

Connection between Bilateral Superior Temporal Gyrus in Schizophrenia: A Preliminary Diffusion Tensor Imaging Study

H. P. Ng^{1,2}, M. Kubicki^{1,3}, D. Terry¹, P. Pelavin¹, A. Rausch¹, and M. E. Shenton^{1,3}

¹Psychiatry Neuroimaging Lab, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, United States, ²Singapore Bioimaging Consortium, Agency for Science, Technology and Research, Singapore, -, Singapore, ³Clinical Neuroscience Division, VA Boston Healthcare System, Harvard Medical School, Brockton, Massachusetts, United States

Introduction

The superior temporal gyrus (STG) has long been linked to the pathogenesis of schizophrenic symptoms which includes auditory hallucinations [1] and thought disorder [2]. It has wide connections to temporolimbic areas which includes the hippocampus and amygdala. There are earlier studies which investigate the structural integrity in STGs [3] but to the best of our knowledge, no prior study has investigated inter-hemispheric connection between the bilateral STGs. Although not well documented, it is believed that this connection plays an important role in integrating these brain regions, which are critical for thought and information processing. In our study here, we compare the STGs connection in normal subjects (NC) and schizophrenics (SZ) using measures derived from diffusion tensor imaging (DTI).

Methods

This study involves 25 male SZ and 26 male NC, group matched for age, right-handedness, IQ, and parental socioeconomic status. Magnetic resonance images (MRI) were acquired using a 3T GE scanner, with the parameters (TR=7.48ms TE=3ms FOV=256mm, 176 axial slices with 1mm thickness each) for structural MRI and the parameters (51 directions, TR=17000ms TE=78ms FOV=24cm, 144x144 encoding steps, 85 axial slices with 1.7mm thickness each) for DTI. Freesurfer (<http://surfer.nmr.mgh.harvard.edu>) segmentation was performed on the structural MRI data of the subjects and non-linear registration between structural and DTI data, with the latter as reference, was conducted. Whole-brain streamline tractography was performed on the DTI data for all subjects. Connections between bilateral STGs (Fig. 1) were extracted using the white matter (WM) of the STGs as the regions of interest (ROIs). These connections were then subdivided into three regions as illustrated in Fig. 2. Mean fractional anisotropy (FA), mode and trace were computed for each of these sub-regions.

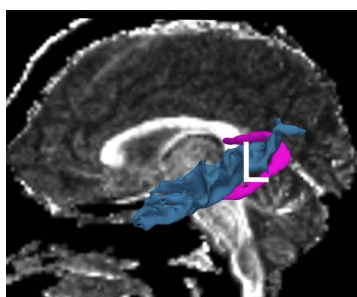


Fig.1: Connection between bilateral STGs through the corpus callosum

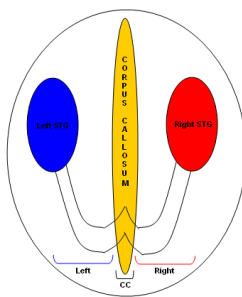


Fig.2: Sub-divisions of the connection

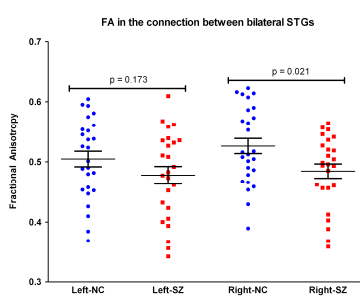


Fig.3: Between-group differences in mean FA

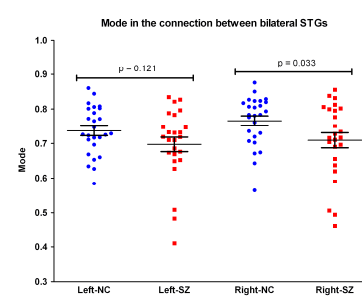


Fig.4: Between-group differences in mean mode

Results and Discussion

The mean FA, mode, trace in the Left, CC and Right sub-regions for NC and SZ are shown in Table 1. Statistically significant between-group differences were observed for mean FA (Fig. 3) and mode (Fig. 4) belonging to the Right sub-region with p-values at 0.021 and 0.033 respectively. Of note, mean FA for NC is greater than that for SZ in the Left and Right sub-regions. This is consistent with the general consensus that a lower FA is associated with decreased WM health due to weaker myelination or disorganization. Comparing within-group differences in NC and SZ, it is noted that NC has a greater difference (0.0215 to 0.0068 in FA; 0.0292 to 0.0117 in mode; 0.206 to 0.163 in trace) compared to SZ. It has been suggested in an earlier review that failure to establish asymmetry leads to risk of reverse transmission, a mechanism of psychotic symptoms [4]. Our findings here support it to a certain extent.

Conclusions

Findings in this preliminary study show that the integrity of the sub-regions in bilateral STG connections differs between NC and SZ. This paves the way for future studies to correlate the differences in bilateral STG connections to positive and negative syndrome scale (PANSS) for schizophrenia and for further identification of the locations where the differences occur.

Acknowledgements

The first author would like to thank the Agency for Science, Technology and Research (A*STAR), Singapore for funding him through the A*STAR Graduate Scholarship (Post-Doc) administered by A*STAR Graduate Academy. This work was supported by: National Institutes of Health (NIH) R01 MH 50747 to MES and U54 EB005149 to MK; Department of Veterans Affairs VA Merit Award to MES; Center for Intervention Development and Applied Research P50 MH080272 to MES.

References

- [1] Barta, P.E., Pearlson, G.D., Powers, R.E., Richards, S.S., Tune, L.E., 1990. Auditory hallucinations and smaller superior temporal gyral volume in schizophrenia. *Am. J. Psychiatry* 147 (11), 1457–1462.
- [2] Barta, P.E., Pearlson, G.D., Brill 2nd, L.B., Royall, R., McGilchrist, I.K., Pulver, A.E., Powers, R.E., Casanova, M.F., Tien, A.Y., Frangou, S., Petty, R.G., 1997. Planum temporale asymmetry reversal in schizophrenia: replication and relationship to gray matter abnormalities. *Am. J. Psychiatry* 154, 661–667.
- [3] Lee, K., Yoshida, T., Kubicki, M., Bouix, S., Westin, C.F., Kindlmann, G., Niznikiewicz, M., Cohen, A., McCarley, R.W., Shenton, M.E., 2009. Increased diffusivity in superior temporal gyrus in patients with schizophrenia: a diffusion tensor imaging study. *Schizophr. Res.* 108, 33–40.
- [4] Crow, T.J., Paez, P., Chance, S.A., M., 2007. Callosal misconnectivity and the sex difference in psychosis. *Int. Rev. Psychiatry* 19, 449–457.

	FA	mode	trace ($\times 10^{-3}$)
Left-NC	0.5049	0.7368	3.575
CC-NC	0.6759	0.9356	2.968
Right-NC	0.5264	0.7660	3.369
Left-SZ	0.4780	0.6976	3.479
CC-SZ	0.6970	0.9240	2.981
Right-SZ	0.4848	0.7093	3.316

Table 1: Collated mean FA, mode and trace