The Basal Ganglia Coupling during Social Interaction Revealed by Dyadic fMRI

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Introduction

Taking advantage of emerging dyadic fMRI (dfMRI) (1), a study on two human-brain interactions inside one MRI scanner was conducted. Besides confirmed most of the previous results regarding BOLD effect in social cognition, the probabilistic independent component analysis (PICA) (2) results of our dfMRI data reveal that the basal ganglia coupling between two brains could be an essential stage in social cognition, as suggested in Ref. (3). This is the first time that fMRI directly shows that a special region of brain becomes coupled during social interaction, while most other BOLD active regions due to social cognition, such as medial prefrontal cortex (fPFC), temporal parietal junction (TPJ), or posterior cingulate cortex (PCC), are only coherent within each individual brain.

Method

The study was conducted with a custom-made dual-head coil system on a Siemens 3T Skyra scanner, as shown in Fig. 1. More than 20 dfMRI studies were conducted with subject-pairs lying on their sides, face-to-face, inside the magnet bore. The pulse sequence used for the functional studies is EPI with TR 2000ms, TE 30ms, FOV 500mm×250mm, sampling matrix 128×64, slice thickness 4mm, voxel size 4mm×4mm×4mm, and flip angle 80°. The field map is acquired by GRE sequence with the same resolution and slices as in the functional EPI sequence. The anatomical images are acquired by MPRAGE sequence with voxel size 2mm×2mm×2mm. Each run has 200 measurements in which the subject-pair periodically open and close their eyes, either simultaneously or alternately. Each period has 20 measurements; ten of them are during open eye intervals and another ten are during closed eye intervals. The functional data was post-processed with software package FSL (Oxford University, UK).

Results

All data sets were post-processed with both GLM and PICA with threshold Z=3.0 and P=0.05, high pass filter cutoff=90s and spatial smoothing FWHM=5mm. Fig. 2 shows BOLD activation during mutual gazing calculated by GLM. However the activation at PCC in right and TPJ in left person are not correlated at all. Fig. 3 is the same data set but processed with PICA. Both basal ganglia from both subjects are clearly coupled into one component, which has 1.52% of explained variance and 1.03% of total variance. Note that among all 52 components, this is one of a few in which both brains are coupled.

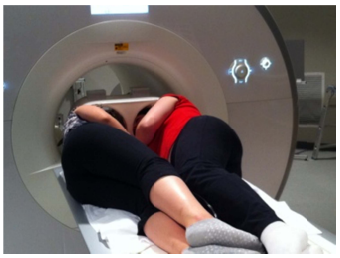
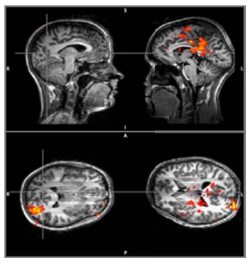


Fig. 1



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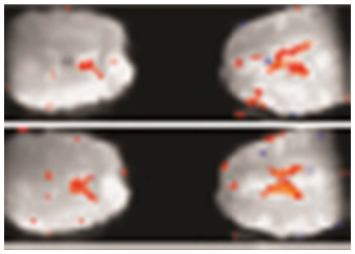

Fig. 3

Conclusions

The dfMRI opens up a new field of studying human brain interaction directly and quantitatively. Its first significant result suggests that the basal ganglia, especially caudate nucleus, could be in coupled mode during social interaction. Given the role of the basal ganglia in implicit learning, quantifying such coupling could be essential for both social cognition study and diagnosis of autism.

References

1. Lee RF, et al. A Twin-Head Coil for Studying Two Brain Interaction with fMRI. Proceeding of Internation Society of Magnetic Resonance in Medicine 18th Annual Meeting. Stockholm, Sweden; 2010. p 1513.
2. Beckmann CF, Smith SM. Probabilistic Independent Component Analysis for Functional Magnetic Resonance Imaging. IEEE trans on Medical Imaging 2004;23(2):137.
3. Lieberman MD. Intuition: A Social Cognitive Neuroscience Approach. Psychological Bulletin 2000;126(1):109.