Aberrant Paralimbic Gray Matter in Incarcerated Male Adolescents With Psychopathic Traits

Elsa Ermer, Ph.D., Lora M. Cope, M.S., Prashanth K. Nyalakanti, M.S., Vince D. Calhoun, Ph.D., Kent A. Kiehl, Ph.D.

Objective: To investigate the relationship between brain structure and psychopathic traits in maximum-security incarcerated male adolescents, and to examine whether the associations between brain volumes in paralimbic and limbic regions and psychopathic traits observed in incarcerated adult men extend to an independent sample of incarcerated male adolescents. **Method:** A structural magnetic resonance imaging (MRI) study of regional gray matter volumes by using voxel-based morphometry in maximum-security incarcerated male adolescents (N = 218) assessed for psychopathic traits using the Hare Psychopathy Checklist–Youth Version (PCL-YV). All analyses controlled for effects of age, substance use, and brain size. **Results:** Consistent with hypotheses and the adult literature, psychopathic traits were associated with decreased regional gray matter volumes in diffuse paralimbic regions, including orbitofrontal cortex, bilateral temporal poles, and posterior cingulate cortex. **Conclusions:** These results strengthen the interpretation that paralimbic regions are central for understanding neural dysfunction associated with psychopathic traits and that psychopathy is best conceptualized as a neurodevelopmental disorder. J. Am. Acad. Child Adolesc. Psychiatry; 2012;52(1):94–103. **Key Words:** paralimbic dysfunction, juvenile delinquency, voxel-based morphometry, psychopathy, antisocial.

For most antisocial male adolescents, problematic behavior peaks in late adolescence or early adulthood and drops off rapidly thereafter; however, some individuals remain on a life-course–persistent trajectory of antisocial behavior throughout adulthood.[1] Some adults on the life-course–persistent trajectory meet diagnostic criteria for psychopathy, a predictor of persistence in criminal activity and violent behavior.[2–4]

Psychopathy is a serious and enduring personality disorder marked by interpersonal, affective, and behavioral traits such as glibness, lack of moral emotions (e.g., remorse, empathy), irresponsibility, and impulsivity.[5] Clinical psychopathy is commonly assessed with the Hare Psychopathy Checklist–Revised (PCL-R),[6] the most widely accepted diagnostic instrument for psychopathy in adults. The assessment of psychopathic traits in youth raises a number of important issues. In the *DSM*,[7] antisocial personality disorder (in adults) and conduct disorder (in youth) are most closely related to the construct of psychopathy; however, these diagnoses focus on more readily observable behavioral traits rather than affective and interpersonal traits conceptualized to be at the core of the disorder.[5] Thus, others have emphasized the particular importance of callous and unemotional traits in conceptualizing psychopathy in adolescents.[8,9] Hare *et al.* constructed a modified version of the PCL-R, the Psychopathy Checklist–Youth Version (PCL-YV),[10] designed for use with adolescents, identifying both interpersonal and affective traits (factor 1) and lifestyle and antisocial traits (factor 2). Although distinguishing psychopathic traits from normative adolescent development can be challenging,[11] and although it is critical to avoid the assumption that adolescents with psychopathic traits are on a predetermined path of adult psychopathy[12,13] or are untreatable,[14] the assessment of psychopathic traits in youth evidences reliability and construct validity.[11,15] Furthermore, male adolescents, like

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adults,[16] who score high on these traits are quicker to reoffend, including violent offenses.[17,18]

The pervasive nature of emotional and behavioral symptoms of psychopathy suggests that a number of associated brain regions may contribute to the disorder. Among adults, converging evidence from electrophysiology,[19,20] functional neuroimaging,[21,22] and lesion studies[23] implicates paralimbic cortex and limbic structures as dysfunctional in psychopathy.[24] These regions are linked based on cytoarchitectural similarities,[25] which suggests a partially shared neurodevelopmental trajectory. These regions include the temporal poles, anterior cingulate cortex (ACC), posterior cingulate cortex (PCC), orbitofrontal cortex (OFC), parahippocampal regions, amygdala, and hippocampus.[24]

The existing structural imaging literature supports the hypothesis that dysfunction in paralimbic and limbic regions is associated with psychopathy. Structural differences in the form of reduced regional gray matter volumes (GMV) are observed in adult men with psychopathic traits.[26–28] However, it is not known when these differences begin to appear and whether they are apparent in adolescence, a time when the brain is still undergoing significant development[29] and psychopathic traits may begin to be observed.[11]

To date, no research has examined brain structure in incarcerated adolescents with psychopathic traits assessed by the PCL-YV. Some previous work has looked at structural differences in (primarily) male adolescents with psychopathic traits, using diverse assessment methods. Youths (mean = 16 years) with early-onset conduct disorder (CD) had reduced temporal lobe volumes; prefrontal volumes were also reduced in these youths, but the difference did not reach statistical significance.[30] Reduced GMV in bilateral insula and left amygdala was reported in male adolescents (mean = 13 years) with CD compared to controls, but there were no significant differences in the ACC or OFC.[31] However, reduced GMV was reported in the temporal lobes bilaterally, left amygdala, left hippocampus, OFC, and ventromedial PFC, and greater GMV in the cerebellum, in male adolescents (mean = 14 years) with early onset CD compared to controls.[32] In contrast, one study of boys from the community (mean = 11 years) with callous and unemotional traits found increased GMV compared to controls in several regions, including the OFC, ACC, superior temporal gyrus, left hippocampus, insula, and PCC.[33]

These studies suggest that adolescents with early CD symptoms have aberrant paralimbic and limbic structure; however no studies have examined psychopathic traits assessed with the expert-rater–based PCL-YV and thus may not be directly comparable to adult samples. In addition, prior studies[30-33] have relied on relatively small samples (N = 20–48) drawn largely from community and outpatient populations; thus, these samples were likely associated only with low to moderate levels of psychopathic traits and had limited ability to control for potential confounds (e.g., substance abuse).

Here we begin to address these limitations by presenting results from a voxel-based morphometry analyses on the relationship between brain structure and psychopathic traits in large sample of maximum-security incarcerated male adolescents. The aberrant structure and dysfunction observed in paralimbic cortex and limbic structures in adult psychopathy predicts that higher scores on psychopathic traits will be associated with reduced GMV in the parahippocampus, amygdala, hippocampus, temporal pole, ACC, PCC, and OFC.

METHOD

Participants

The data analyzed were drawn from the National Institute of Mental Health (NIMH)–funded SouthWest Advanced Neuroimaging Cohort, Youth sample (SWANC-Y), collected between June 2007 and March 2011, from ongoing research studies at a maximum-security youth detention facility in New Mexico. This research was approved by the University of New Mexico Health Sciences Center Human Research Review Committee, and individuals volunteered to participate after providing written informed consent (if ≥18 years of age) or after providing written informed assent and parent/guardian written informed consent (if <18 years of age). Participants were excluded from participation if they had a history of seizures, psychosis, traumatic brain injury, other major medical problems, or failed to show fluency in English at or above a grade four reading level. High-resolution structural magnetic resonance imaging (MRI) scans and PCL-YV scores were available from 218 male adolescents. Our final sample included 191 individuals, after excluding 18 individuals for excessive motion or radiological findings and nine who were determined to meet the above exclusion criteria after scanning.

Participants were incarcerated for crimes that included murder, assault, rape, arson, weapons possession, burglary, fraud, drug possession/distribution, and criminal mischief (Table 1). Participants were predominantly Hispanic/Latino (56.6%), white (14.8%), or Native American (11.7%). From self-report, 89.0% of