Localization of the Language Network using Resting State Functional Connectivity MRI and Diffusion Tensor Tracking

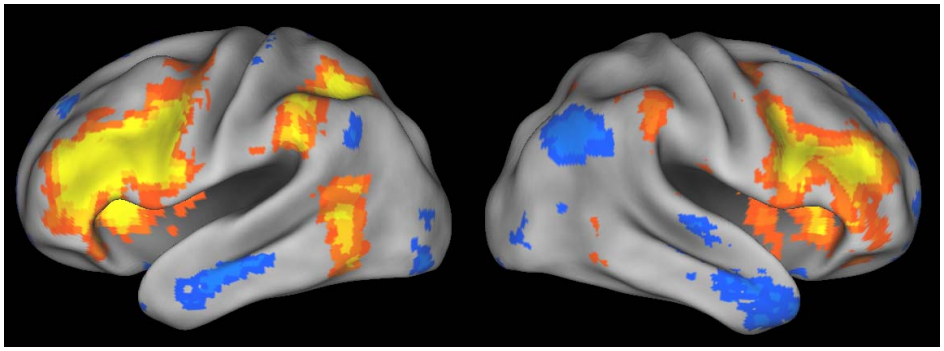
J. S. Shimony[1], A. A. Epstein[1], S. N. Vaishnavi[1], M. W. Sansbury[1], J. G. Ojemann[2], A. Z. Snyder[1], and M. E. Raichle[1]

[1]Washington University School of Medicine, St. Louis, MO, United States, [2]Department of Neurological Surgery, University of Washington School of Medicine, Seattle, WA, United States

INTRODUCTION: Although the language network is localized around the left sylvian fissure in a great majority of the population, there is a significant amount of variability in localization between individuals [1, 2]. Localization in individuals is of great interest for pre-surgical planning to help decrease the morbidity from left temporal lobe surgery. Localization of the language network has been performed functionally with fMRI [1], and anatomically with diffusion tensor tracking (DTT) [2, 3]. The purpose of this project was to study the variability of the language network in individuals and to validate its localization by correlating the results from resting state functional connectivity MRI (fcMRI) and DTT.

METHODS: Eleven neurologically normal young females (ages 18-30) were studied on a 3T Allegra MRI scanner (Siemens, Erlangen, Germany) using DTI (TR=6400ms, TE=87ms, 1.5 x 1.5 x 1.5 mm voxels, 52 directions, b=600-1400 s/mm^2) and resting state fcMRI (TE=25ms, 90° flip, 4 x 4 x 4 mm voxel size) as previously described in [4]. Standard anatomical scans (MPRAGE, T2-weighted fast spin echo) were also obtained for anatomic registration. Post-processing was preformed to align each set of scans into standardized Talairach coordinate system using cross modal affine transformations. DTT was performed using streamline methods and the arcuate fasciculus was identified by selecting tracks that passed through two large regions of interest (ROI) in the perisylvian region, similar to the methods of [3]. Functional connectivity within the language system was determined by selection of a seed region in the left BA44/45 region [1] and calculating the connectivity of the reset of the brain to this region. Details of the resting state fcMRI processing, including signal filtration is described in [4].

RESULTS: The top figure is a group average of the fcMRI results in the 11 females. This nicely demonstrates the ability of the fcMRI to localize the known left-right asymmetry in the language network. On the left 3 major language regions (Broca, Wernicke, and Geschwind [3]) are clearly highlighted in yellow/orange. Examination of the results in individual subjects demonstrates the existence of these regions in all subjects with some degree of variability. A high correlation is seen between the results of the fcMRI and the arcuate fasciculus as determined by DTT. This is illustrated in the bottom figure, which shows two slices from one of the subjects in our sample. The slices are selected to demonstrate Broca's region (left bottom figure) and Wernicke's region (right bottom figure). The green/red scale displays the fcMRI results superposed on the axial slices. The blue scale is a volumetric representation of the arcuate fasciculus as determined by DTT. The high correlation between the two distinct methods is clearly visible. This degree of correlation is seen in a large majority of our subjects.



CONCLUSION: Our preliminary data indicate that the language network can be accurately localized using a functional (fcMRI) and an anatomic method (DTT) and that these two methods have a high degree of correlation between them. This data can be obtained in under one hour of scan time, which makes it clinically feasible for pre-surgical planning.

SUPPORT: JSS: NIH K23 HD053212.

REFERENCES: [1] K.B. McDermott, et. al., Neuropsychologia 41:293-303, 2003. [2] M. Catani, et. al., PNAS 104:17163-17168, 2007. [3] M. Catani, et. al., Ann Neurology 57:8-16, 2005. [4] M.D. Fox and M.E. Raichle, Nat. Rev. Neurosci. 8:700-711, 2007.