



## Reduced temporal lobe volume in early onset conduct disorder

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### Abstract

Regional brain volumes derived from magnetic resonance imaging (MRI) scans from 10 youths with early onset conduct disorder and 10 healthy controls matched for age, sex and handedness were compared to determine whether prefrontal or temporal lobe brain volumes differed in the two groups. Right temporal lobe and right temporal gray matter volumes were significantly reduced in subjects with conduct disorder compared with controls. Prefrontal volumes in subjects with conduct disorder were 16% smaller than in controls, but the difference did not reach statistical significance. Early onset conduct disorder without substance abuse comorbidity was also significantly associated with smaller right temporal gray volumes. Further investigation of both the temporal and frontal localizations of the pathophysiology of early onset conduct disorder is warranted in larger samples.

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### 1. Introduction

Although a childhood history of conduct disorder is a precursor for antisocial personality, the majority

of conduct-disordered children do not go on to develop antisocial personality disorder as adults (Robins, 1978; Zoccolillo et al., 1992). The life-course-persistent form of conduct disorder is particularly likely to have an early age of onset (Moffitt, 1993). An increased risk for antisocial outcomes is associated with an early onset of conduct disorder accompanied by comorbid attention deficit hyperactivity disorder (ADHD) plus a continuity and variety of conduct disorder symptoms (Robins,

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1978; Henn et al., 1980; Farrington et al., 1990; Moffitt, 1993; Lahey et al., 2002; Loeber et al., 2002). Early onset, persistent conduct disorders carry a high risk for subsequent substance abuse (Crowley and Riggs, 1995; Robins, 1998; Biederman et al., 2001).

Until recently, little was known about the brain anatomic correlates of antisocial personality, although data from earlier adoption studies (Crowe, 1974; Mednick et al., 1984; Cloninger et al., 1988) had long indicated a genetic risk for this diagnosis. Hypotheses have repeatedly focused on two regions as sites for relevant pathology: the frontal lobes (Elliott, 1978; Schalling, 1981; Gorenstein, 1982; Damasio et al., 1990; Pennington and Bennetto, 1993; Raine et al., 2000) and the temporal lobe/limbic system (Hare, 1970; Gray, 1972; Gorenstein and Newman, 1980; Dolan et al., 2002; Blair, 2003). Lesions of the septal–hippocampal–frontal system described by Gray (1972) in animals lead to behaviors similar to those seen in sociopaths (Gorenstein and Newman, 1980): increased stimulation seeking, problems in passive avoidance, deficiencies in acquiring conditioned fear, and difficulty in suppressing tendencies to respond immediately as a means of gaining a reward subsequently.

Case reports of behavior associated with lesions support frontal and temporal involvement. Damage to the frontal lobes, particularly the ventromedial cortices, acquired in adulthood is associated with the appearance of sociopathic behavior in adults with previously normal personalities (Damasio et al., 1990; Meyers et al., 1992). Seven of nine pediatric case reports of acquired frontal lobe damage displayed significant conduct disorder symptoms (Pennington and Bennetto, 1993). Temporal/limbic lesions have also been reported in case reports of aggressive/antisocial children (Martinus, 1982; Hennessy et al., 2001).

Anatomic imaging studies of antisocial adults provide some evidence of frontal and/or temporal involvement. Early computed tomographic studies of antisocial adults found temporal lobe abnormalities in some cases, although methodological limitations and inconsistent findings constrain firm conclusions (Bassarath, 2001). A seminal study by Raine et al. (2000) compared quantitative frontal lobe volumes on magnetic resonance imaging (MRI) in 21 men with antisocial personality disorder with those of 34

nonantisocial, nonsubstance-abusing controls and 27 nonantisocial substance abusers. Smaller frontal lobe volumes were seen in antisocial personality disorder compared with both control groups. In a study of 18 violent offenders with antisocial personality disorder and alcoholism, reduced bilateral posterior hippocampal volumes correlated with higher psychopathy scores (Laakso et al., 2000). A study of 18 personality-disordered adult violent offenders classified as psychopaths found temporal lobe volumes reduced by 20% compared with 19 healthy controls, but did not find significantly reduced frontal lobe volumes (Dolan et al., 2002).

It is plausible that pathology central to antisocial personality disorder is present in early onset conduct disorders given the continuity of the disorders. Reviewers have lamented the dearth of quantitative MRI studies comparing conduct disorder subjects and controls to address the premorbid pathology question (Peterson, 1995; Eliez and Reiss, 2000; Hendren et al., 2000). The purpose of this investigation was to compare prefrontal and temporal brain volumes in individuals with early onset conduct disorder with those of healthy controls.

## 2. Methods

The data in this study were acquired from 1990 to 1991. Accordingly, the methods reflect those of that time. For example, the 5-mm MRI slices are considerably thicker than those in contemporary studies, DSM-IV criteria did not yet exist, and relationships between brain volume and intelligence (e.g., Willerman et al., 1991; Andreasen et al., 1993; Reiss et al., 1996; Posthuma et al., 2002) were not a consideration in our 1989 design (see Yeo et al., 1987; Teasdale and Parkenberg, 1988).

### 2.1. Subjects

#### 2.1.1. Early onset conduct disorder

Subjects were 10 individuals, mean age  $16.1 \pm 3.6$  (range 9.75–20.5) years, who had been characterized previously (Kruesi et al., 1989, 1992, 1994a,b). Nine subjects were male and one was female. For this study, subjects were recruited who had been known to the investigator (MJPK) longitudinally and were

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