



Association of television violence exposure with executive functioning and white matter volume in young adult males



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ABSTRACT

Prior research has indicated that self-reported violent media exposure is associated with poorer performance on some neuropsychological tests in adolescents. This study aimed to examine the relationship of executive functioning to violent television viewing in healthy young adult males and examine how brain structure is associated with media exposure measures. Sixty-five healthy adult males (ages 18–29) with minimal video game experience estimated their television viewing habits over the past year and, during the subsequent week, recorded television viewing time and characteristics in a daily media diary. Participants then completed a battery of neuropsychological laboratory tests quantifying executive functions and underwent a magnetic resonance imaging (MRI) scan. Aggregate measures of executive functioning were not associated with measures of overall television viewing (any content type) during the past week or year. However, the amount of television viewing of violent content only, as indicated by both past-year and daily diary measures, was associated with poorer scores on an aggregate score of inhibition, interference control and attention, with no relationship to a composite working memory score. In addition, violent television exposure, as measured with daily media diaries, was associated with reduced frontoparietal white matter volume. Future longitudinal work is necessary to resolve whether individuals with poor executive function and slower white matter growth are more drawn to violent programming, or if extensive media violence exposure modifies cognitive control mechanisms mediated primarily via prefrontal cortex. Impaired inhibitory mechanisms may be related to reported increases in aggression with higher media violence exposure.

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1. Introduction

Concern about the potential psychological and neural effects of exposure to violence depicted on broadcast television and other media has led to an enormous scientific literature, much of which has revealed an association between viewing violence on television and risk of subsequent aggressive thoughts, emotions, and behaviors (Anderson et al., 2003; Paik & Comstock, 1994). Longitudinal research has indicated that childhood television violence exposure predicts adult aggression, even when controlling for such factors as intelligence, family environment and, notably, the amount of aggression the child originally demonstrated (Eron, Huesmann, Lefkowitz, & Walder, 1972; Huesmann, Moise-Titus, Podolski, & Eron, 2003; Lefkowitz, Eron, Walder, & Huesmann, 1977).

A number of explanations for this relationship between media violence and aggression have been offered, ranging from imitation and observational learning to more complex influences on worldview and the nature of social interactions. The General Aggression Model (GAM) encompasses these ideas, proposing that repeated exposure to media violence causes changes in an individual's aggressive beliefs, social-cognitive schemata, behavioral scripts, and desensitization to violence (Bushman & Anderson, 2002), all of which contribute to a more aggressive personality. In addition, extensive observation of violent scenes can reduce natural inhibitions toward conflict and aggression, which, combined with altered social perceptions, may increase violent behavior (Bushman & Geen, 1990). When influenced by environmental variables and/or physiological arousal, it is more difficult for individuals to control aggressive thoughts and to inhibit themselves from engaging in injurious words or actions when inhibitory mechanisms are compromised. Such cognitive control and inhibition are prominent facets of executive functioning, underlining the importance of

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neuropsychological factors in the relationship between media violence exposure and aggressive behavior.

Executive function encompasses a variety of higher-level cognitive processes that includes control of behavior, inhibition, planning, problem solving, working memory, and organization. Kronenberger et al. (2005a) reported that high media violence exposure was associated with poorer executive functioning in adolescents, as measured by both behavioral and questionnaire measures. Notably, this relationship remained strong when statistically controlling for total media exposure, as well as for demographic, diagnostic and intelligence measures. Other investigations have indicated a relationship between overall childhood television viewing and attention problems (Huesmann et al., 2003; Landhuis, Poulton, Welch, & Hancox, 2007), though the strength and timing of such effects have been called into question (Foster & Watkins, 2010; Zimmerman & Christakis, 2007).

The neural mechanisms underlying this reported relationship between media violence exposure and executive dysfunction are unclear. Executive processes are associated primarily with frontal lobe functioning, which provides a neurobiological link with media violence exposure and aggression. Aggressive individuals demonstrate diminished activity and structural abnormalities in prefrontal cortex, particularly related to impulsive and disinhibited behaviors (Brower & Price, 2001; Giancola, 1995). In addition, exposure to violent media has been associated with reduced frontal lobe activity (Mathews et al., 2005), as has playing a violent video game (Hummer et al., 2010; Wang et al., 2009). Violent video game players have also demonstrated a reduced P300 response to violent images, which was associated with trait aggression (Bartholow, Bushman, & Sestir, 2006).

Despite these connections, little research has examined the relationship between media violence exposure and structural brain development. In adolescent males, increased violent media exposure is associated with reduced lateral orbitofrontal cortex density (Strenziok et al., 2010), using a subscale from the Children's Report of Exposure to Violence (Cooley, Turner, & Beidel, 1995). In addition, exposure to real-life violence is related to reduced visual cortex gray matter volume (Tomoda, Polcari, Anderson, & Teicher, 2012) or maturation of visual–limbic white matter tracts (Choi, Jeong, Polcari, Rohan, & Teicher, 2012). While this research is promising, much additional work is necessary to characterize the relationship between media violence exposure and brain development.

The relationship between brain structure and executive function is somewhat better understood, however. In studies of healthy young adults, both gray and white matter volume have been found to be significantly correlated with neuropsychological performance, particularly in lateral prefrontal regions, using a variety of measures (Brickman et al., 2006; Gur et al., 1999; Matsuo et al., 2009; Newman, Trivedi, Bendlin, Ries, & Johnson, 2007). In these studies, better performance on executive function measures is associated with larger gray or white matter volume within networks involved in executive control (particularly attention and inhibitory processes). In addition, greater growth and development of frontoparietal white matter connections, such as the superior longitudinal fasciculus, is tied to better working memory, attention, delay discounting, and interference control (Burzynska et al., 2011; Mabbott, Noseworthy, Bouffet, Laughlin, & Rockel, 2006; Olson et al., 2009; Silveri, Tzilos, & Yurgelun-Todd, 2008; Tamnes et al., 2010a). Because media violence viewing has been tied to poorer executive functioning (Kronenberger et al., 2005a), we hypothesize that higher television violence exposure is related to reduced gray and white matter volume, particularly in lateral prefrontal regions or frontoparietal connections.

This study aims to extend previous work showing a relationship between media violence exposure and neuropsychological function and to examine whether television violence is related to volumetric

measures of gray and white matter. Establishing this relationship is an important step into identifying potential long-term relationships of media exposure to brain development. To this end, a battery of neuropsychological tests were provided to young adult males who also underwent a structural magnetic resonance imaging (MRI) scan. Voxel-based morphometry (VBM) techniques were utilized to examine potential relationships of television violence exposure with gray or white matter volume in the young adult brain.

This investigation extends previous media exposure research in several additional ways, including use of an adult sample, which likely has more mature and stable neuropsychological functioning than in adolescent years. In addition, the population in this investigation was more rigorously controlled, consisting solely of adult males with low levels of video game experience and no clinical diagnoses. The use of men who only sparingly play video games provides a more powerful look specifically at violent television exposure, by essentially controlling for video game exposure, which is another common source of media violence exposure for young adult males. Finally, multiple measures of media violence exposure were utilized in this study, including the use of daily media diaries, in order to more accurately assess television viewing habits.

Consistent with prior data, we hypothesized that increased television violence exposure would be associated with poorer executive functions, particularly those related to inhibitory processes. We also hypothesized lower prefrontal gray matter volume and reduced frontoparietal white matter volume with higher levels of television violence exposure. In order to examine this idea, healthy male participants underwent neuropsychological testing and an MRI scan and also provided detailed measurements of television viewing time and content.

2. Methods

2.1. Participants

Seventy-three participants aged 18–29 (inclusive), all with a nonverbal IQ greater than 80 (Kaufman & Kaufman, 2004), were recruited to take part in a larger project on the effects of media violence on neuropsychological and brain functioning. These young men were recruited via informational flyers and online notices at local hospital and university settings. Sixty-five participants completed testing, an MRI scan and at least six days of daily media diary reports (details below) and were included in data analyses.

Institutional ethics approval was provided for the study protocol by the university Institutional Review Board, and written informed consent was obtained before any procedures were initiated. All participants were males free of self-reported psychiatric diagnoses, as indicated by scores on the Adult Self-Report Inventory (AI-4; Gadow, Sprafkin, & Weiss, 2004) and self-reported psychiatric history. In addition, participants were required to have a self-reported history of no more than 5 hours per week of video game play or 2 hours per week specifically of violent video game play in the past year.

2.2. Procedure

During their first visit, participants completed questionnaires about demographic characteristics, potential psychiatric symptoms, behavior, and past media exposure. They were also instructed on the use of daily media diaries that they were to fill out at home during the subsequent week. Participants were instructed to refrain from video game play during this week as part of the larger study protocol, although these participants were already minimal game players. After 1 week, participants returned

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