TEMPORAL RELIABILITY OF FUNCTIONAL LATERALIZATION OF RESTING-STATE LANGUAGE NETWORK

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Target Audience: Researchers interested in resting-state networks, functional lateralization and language-related studies will pay attention to this abstract.

Purpose: The human brain is a complex structure that controls sophisticated cognitive behavior. A fundamental feature of the human brain is the presence of both structural and functional asymmetries between two hemispheres[1]. One of the earliest observations of brain asymmetry is the dominance of the left hemisphere in language. Broca and Wernicke both found the left lateralization of language function from lesion studies[2, 3]. In addition, fibers between Broca's (lBro) and Wernicke's areas (lWer) seem to be leftward asymmetry[4]. Disrupted asymmetries in language associated cortical areas have been found not only in language related diseases, such as developmental dyslexia, but also in some psychiatric diseases, including autism and schizophrenia[1]. Functional lateralization of language network was testified to be consistent among various research centers[5], however, its temporal reliability, which should be more crucial to clinical applications, still needed to be investigated. The present work aimed to provide a temporal reliability examination of functional lateralization of resting-state language network.

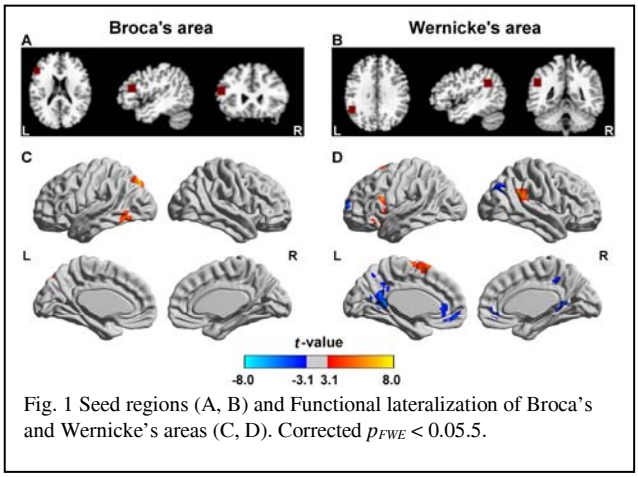

Fig. 1 Seed regions (A, B) and Functional lateralization of Broca's and Wernicke's areas (C, D). Corrected $p_{FWE} < 0.05.5$.

Methods: The TRT resting-state fMRI dataset we used was acquired by New York University and freely available at NITRC website. This dataset consists of 25 right-handed subjects who were scanned three times. The second and the third scan, 45 min apart in a single session, were obtained 5-16 months (mean 11 ± 4) after the first scan. Standard rsFC preprocessing steps were done in SPM8 and DPARSF. Several types of covariance were regressed according to the study of Fox[6]. "Temporal scrubbing" method was used to eliminate head motion effect[7]. After scrubbing, 23 subjects were left for further analysis. Two cubic regions centered at (-51, 27, 18) and (-51, -51, 30) were selected to represent lBro and lWer (Fig. 1), respectively, according to previous study[6]. To estimate the functional hemispheric asymmetry of language network, the LR-flipped regions of the above two ROIs were picked as rBro and rWer, respectively. rsFC maps of these four ROIs with all voxels of the whole brain were computed. After that, the rsFC patterns of rBro and rWer were LR-flipped. Hemispheric asymmetry of rsFC patterns was revealed by the subtraction of rsFC patterns of left seed and the flipped rsFC patterns of right seed[8]. As a result, significant areas in left hemisphere reveal ipsilateral functional asymmetry and in right hemisphere indicate contralateral functional asymmetry. Intra-class correlation (ICC) coefficient was computed to assess TRT reliability of these functional asymmetries.

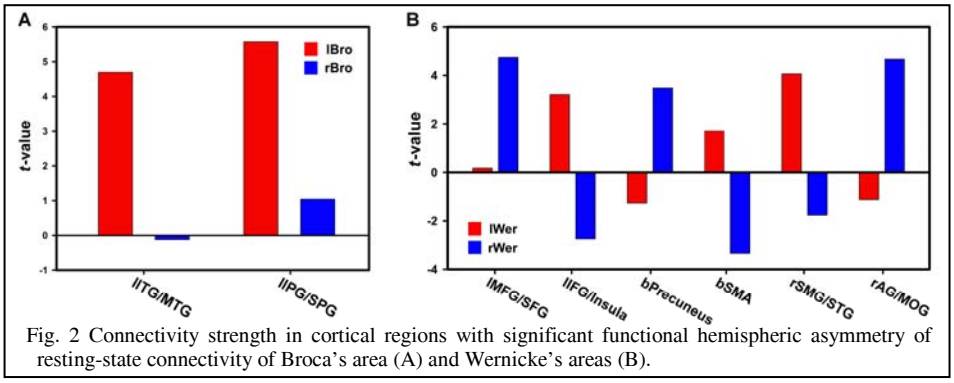

Fig. 2 Connectivity strength in cortical regions with significant functional hemispheric asymmetry of resting-state connectivity of Broca's area (A) and Wernicke's areas (B).

Results & Discussion: The lateralization of networks of both Broca's area and Wernicke's area were revealed in Fig. 1. Only ipsilateral functional asymmetry of Broca's area was shown in ITG/MTG and IOG. Significant functional asymmetrical regions of Wernicke's area were more than Broca's area. IFG/MFG, anterior and posterior cingulate cortex and SMA contributed mainly to the significant ipsilateral asymmetry. In addition, the Wernicke's area showed significant asymmetric FC with its contralateral hemisphere in several brain regions, such as precuneus, calcarine gyrus, SMG, STG, AG, MOG and SMA. Fig. 2 demonstrates the mean functional connectivity strength of each seed in cerebral regions with significant functional asymmetry. The functional connectivity of the Broca's area was left lateralized, while that of the Wernicke's area was mainly right lateralized. This was consistent with previous studies[5]. The TRT reliability of those functional asymmetry results were illustrated in Fig. 3. The lateralization of functional networks of Broca's and Wernicke's areas showed high reliability for both short-term and long-term, especially in language related regions.

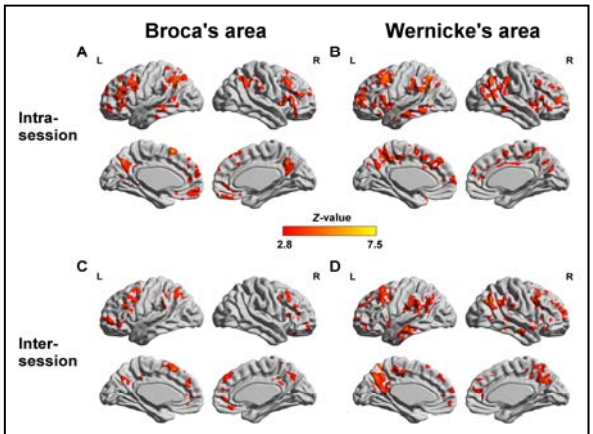

Fig. 3 Intra-session (A, B) and inter-session (C, D) reliability of functional hemispheric asymmetry of resting-state connectivity of of Broca's area (A, C) and Wernicke's area (B, D). Corrected $p_{FWE} < 0.05$.

Conclusion: The Broca's area was functionally left lateralized, while the Wernicke's area was not. These results were consistent with previous studies[5]. Furthermore, the functional lateralization of resting-state language network was reliable across both short- and long-term.

References: [1] Toga et al., Nat. Rev. Neurosci., 2003; [2] Broca, Bull. Soc. Anthropol., 1861; [3] Wernicke, 1874; [4] Barrick et al., Cerebral Cortex, 2007; [5] Tomasi et al., Mol. Psychiatry, 2012; [6] Fox et al., PNAS, 2005; [7] Power et al., NeuroImage, 2012; [8] Yan et al., NeuroImage, 2009;