Media Violence and Social Neuroscience

New Questions and New Opportunities

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ABSTRACT—*Decades of research have demonstrated that exposure to violence on television can cause increases in aggression. The recent emergence of violent video games has raised new questions regarding the effects of violent media. The General Aggression Model (GAM) predicts that exposure to violent media increases aggressive behavior through one of three primary pathways (arousal, cognitions, and affect). Past psychophysiological research has supported GAM but has been limited to examining arousal-related variables. Recent advances in social neuroscience have opened the door to investigations of exposure to violent media on cognitive and affective components and their neurocognitive underpinnings. Neuroscience tools have the potential to provide answers to the new questions posed by recent advances in media technology.*

KEYWORDS—*aggression; brain imaging; fMRI; media violence; violent video games*

It is no secret that we are surrounded by electronic media. In a matter of years, through the development of the Internet, satellite television, cell phones, iPods, and video game systems, entertainment media have become more available than ever. As media technology has advanced, the amount of time that children and adolescents spend with it has increased. On average, American children now spend more than 5 hours a day consuming screen media (television, films, video games)—nearly as much time as they spend in school. Similar increases in media consumption have been reported in Europe and Asia. In addition, the most popular screen media consumed by children and adolescents contain considerable amounts of violence (Anderson et al., 2003). Such high levels of exposure to violent media in modern society have led to a combination of scientific intrigue and public concern. Although media technology is arguably causing changes in society at a faster pace than scientists can examine it, other technological advancements are benefiting the scientists' cause. Recent developments in neuroscience have allowed scientists to understand the interaction between the psychological and physiological mechanisms like never before. This article reviews the findings of past research on violent media and explores how the development of violent video games presents social scientists with new empirical questions, as well as how developments in social neuroscience can provide novel approaches to address those questions.

VIOLENT MEDIA EXPOSURE AND AGGRESSION

Children's exposure to violent media (e.g., television, movies, music, video games) has been a social concern for decades. For example, news reports linked Clint Eastwood's "Dirty Harry" film character to copycat killings involving forced ingestion of Drāno. More recently, violent video games have been linked to numerous school killings (e.g., Columbine High School) and other violent crime sprees (e.g., in California, Michigan, Minnesota, and Ohio). Most studies examining violent media have focused on the effects of violent television and movies on viewers' aggression. The most recent comprehensive review of the effects of violent media found "unequivocal evidence that media violence increases the likelihood of aggressive and violent behavior in both immediate and long-term contexts" (Anderson et al., 2003, p. 81). Figure 1 (originally from the Anderson et al. review), shows that violent media are linked to increased aggression, regardless of the type of study design used to investigate its effects.

Although comparably fewer studies have specifically focused on violent video games, existing research demonstrates that they also cause increases in aggressive behavior (e.g., Anderson et al., 2004). For example, one recent experiment (Anderson, Gentile, & Buckley, 2007) found that brief exposure to a violent children's video game increased delivery of high-intensity noise

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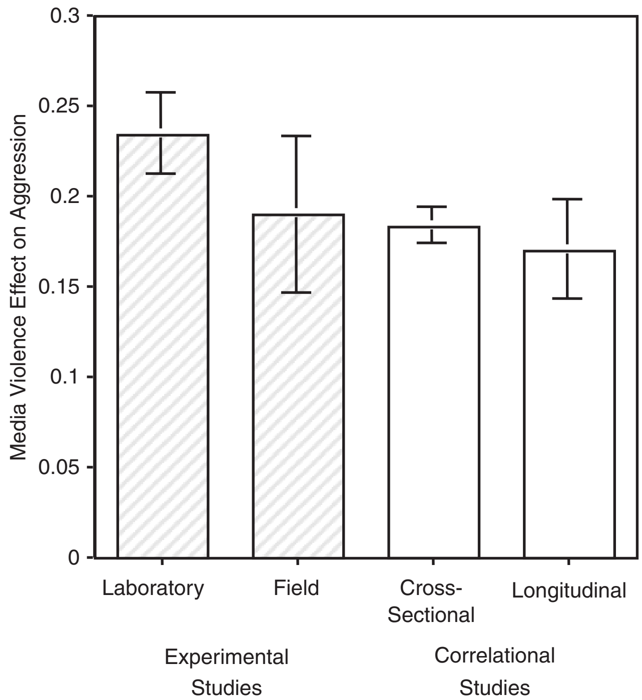

Fig. 1. Effects of media violence on aggression for two types of experimental studies and two types of correlational studies. Effect sizes are presented in terms of *r* (correlation coefficient). Vertical capped bars indicate 95% confidence intervals. Because the bars do not include the zero line, the effect of media violence on aggression is statistically significant for each type of study. This figure originally appeared in Anderson et al. (2003).

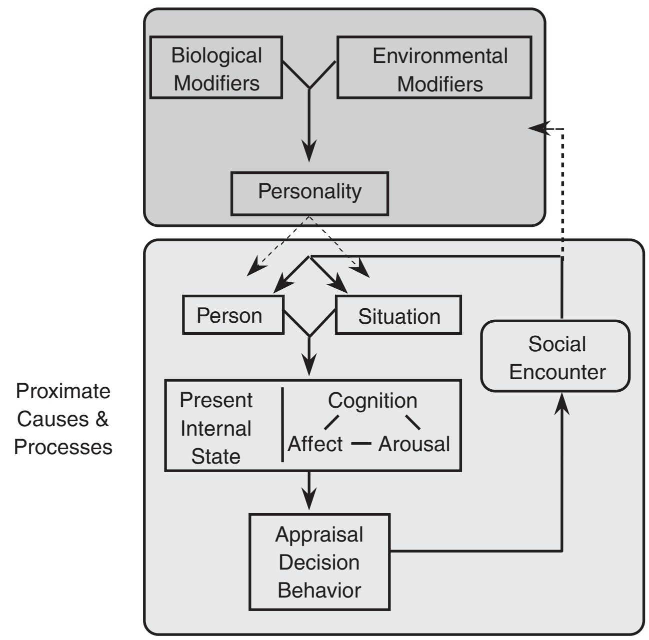

Fig. 2. An overview of the General Aggression Model (GAM). GAM describes how a cyclical pattern of interaction between personal factors (e.g., knowledge structures, trait aggression) and situational factors (e.g., provocation, recent exposure to violent media) influences the likelihood of aggressive behavior in the current situation and the development of aggressive personality over time. These input variables influence behavior ultimately by affecting decision processes through three primary routes: cognitive, affective, and physiological arousal. Although GAM is a comprehensive model of aggression, its theoretical constructs can be specifically applied to the effects of violent media.

blasts to an opponent by over 40%. This effect occurred for elementary school children and for college students.

Beyond these basic findings, violent video games have presented scientists with a host of new questions. Video games are a qualitatively different form of media than television and film, primarily because video games are more interactive and immersive. Players of violent video games actually engage in virtual violent actions, receive direct rewards for those actions, closely identify with the characters they control, and actively rehearse aggressive behavioral scripts.

GENERAL AGGRESSION MODEL

There also are strong theoretical reasons to believe that exposure to violent media can increase aggression-related outcomes. The General Aggression Model (GAM; see Fig. 2) is an integration of several prior models of aggression (e.g., social learning theory, social cognitive theory, cognitive neoassociation, excitation transfer; see Anderson & Carnagey, 2004). Although GAM is not specifically a model of media effects, it is easily applied to this domain. Theoretically, violent media could affect one, two, or all three aspects of a person's present internal state. Recent research has demonstrated that violent video games can temporarily increase aggressive thoughts, aggressive affect, and physiological arousal (e.g., Anderson et al., 2004), and can reduce arousal to subsequent depictions of violence (e.g., Carnagey, Anderson, & Bushman, 2007). Exposure to violent media can increase aggressive behavior by influencing any combination of these internal states.

PHYSIOLOGICAL CONSEQUENCES OF MEDIA-VIOLENCE EXPOSURE

Media Violence and Arousal-Related Variables

Media-violence researchers have long used physiological tools to better understand the relationship between violence exposure and aggression. Most of this research has focused on the potential effects of violent media on arousal. Numerous models have linked physiological arousal with human aggression. For example, excitation transfer theory (e.g., Zillmann, 1983) states that arousal elicited by external sources (e.g., exercise) may be misattributed as anger in situations involving provocation and may thereby increase the chances of producing anger-motivated aggressive behavior. Recent meta-analyses have demonstrated that playing violent video games can increase physiological arousal and anger (e.g., Anderson et al., 2004). Thus, one route by which playing violent video games can increase aggression is through increased physiological arousal.

In addition to arousal-facilitated aggression, other research links violent media to physiological desensitization to violence. In this context, physiological desensitization refers to a reduction in physiological reactivity upon later exposure to violence. Most people have an automatic aversive emotional response to scenes of violence, often assessed by changes in heart rate and skin conductance. Such negative emotional responses help inhibit aggressive behavior and inspire helping behavior. Past research has shown that, following exposure to either violent television (e.g., Thomas, Horton, Lippincott, & Drabman, 1977) or to violent video games (Carnagey, Anderson, & Bushman, 2007), participants show reduced skin conductance and heart-rate reactivity when encountering subsequent depictions of real violence. In other words, exposure to virtual violence produces desensitization to actual violence, which has been linked to increased aggression and reduced helping.

Media Violence and Social Neuroscience

Until very recently, research on physiological mechanisms underlying the effect of violent media has been restricted to indicators of arousal. However, most social-cognitive models of human aggression clearly make predictions about cognitive and affective influences on aggression as well. Contemporary measures of physiological responding permit researchers to address the other routes to aggression (i.e., cognitive and affective) depicted in GAM. Through the use of neurocognitive tools such as event-related brain potentials (ERPs) and functional magnetic resonance imaging (fMRI), scientists can now examine the effects of exposure to violent media on specific neural structures that support processes such as emotional regulation, memory storage and retrieval, and executive functioning. These tools eventually will provide a more comprehensive understanding of the impact of violent media on the consumer by giving insight into the interaction between neural and psychological processes.

Although research examining the neurocognitive effects of exposure to violent media is currently scarce, a growing literature is emerging. For example, Bartholow, Bushman, and Sestir (2006) demonstrated that individuals with a history of high exposure to violent video games have different physiological reactions to scenes of real violence than do individuals with a low exposure history. Participants with varying degrees of exposure to violent video games were presented with a series of negative photos, half violent and half nonviolent, included among a set of more numerous neutral photos while ERPs were recorded. ERPs are scalp-recorded voltage fluctuations that represent neural activity associated with various information-processing operations. The P300 component of the ERP, which is a positive voltage deflection occurring approximately 300 to 600 milliseconds after stimulus onset, has been shown to be positively related to activation of the aversive motivational system (e.g., Ito, Larsen, Smith, & Cacioppo, 1998). Results demonstrated that high exposure to violent video games was associated with decreased amplitude of the P300 elicited by images of real violence and that this reduced brain activity predicted increased aggression in a later task. This work extends the concept of violence desensitization to the cognitive domain.

Other emerging evidence demonstrates that different neural regions are activated when one views violent scenes than when one views nonviolent scenes (Murray et al., 2006). Children were shown violent and nonviolent scenes from commercially released movies while fMRI data were collected. Violent scenes activated a network of brain regions (e.g., posterior cingulate cortex, hippocampi) involved in processing emotional stimuli, episodic memory retrieval, detecting threats in the environment, memory encoding, and motor programming. This combination of activation in areas linking memory and emotion to motor activation suggests that viewing media violence could integrate existing aggression-related thoughts and feelings, potentially facilitating aggressive behavior by increasing the strength or accessibility of aggressive behavior scripts in memory.

There is recent evidence that exposure to violent media may be linked to decreases in the activity of brain structures needed for regulation of aggressive behavior and to increases in the activity of structures needed to carry out aggressive plans. The anterior cingulate cortex (ACC), located in the medial frontal lobe, has been linked to aggressive and antisocial behavior (e.g., Sterzer, Stadler, Krelbs, Kleinschmidt, & Poustka, 2003). The ACC appears to be vital for various executive functions, including inhibition, performance monitoring, and possibly error correction, and serves as an interface between cognition (the dorsal ACC) and emotion (the rostral ACC; see Bush, Luu, & Posner, 2000). Recent work by Weber, Ritterfeld, and Mathiak (2006) used fMRI to test potential links between exposure to violent games, ACC activity, and aggression. Participants played a violent video game while fMRI data were collected. Game play was recorded and analyzed frame by frame to determine when participants were engaging in violent and nonviolent actions so that neural activations could be time locked to those actions. Results demonstrated that engaging in virtual violence led to decreased activity in the rostral ACC and increased activity in the dorsal ACC. The rostral ACC results indicate suppression of affective information processing. These results are the first to provide neural evidence distinguishing the impact of exposure to violent media on cognitive and affective processes.

Chronic consumption of violent media has also been linked to suppression of the ACC. In a recent study (Matthews et al., 2005), two groups of adolescents, one with disruptive behavior disorder with aggressive features and a clinically normal group, provided self-report data on their exposure to violent media and then completed a modified Stroop task while fMRI data were collected. In the classic Stroop task, participants respond to the color of printed words. Congruent trials require little executive control because the color and text of the word are the same (e.g., “RED” printed in red type). In contrast, incongruent trials (e.g., “RED” printed in blue type) require executive control to overcome the prepotent tendency to read the word and respond to the written color name. Incongruent Stroop task trials are known to elicit enhanced activity in the ACC (see Botvinick, Braver, Barch, Carter, & Cohen, 2001). Results from these Stroop tasks demonstrated that both the subjects with disruptive behavior disorder and the clinically normal subset who self-reported high exposure to violent media showed reduced ACC function in comparison with clinically normal subjects who self-reported low exposure to violent media.

Taken together, the results reported by Weber et al. (2006) and Matthews et al. (2005) form an important bridge linking the perpetration of virtual violence with reduced activation of a neural mechanism known to be important for self-control and for evaluation of affect. These findings strongly suggest that focusing on the activity of prefrontal cortical structures important for executive control could provide important mediational links in the relationship between exposure to violent media and increased aggression.

FUTURE DIRECTIONS: SOCIAL NEUROSCIENCE AND VIOLENT VIDEO GAMES

As this brief review illustrates, recent developments in social neuroscience have the potential to provide more insight into the effects of exposure to violent media by examining the affective and cognitive components of GAM at a neural level. These new advances also have the potential to address numerous unanswered questions. One such unanswered question is whether violent video games have a larger effect on children than on adults. For numerous reasons (e.g., children's brains, particularly the frontal cortex, are not fully developed; children's social scripts are more malleable), the theoretical response would be "yes." However, existing empirical evidence is sparse and unclear. Approaching this question from a social-neuroscience perspective, particularly within the framework of a longitudinal, developmental design, could shed needed light on the neurocognitive systems underlying the effects of violent media as well as on how those systems are shaped, perhaps permanently, by repeated exposure to violent media as the brain develops. Advances in neural-imaging technology also could increase our understanding of the brain structures that are at work (and those that are relatively silent) when someone is intentionally trying to harm another individual and how activations and deactivations in these structures during consumption of violent media relate to aggressive behavior.

Also, neuroimaging tools could assist in testing the causal association between brain activations while engaging in acts of virtual violence and subsequent real-life aggression. Initial results suggest that, although video-game players are aware that they are engaging in fictitious actions, preconscious neural mechanisms might not differentiate fantasy from reality. This suggests that engaging in virtual violence (i.e., playing violent video games) could impact neural systems in a manner comparable with engaging in actual violence. This question remains to be rigorously tested in future brain imaging research.

Finally, a question that has emerged in both the public-policy arena and the scientific community is whether aggression-related variables are affected more by exposure to violent video games than by exposure to violent television. There are a host of theoretical reasons to expect that exposure to violent video games would have a larger impact. From a social-neuroscience perspective, the interactive and immersive nature of violent video games could more strongly engage neural systems associated with activation of aggressive behavioral scripts and could more strongly suppress executive structures that would normally inhibit aggressive and violent actions. Neuroimaging tools could provide unique insight regarding the neural impact of exposure to passive television violence in comparison with exposure to interactive video-game violence. With next-generation media technology becoming more immersive, it is important to understand the impacts of such violent virtual immersion sooner rather than later.

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