]	84	5th graders	V game increased aggressive toy choice and play for girls, but not aggressive or prosocial behavior (punishment and reward time) toward other children
Graybill *et al.* (1987) [33]	79	7-11 years	V games did not decrease helpful and increase hurtful responses compared to NV games
Chambers *et al.* (1987) [46]	160	3rd-4th and 7th-8th grades	V games decreased prosocial (money donations) behaviors more more than NV game
Silvern *et al.* (1987) [47]	28	4-6 years	Increased aggressive behavior and decreased prosocial behavior in free play after V game play or violent cartoon viewing (no NV control)
Winkel *et al.* (1987) [28]	56	8th graders	No effect of V game on aggressive behavior (money deduction)
Brusa (1987 - unp)	32	6-year-olds	Physical and verbal aggression toward same-sex peer higher, but not significantly, after playing Centipede (V game) than after playing computer pinball.
Shutte *et al.* (1988) [48]	31	5-7 years	V game increased physically aggressive behaviors to children and toys in free play
Irwin *et al.* (1995) [30]	60	2nd graders	V game increased verbal and physical aggression to a peer in a frustrating situation and to toys in a free-play situation
Cohn (1995 - unp)	124	6th-8th graders	No significant differences in aggressive behavior after V game compared to NV game (noise blast)
Anderson *et al.* (in press)	161	9-12 years	Playing V E- and T-rated games increased aggressive behavior (noise blast)
Correlational studies on aggressive behavior			
Dominick (1984) [37]	250	10th-11th grade	Arcade game playing (but not home use) correlated with self-reported physical aggression and aggressive delinquency
McClure *et al.* (1986) [49]	290	9th-12th grade	High-rate VG playing not correlated with psychopathic deviance or neuroticism
Lin *et al.* (1987) [50]	189	4th–6th grade	Arcade use of games (but not home use) correlated with teacher ratings of impulsiveness and aggressiveness
Fling *et al.* (1992) [51]	153	6th-12th grade	Amount of VG play correlated with self-reported and teacher ratings of aggressive behavior
Cohn (1995 - unp)	124	6th-8th graders	Higher aggressive behavior shown in lab by high experience Mortal Kombat players compared to low experience players (noise blast)
Funk *et al.* (1996) [52]	357	7th and 8th grade	For girls, but not boys, V game play associated with lower self-esteem, poorer behavioral conduct, and other self-perceptions
van Schie *et al.* (1997) [53]	346	7th and 8th grade	Greater amount of video game play negatively correlated with prosocial behavior but not significantly correlated with aggressive behavior
Wiegman *et al.* (1998) [54]	278	7th and 8th grade	Greater amount of video game play and preference for violent games negatively correlated with prosocial behavior; preference, but not amount, positively correlated with aggressive behavior
Janey (1999 - unp)	201	5th and 6th grade	Amount of VG play associated with self-reported aggressive boys behaviors and attitudes after controlling for masculine ideology and father availability, but not with teacher-reported aggression

unp = unpublished; V = violent, NV = non-violent; VR = virtual reality; HR = heart rate, BP = blood pressure, SBP = systolic blood pressure, DBP = diastolic blood pressure

Continued Table IV

Table IV continued.

Study	N	Age	Major findings
Correlational studies on aggressive behavior			
Colwell *et al.* (2000) [38]	204	12-14 years	Game exposure correlated with aggressive behaviors
Funk *et al.* (2000) [55]	364	4^{th} and 5^{th} grade	Preference for violent games correlated with poorer behavioral conduct (self-perception)
Walsh (2000) [64]	137	8^{th} and 12^{th} grade	Greater game exposure correlated with physical figths
Durkin *et al.* (2002) [24]	1 304	10^{th} graders	High computer game use correlated with greater aggressive behavior compared to low computer game use
Colwell *et al.* (2003) [56]	509	12-14 years	Amount of play and V game exposure predicted aggression in samples of UK and Japanese adolescents
Gentile *et al.* (2004) [26]	607	8^{th} and 9^{th} grade	Greater V game play positively correlated with physical fights after controlling for hostility
Vandewater *et al.* (2005) [57]	225	7-12 years	Family conflict correlated with increased V game play for girls, but not for boys
Anderson *et al.* (in press)	615	9-12 years and 17-29 years	V game play correlated with violent behavior
Anderson *et al.* (in press)	189	14-19 years	V game play correlated with verbal and physical aggression and violent behavior
Longitudinal studies on aggressive behavior			
Ihori *et al.* (2003) [25]	807	5^{th} and 6^{th} grade	Increased amount of video game play related to later indirect aggression (boys and girls) and later physical aggression (boys)
Slater *et al.* (2003) [58]	2 550	6^{th} and 7^{th} grade	Media violence exposure (including video games) increases aggressive cognitions and behaviors, which in turn increase media violence exposure, which increases aggressive cognitions and behaviors etc. over a two-year period (unable to separate out VGs)
Anderson *et al.* (in press)	430	3^{rd}-5^{th} grade	V VG play early in a school year related to later increases in verbal and physical aggression (as rated by self, peers, and teachers) after controlling for sex, race, total screen time, hostile attribution bias, parental involvement, and earlier verbal and physical aggression

unp = unpublished; V = violent, NV = non-violent; VR = virtual reality; HR = heart rate, BP = blood pressure, SBP = systolic blood pressure, DBP = diastolic blood pressure.

at r=0.24. In his more recent meta-analysis, across studies with either children or adults, the average effect size was r=0.23.

Aggressive behavior

The GAM predicts that if violent video games can cause increases in arousal, aggressive affect, and aggressive cognitions, then these in turn may cause increases in aggressive behavior. At the time of this writing, there have been 10 experimental studies (Cooper *et al.*,[45] Graybill *et al.*,[33] Chambers *et al.*,[46] Silvern *et al.*,[47] Winkel *et al.*,[28] Shutte *et al.*,[48] Irwin *et al.*,[30] Brusa and Cohn unpublished, Anderson *et al.* submitted), 18 correlational studies (Dominick,[37] McClure *et al.*,[49] Lin *et al.*,[50] Fling *et al.*,[51] Funk *et al.*,[52] van Schie *et al.*,[53] Wiegman *et al.*,[54] Colwell *et al.*,[38] Funk *et al.*,[55] Durkin *et al.*,[24] Colwell *et al.*,[56] Gentile *et al.*,[26] Vandewater *et al.*,[57] Cohn and Janey unpublished, Anderson *et al.* and Anderson *et al.* in press), and 3 longitudinal studies (Ihori *et al.*,[25] Slater *et al.*,[58] Anderson *et al.* submitted) of video games and aggressive behavior conducted with children and adolescents (Table IV). Again, only a minority of the studies meet our criteria for high quality studies. Most of the experimental studies do not match violent and non-violent games on other confounding dimensions. Many of the experimental studies were conducted in the 1980s, before games included much violent content against other game characters; therefore there cannot have been particularly strong differences between the violent and non-violent games (for example, Brusa, unpublished data, 1987, used Centipede as a violent game, which would not be considered to be a violent game by today's standards). Several include measures of aggressive behavior that are probably not truly aggressive behavior. For example, some used the choice of an aggressive or non-aggressive toy as measures of aggression [45] and others used money donations.[31, 37] There is nothing inherently wrong with using these types of proxies for aggressive behavior, but it is important that these measures be validated to show that children who donate less money are also the types of children who would be likely to hit other children outside of the laboratory. This type of validity study has been conducted with noise blasts, suggesting that noise blasts are a valid approach to studying aggressive behavior in the laboratory (at least for adults). Unfortunately, very few experimental studies have been conducted with children since the mid-1990s (although there have been several excellent studies with undergraduates and adults). In the most recent, 161 nine- to twelve-year-olds were randomly assigned to play either a violent or non-violent video game rated as age-appropriate by the Entertainment Ratings Software Board. The games were matched on frustration levels, and although entertainment levels differed, they were not related to aggressive responding. After playing the video game, children played a competitive reaction time game against a same-sex partner, who was in reality the computer. When they were slower than their partner, they received a blast of white noise through headphones. When they were faster, they set the level of noise blast their partner received. Children who played the violent video game gave significantly more high-intensity noise blasts than children who played the non-violent game.

Many of the correlational and one of the longitudinal studies share the problem of confounding amount of video game play with the content of games played [24, 25, 37, 38, 49-53] (Janey BA, unpublished data, 1999). As noted earlier, amount of play is not a good indicator of violence exposure, although they are correlated, at least with recent data. For any studies conducted prior to about 1992, the correlation between amount of play and violence exposure is probably low because there were far fewer truly violent games. For this reason, it is surprising that amount of play still predicts aggressive behaviors in most of these studies. In comparison, all of the correlational studies where amount of violent game exposure is measured show a correlation between violence exposure and aggressive behavior (for at least some of the sample). Correlational studies can not demonstrate causality – it could be argued that playing violent games increases aggression, or that naturally hostile children prefer violent games. However, although correlational studies can not prove causality, they could disprove causality if no relation is found between variables and they can provide support for causal theories. For example, in a sample of 607 8th and 9th graders, violent game exposure was correlated with physical fights.[26] Because personality trait hostility was measured in this study, it allowed a test of the hypothesis whether the correlation between violent game exposure and fights was spuriously caused by the third variable of hostile personality. If hostility were the necessary factor, then only hostile children would get into physical fights, and children with the lowest hostility scores would not get into fights regardless of their video game habits. Figure 4 displays the percentages of students who report being involved in physical fights within the previous year. Children with the lowest hostility scores are almost 10 times more likely to have been involved in physical fights if they play a lot of violent video games than if they do not play violent games (38% compared to 4%). Children with the highest hostility scores are over 2 times more likely to be involved in fights if they play a lot of violent games than if they do not (63% compared to 28%). In fact, the least hostile children who play a lot of violent video games are more likely to be involved in fights than the most hostile children if those children do not play violent video games.

Slater *et al.*[58] addressed the developmental course of media violence exposure and aggressive cognitions and behavior in a longitudinal study of 2 550 6^{th} and 7^{th} graders. Students were surveyed 4 times across 2 years about their media violence exposure (movies, video games, and Internet). In short, their data provide evidence of a downward spiral, where media violence exposure increases aggressive cognitions and behaviors, which in turn increase media violence exposure, which further increases aggressive cognitions and behaviors. Unfortunately, the authors combined all media violence, so it is unclear how much of this effect may be due to violent video games.

In the longitudinal study of 3^{rd}-5^{th} graders, violent video game exposure was measured separately from other media violence and several subtypes of aggressive behavior were measured. Figure 3 displays the results of path analyses, in which variables at Time 1 are shown at the left and variables at Time 2 are shown at the right. Video game violence exposure and total screen time both increased hostile attribution bias, which in turn was related to increased verbally, physically, and relationally aggressive behavior, as well as decreased prosocial behavior. Verbal aggression and prosocial behavior were in turn related to Time 2 peer acceptance. Video game violence exposure was also directly related (over and above the mediated path *via* hostile attribution bias) to increased verbal aggression, increased physical aggression, and decreased prosocial behavior. Having parents involved in children's media habits resulted in children showing less relational aggression and more prosocial behavior.

The results of studies with children and adolescents are again consistent with the studies with adults. Meta-analyses [44] of the studies with children show a significant overall relation between violent video game exposure and aggressive behavior of r=0.18. Combining studies with children and adults,[27] the overall relation is r=0.19.

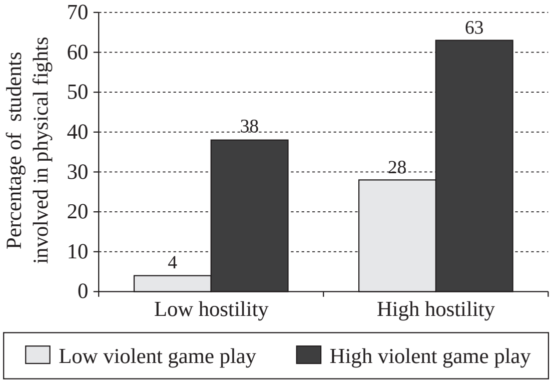

Figure 4.—Percentages of 8^{th} and 9^{th} graders involved in physical fights, split by hostility and violent video game exposure. The low and high hostility bars represent children iin the bottom and top quartiles on a measure of trait hostility, respectively. The low and high violent video game play bars represent children in the bottom and top quartiles on a measure of exposure to violent video games. Data are extracted from Gentile, Lynch, Linder & Walsh, 2004. Total N=607.[27]

Summary

In general, combining the results of experimental, correlational, and longitudinal studies, there is a preponderance of evidence that violent video game play is related to aggressive affect, physiological arousal, aggressive cognitions, and aggressive behaviors. We feel that it is fair to consider violent video games (and media violence in general) as one risk factor for aggressive behavior. They are not the only risk factor for aggression, nor are they the largest risk factor. However, they appear to be a significant risk factor when one considers the large number of children exposed to them. Furthermore, among the dozens of documented risk factors for aggressive behavior,[59] media violence is unique in that it is the risk factor that is most easily controlled.

In this review, we have attempted to note methodological problems that are common in the literature. Because so many of the studies have at least one methodological problem, it could be argued that the relation between violent games and aggression might be artificially high because of the flaws. In his meta-analysis, Anderson [27] coded whether each study had any of 9 types of methodological flaws and then compared the meta-analytic results between studies using best practices (*i.e.*, having none of 9 flaws) with the studies with flaws. In all cases (for arousal, aggressive affect, cognition, and behavior), the best practice studies showed higher effect sizes than the studies with flaws. Therefore, the consistent relation between violent video games and aggression is not due to methodological flaws – indeed, when studies are more carefully controlled, the effect seems to be more easily found.

School performance

Although studies of violent video games get the most attention, many other effects have been studied. One that is of particular concern for children and adolescents is the effects on academic achievement. Successful or poor academic performance can have lifelong consequences. Many studies have documented negative correlations between video game use and school performance for children, adolescents, and college students [13, 26, 38, 60-64] (Anderson *et al.*, in press). Overall, the preponderance of studies demonstrates a consistent negative correlation between recreational video game play and school performance. However, there is also a widespread belief that some types of computer or software use could have positive effects on school performance.

Durkin *et al.*[24] have recently attempted to argue that there is no negative relation between video game use and school grades, aggression, or many other variables. Specifically, they reported that students who never use computers have lower grades (mean grade point averages, GPA=2.53) than low use (2.79) and high use (2.61) students (usage measured with a single seven-point Likert scale from "never" to "daily"). Yet, they based these conclusions on survey data gathered in 1988, before games became particularly violent, and when there was a strong relationship between computer use and socioeconomic status. That is, children from poorer families were far less likely to own computers in 1988. Children from poorer families also typically have poorer school performance. Therefore, this is not a fair comparison. The fair test is whether the low use and high use groups differ, since both groups come from families that own computers. The Durkin *et al.* data actually show that high use students have significantly lower GPAs and exhibit significantly more aggressive behavior than low use students. This completely changes the interpretation of their data, as it can explain why students who never use computers also have higher depressed mood, lower self-esteem, higher disobedience, substance use, and truancy, and lower GPAs than computer users. All of these relations would be predicted by lower socioeconomic status.

Other studies have been more careful in their analyses. In one early study, children who used computers to play games performed more poorly in school, whereas those who used computers for schoolwork performed better in school.[62] Furthermore, many video games have been designed specifically to teach academic skills and concepts. The quality of research in this domain varies greatly, but a recent meta-analysis of high-quality studies shows that educational software has a significant positive effect on academic skills and student achievement.[65] The average correlation is 0.35 for educational games teaching reading skills, and 0.45 for games teaching math skills.

Given these apparently conflicting results, how are we to understand the effects of video games on school performance? The majority of studies on school performance have been atheoretical, and provide little predictive power about when we would expect video games to have positive or negative effects. However, 2 recent studies shed some light suggesting that there may be several dimensions along which video games may have effects.

In a correlational study of adolescents, path analyses revealed that the amount of time adolescents spent playing video games directly predicted poorer grades, but was not directly related to aggressive behaviors. However, playing violent games directly predicted aggressive behaviors, but did not predict poorer grades.[26] This pattern was replicated in a longitudinal study of elementary school children (Figure 4, Anderson *et al.*, in press). Children who spent a lot of time playing video games had poorer grades later in the school year, but amount of play did not directly predict aggressive or prosocial behaviors. In contrast, playing violent games directly predicted increased aggressive behaviors and decreased prosocial behaviors, but did not directly predict grades. These studies and others suggest that there are at least 4 theoretically independent dimensions along which video games can have effects: amount, content, form, and mechanics.

The dimensional approach to video game effects

Amount

As shown in Figure 4, the total amount of time that children and adolescents spend playing video games appears to be responsible for the negative correlation between video games and school performance. This provides some support for the displacement hypothesis, which states that one way electronic media have effects on children is by displacing other activities.[66] In essence, every hour that children play entertainment video games is an hour that they are not doing homework, reading, exploring, creating, or any of several other activities that may have more educational benefits. In addition, several other scientifically-documented effects are likely to be related to amount of play. Some research documents that the amount of time spent with video games can be linked to lower activity levels, higher weight, and higher risk of obesity.[67-69] In addition, there are a number of muscular and skeletal disorders associated with heavy computer or video game use, such as tendonitis and nerve compression. There is even a form of tendonitis named "Nintendinitis", caused by repeatedly pressing game-controller buttons with one's thumb.[70]

However, total amount may not be the only aspect of amount that matters – how children distribute their time with video games may also enhance or reduce the effectiveness of learning from them. Educational psychologists have shown that learning and transfer are most likely if the learner practices some each day (distributed practice) rather than "cramming" – trying to learn it all at once in one long session (massed practice). From an educational standpoint, video games encourage a close-to-optimal combination of massed and distributed practice. Initial attempts at the game provide immediate feedback and most people will keep playing until they begin to show some progress. Such massed practice eventually begins to produce diminishing returns (when a plateau is reached or fatigue sets in). However, the repetition will have begun to develop both physical and mental skills on parts of the task. Each subsequent encounter with the game provides memory benefits – namely, relearning anything that was forgotten, providing new cues for memory, interpreting new information or examples with what is already in memory, and reorganizing the memory accordingly. This combination of massed practice to build sufficient initial mastery to play the game, followed by distributed practice over days or weeks is optimal for learning.[71-73] Although there is a great deal of research on this aspect of repetition and amount in traditional education, there is almost none with video games.

There is also some evidence that video game "addiction" is a problem that the medical community is beginning to face [74, 75] (Gentile, Tapscott, submitted). In a recent set of analyses with younger adolescent (8th/9th grade) and older adolescent (undergraduate) samples, the prevalence of video game addiction ranged between 6% and 13% of gamers. Among younger adolescents, addicted gamers averaged 21 h per week playing video games (compared to 8 h/week among non-addicted gamers). Although there is not yet a medically agreed-upon diagnosis for video game addiction, it appears to have high construct validity (Gentile, Tapscott, in press). Furthermore, addicted gamers display patterns of comorbidity similar to those displayed by other types of addicts, and addicted gamers display higher emotional reactivity to games than non-gamers and non-addicted gamers (Gentile, Tapscott, submitted). We do not mean to imply, however, that addiction can be reduced to amount of play. To be considered addicted, one must play to the extent that it damages one's social and/or professional life. However, addicted gamers are also more likely to suffer any effects that may be due to amount of play.

Content

Most of the research on video games has documented what are likely to be effects of the content of the games. For example, the research reviewed here showing effects of violent games represents the effects of violent content. As described above, there is evidence that violent content has effects that are specific to aggressive and prosocial thoughts, feelings, and behaviors, and that these effects are theoretically and empirically independent of the effects of amount (although there is a significant correlation between amount and violence exposure – people who spend a lot of time playing video games also tend to be exposed to more violent content). There are also studies showing that specially designed video games can teach children healthy skills for the self-care of asthma and diabetes.[76, 77] These games have succeeded on multiple levels, modifying the attitudes, skills, and behaviors that they were designed to teach. Recent advances in virtual reality (VR) technology have also made it possible for physicians and therapists to incorporate them into therapeutic programs. For example, studies have shown that VR programs can be effective in helping patients manage the pain of burns and wound care, as well as desensitizing phobic patients to their fears, such as fear of heights, flying, and spiders.[78, 79] Each of these studies on violent video games, educational video games, systematic desensitization via virtual reality, and health promotion video games documents effects of game content. In the case of educational games, these are intentional content effects; in the case of violent games, these are unintentional content effects.

Form

There is a large body of literature with television and film on what are called "formal features." In general, this literature examines how people understand the formal conventions of the medium and what they signify. For example, most people extract different meanings from editing cuts and dissolves. If a couple enters a bedroom and the scene gradually dissolves to the next morning, most people take a very different meaning away from it than if the scene abruptly cuts to the new scene the next morning. Similarly, several of the studies on video games suggest patterns of effects that are not due to the content *per se*, but to the form in which it is presented. There appear to be many features that are capable of differential effects, only 3 of which will be discussed here.

First, some games require the use of 2D representations to provide 3D information and navigation.[80] If players play these types of games, then we should be able to document improvements in their ability to use 2D information for 3D navigation. Although data are limited at this point, 2 studies suggest that these skills may be learnable and show transfer. In the first of these, Greenfield *et al.*[81] showed that skill in a game requiring 3D navigation was related to 3D mental visualization skill. Second, Rosser *et al.*[82] showed that demonstrated skill on video games and past experience with video games were the best predictors of surgeons' advanced laparoscopic surgical skills. Surprisingly, video game experience and skill were better predictors of advanced surgical techniques than either amount of medical training or number of laparoscopic surgeries performed. These findings are difficult to explain using only amount or content types of explanations, but seem to fit a form argument - that more experience with games leads to increased skill in using 2D representations for 3D navigation.

Second, some games require constant scanning of the screen for information – for example, in action games it is critical to be constantly scanning all parts of the screen because an enemy could jump out from any-where and a quick reaction is necessary. If players play these types of games, then we should be able to document improvements in visual attention skills to computer screens. This pattern has indeed been found, comparing different types of games that require different types of attention.[83, 84]

Third, some games portray their subjects with more realism than others. If players play games with similar content, but with varied realism, then we should be able to document better learning and transfer. There are few data to support this at the present time, but it makes intuitive sense when considering simulation games. For example, if one wanted to learn to fly an airplane, more realistic simulators should result in better learning that would transfer to outside situations. Some results appear to suggest this may be correct, such as the finding that playing Mortal Kombat with the blood setting turned on (so that injuries are accompanied by depictions of spurts of blood from the body) led to greater increases in hostility and arousal than with it turned off.[85] In this study, the game content is equally violent in both cases, but the form is different. Furthermore, effect sizes have been increasing as games have been becoming more realistic.[6] However, there may be many other reasons for this result, so this interpretation should be viewed with caution. Certainly gamers cite realism as one of the primary facets that are important to them.[86] Future studies will need to be conducted to determine the amount to which realism (and what dimensions of realism) makes a difference.

Mechanics

The types of mechanical input/output devices used to play the games could also show effects. If players play games with identical content, but with varied mechanical interfaces, where some have increased similarity to reality, then researchers should be able to document better learning and transfer. For example, playing a driving simulation game with a wheel and pedals should improve driving skill more than playing the same game with a mouse and a keyboard. Similarly, if surgical simulators are designed with input devices that are similar to actual surgical instruments, then learning and transfer should be improved compared to input devices with less verisimilitude. To date, no studies have been conducted to test this hypothesis. This issue is further complicated because mechanics are not entirely independent from form. Game movements are guided both by visual information gathered from the screen and use of the input/output devices, and these inform each other (for a complete description of how visual information, movement, and proprioception are linked see Gibson [87]). For example, in a first-person shooter game such as Halo, gamers can often shoot at an enemy in a standard game view or through a magnifying scope on the weapon their character is using. The optics are very different under these 2 situations, as a small movement with the mouse changes what is seen on the screen a small amount in the standard view, but a large amount when viewed through the scope. Research is needed to determine how mechanics affect video game effects.

Conclusions

When attempting to understand all of the varied empirically-identified effects of video games, conceptualizing the effects along the 4 dimensions of amount, content, form, and mechanics is useful. One clear benefit of this approach is that it allows researchers and the public to move beyond the dichotomous thinking that has too often characterized the debate around video games, in which the discussion is reduced to a question of whether video games are good or bad. As the preceding analysis shows, this is too simplistic a question. The same video game could have both positive and negative effects, depending on what dimension one considers. For example, playing the Grand Theft Auto series of games (in which one plays a criminal sociopath) a lot each day could hamper school performance (amount effect), increase aggressive thoughts and behaviors (content effect), improve visual attention skills (form effect), and improve driving skills if one plays with a driver's wheel and pedals or shooting skills if one plays using a gun input/output device (mechanics effects).

Riassunto

Effetti sui bambini e sugli adolescenti dei video game violenti: una revisione della letteratura

Per 1) determinare i multipli effetti, 2) offrire osservazioni critiche circa le affermazioni presenti in letteratura e 3) fornire una prospettiva più ampia per comprendere la ricerca sugli effetti dei video game sono stati rivisti gli studi eseguiti su bambini e adolescenti che giocano con i video game violenti. Questa revisione comprende le considerazioni generali teoriche e metodologiche sulla violenza dei mezzi di informazione e la descrizione del general aggression model (GAM). Tutti i lavori pubblicati sono stati valutati tenendo conto del GAM. Sono stati rivisti tutti i lavori pubblicati, comprese le meta-analisi, così come dati importanti non ancora pubblicati, quali comunicazioni a congressi. In generale, l'evidenza supporta le ipotesi che giocare con video game violenti abbia un effetto sull'aggressività, sulla fisiologia, sulla percezione dell'aggressività e sui comportamenti aggressivi. Sono anche stati valutati gli effetti dei video game violenti sul rendimento scolastico, e questa revisione concorda con l'approccio dimensionale agli effetti dei video game. L'approccio dimensionale valuta gli effetti dei video game in termini di quantità, contenuto, forma e meccanicità e sembra presentare molti vantaggi per la comprensione e la predizione dei diversi tipi di effetti dimostrati in letteratura.

Parole chiave: Video game - Età pediatrica - Violenza.

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