

Conduct disorder and callous-unemotional traits are related to the microstructure of the dorsal default-mode network

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TARGET AUDIENCE: Neuroscientists interested in psychopathy, conduct disorder and callous-unemotional traits, as well as those interested in the functional neuroanatomy of the default-mode network and diffusion MRI tractography.

PURPOSE: Conduct disorder is characterised by persistent antisocial behaviour over a 6-12 month period before the age of 18. The presence of callous-unemotional traits (disregard for others, lack of empathy, deficient affect) in the disorder appears to be important in determining the outcome of these youths, and confers increased severity and stability of antisocial behaviour as well as further emotional, cognitive and personality abnormalities.¹ Partly as a consequence of this pattern of deficits, callous-unemotional traits have been argued to be essential for extending the concept of psychopathy to childhood,² and are thought to reflect factor 1 (emotional detachment) of the psychopathy checklist revised (PCL-R). In psychopathy research, recent work has suggested that the two factors of the PCL-R: emotional detachment (factor 1) and antisocial behaviour (factor 2) are related to a mediadorsal fronto-cingulate ('default-mode' / dorsal cingulum) network and a ventral fronto-temporal (uncinate fasciculus) network respectively.^{3,4} In the interest of translating this neuroanatomical model of psychopathy to youths, it has been found that microstructural abnormalities also occur in the ventral fronto-temporal network in adolescents with conduct disorder.⁵ However, whether the previously observed neuroanatomical correlate of factor 1 in psychopaths is predictive of conduct disorder and callous-unemotional traits in adolescents is not yet clear. We therefore sought to assess the microstructure of the dorsal cingulum in adolescents with conduct disorder and typically developing controls, to assess any relationship to this disorder and callous-unemotional traits.

METHODS: 27 adolescents with conduct disorder (mean full scale WASI IQ: 99 ± 8; mean age: 16 ± 2) and 19 typically developing controls (mean full scale WASI IQ: 107 ± 13; age: 16 ± 2) were scanned. The Kiddie Schedule for Affective Disorders and Schizophrenia – Present and Lifetime version (K-SADS-PL) was used to obtain a research diagnosis of conduct disorder. Participants were administered the Antisocial Personality Screening Device (APSD) to assess callous-unemotional traits.

A GE Signa HDx 3.0T MR scanner (actively shielded magnetic field gradients; max amplitude 40mT/m-1) was used for scanning, with a body coil used for RF transmission and 8 channel head coil used for NMR reception. We used a multi-slice doubly refocused single-echo echo planar imaging (EPI) sequence to acquire 60 near contiguous axial slices, with a slice thickness of 2.4mm and an in-plane resolution of 1.85X1.85mm. The echo time was 104.5ms, and the TReff was 12-20 RRs, using a cardiac gated acquisition. A maximum diffusion weighting of 1300 s/mm⁻² was used, and 32 diffusion-weighted volumes with diffusion gradients uniformly distributed in space were collected at each slice location, as well as 4 volumes with no diffusion weighting applied.

Data was corrected for eddy currents and motion distortion, the diffusion tensor was estimated, and whole brain tractography (step size: 0.5mm; FA threshold: 0.2; angle threshold: 30°) was performed. The dorsal and ventral cingulum were identified and dissected on the sagittal plane (Figure 1).

RESULTS: Radial diffusivity was decreased in the conduct disorder group in the left ($F(1, 42) = 7.64, p = .008$) and right ($F(1, 42) = 7.35, p = .010$) dorsal cingulum, even after correcting for age and IQ and multiple comparisons. No significant differences in radial diffusivity were detected in the ventral cingulum, or fractional anisotropy in either tract portion. Callous-unemotional traits were found to be significantly negatively correlated with radial diffusivity in the left dorsal cingulum after correcting for age and IQ in the whole population ($r(42) = -.30 p = 0.049$).

DISCUSSION: These findings suggest a relationship between conduct disorder and callous-unemotional traits, and microstructural differences in the dorsal default-mode network. This is potentially due to affective, social and moral processing in this functional subdivision. This supports an overlap in default-mode abnormalities between adults with psychopathy and youths with conduct disorder. More specifically, this appears to suggest continuity between abnormalities associated with callous-unemotional traits and emotional detachment (PCL-R factor 1). As conduct disorder and callous-unemotional traits appear to be related to decreased radial diffusivity, this further suggests that the differences in this network may relate to increased myelin content. Interestingly, this reflects other studies looking at children with conduct disorder,^{5, 6} but differs from studies in psychopathy (where fractional anisotropy is generally observed to be reduced).^{3, 4} This may imply the presence of an increased development trajectory for myelination during adolescence, followed by an eventual slowing/reversing of this process, resulting in lower myelination in adults with psychopathy.

REFERENCES: 1. Frick PJ & White SF. *J Child Psychol Psyc* 2008; 49, 359-75; 2. Barry CT, et al. *J Abnorm Psychol*. 2000; 109(2):335-40; 3. Craig MC, et al. *Mol Psychiatr*. 2009; 14(10): 946-53; 4. Sethi A et al., (Under submission); 5. Sarkar S, et al. *Psych Med*. 2012; 43(2): 401-11; 6. De Brito SA et al. *Brain*. 2009; 132(Pt 4): 843-52.

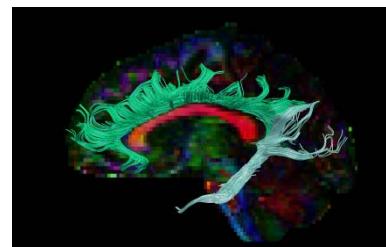


Figure 1. Dissection of the dorsal and ventral cingulum on the sagittal plane