IVA TO DETECT SPATIAL MAP DIFFERENCES BETWEEN SCHIZOPHRENIA PATIENTS AND HEALTHY CONTROLS

Shruti Gopal[1,2], Robyn Miller[1], Andrew Michael[1], Mustafa Cetin[1], Srinivas Rachakonda[1], Stefi Baum[2], and Vince Calhoun[1]
[1]*The Mind Research Network, Albuquerque, NM, United States,* [2]*Rochester Institute of Technology, Rochester, NY, United States*

Target Audience: This paper is useful to researchers interested in a data driven, multivariate, blind source separation technique that offers greater flexibility and retains spatial variability across subjects.

Purpose: We demonstrate that Independent Vector Analysis (IVA) as a non-parametric, multivariate, data driven algorithm can be used to analyze large datasets and look for group differences while exploiting the advantage that it captures greater variability in spatial maps [2]. We validated that IVA generates gray matter cortical components of intrinsic networks that are comparable to those obtained from group ICA (GICA) on the same dataset. Furthermore, we show that IVA's ability to capture greater spatial variability among healthy controls (HC) and schizophrenia subjects (SZ) affected the group differences observed.

Methods: Resting state fMRI data from 89 HC (age: 35.71) and 82 SZ (age: 38.07) was collected and preprocessed according to protocol described in[3]. We used the GIFT toolbox (http://mialab.mrn.org/software/gift/) for IVA and GICA on the data to obtain 75 independent components for each subject (after back-reconstruction for GICA). A correlation of the vectorized components (GICA vs IVA) was done to validate the presence of relevant networks in the IVA components. Of the 75, 40 non-artifactual components were identified that contained resting state spatial networks from GICA group maps through visual inspection. Voxel wise parametric tests assessed group differences between HC and SZ using individual subject spatial maps on the non-artifactual components for both IVA and GICA components. For these components, within group parametric tests for HC and SZ were also done to help us assess the direction of differences between the two groups. The significant regions were corrected for multiple comparisons at FWE corrected $p<0.05$.

Results: The non-artifactual components represent gray matter regions in brain networks characterized by Schizophrenia [1]. All the non-artifactual components were found to be present in IVA components (correlation>0.6). Of these relevant networks group differences in the auditory area (bilateral), basal ganglia, sensorimotor network and visual area(Fig 1) were found to be statistically significant (FWE $p<0.05$) for IVA while the differences if at all did not survive adjustment for multiple comparison in GICA. Based on one sample t-test, we found that the activation in these areas was consistently greater in HC compared to SZ (IVA and GICA).

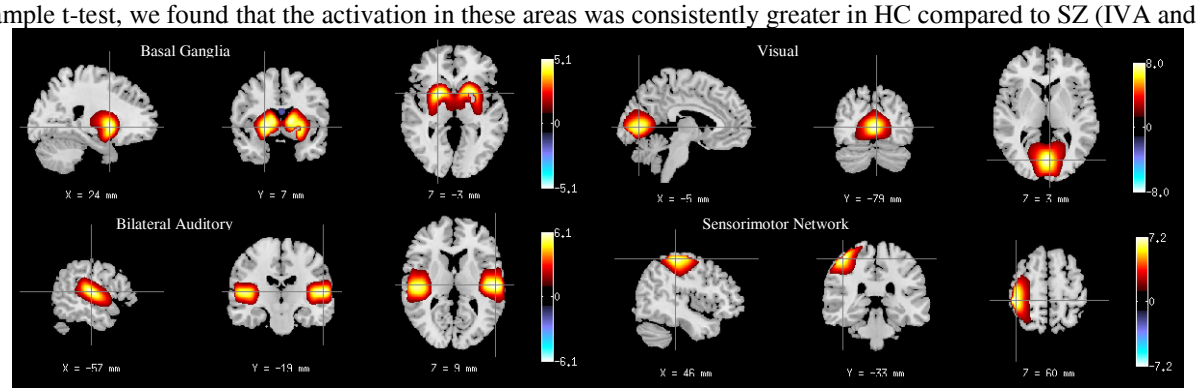

Fig 1: IVA components with statistical significance for between group differences.

Conclusion: The ability of IVA to preserve subject variability among network spatial maps brings additional power to analyses of group differences between healthy and patient populations for disorders in which specific brain structures are believed to play critical roles. Our results demonstrate the benefits of IVA over GICA in what we believe is the first application of IVA to a clinical population. Our results indicate that IVA is not only effective in identifying the networks relevant to Schizophrenia such as basal ganglia, superior temporal gyrus, visual cortex and the sensorimotor network, but is also demonstrably better at differentiating schizophrenia patients from controls based exclusively on easily-assessed properties of the network spatial maps. Future work entails evaluating the effectiveness of IVA in identifying temporal differences as well as possibly extending this analysis to characterize functional anisotropy, and/or structural maps.

References: 1) Vince D. Calhoun, Tom Eichele and Godfrey Pearlson Functional brain networks in schizophrenia: a review. Frontiers in Human Neuroscience Aug 09, Vol 3, Article 17.

2) Jong-Hwan Lee,a Te-Won Lee,b Ferenc A. Jolesz,a and Seung-Schik Yoo, Independent vector analysis (IVA): Multivariate approach for fMRI group study NeuroImage 40 (2008) 86–109.

3) Mustafa S. Çetin, Fletcher Christensen, Christopher C. Abbott, Julia M. Stephen, Andrew R. Mayer, José M.Cañive,Juan R Bustillo,Godfrey D. Pearlson, Vince D. Calhoun, Thalamus and posterior temporal lobe show greater inter-network connectivity at rest and across sensory paradigms in schizophrenia NeuroImage(In Process).