Symposium 13: Imaging Human Cognition (Sat July 31, 9:00-11:00 JST)
Chair: Fang Fang (School of Psychological and Cognitive Sciences, Peking University)

9:00-9:30 Yuji Naya (School of Psychological and Cognitive Sciences, Peking University, China)
Objects and space in the medial temporal lobe memory system

9:30-10:00 Masahiko Haruno (NICT Center for Information and Neural Networks, Osaka, Japan)
Functional connectivity basis and underlying cognitive mechanisms for gender differences in guilt aversion

10:00-10:30 Won Mok Shim (School of Biomedical Engineering, Sungkyunkwan University, Korea)
Dynamics of brain states in naturalistic cognition

10:30-11:00 Fang Fang (School of Psychological and Cognitive Sciences, IDG/McGovern Institute for Brain Research, Peking University, China)
Maps and functions of human attention

Symposium 13 Speaker 1
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Objects and space in the medial temporal lobe memory system

Recent studies suggest involvements of the medial temporal lobe (MTL) in scene perception as well as episodic memory. However, it is still unclear how the MTL constructs a scene. To address this problem, we investigated neural mechanisms to represent objects, space and their relationship using monkey electrophysiology and human neuroimaging. In the single-unit study, we found two distinct signals in the ventral ("what") visual pathway and its downstream MTL areas: spatially-invariant object signal and view-centered background signal. The two distinct signals were integrated in the perirhinal cortex before the hippocampus. In the fMRI study, we found that the human left hippocampus represents a spatial environment defined by three objects around the self-body. Interestingly, the parahippocampal cortex represented the first person's perspective of the spatial layout of objects regardless of their object identities. These findings suggest two types of spatial information of objects represented in the perirhinal cortex and parahippocampal cortex, which might be integrated in the hippocampus to construct a mental representation of a scene including objects.

Symposium 13 Speaker 2
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Functional connectivity basis and underlying cognitive mechanisms for gender differences in guilt aversion

Prosocial behavior is pivotal to our society. Guilt aversion, the tendency to reduce the discrepancy between a partner's expectation and his/her actual outcome drives human prosocial behavior as well as well-known inequity aversion. Although women are known to be more inequity averse than men, gender differences in guilt aversion remain unexplored. Here, we conducted a functional magnetic resonance imaging (fMRI) study (n = 52) and a large-scale online behavioral study (n = 4723) of a trust game which was designed to investigate guilt and inequity aversions. The fMRI study demonstrated that men exhibited stronger guilt aversion and recruited right DLPFC-VMPFC connectivity more for guilt aversion than women, while VMPFC-DMPFC connectivity was commonly used in both genders. Furthermore, our regression analysis of the online behavioral data collected with Big Five and demographic factors replicated the gender differences and revealed that Big Five Conscientiousness (rule-based decision) correlated with guilt aversion only in men, but Agreeableness (empathetic consideration) correlated with guilt aversion in both genders. Thus, this study suggests that gender differences in prosocial behavior are heterogeneous depending on underlying motives in the brain and that the consideration of social norms plays a key role in the stronger guilt aversion in men.

Symposium 13 Speaker 3:
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Dynamics of brain states in naturalistic cognition

Previous work has proposed that large-scale interactions of functional brain networks can represent time-varying cognitive states. Here I introduce our recent behavioral and fMRI work using narrative movies to investigate how low-dimensional brain state dynamics are involved in moment-to-moment narrative comprehension. Specifically, I discuss how whole-brain functional networks are reconfigured as the narrative unfolds, how functional connectivity patterns predict individual differences in narrative comprehension, and more broadly, how characteristic latent brain states that are linked to the current attentional state or that are predictive of subsequent memory emerge under a range of experimental conditions, including naturalistic and structured task settings. Taken together, our work provides insight into the dynamics of brain states associated with continuously changing cognitive states during naturalistic cognition.

Symposium 13 Speaker 4:
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Maps and functions of human attention

In everyday life, our brain is faced with the critical challenge of selecting the most relevant fraction of external inputs at the expense of less relevant information. Attention is widely acknowledged to be responsible for this selection process. In the first part of this talk, we show how to identify two key components of attention - the saliency map and the priority map in the human brain. Both the maps describe the topographic representation of attentional allocation. The saliency map is primarily based on bottom-up physical inputs, while the priority map is determined by both bottom-up and top-down signals. We demonstrate that the saliency maps from artificial and natural images are created in early visual cortex, especially in V1. Based on the properties of V1 neurons and the principle of information maximization, we propose a computational saliency map model to simulate human saccadic scanpaths on natural images, which outperforms many other models. Furthermore, we use the fMRI population receptive field (pRF) mapping technique and eye tracking technique, and show that the priority maps of natural images could be found in early visual cortex, including V1-V3.These findings provide converging evidence that the neural substrate of attention maps (including the saliency map and the priority map) could be located in human early visual cortex and significantly extend traditional attention theories that emphasize that only the parietal and frontal cortices are responsible for generating attention. In the second part, we address how the brain concurrently attends to multiple features. We found that, instead of being simultaneously and persistently enhanced, the neural representations of the attended features alternated with each other as they underwent a theta-band (~4 Hz) rhythmic fluctuation over time. This finding revealed for the first time a rhythm-based, time-multiplexing neural machinery supporting concurrent multi-feature attention.