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The effects of violent video games on adolescents The overlooked influence of development

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Abstract

Recent acts of extreme violence involving teens and associated links to violent video games have led to an increased interest in video game violence. Research suggests that violent video games influence aggressive behavior, aggressive affect, aggressive cognition, and physiological arousal. Anderson and Bushman [Annu. Rev. Psychol. 53 (2002) 27.] have posited a General Aggression Model (GAM) to explain the mechanism behind the link between violent video games and aggressive behavior. However, the influence of violent video games as a function of developmental changes across adolescence has yet to be addressed. The purpose of this review is to integrate the GAM with developmental changes that occur across adolescence.

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1. Introduction

Since the late 1970s, one of the preferred leisure activities of adolescents has been playing video games (i.e., interactive games run on computers or video games consoles; Cesarone, 1998). However, due in part to a rash of school shootings perpetrated by adolescent boys, the effects of video games recently have come under scientific, public, and political scrutiny. For

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instance, several of the leading researchers in the field recently testified before a U.S. Senate Commerce Committee hearing about the deleterious effects of violent video games on children and adolescents (e.g., [Anderson, 2000](#); [Funk, 2000](#)). Although links between violent video game play and aggression have been found (see [Anderson & Bushman, 2001](#); [Dill & Dill, 1998](#); [Griffiths, 1999](#)), the vast majority of research has focused on children or late adolescents (i.e., college students). In fact, few studies have assessed the influence of violent video games on aggression during the age periods (i.e., early and middle adolescence) associated with school shootings, and none of these studies assessed the influence of violent video games from a developmental perspective. Given that the incidence of aggressive behavior varies across adolescence ([Lindeman, Harakka, & Keltikangas-Jaervinen, 1997](#); [Loeber & Stouthamer-Loeber, 1998](#); [Steinberg, 2001](#)), a developmental perspective is crucial to the understanding of the influence of video game violence on adolescent aggression. It may be that adolescents are more vulnerable to the effects of violent video games during certain developmental periods of adolescence than others. Additionally, the developmental notion of individual differences suggests that only certain adolescents (i.e., those with the greatest number of risk factors) may be susceptible to the negative consequences associated with playing violent video games. These issues will be addressed in later sections of this article.

1.1. Consequences of violent video games as a function of development: current research

Over the past two decades, more than 20 studies have assessed the relationship between violent video game play and aggression during the adolescent period (including late-adolescent college students). Both correlational (e.g., [Fling et al., 1992](#); [Griffiths & Hunt, 1995](#)) and experimental (e.g., [Anderson & Dill, 2000](#); [Ballard & Lineberger, 1999](#)) studies offer support for a connection between exposure to violent video games and aggressive behavior. For instance, [Fling et al. \(1992\)](#) found a positive association between video game play and self- and teacher-reported aggression in a group of 11- to 17-year-olds. [Anderson and Dill \(2000\)](#) demonstrated a link between playing violent video games and laboratory aggression in college students. [Lynch, Gentile, Olson, and van Brederode \(2001\)](#), in an assessment of eighth and ninth graders, identified significant associations between violent video game play and aggressive attitudes and behavior.

Given that the primary purpose of this review is to integrate aggression theory, video game research, and adolescent development, only those articles specifically relevant to this task will be discussed in detail. To help integrate theory, research, and development, without having to reevaluate the research on a study-by-study basis, summaries, and conclusions reported in other review articles will be used. Readers interested in study-by-study critiques of the video game literature should read one of the following articles: [Bensley and Van Eenwyk \(2001\)](#), [Dill and Dill \(1998\)](#), or [Griffiths \(1999\)](#).

Most studies assessing the influence of violent video games on aggression have assessed part, but not all, of the adolescent age range (i.e., early, middle, and late). For instance, [Colwel and Payne \(2000\)](#) assessed 12- to 14-year-olds, [Lynch et al. \(2001\)](#) assessed eighth and ninth graders, and [van Schie and Wiegman \(1997\)](#) sampled seventh and eighth graders (see [Griffiths, 1999](#), for additional studies and associated age ranges). Other studies have

assessed samples containing late adolescents (i.e., college students; [Anderson & Dill, 2000](#); [Ballard & Lineberger, 1999](#)). In addition, several studies have assessed adolescents collapsed across a 5- to 7-year age span (e.g., [Fling et al., 1992](#); [Gibb, Bailey, Lambirth, & Wilson, 1983](#); [Lynch, 1994](#)). However, no research has addressed the consequences of violent video game play across adolescence from a developmental perspective.

1.2. Theories of aggression and violent video games

Theoretical explanations for the link between exposure to violent video games and aggression have been posited using several classic theories of aggression. For instance, when applied to video game violence, [Bandura's \(1986\)](#) social learning theory hypothesizes that exposure to video game violence would evoke behavioral mimicry, reinforce already existing aggressive habits, and increase internal arousal. In turn, this internal arousal could be interpreted as anger, which increases the likelihood of aggression. Playing violent video games, according to [Berkowitz's \(1984\)](#) cognitive neoassociation model of aggression, should create and/or activate networks of aggressive thoughts, feelings, memories, and beliefs. An additional explanation for the link between violent video game play and aggressive behavior comes from the literature on social information processing in aggressive children. [Dodge \(1980\)](#) contends that aggressive children act aggressively, in part, due to a hostile attributional bias. That is, when exposed to a frustrating social stimulus (e.g., being bumped into a puddle), a hostile attributional bias results in cue distortion, which leads aggressive children to interpret the stimulus as an aggressive cue and respond aggressively ([Dodge & Frame, 1982](#)). Social experiences, such as violent video game play, may lead to the formation of a hostile attributional bias. For instance, [Kirsh \(1998\)](#) induced a hostile attributional bias in third and fourth grade children through violent video game play.

More recently, [Anderson and Bushman's \(2002\)](#) General Aggression Model (GAM) has been developed, in part, to account for the effects of violent video games on aggressive behavior. The GAM, described in more detail below, is compatible with theories proposed by [Bandura \(1986\)](#), [Berkowitz \(1984\)](#), and [Dodge \(1980\)](#). Although the GAM has received empirical support ([Anderson & Bushman, 2001](#); [Lynch et al., 2001](#)), additional research is necessary to validate the interactive nature of the various GAM components as well as establish the ability of the GAM to predict aggressive behavior. Furthermore, the GAM has yet to be integrated with the developmental issues surrounding aggressive behavior during adolescence.

The present article is organized as follows. Sections 2 and 3 describe the nature of adolescent video game play and development of aggressive behavior during adolescence, respectively. A review of biological and psychosocial causes of adolescent aggressive behavior follows. Section 5 discusses violent video game play as a function of developmental changes in adolescent aggression. Section 6 describes the GAM in detail. Next, the importance of a developmental approach to the assessment violent video games is addressed. Finally, the notions of aggression as a multivariate construct and risk assessment are introduced and discussed in terms of video game research.

2. Video game play across adolescence

Across adolescence, video game play is associated with gender and age. Recently, [Roberts, Foehr, Rideout, and Brodie \(1999\)](#) found that older children and adolescents (8- to 18-year-olds) play video games, on average, between 1.2 and 7.5 hours per week. According to [Dill and Dill \(1998\)](#), although adolescent boys play video games for more hours than adolescent girls, both male and female adolescents play video games on a regular basis. Similarly, [Funk and Buchman \(1996\)](#) found that early-adolescent boys play video games nearly twice as much as early-adolescent girls; Roberts et al. found the same pattern and showed that it persisted throughout adolescence. However, Roberts et al. also found that the amount of video game play, regardless of gender, decreases with age. Specifically, whereas early-adolescent boys (8 to 13 years of age) play video games approximately 7.5 hours per week, boys in middle to late adolescence play video games 3.5 hours per week. For girls, although the amount of video game play was far less than boys, a similar developmental pattern emerged. Whereas early-adolescent girls played video games 3.15 hours per week, middle- and late-adolescent girls played video games 1.2 hours per week ([Roberts et al., 1999](#)). To summarize adolescent video game play, boys play video games more than girls and early adolescents play video games more than middle and late adolescents.

[Griffiths \(1999\)](#) identified nine different types of video games: sport simulations (e.g., golf, baseball), racers (e.g., motor sports), adventures (e.g., fantasy rescue), puzzlers (e.g., brainteasers), platformers (e.g., jump to and from platforms), platform blasters (e.g., platformer with shooting), beat 'em ups (e.g., games with punching and kicking), shoot 'em ups (e.g., shooting and killing with weapons), and weird games (i.e., games that do not fit other categories). Although not all video games contain violence, research by [Funk and Buchman \(1996\)](#) suggests that adolescent boys and girls both prefer violent video games. These findings are supported by the dominance of violent video games being sold to adolescents. [Dietz \(1998\)](#) found that 80% of the most popular video games on the market today are violent in nature. There is also a trend toward greater realism: the schematic, cartoonish video games of the 1970s and 1980s have gradually become more realistic, so that many games now depict graphic gore in addition to violence ([Dill & Dill, 1998](#)).

3. Aggressive behavior across adolescence

The pattern of video game play across adolescence mirrors the development of aggressive behavior across adolescence. For instance, [Lindeman et al. \(1997\)](#) assessed 11-, 14-, and 17-year-olds responses to hypothetical interpersonal conflict situations involving two different types of aggression. The first conflict situation assessed direct aggression (i.e., mean teasing) and the second conflict situation assessed indirect aggression (i.e., spreading rumors). Consistent with gender differences in real-life aggression ([Leschied, Cummings, Van Brunshot, Cunningham, & Saunders, 2000](#)), [Lindeman et al. \(1997\)](#) found that aggressive responding to hypothetical conflict scenarios was more frequently seen in males than in females. However, both males and females showed curvilinear patterns for both types of

aggression. The amount of aggressive responding increased from 11 to 14 years of age and decreased from 14 to 17 years of age. Additional research has shown that actual physical aggression (e.g., fighting) peaks between 13 and 15 years of age and then decreases as individuals enter late adolescence (Loeber & Stouthamer-Loeber, 1998). Interestingly, parent–teen conflict and sibling conflict both appear to peak during early adolescence as well (Steinberg, 2001).

4. Correlates of aggressive behavior in early adolescence

4.1. Psychosocial correlates

The increase in aggressive behavior and conflicts in early adolescence appears to be related to the variety of new social and emotional challenges that arise during early adolescence. For instance, early adolescents must adjust to rapid physical growth and maturation and increasing sexual feelings. In addition, early adolescents are faced with increasing cognitive and socio-emotional challenges at school and changes in the emotional, social, and psychological relationships with their parents and peers (Steinberg, 2001). Although most adolescents cope well with these challenges, early adolescence is also a time of increased negative emotions and depression (Steinberg, 2001). One possibility for the increased aggressive behavior and conflict during early adolescence is that the increase in negative affect and depression increases the likelihood of responding to a variety of provocation situations with aggression. In fact, research has demonstrated that individuals who are depressed (Quiggle, Garber, Panak, & Dodge, 1992) or are high in trait anger (Kirsh & Olczak, 2000) interpret ambiguous provocation situations (i.e., an individual gets hurt, but the intent of the provocateur may be either benign or malevolent) as stemming from hostile intent. Research on mood congruent memory suggests that individuals with a negative mood are more likely to remember negatively valenced information better than other emotionally valenced information (Fiedler, Nickel, Muehlfriedel, & Unkelbach, 2001). Furthermore, recent research suggests that early adolescents have more difficulty recognizing facial expressions of emotions than do late adolescents (Yurgelun-Todd, 1998). These misidentifications of emotions may make the context surrounding emotionally laden situations unclear, resulting in miscommunication and conflict. Together, these findings suggest that the increase in negative affect and depression associated with early adolescence may result in an increase in negatively biased social information processing. In turn, this negative bias could increase the likelihood of acting aggressively in certain situations.

4.2. Biological correlates

Apart from psychosocial factors, biological changes during early adolescence, both hormonal and cortical, may influence the aforementioned increase in aggressive behavior. During early adolescence, there is an increase in adrenal hormones (adrenarche) and gonadal hormones (gonadarche). Spear (2000) suggests that adrenarche is a contributing factor to adjustment and behavior problems. Furthermore, gonadarche is positively (albeit weakly)

correlated with aggressive behavior. In support of this connection, experimental studies have shown that after gonadal steroids are given to hormonally deficient adolescents, increases in physical aggression and aggressive impulses follow. However, gonadal steroids appear to account for only a small proportion of the variance for behavior during normative adolescence (see [Spear, 2000](#), for review).

Additional research has indicated that structural changes occur in the brain during adolescence. According to [Spear \(2000\)](#), between 7 and 16 years of age, adolescents lose one-half of their prepubertal neocortical synapses (at a rate of 30,000 synapses per second). Although the resulting impact of synaptic pruning on adolescent functioning is not well known, [Brownlee \(1999\)](#) suggest that pruning enhances the efficiency of prefrontal cortical processing. In early adolescence, prior to pruning, excessive synapse connections may limit the prefrontal cortex's ability to efficiently process and evaluate situations, in turn reducing early adolescents' ability to make sound judgments. Thus, it is possible that higher levels of aggressive behavior during early adolescence are in part due to biologically driven limitations in rational thought and evaluation of consequences.

Functional magnetic resonance imaging (fMRI) suggests that the brains of early and late adolescents may function differently. Using fMRI technology, [Yurgelun-Todd \(1998\)](#) observed the brains of 10- to 18-year-olds while they were viewing emotionally laden pictures. Yurgelun-Todd found that during picture viewing both the limbic system (emotional responses) and the prefrontal cortex (center for higher thinking) of late adolescents became activated. In contrast, for early adolescents, emotionally laden drawings were processed primarily with the limbic system. It may be that early adolescents are responding to emotionally laden situations with less prefrontal cortical activity, and thus are proportionally more emotion-driven than older individuals.

Of note, testosterone (a gonadal hormone) has been associated with an increase in the size of at least one limbic structure (amygdala), which is the part of the limbic system primarily responsible for fear and anger. Furthermore, this increase appears to be greater for boys than girls ([Brownlee, 1999](#)). It is possible that one reason adolescent boys are more overtly aggressive than adolescent girls ([Parke & Slaby, 1983](#)) is due to structural differences in the limbic system.

In summary, excess synapses during early adolescence, the impact of adrenarche and gonadarche, and the primacy of the limbic system over the neocortex in emotionally laden situations may lead to the increased aggression of early adolescence (more so for boys than girls) in negatively valenced emotion-related contexts. In contrast, by late adolescence, synaptic pruning and increased neocortical processing of emotionally laden situations may allow the adolescent to become more rational in negative emotion-inducing situations and choose alternative paths to aggression.

5. Violent video game play as a function of development

Adolescents play video games with the greatest frequency during the developmental period during which they respond to provocation situations with the greatest frequency of

aggression. The question as to why violent video game play and developmental changes in adolescent aggression correspond is intriguing. One possibility is that as adolescents become more aggressive, they become more attracted to activities that involve aggression. Previous research supports this contention. For instance, highly aggressive boys have been shown to prefer violent media (e.g., toys, video games, television) more than less aggressive boys (see [Goldstein, 1998](#)). It follows that as psychosocial and biological factors trigger adolescents' aggressive tendencies, adolescents should become drawn to more violent activities. Later, developmental changes resulting in a decrease in aggressive behavior may lead to decreases in preference for aggressive activities, such as video games. A second possibility is that because video game play is action-oriented, it creates a high level of arousal. According to [Goldstein \(1998\)](#), individuals who have a high need for sensation or arousal are attracted to violent imagery. In support of this contention, [McCauley \(1998\)](#) suggests that individuals who are high in sensation seeking find violence in television and film more appealing than do their low sensation-seeking counterparts. Recent research by [Lynch \(1999\)](#) has shown that, following violent video game play, individuals high in trait hostility show greater increases in epinephrine than individuals low in trait hostility. Additional research has shown that increases in heart rate and blood pressure accompany violent video game play ([Anderson & Bushman, 2001](#)). Thus, research indicates that violent video games result in an increase in physiological arousal. Early adolescence is a time of increased risk taking and novelty seeking. [Spear \(2000\)](#) suggests that adolescents may be less affected by moderate stimuli than children or adults. Consequently, adolescents may seek out sensation-producing activities, such as video game play, for rewarding experiences. Thus, violent video game play may be an attempt to provide the adolescent with acceptable levels of arousal. However, more research is necessary to determine the exact reasons why early adolescents are more attracted to violent video games than middle or late adolescents.

6. Consequences of violent video games as a function of development: GAM

Regardless of the reasons why adolescents play violent video games, consequences of such play have been shown to negatively impact social and emotional functioning in children, adolescents, and young adults ([Bushman & Anderson, 2001](#)). To explain how violent video games influence aggressive behavior, [Anderson and Bushman \(2002\)](#) have posited the GAM. Of note, this model can be used to explain both the development of aggression across adolescence and individual differences in susceptibility to the influence of violent video games. According to the GAM, personological variables (e.g., trait hostility, attitudes toward violence) and situational variables (e.g., exposure to real-world or media violence) interact to influence an individual's present internal state. Within an individual's internal state, cognitions (e.g., aggressive scripts, hostile thoughts), affects (e.g., hostile feelings), and arousals (e.g., heart rate, blood pressure) influence one another. For example, hostile thoughts (a cognition) can increase hostile feelings (an affect). Subsequently, cognitions, affects, and arousal interact to influence an individual's interpretation of an aggressive act (e.g., harm-

doer has hostile or benign intent). Once an interpretation has been made (i.e., harm-doer had benign or malevolent intent), decision-making processes (e.g., aggress, ignore) occur.

According to the GAM, violent video games influence aggressive behavior through short- and long-term effects. In the short term, violent video games function as a situational variable, resulting in an increase in aggressive cognitions, affects, and arousal. Anderson and Bushman (2001) have recently produced a meta-analytic review that provides empirical support for the contention that violent video games lead to aggressive behavior ($r_+ = .19$), aggressive cognitions ($r_+ = .27$), hostile affects ($r_+ = .18$), and increased physiological arousal ($r_+ = .22$). In the long term, violent video games are hypothesized to influence aggressive behavior by promoting aggressive beliefs and attitudes and creating aggressive schema, aggressive behavioral scripts, and aggressive expectations, as well as desensitizing individuals to aggression. In turn, these factors bias an individual's personality toward aggression. At this time, there are no longitudinal data to support the long-term effects of exposure to video game violence. However, Anderson and Bushman believe that given the similarities between video game violence and television violence and the fact that long-term exposure to television violence is significantly associated with increased aggressive behavior (Strasburger, 1995), the long-term impact of violent video games should correspond to GAM predictions.

7. The importance of a developmental approach to understanding the influence of violent video games

Violent video games negatively influence socio-emotional functioning during the adolescent period (Anderson & Bushman, 2001). However, given that biological and psychosocial changes occur during adolescence, exposure to violent video games should differentially affect the processes operating within the GAM across adolescence. By the time children reach adolescence, personological and internal state components of the GAM, such as cognition, affects, and arousal, are already in place. However, between early and later adolescence, these variables will continue to develop and be influenced by current environments. The general increase in aggression that accompanies early adolescence (Lindeman et al., 1997; Loeber & Stouthamer-Loeber, 1998; Steinberg, 2001) should affect the internal state variables of the GAM by reinforcing and increasing aggressive cognitions, aggressive affects, and arousal. Exposure to violent video should further affect the aggressive nature of the adolescent by creating and/or reinforcing aggressive cognitions and scripts, by creating and/or reinforcing hostile affects, and by increasing aggression-related arousal. According to the GAM, cognitions, affects, and arousals directly influence one another. Thus, the increases in physiological arousal (Lynch et al., 2001), aggressive cognitions, and hostile affects (Anderson & Bushman, 2001) that follow violent video game play should interact with one another to negatively bias internal state variables. Although the effects of violent video game play impact early, middle, and late adolescents, the influence of violent video games should be more pronounced in early adolescence than in middle and late adolescence. The heightened physiological arousal experienced by early adolescents (Spear, 2000) should interact with internal state arousal caused by violent video games to create a *cumulative* level

of internal state arousal that is higher than in middle and late adolescence, resulting in more aggressive behavior.

The decision-making processes of GAM may also function differently across adolescence. Cognitive deficiencies may result in more aggressive responding in early adolescence than in middle and late adolescence. Early adolescents should act impulsively and with little cognitive evaluation during emotionally laden (e.g., stressful) situations. This effect should be heightened following violent video game play since the aggressive nature of video games should result in increased internal state arousal (e.g., limbic system activity and adrenal hormone release). In contrast, as individuals enter late adolescence, the decision-making portion of GAM will become more rational and evaluative. Thus, even if a state of heightened arousal accompanied by hostile cognitions and affects occurs following violent video game play, late adolescents should be less likely than early adolescents to act aggressively due to late adolescents' increased cognitive ability and relatively lower levels of limbic system activity and adrenal hormones. However, even if violent video games affect early, middle, and late adolescents' internal state variables (i.e., cognition, affect, and arousal) similarly, early adolescents should experience a greater increase in aggressive behavior than older adolescent because of impulsive behavior and poor decision-making processes.

8. Viewing aggression as a multivariate construct: GAM and violent video games

A variety of factors have been shown to contribute to aggressive behavior across adolescence. Gender, family (e.g., low parental involvement, verbal, and physical aggression), peer (e.g., aggressive or nonaggressive, popularity), school (e.g., achievement, dropout status), and personality (e.g., self-esteem, trait hostility) factors have all been linked to aggression (Leschied et al., 2000). For instance, Viemero (1996) found a positive correlation between parental rejection and peer-nominated aggression. Ellickson, Saner, and McGuigan (1997) linked low academic orientation and dropping out of school with violent behavior. Research also indicates that peers of both adolescent boys (Dishion, Andrews, & Crosby, 1995) and girls (Harris, 1994) tend to encourage and reinforce aggressive behavior. Furthermore, the potential influence of peers, parents, and school may vary across adolescence. For instance, conformity to antisocial peer pressure increases throughout early adolescence, peaking around age 15 (Berndt, 1979).

Like video game play, peer, family, and school factors are considered situational factors in the GAM. Although many factors contribute to aggressive behavior across adolescence, when assessing the impact of video game violence on aggression, the most frequently assessed factors (other than violent video games) are gender and personality. Although physical aggression (e.g., fighting, bullying) and violent crimes (e.g., school shootings) are typically perpetrated by adolescent boys (Leschied et al., 2000), the effects of violent video games *do not* consistently vary by gender (see Dill & Dill, 1998, for a review). Similarly, research assessing the influence of video game violence as a function of personality has contradictory findings. For instance, whereas some studies find greater effects of video game violence on aggression for individuals high in trait hostility (e.g., Study 1, Anderson

and Dill, 2000), other studies find no moderator effects for trait hostility and video game violence (e.g., Study 2, Anderson & Dill, 2000; Lynch et al., 2001). However, as Lynch et al. (2001) contend, few studies have adequately addressed personality and video game moderator issues.

One possibility for the inconsistent moderator effects involving violent video games, gender, and personality is that other situational factors associated with aggression during adolescence (e.g., peers and family factors) were not assessed. Given that aggression is a multivariate construct, a multivariate assessment of the major personological (e.g., hostility, impulsivity) and situational factors (e.g., peers, parents, school) that contribute to aggression during adolescence is warranted. Research on television violence suggests that such an assessment would be valuable. For instance, Singer et al. (1999) found that a combination of exposure to television violence, lack of parental monitoring, and amount of television watched best accounted for aggressive behavior in elementary and middle-school children. Garbarino (1999) contends that the number of risk factors affecting children and adolescents is an important determinant of aggression. Garbarino feels that most children can cope with one or two risk factors (e.g., impoverished family, exposure to violence) without increasing their aggressive behavior. However, when three or more risk factors are present, aggressive behavior is more likely than not. It may be that violent video games primarily impact the aggressive behavior of adolescents who have a certain number of risk factors associated with aggression (e.g., impulsivity, violent home, low parental involvement, aggressive peer group). Adolescents without these risk factors, in contrast, may face little to no risk of increasing their aggressive behavior by playing violent video games.

According to Borum (2000), the construct of “risk of violence” is determined by “contextual,” “dynamic,” and “continuous” influences. Risk of violence is “contextual” in that violent acts occur in particular settings (e.g., school) and under certain circumstances (e.g., peer rejection). The potential for violence changes from day to day, and therefore, the risk of violence is “dynamic.” Finally, risk of violence is “continuous” in that the probability of violent acts varies along a continuum. Risk assessment moves beyond identifying “dangerous” adolescents. Instead, risk approaches to violence determine the likelihood of an adolescent acting violently and the nature of that violence (e.g., physical or verbal assault) given certain circumstances (e.g., bumped into) and contexts (surrounded by aggressive peers). To better understand the impact of exposure to violent video games on aggressive behavior, research needs to move beyond two- and three-factor assessments (e.g., video game violence, trait hostility, and gender) and employ a risk factor approach. Aggressive behavior, in its various forms (e.g., physical or verbal assault), is the result of the cumulative influence of a variety of factors, involving a multitude of contexts. Thus, video game violence research needs to reflect the fact that the risk of violent behavior is contextual, dynamic, and continuous.

Furthermore, it is imperative that developmental issues be considered when assessing the influence of violent video games on aggressive behavior. As previously reviewed, research has demonstrated that biological (e.g., adrenarche, gonadarche, synaptic pruning) and psychosocial (e.g., peers, parents, siblings, school) components of aggression differentially impact the adolescent across development: early adolescents appear to be more vulnerable than late adolescents. Thus, it may be that the risks associated with violent video games are the greatest

during early adolescence (the developmental period that adolescents play violent video games the most) because, overall, there are more risk factors for aggression during early adolescence than during later periods of adolescent development.

9. Summary

The issue of whether or not video game violence influences aggression has been addressed for over 20 years. Recent acts of extreme violence involving teens and associated links to violent video games have led to an increased interest in video game violence. Anderson and Bushman's (2001) meta-analysis suggests that violent video games, in fact, do influence aggressive behavior, aggressive affects, aggressive cognition, and physiological arousal. Furthermore, Anderson and Bushman (2002) have posited the GAM to explain the mechanisms behind the link between violent video games and aggressive behavior. Research by Anderson and Bushman (2001) and others (e.g., Lynch et al., 2001) has provided empirical support for the GAM. However, the influence of violent video games as a function of developmental changes across adolescence has yet to be addressed.

The biological and psychosocial changes of adolescence are associated with a peak in aggressive behavior during early adolescence, the exact period in which violent video game play is at its zenith. Applying the GAM to adolescent development, it appears that the effects of violent video games should have their greatest impact during early adolescence. Although research has assessed video game violence during different developmental periods, currently there are not enough studies to evaluate the influence of violent video games across development. Thus, more research is necessary to investigate the influence of violent video games during different developmental periods of adolescence. Anderson and Bushman (2001) contend that violent video games pose a "public health threat to children and youth." More research is necessary to determine the periods of adolescent development during which video games pose the greatest threat. Furthermore, future research needs to assess the major risk factors associated with aggression during adolescence along with violent video games. Such an assessment should provide a better understanding of the health threat accompanying exposure to violent video games.

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