

Structural brain abnormalities in the frontostriatal system and cerebellum in pedophilia

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Abstract

Even though previous neuropsychological studies and clinical case reports have suggested an association between pedophilia and frontocortical dysfunction, our knowledge about the neurobiological mechanisms underlying pedophilia is still fragmentary. Specifically, the brain morphology of such disorders has not yet been investigated using MR imaging techniques.

Whole brain structural T1-weighted MR images from 18 pedophile patients (9 attracted to males, 9 attracted to females) and 24 healthy age-matched control subjects (12 hetero- and 12 homosexual) from a comparable socioeconomic stratum were processed by using optimized automated voxel-based morphometry within multiple linear regression analyses.

Compared to the homosexual and heterosexual control subjects, pedophiles showed decreased gray matter volume in the ventral striatum (also extending into the nucl. accumbens), the orbitofrontal cortex and the cerebellum.

These observations further indicate an association between frontostriatal morphometric abnormalities and pedophilia. In this respect these findings may support the hypothesis that there is a shared etiopathological mechanism in all obsessive–compulsive spectrum disorders.

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1. Introduction

Pedophilia is a psychiatric disorder of great public concern, characterized by intense sexually arousing urges and behaviors focused on sexual activity with a prepubescent child. According to estimates of the German authorities (Bundeskriminalamt), the incidence of child sexual abuse in Germany is as high as 550 cases per day (200,000 per year), though only every 20th case is recorded. For the

U.S., the estimates are as high as 500,000 per year (Fuller, 1989).

Variations in sexual preferences in men may have multiple causes; genetically initiated events, experience-induced learning, brain structure, and certainly features of an ancestral environment (Quinsey, 2003). Despite multiple investigations, evidence of a causal relationship between abnormal brain functioning and pedophilia has remained elusive. Numerous studies have discussed associations between behavioral disinhibition, frontal abnormalities, and impaired cognitive executive functioning. Although recent data from neuropsychological, personality, sexual history, plethysmography, and neuroimaging research suggest that pedophilia is linked to early

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neurodevelopment perturbations (Cantor et al., 2004; Cohen et al., 2002), the neurobiological basis of the disorder is still largely unknown.

It has been suggested that sexual compulsive disorders such as pedophilia may be related to the obsessive–compulsive spectrum disorders (OCD spectrum), including impulse-control disorders such as pathological gambling, kleptomania and trichotillomania, disorders associated with bodily preoccupation, and neurological disorders such as Tourette's syndrome (Stein, 2000; Castle and Phillips, 2006; Hollander, 1998). Although the etiology of all these disorders is not well understood, substantial phenomenological and genetical overlap exists (e.g. repetitive and poorly inhibited behaviors, dopamine receptor alleles, etc., Chamberlain et al., 2005), and pharmacological treatments that modulate levels of 5-HT have been shown to be effective in all of them (Chamberlain et al., 2005; Stein, 2000; Bradford, 2001). Studies on structural brain alterations in obsessive–compulsive (OC) and spectrum disorders showed abnormalities in frontostriatal circuits, the basal ganglia, and insulo-opercular regions as well as the cerebellum (see Jenike et al., 1996; Pujol et al., 2004; Valente et al., 2005; Szeszko et al., 2004; Szeszko et al., 2005) that were comparable to those discussed for aggressive and violent behavior (Raine et al., 2000; Bufkin and Luttrell, 2005).

It has been argued that structural alterations might be responsible for the development of functional deficiencies in the context of social or antisocial behavior. This leads to the hypothesis that pedophilic subjects may show structural deficiencies in brain regions that are part of the frontostriatal system. The striato-thalamo-cortical network initially reported by Alexander et al. (Alexander and Crutcher, 1990; Alexander et al., 1986, 1990) is closely associated with both the dopaminergic innervations of the frontal lobes and the pathophysiology of impulsive, addictive and compulsive behavioral propensities. In particular, the lateral orbitofrontal loop (Mega and Cummings, 2001) seemed to be associated with disinhibition and stimulus-controlled behavior, such as sexual compulsive behaviors. However, apart from two anecdotal case studies (Burns and Swerdlow, 2003; Mendez et al., 2000) no data regarding the characteristics of brain structure in paraphilia using modern MR imaging techniques have so far been reported.

Here, we report on the first study using voxel-based-morphometry (VBM) to investigate abnormalities in brain morphology in pedophiles. VBM is a fully automated, whole-brain image analysis technique that involves the voxel-wise comparison volumes of segmented gray and white matter of two groups of subjects (Ashburner and Friston, 2000; Good et al., 2001). It has the advantage that macroscopic differences are discounted using normalization, and differences in local tissue composition can be explored without resorting to the use of manually placed regions of interest. Furthermore, no a priori hypothesis regarding the localization of group differences is required. We hypothesized that subtle abnormalities in the frontostriatal and limbic system are apparent in pedophiles, in

contrast to age-, sex- and socio-demographic-matched healthy controls. According to our hypothesis, alterations in these systems may underscore that pedophiles share similar neurobiological features with the wide OCD spectrum, including impulsive or antisocial behavior.

2. Methods

2.1. Subjects

Out of a population of 200 sex offenders from two high-security forensic treatment facilities, we screened 60 male child molesters for participation in this study. Those included in the study met the DSM-IV criteria for pedophilia were exclusively attracted to male or female children, not limited to incest, and were not on medication. Typologically, only child molesters from the interpersonal type with a high deviant fixation level were included (Knight and Prentky, 1990). Out of the 22 pedophile patients who met these criteria, 18 (9 exclusively attracted to girls and 9 to boys) with a mean age of 37.7 years (± 7.9 SD, range 22–54) were prepared to take part in the examination. Three subjects refused participation; one because of neurological impairments.

Twenty-four healthy male volunteers (12 homosexually oriented and 12 hetero-sexually) with a mean age of 33.6 years (± 7.2 SD, range 22–46) were recruited to match the patient group for age, sexual orientation, handedness, and education level, though the latter criterion could not be fully achieved (see Table 1). Sexual orientation was assessed by the volunteers themselves using the Kinsey Scale (Kinsey et al., 1948). Only those subjects were included who scored 0 or 1 (exclusively or predominantly heterosexual), or 5 or 6 (exclusively or predominantly homosexual). Controls with a history of neurological or systemic illness, head injury or substance abuse, and a personal or family history of psychiatric illness were excluded. Permission to conduct the study was obtained from the ethics committee of the Faculty of Medicine, University of Duisburg-Essen, Germany. Written informed consent was obtained from all participants.

2.2. Diagnostic assessment

All diagnoses shown in Table 2 are based on the DSM-IV criteria and were confirmed using the Structural Clinical Interview for Axis I DSM-IV Disorders (SCID I) and the Structured Clinical Interview for DSM-IV Axis II Personality Disorders (SCID II) (Wittchen et al., 1997; American Psychiatric Association, 1994).

For crime assessment, we analyzed the court reports. Only those patients with a history of repeated sexual abuse of children were included in the study.

The WIP (a reduced version of the German Wechsler Adult Intelligence Scale) was employed to assess global intelligence (Dahl, 1986). Further, the Wisconsin Card Sorting Test (WCST-64) (Kongs et al., 2000) was used to

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