Hemispheric Interaction in Cognitive Processes

Brenda Milner

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Brenda Milner is Dorothy J. Killam Professor of Psychology at the Montreal Neurological Institute and Professor in the Department of Neurology and Neurosurgery at McGill University. The research project funded with the second part of the Balzan Prize awarded to Dr. Milner seeks to illuminate the nature of hemispheric interaction in the human brain and to show how the integration of information between the two hemispheres enables remembering. To this end, fine-grained behavioural paradigms were combined with conventional functional magnetic resonance imaging (fMRI) experiments as well as newly emerging tools in fMRI (resting-state fMRI) to allow the examination of patterns of interaction between distant brain regions. Dr. Milner's lab studied a cohort of healthy young right-handed subjects in order to determine how individual differences in patterns of hemispheric connectivity relate to the natural variation in capability for different types of memory task and to the cognitive strategies adopted by each individual.

The project has made significant progress. Neuroimaging and neuropsychological data from 30 healthy participants have been collected, and data has been analyzed. Xiaoqian Jenny Chai joined Milner's team in September 2015 to assist with this analysis. Dr. Chai, who has a multidisciplinary quantitative background, is a research affiliate of the McGovern Institute for Brain Research at the Massachusetts Institute of Technology, with expertise in resting-state fMRI analysis.

Two aspects of the study have yielded results of interest. With respect to the task-based fMRI, Dr. Milner's team is currently in the process of writing a manuscript

related to the role of imagery in facilitating memory, including specific contributions of the left inferior frontal cortex and left hippocampus. Preliminary results of this work were presented in 2015 at the Annual Meeting for the Organization for Human Brain Mapping. The findings shed light on some of the current issues related to hippocampal contributions to memory. In the second manuscript in preparation, her team combined behavioural data with resting-state fMRI and found a link between interhemispheric-connectivity measures in the posterior hippocampus and memory test scores, showing that individuals with stronger interhemispheric connectivity have higher performance on two specific memory tasks.

As the next phase, Dr. Milner's team have initiated an inter-institutional collaboration with a team at Bordeaux University in France to further investigate the relationship between interhemispheric organization and cognition. The Neuroimaging Group at Bordeaux, headed by Bernard Mazoyer and Nathalie Tzourio-Mazoyer, has been interested in asking similar questions about the behavioural and neural correlates of hemispheric specialization and interhemispheric integration, and this group has collected a unique dataset of nearly 400 healthy volunteers balanced for gender and handedness (BIL&GIN: Mazoyer et al. 2016). These participants have completed an extensive battery of cognitive tests and have also undergone structural (anatomical and diffusion-weighted MRI) and functional (task-based and resting-state fMRI) brain-imaging sessions. Mutual visits of the lab members were planned to work on the dataset in order to ask specific questions regarding the role of interhemispheric connectivity architecture in shaping individual differences in memory functions.

To summarize, Dr. Milner's lab is in the process of preparing two manuscripts based on the neuroimaging and neuropsychological assessment of 30 healthy subjects; and engaging in a new collaboration with the Bordeaux team to use a large-scale dataset that allows further investigation of hemispheric connectivity architecture and individual differences in cognition.