Cortical Thinning of Cingulate Gyrus in Schizophrenia

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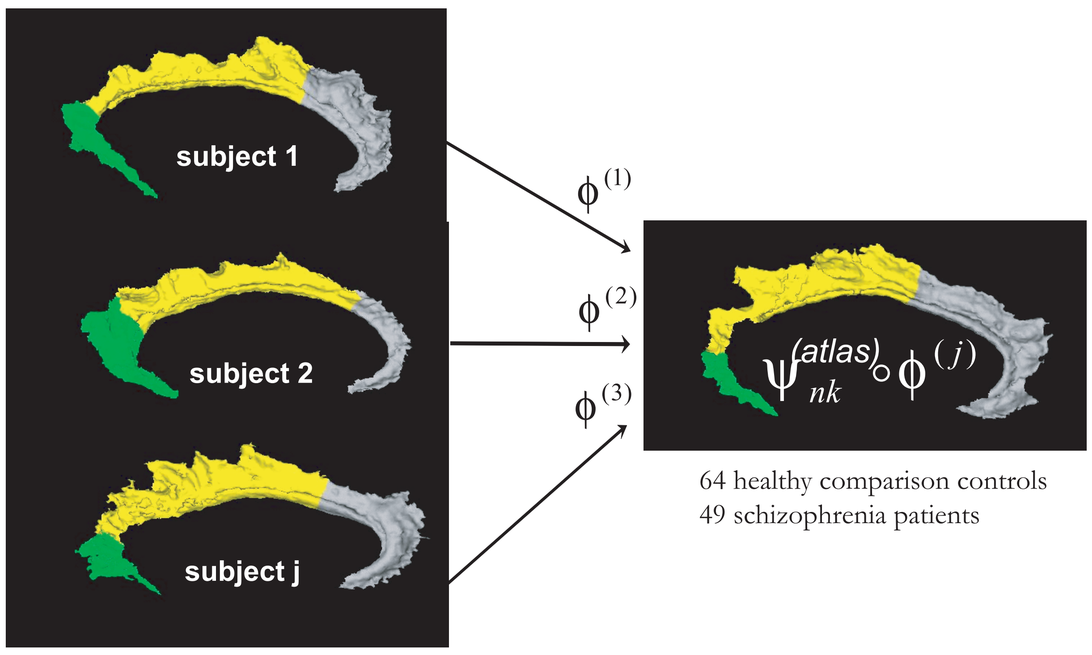
Introduction

Neuroimaging studies have shown reduction in gray matter volume of the cingulate gyrus in schizophrenia. Variation in cortical thickness measuring the depth of the gray matter ribbon may reflect the location of gray matter loss and neuronal organization in schizophrenia. We present an extrinsic analysis framework to investigate such variation within the partition of the cingulate gyrus. The partition of the cingulate atlas was automatically generated from the eigenfunction of the Laplace-Beltrami operator. Our results suggest cortical thining of the cingulate gyus in schizophrenia.

Data Processing



64 healthy comparison controls
49 schizophrenia patients

1.Segment MRI volumes via Bayesian method and generate the cortical surface at the boundary between gray and white matters;

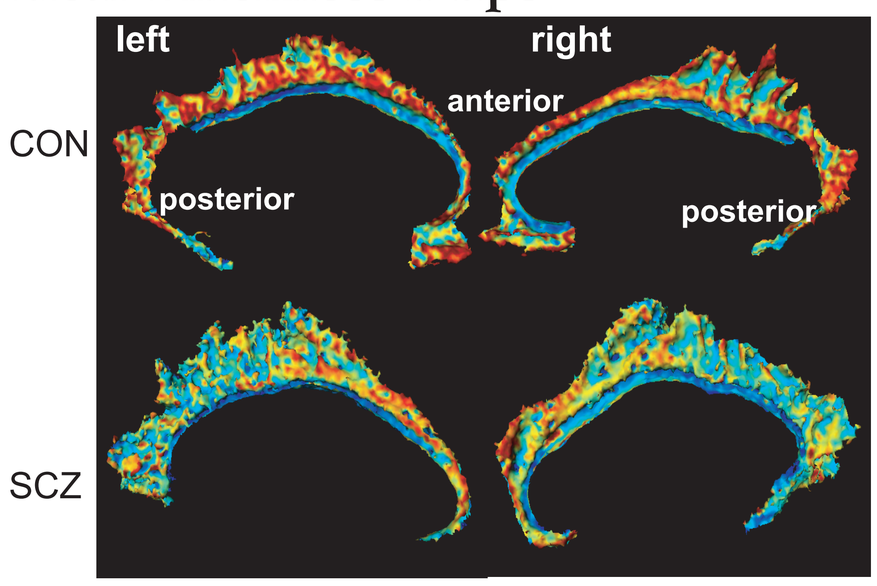
2.Delineate the cingulate structure via dynamic programming;

3.Estimate cortical thickness map indexed over each individual cingulate surface [1];

4.Map cingulate cortical sufaces to the atlas via Large Deformation Diffeomorphic Surface Mapping algorithm (LDDMM-Surface) [2];

5. Generate partitions of the surface atlas based on the eigenfunction of the Laplace-Beltrami operator [3].

Cortical Thickness Maps



Fiugre shows the cortical thickness maps of the left and right cingulate gyri in one healthy comparison subject and one schizophrenia patient. The maps suggest that thickness is not uniformly distributed over the cingulate surface; i.e., the anterior segment of the cingulate is thicker than the posterior segment and the gyral region is thicker than the sulcal region.

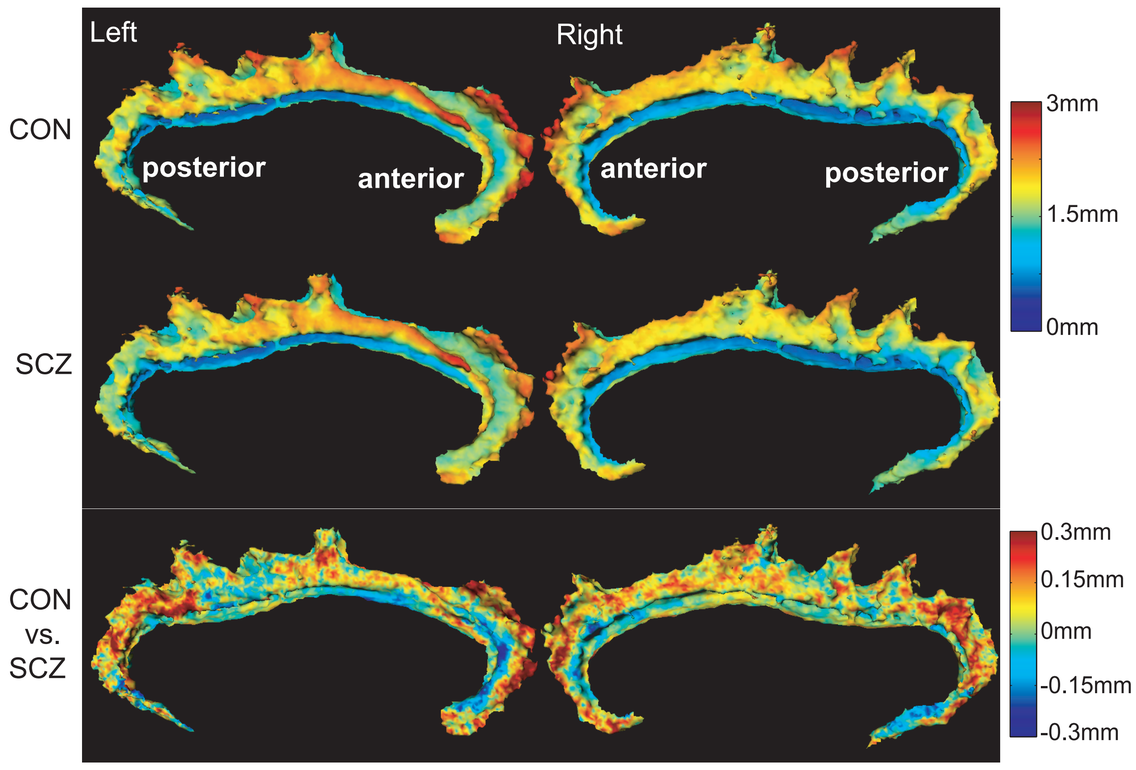
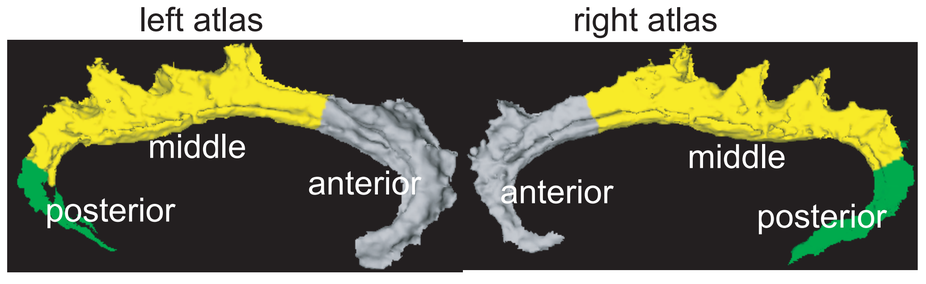


Figure shows average thickness maps of the left and right cingulate surfaces within each diagnosis groups (the top row for the healthy comparison group, and the second row for the schizophrenia group). The third row shows the average difference in the cortical thickness between diagnostic groups. Red denotes thicker regions in the healthy comparison group and blue denotes thicker regions in the schizophrenia group.

Statistical Analysis and Conclusion



To perform statistical analysis, the atlas surface was partitioned into three regions (anterior, middle, and posterior) using the eigenfunction of the Laplace-Beltrami operator on the atlas. As shown in the figure above, the anterior, middle, and posterior partitions are respectively colored in gray, yellow, green. We performed the rank sum test on the null hypothesis that the mean thickness within each partition is equal in the control and schizophrenic populations against the alternative that the mean thickness is greater in the control than that in the schizophrenia. The p-values listed in the table suggest that the cortical thickness is reduced in both left and right cingulate cortex in the schizophrenic group.

p-value	Anterior	Middle	Posterior
left	0.0351*	0.0585	0.0184*
right	0.0592	0.0263*	0.0053*

References:

[1] Qiu, A. et al., "Region of interest based analysis of cortical thickness variation of left planum temporale in schizophrenia and psychotic bipolar disorder", submitted to HBM.

[2] Vaillant, M. and Glaunes, J., "Surface mapping via currents", IPMI, 2005.

[3] Qiu, A. et al., "Smooth functional and structural maps on the neocortex via orthonormal bases of the Laplace-Beltrami operator. IEEE Trans Med Imaging. 25, 1296-1306.

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