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Lower Lateral Orbitofrontal Cortex Density Associated with More Frequent Exposure to Television and Movie Violence in Male Adolescents

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Abstract

The relationship between cortical grey matter density and media violence exposure in healthy male adolescents was investigated using voxel-based morphometry and the Childrens' Report of Exposure to Violence. Adolescents with more frequent exposure have lower left lateral orbitofrontal cortex density - a possible risk factor for altered socio-emotional functioning.

Keywords

Voxel-based morphometry; media; aggression

Violent media use has become a major adolescent health concern because it is linked to aggression [1]. Neuroimaging evidence in patients and healthy individuals indicate that aggression, social norm violations, and emotional dyscontrol are associated with altered orbitofrontal cortex (OFC) structure and function [2], particularly in the left OFC [3]. Although little is known about the neural effects of violent media exposure, two functional imaging studies revealed that playing violent video games [4] and viewing violent movies [5] are associated with reduced left and right lateral OFC (lOFC) activation, respectively. In addition, reduced lOFC activation towards violent movies was associated with more reactive-affective aggression, indicating that the lOFC may be involved in increasing the likelihood of aggression through dysfunctional emotion regulation [5].

Here we investigated the relationship between media violence exposure and lOFC density in healthy male adolescents. During adolescence, significant changes occur in cortical structure [6]. lOFC grey matter increases during childhood, peaks at age 9.5 years, and then declines gradually into adulthood [6]. This decline is thought to result from a combination of synaptic pruning -the use-dependent elimination of synaptic connections- and ongoing myelination of

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axonal fibers [6]. It has been suggested that synaptic pruning may temporarily perturb neural information processing placing adolescents at risk for inefficient socio-emotional functioning and psychiatric diseases [7].

We assessed grey matter density using voxel-based morphometry (VBM) of MRI images and self-reported exposure to movie and TV violence employing the media exposure subscale of the Childrens' Report of Exposure to Violence (CREV) [8]. We assumed that more frequent exposure to violent media would be associated with less IOFC grey matter density based on previous studies that showed an IOFC involvement in media violence and aggression [2,3,4, 5] and a decline in grey matter during adolescence [6].

METHODS

Participants

Thirty-seven right-handed male adolescents (years of age: mean $\pm$ sd, 16.4 $\pm$ 1.16; range=14–17) with no history of psychiatric or neurological illness participated in the study. Parents and adolescents gave written informed consent and assent for the procedures that were approved by the NINDS IRB at the NIH.

Data acquisition

Participants completed the CREV [8], a 33-item self-report questionnaire, to assess participants' lifetime exposure to community and media violence. We used the lifetime exposure to media violence subscale measuring the frequency (5-point Likert scale: 0=never, 4=everyday) of adolescents' exposure to TV and movie violence, including viewing of someone being beaten-up, chased, threatened, robbed, mugged, shot, stabbed, or killed.

Structural imaging data were collected using a 3T MRI scanner equipped with an 8-channel head coil. Anatomical scans were performed using a T1-weighted 3D MP-RAGE sequence (TR=9ms, TE=4ms, flip angle=12°, FoV=256mm, matrix size=256 $\times$ 256, slice thickness=1.2mm, in-plane resolution=0.8594mm²).

Data analysis

Total raw scores of the CREV media violence subscale were calculated. VBM analyses were performed with SPM5. Images were reoriented to the anterior commissure, segmented into grey matter, white matter, and cerebrospinal fluid, spatially normalized to the MNI ICBM 152 standard anatomical space, and modulated to transform volume information into voxels. Afterwards, images were smoothed with a 12mm FWHM isotropic Gaussian kernel. The total intracranial volume (TIV) was calculated from unsmoothed, segmented, and modulated grey matter, white matter, and cerebrospinal fluid images.

To identify grey matter changes correlated with participants' media violence exposure, a within-subjects covariate analysis was performed. Raw scores of the CREV were entered as regressors with the TIV and age as confounding covariates to assess media exposure-related grey matter changes independently of individual differences in TIV and brain maturation.

A one-sided *t* test was performed assuming that more exposure to violent media would be associated with less grey matter density in the IOFC. A whole-brain explorative correlational analysis was performed with SPM's default voxel-level uncorrected statistical threshold of *P*=0.001. Afterwards, a small-volume FWE correction at *P*<0.05 was applied within the OFC for which we had an a priori hypothesis. The left and right OFC regions of interest were created including the superior, middle, inferior, and medial orbitofrontal cortices and the gyrus rectus as defined by the WFU Pickatlas.

RESULTS

Our ROI analysis revealed reduced grey matter density in the left IOFC (Brodmann area 10; Talairach, $-24,48,-4$, $t=3.78$, $P<0.0005$, FEW-corrected, Fig. 1) that was significantly associated with more frequent viewing of violent TV programs and movies.

DISCUSSION

Our goal was to investigate the relationship between cortical grey matter density and media violence exposure. Consistent with previous structural and functional neuroimaging findings in patients and healthy individuals [2,3,4,5,6,7], we demonstrated a negative correlation between left IOFC grey matter density and frequency of exposure to TV and movie violence in healthy male adolescents. Our finding raises the question whether higher media violence exposure alters IOFC structure or adolescents with reduced IOFC grey matter are more attracted to violent media.

Because the IOFC receives inputs from all sensory modalities and has connections with the striatum, thalamus, and limbic structures, it is well-suited to respond to observable, environmental cues and to interpret them regarding their socio-emotional and motivational values, enabling flexible responding to changing environmental contingencies [2,9]. In aggression, for example, when the IOFC detects threat signals from angry faces or social norm violations from individuals' actions it may capture aspects of negative valence and activate or inhibit aggressive behavior [2].

It has been suggested that the brain is sculptured through experience and synaptic pruning may be one mechanism that changes cortical structure and subsequently function, e. g., towards more focal activation [10]. Synaptic pruning may temporarily perturb information processing, ultimately increasing the efficiency of often-used neurotransmission pathways while eliminating less often-used neuronal connections [6,7]. As the progression of age, an approximate measure of development, encompasses diverse biological and environmental influences that likely drive cortex maturation, exposure to media violence may be one environmental factor that can alter IOFC structure through pruning. A temporarily decline in the efficiency of neural information processing resulting from pruning may be a risk factor for altered socio-emotional functioning during adolescence.

Further studies, including measures of media violence severity, are needed to clarify whether these results are adolescent-specific and how IOFC structure differs in female adolescents, adults, and individuals with psychiatric problems, including aggression.

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Figure 1. Neurostructural Correlate of Exposure to Media Violence (ROI analysis)

Lower grey matter density in the left IOFC was negatively correlated with higher exposure to TV and movie violence (Brodmann area 10; Talairach, -24, 48, -4, $t=3.78$, $P<0.0001$, FWE corrected; thresholded at $p<0.001$ for display purposes only); R=right, L=left.