Discriminating Schizophrenia and Bipolar Disorder by Unique Patterns of Brain Function and Structure

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Introduction: Diverse structural and functional brain alterations have been identified in both schizophrenia (SZ) and bipolar disorder (BP), but with variable replicability, significant overlap and often in limited numbers of subjects. In this work, we highlighted both similarities and differences between two modalities across three diagnostic groups by fusion of functional MRI and diffusion tensor imaging data, which had not yet been attempted for a relatively large number of subjects.

Method: We proposed a multimodal fusion method, 'mCCA+jICA', which enabled more flexibilities in statistical assumptions. A major strength the proposed model, is that it improves the source decomposition performance substantially by taking maximum advantage of the flexibilities offered by joint independent component analysis (jICA)[1] and multimodal canonical correlation analysis (mCCA)[2]. The modal was then applied to contrast maps of fMRI (auditory oddball task, AOD) and the FA maps of DTI collected from 164 subjects including three groups (HC, SZ, BP), with the goal to find the aberrant brain activities in SZ and BP, as shown in Figure1.

Results and Conclusions: The brain results were examined on several perspectives. Ten components were estimated for each feature according to an improved MDL criterion. We found group-discriminating regions for each modality and each pair-wise groups in their mixing coefficients (Figure 2). Most importantly, we are able to provide insights into the complex network between brain structure and function. In Figure 3, we see that *the identified WM fiber tracts in FA maps do in fact connect the activated functional regions in fMRI contrasts, and may reveal the underlying pathway of information segregation and integration*. Abbreviations are defined as, F: frontal lobe, P: parietal lobe, T: temporal lobe, O: occipital lobe, SLF: Superior longitudinal fasciculus, CST: Corticospinal tract, UF: Uncinate fasciculus, IFO: Inferior fronto-occipital fasciculus, ILF: Inferior longitudinal fasciculus, ATR: Anterior thalamic radiation. The derived mixing coefficients also offer a way to investigate the relationship between brain activations and subjects' behavior data, *e.g.* age or sex. Figure 3(c) illustrates that both patient groups have significant anti-correlation r >0.4 between age and loadings, while HC don't; suggesting that white matter density of schizophrenia and bipolar disorder may decrease faster than controls in specific tracts, such as UF and ATR. Note that all these specific joint information was not accessible from separate analysis of each modality. Our findings suggested although two patient groups showed distinct brain patterns, they also shared common abnormalities in frontal brain mechanisms and in prefrontal thalamic white matter tracts, which may serve as potential illness biomarkers.

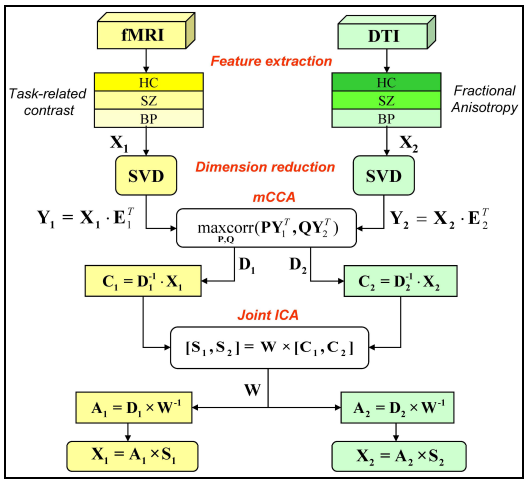

Figure 1 A flowchart summarizing the whole analysis process.

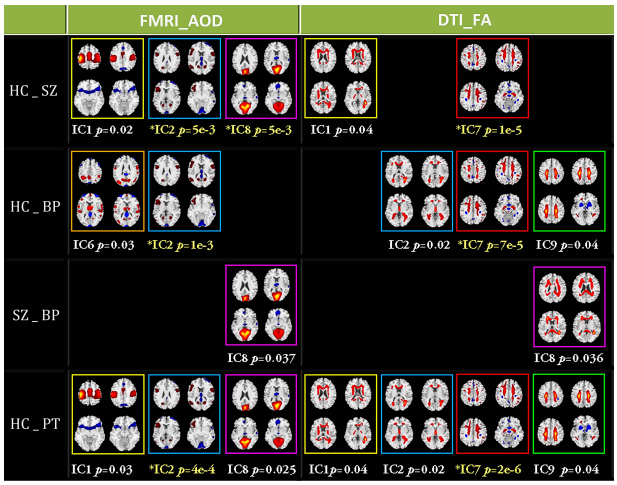

Figure 2. The components with significant group differences in their loadings

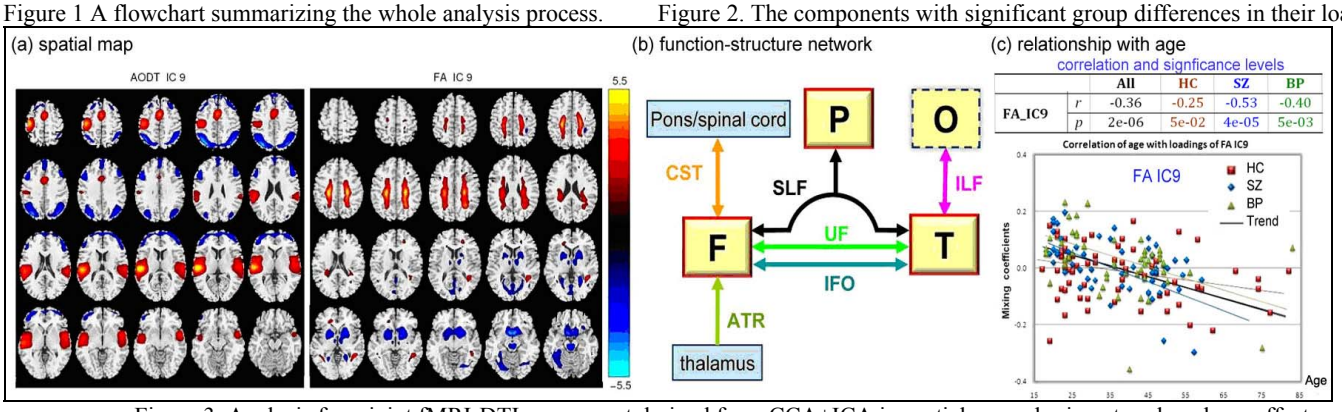

Figure 3. Analysis for a joint fMRI-DTI component derived from CCA+ICA in spatial maps, brain network and age effect.

References

[1] Calhoun VD, Adali T, Kiehl KA, Astur R, Pekar JJ, Pearlson GD. 2006b. A method for multitask fMRI data fusion applied to schizophrenia. Hum Brain Mapp 27(7):598-610.
[2] Correa NM, Eichele T, Adali T, Li YO, Calhoun VD. 2010b. Multi-set canonical correlation analysis for the fusion of concurrent single trial ERP and functional MRI. Neuroimage.