Abnormal Inter-hemispheric Brain Asymmetry in Adolescents with Disruptive Behavioral Disorder

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Introduction

Adolescents with disruptive behavioral disorder exhibit abnormal cognitive function (1) and abnormal brain function in response to emotional stimuli (2). The purpose of the current study was to determine whether brain structure, in the form of inter-hemispheric asymmetry, is abnormal in this same population.

Methods

Adolescents with DSM-IV diagnoses of Disruptive Behavior Disorder (DBD, n=22) were aged 14.7±1.3 yrs (mean±SD) and 58% male; normal healthy subjects (n=21) were aged 15.0±1.6 yrs and 48% male. Ten (71%) of the DBD subjects also were diagnosed with attention deficit/hyperactivity disorder. 3D T1-weighted (SPGR) brain images were obtained using a GE 1.5T clinical MRI scanner. Inter-hemispheric asymmetry was computed by non-linear registration (AIR, 10^{th} order polynomial warping) of the 3D brain image onto its left-right mirror image, followed by the computation of the Jacobian determinant of the deformation gradient tensor (gradient of the warping displacement field). The result was a 3D map of the asymmetry metric – the difference in volume between hemispheres. The original T1-weighted image was spatially warped to the MNI brain atlas template using SPM2 and the same warping file was used to coregister the brain asymmetry map in the MNI brain atlas space. Statistical analysis on the asymmetry maps was then performed using SPM2.

Results

Figure 1 shows the mean asymmetry maps for the normal and DBD groups and the group mean difference. Cluster level post-hoc statistical analysis showed significant difference (cluster $p < .01$ after false discovery rate correction) in two clusters: one located in the temporal and the other located at the boundary of the parietal and occipital lobes. The right-versus-left volume difference in the inferior temporal lobe was decreased significantly from its normal positive value, and in the parietal/occipital region it was increased significantly from a normal negative value.

Conclusions

The two cortical regions found to have significantly reduced asymmetry in the DBD subjects are connected by the inferior longitudinal fasciculus, a white matter tract connecting the parietal and temporal lobes. This pathway is part of the "ventral stream" of visual sensory integration involved in object recognition and the guiding of spatial attention through a cluttered visual environment (3). A neurodevelopmental structural abnormality in this processing pathway might underlie or at least contribute to the cognitive and behavioral dysfunction manifest in disruptive behavioral disorder.

References

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Acknowledgments

This work was funded by the Center for Successful Parenting (VPM) and the National Library of Medicine (JDC). AIR was provided by Roger Woods of UCLA. SPM2 was provided by the Wellcome Neurological Institute, University College London.

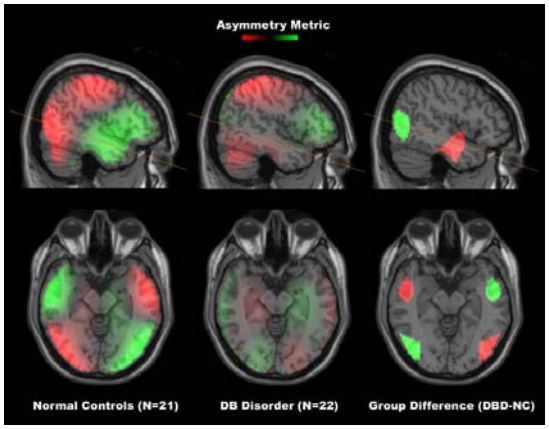

Figure 1. The asymmetry metric is overlaid in color over the high resolution atlas reference image; green indicates larger volume compared to the opposite hemisphere and red indicates the opposite. A sagittal slice through the right temporal lobe and an oblique axial slice oriented parallel to the AC-PC line is shown for the normal group (left) and the DBD group (middle); the group difference (right) is shown masked for those cluster regions with significant difference (cluster $p < .01$ after false discovery rate correction). The magnitude of asymmetry is decreased in the DBD group in two regions: one in the temporal lobe and the other in the parietal/occipital border region.