Schizotypal Traits in Relation to Cerebellar Volume and Asymmetry: A High-Resolution 3D Magnetic Resonance Imaging Study

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Introduction

The cerebellum plays an important role in a wide range of cognitive and perceptual as well as motor functions, and it has been proposed that many symptoms of schizophrenia could plausibly be explained by cerebellar dysfunction. Cerebellar abnormalities have already been reported in developmental dyslexia, which is strongly associated with positive schizotypal traits. Cerebellar structure in high-resolution 3D MRI scans was therefore studied in relation to schizotypal traits in non-psychotic adults (dyslexic and non-dyslexic) using a recently developed technique of cerebellum segmentation employing texture analysis and knowledge-based image processing.

Method

Eleven dyslexic and 10 non-dyslexic adults completed the OLIFE inventory, indexing four major dimensions of schizotypy: Unusual Experiences, Cognitive Disorganisation, Introvertive Anhedonia and Impulsive Nonconformity.

T1-weighted, 3-dimensional RF spoiled volume scans were obtained from these subjects using a Picker 1.0 T HPQ system (sagittal plane, TR = 21 ms, TE = 6 ms, flip angle 35°, FOV = 25 cm), 152 x 256 matrix, 2NEX, 114 sections. The slice thickness was 1.6 mm, and in-plane resolution was 0.98 x 0.98 mm. The brain was isolated using a knowledge-based image segmentation procedure. A small seed contour was installed by the operator within the cerebellum and was replicated over several slices in the sagittal plane. This contour, encompassing both grey and white matter, approximately defined the location of the cerebellum in relation to the full brain in a slice.

The contour was dilated using a grey operation in conjunction with a circular structuring element of 5 mm radius. The shape of the structuring element guaranteed preservation of the slowly varying curved appearance of the boundary of anatomical structures in the brain. The dilation operation monitored the intensity and texture properties within the structuring element in relation to the properties of the voxels enclosed within the previously dilated contour in a slice.

The mean (Gm) and standard deviation (Gsd) of the grey intensity value for the voxels within the contour were computed and the ratio Gsd/Gm, Gsdm, was obtained.

Also, the mean intensity (Cm) and standard deviation in intensity (Csd) along the contour were computed. The image was edge enhanced using a Prewitt operator and the distribution of edges quantified. This involved computing the mean and standard deviation in intensity, Em and Esd, respectively, in the edge-enhanced image, with the region limited to voxels enclosed within the contour. The Gm, Gsd and Gsdm values in conjunction with the intensity distribution in the edge image (Em ± Esd) gave a measure of texture. A central voxel within a structuring element was added to the dilated feature if the texture property in the structuring element was similar to that for voxels in the last dilated contour, and the intensity of the central voxel satisfied the intensity distribution criterion for the contour voxels as defined in the last dilated contour, otherwise the dilation ceased at the central voxel. The contour voxel intensity distribution criterion involved making sure that the intensity of the central voxel lay in the range, Cm ± 2.5×Csd.

The cerebellum was extracted from the scans using the segmentation procedure described. A single operator with expert knowledge of neuroanatomy analyzed the scans of all the subjects.

Results

High scores on the positive schizotypy measure of Cognitive Disorganisation were associated with rightward asymmetry of the cerebellum (p < 0.01) and also with smaller cerebellar volumes, both left and right (p < 0.01). The asymmetry association held in both dyslexic and non-dyslexic subjects, but the relationship with cerebellar volume appeared specific to the latter.

Conclusion

These results provide further evidence for commonalities between dyslexia and the schizophrenia spectrum, and are consistent with the proposal that cerebellar abnormalities may contribute to the predisposition to schizophrenia.

References