Form 2-4-2

Japan-U.S. Brain Research Cooperation Program
Group Joint Study Project Program FY2017 - FY2019 : Report

<u>Field: ③行動・システム・認知</u>

1. Principal Researcher

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Title:        Associate Professor

Affiliation:   Division of Cerebral Integration, National Institute for Physiological Sciences

2. Project Title:

Ultra high field functional-structural MRI analysis of neural basis of intentional sharing

3. Japanese Group

Principal Researcher

Masaki Fukunaga, Associate Professor, National Institute for Physiological Sciences

Collaborating Researcher

Sho Sugawara, Assistant Professor, National Institute for Physiological Sciences

Tetsuya Yamamoto, Postdoctoral fellow, National Institute for Physiological Sciences

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Takahiko Koike, Assistant Professor, National Institute for Physiological Sciences

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Yoshinori Nanjo, Graduate student, SOKENDAI

Norihiro Sadato, Professor, National Institute for Physiological Sciences

4. U.S. Group

Principal Researcher

Essa Yacoub, Professor, Center for Magnetic Resonance Research,
Department of Radiology, University of Minnesota

Collaborating Researcher

Gregor Adriany, Associate Professor, Center for Magnetic Resonance Research,
Department of Radiology, University of Minnesota

5. Research Period, from/to (mm/dd/yyyy) and total number of years.

From   04/01/2017    to       03/31/2020    (3 yeras)

6. Abstract, Results, and Research Significance (300 words):

One of the characteristic abilities of human sociality is "shared intentions". In order to elucidate the neural basis

of this ability, it is necessary to measure an individual's brain activity under social interaction. For this purpose, we developed a hyperscanning functional MRI (fMRI) system which allows to mesure two individual brain activities simultaneously. We found, the brain activity specific to sharing intentions through non-verbal communication in the insula, inferior prefrontal cortex and temporoparietal parietal junction (TPJ). These brain activities were unevenly distributed within the region, suggesting a possible subdivision of the brain activity. On the other hand, 7-tesla (7T) ultra-high-field MRI provides excellent sensitivity and tissue contrast, and is expected to reveal the fine structure, functional and structural circuitry of the cerebral cortex. However, unlike conventional scanner, 7T MRI is required to solve the technical issues (i.e. magnetic and transmit field inhomogeneity), establish dedicated preprocessing and analysis pipelines.

In this study, we collaborated with Prof. Essa Yacoub and Prof. Gregor Adriany, Center for Magnetic Resonance Research (CMRR), University of Minnesota, to develop the dedicated measurement and analysis procedures for understanding structure and functional relationship of asscoation brain areas, such as insula,  inferior frontal gyrus and TPJ on 7T. Firstly, 7T specialized multiband EPI was installed, which is high-speed MRI pulse sequence and developed by CMRR. Then the Human connectome project pipline has been optimized to analyze the 7T MR images, and quantitatively evaluated the correction effect of geometric distortions (Yamamoto et al. in prep.). We visited CMRR to discuss prescan optimization and other issues, and held discussions in actual MRI scanner. Based on these techniques, we succeeded in delineating the subnucleus of the globus pallidus (Maruyama et al., Sci Rep. 2019).

From these results, we have developed a basic technology to analyze brain microstructure and functional relationships using 7T MRI. These technique was applied to multi-band EPI based high-resolution diffusion MRI and resting-state fMRI. We have found a trend of functional and structural connectivities within the atlas-predefined ROI (Fukunaga, JHBM 2019), suggesting that the traditional brain classification may be further subdivided.


7.  Other (Research-related concerns, particular points of note):
   None


*Please attach any reference materials as necessary.