Comparison of Brain Patterns of Different Object Categories on 3T and 7T scanners

Sun Mi Park\(^1\), Francesca Branzoli\(^2\), Misun Kim\(^1\), Hyerin Lim\(^1\), Matthias J. P. van Osch\(^2\), Itamar Ronen\(^2\), Dae-Shik Kim\(^1\)

\(^1\) Department of Electrical Engineering, Korea Advanced Institute of Science and Technology, Republic of Korea
\(^2\) C. J. Gorter Center for High-field MRI, Department of Radiology, Leiden University Medical Center, Netherlands

I. Objective

Multi-voxel pattern analysis (MVPA) methods aim at determining how mental representations map onto patterns of neural activity and constitute a useful new tool for a better understanding of neural coding and information processing. Distinct brain regions relevant to recognizing objects are well established, i.e. face-recognition is located in the fusiform face area (FFA) and houses in the parahippocampal place area (PPA). Ultra-high field MRI enables imaging at higher spatial resolution and improved localization, thereby potentially leading to improved discrimination between different neuronal patterns. The goal of the present study is to compare the distinctiveness and similarity of neuronal patterns associated with classification of eight object categories when measuring at high field (3T) and ultra high-field (7T). Detection of neuronal patterns was performed both with standard general linear model (GLM) and MVPA.

II. Methods

BOLD activation patterns were measured in three healthy volunteers with a gradient echo echoplanar imaging sequence on a 3T and a 7T Philips Achieva whole-body MRI scanners (Philips healthcare, Best, The Netherlands). The stimuli were gray-scale images (angle coverage \(\sim 3.3\text{–}10\) degrees) of the following eight categories: faces, houses, cats, bottles, scissors, shoes, chairs, or nonsense images. The categories were chosen from Haxby’s previous study to allow comparison [Science 293 (2001) 2425]. Stimuli were presented in a block design with objects shown at different viewing angles and the subjects were asked to perform a one-back repetition detection task. Image data were analyzed with GLM and MVPA.

III. Results

The BOLD SNR was higher at 3T than 7T due to increased physiological noise at 7T, but spatial specificity was better at 7T. The activated regions of each object category overlapped, so that the GLM results of each category were similar at 3T and 7T. However, the brain pattern of each category was distributed so that within-category correlations were better than between category correlations with MVPA.

IV. Conclusion

The better spatial specificity observed at 7T, enables improved brain pattern classification among different object categories.
V. Keywords
Multi-voxel pattern analysis, Pattern classification, 7T scanner, fMRI

VI. Acknowledgement
This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2011-0004110, 2011-0018288, 2012-0001769, 2012-0005790, 2010-1-B00280), the Center for Integrated Smart Sensors funded by the Ministry of Education, Science and Technology as Global Frontier Project (SIRC-20110031866), Basic Science Research Program through the S&T Reading Primary Research funded by KAIST (N10120030), and Brain Korea 21 Project through the BK Electronics and Communications Technology Division in KAIST.