Research conducted over the past 30 years leads to the conclusion that televised violence does influence viewers' attitudes, values and behavior (Hearold, 1986; Murray, 2000, 1994, 1973; Paik and Comstock, 1994; Surgeon General's Scientific Advisory Committee on Television and Social Behavior, 1972). Although the social effect of viewing televised violence is a controversial topic of research and discussion, the body of research is extensive and fairly coherent in demonstrating systematic patterns of influence. In general, there seem to be three main classes of effects:

**Aggression.** Viewing televised violence can lead to increases in aggressive behavior and/or changes in attitudes and values favoring the use of aggression to solve conflicts (Huston et al., 1992).

**Desensitization.** Extensive violence viewing may lead to decreased sensitivity to violence and a greater willingness to tolerate increasing levels of violence in society (Drabman and Thomas, 1974; Thomas et al., 1977).

**Fear.** Extensive exposure to television violence may produce the "mean world syndrome," in which viewers overestimate their risk of victimization (Gerbner, 1970; Gerbner et al., 1994). Although we know that viewing televised violence can lead to increases in aggressive behavior or fearfulness and to changed attitudes and values about the role of violence in society, we need to know more about how these changes occur in viewers -- the neurological processes that lead to changes in social behavior.

Within the context of social learning theory, we know that changes in behavior and thoughts can result from observing models in the world around us, such as parents, peers or the mass media. The processes involved in modeling or imitating overt behavior were addressed in social learning theories from the 1960s (Bandura, 1969, 1965, 1962; Berkowitz, 1965, 1962), but we must expand our research approaches if we are to understand the neurological processes that might govern the translation of the observed models into thoughts and actions.
Both Bandura (1994) and Berkowitz (1984) have provided some theoretical foundations for the translation of communication events into thoughts and actions. Bandura’s social-cognitive approach and Berkowitz’s cognitive-neoassociation analysis posit a role for emotional arousal as an “afflектив tag” that may facilitate lasting influences. With regard to aggression, we know that viewing televised violence can be emotionally arousing (e.g., Cline et al., 1973; Osborn and Endsley, 1971; Zilmann, 1982, 1971), but we lack direct measures of cortical arousal or neuroanatomical patterns in relation to viewing violence.

The pursuit of neurological patterns in viewing violence would likely start with the amygdala, because it has a well-established role in controlling physiological responses to emotionally arousing or threatening stimuli (Damasio, 1999, 1994; LeDoux, 1996; Orstein, 1997). Indeed, a National Research Council report (Reiss and Roth, 1993) concluded:

All human behavior, including aggression and violence, is the outcome of complex processes in the brain. Violent behaviors may result from relatively permanent conditions or from temporary states...Biological research on aggressive and violent behavior has given particular attention to...functioning of steroid hormones such as testosterone and glucocorticoids, especially their action on steroid receptors in the brain;...neurophysiological (i.e., brain wave) abnormalities, particularly in the temporal lobe of the brain; brain dysfunctions that interfere with language processing or cognition.

Thus, one suggestion for further research on the impact of viewing media violence is to assess some of its neurological correlates. In particular, the use of videotaped violent scenes can serve as the ideal stimulus for assessing activation patterns in response to violence.

It is very likely that the amygdala is involved in processing violence, but the projections to the cortex are not clear. However, developing hypotheses about viewing violence and brain activation needs to start with research on physiological arousal (e.g., Osborn and Endsley, 1971; Zilmann, 1982; Zilmann and Bryant, 1994) and then link this to cortical arousal. In this regard, the work of Paul Ekman, Ph.D., and Richard Davidson, Ph.D., using electroencephalogram recordings while subjects viewed gruesome films indicated asymmetries in activation patterns in the anterior regions of the left and right hemispheres (Davidson et al., 1990; Ekman and Davidson, 1993; Ekman et al., 1990). In particular, positive affect (indexed by facial expression) was associated with left-sided anterior activation, while negative affect was associated with right-sided activation (Davidson et al., 1990).

Our preliminary research (Liotti et al., in press; Murray et al., 2001) has focused on the amygdala and related structures in an effort to identify the neurological correlates of viewing televised violence. In this instance, we used functional magnetic resonance imaging (fMRI) to map the brains of eight children (five boys, three girls; aged 8 to 13 years) while they watched violent and nonviolent videotapes. The violent video segments consisted of two, three-minute clips of boxing from “Rocky IV.” The nonviolent video segments were two, three-minute clips of a National Geographic program on animals at play and “Ghostwriter,” a children’s literacy program set in a mystery context. In addition, we presented two, three-minute control, restoration clips of an “X” on a blue screen.

We conducted whole brain (18 to 22 slices) echoplanar fMRI throughout the 18 minutes of viewing. Following the viewing, structural or anatomical (aMRI) images were acquired. Both the fMRI and aMRI images were normalized to Talairach space, and statistical analyses were conducted with task-induced blood oxygenation-level dependent (BOLD) changes detected using a conventional statistical parametric mapping method of voxel-wise independent paired t-tests.

In this study, we found that both violent and nonviolent viewing activated regions implicated in aspects of visual and auditory processing. In contrast, however, viewing violence selectively recruited right precuneus, right posterior cingulate, right amygdala, bilateral hippocampus and parahippocampus, bilateral pulvinar, right inferior parietal and prefrontal, and right premotor cortex. Thus, viewing televised violence appears to activate brain areas involved in arousal/attention, detection of threat, episodic memory encoding and retrieval, and motor programming. These findings are displayed in the Figure, which provides the significant contrasts between the violence-viewing and nonviolence-viewing sessions. The regions of interest in the composite activations of the eight children included the amygdala, hippocampus and posterior cingulate. These areas of the brain are likely indicators of threat-perception and possible long-term memory storage of the threat-event (particularly, these patterns are similar to the memory storage of traumatic events in posttraumatic stress disorder) (Brannan et al., 1997; Liotti et al., 2000). These activation patterns are important because they demonstrate that viewing video violence selectively activates right hemisphere and some bilateral areas that collectively suggest significant emotional processing of video violence.

Of course, this is a preliminary study with a small sample of children, and we must conduct further studies with larger samples of young viewers. However, this preliminary research leads us to conclude that there are important...
theoretically predictable patterns of neurological response to viewing media violence.

In our next series of studies, we will explore these neuroanatomical correlates of viewing violence in children who have had differing experiences with violence in their lives in order to better understand the processes of sensitization and desensitization.

In this instance, we will assess the responses of children who have experienced violence as victims of abuse, in contrast to youngsters who are more aggressive. We also expect to see differences in response to viewing violence among the abused, high-aggression and low-aggression children. We expect to see increased responsiveness to threat in the abused children and decreased responsiveness to threat in the high-aggression children.

Furthermore we anticipate differences in media preferences and viewing patterns to correlate with the level of aggression in these children. This constellation of findings will begin to address the patterns of response to aggression and the learning of aggression from media models. The issues of desensitization and enhanced aggression may be related to the patterns of brain activation observed in these children. The social significance of brain mapping and violence viewing is the contribution these studies make to our understanding of the learning and cognitive/affective processing of aggression in children and youth.

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