Human Perception and Decision Making

December 5 (Thursday), 2013
14:00-17:15
BSI EAST, 1F Seminar Room

14:00-15:00
From neural correlates to neural causes of visual perception
Dr. Kaoru Amano, Senior Researcher
Center for Information and Neural Networks (CiNet)
National Institute of Information and Communications Technology

15:00-16:00
Modeling and decoding brain activity evoked by natural movies
Dr. Shinji Nishimoto, Senior Researcher
Center for Information and Neural Networks (CiNet)
National Institute of Information and Communications Technology

16:00-16:15 Coffee Break

16:15-17:15
Characterizing choice and neural computations in the framework of statistical decision theory
Dr. Shih-Wei Wu, Assistant Professor
Institute of Neuroscience, Brain Research Center
National Yang-Ming University, Taipei, Taiwan

Hosts:
Justin Gardner, Lab for Human Systems Neuroscience
Kang Cheng, Functional Magnetic Resonance Imaging, RRC
From neural correlates to neural causes of visual perception

Dr. Kaoru Amano
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The talk consists of three parts. In the first part, we show the neural correlates of two temporal aspects in perception; simple reaction time and point of subjective simultaneity (PSS) measured with synchrony judgment task. We found that motion coherence affected RT and the PSS differently, but the modulations of RT and PSS were both predicted by the timing when leaky-integrated hMT+ response crossed a certain threshold. The threshold for PSS was smaller than that for RT, indicating that the time marker for simultaneity judgment is located at the timing earlier than the detection latency. We suggest that time marker is considerably independent of stimulus amplitude, and thus contributes to accurate timing perception.

In the second part, we present an experiment showing a functional role of alpha oscillation in visual processing. When borders defined by iso-luminant color change and those defined by luminance change are placed in close proximity, an illusory spatial jitter of the color-defined boundary is perceived. We found that perceived jitter frequency was around 10 Hz, and the MEG responses at the same frequency (alpha oscillation) were enhanced with the illusory jitter perception. These results suggest a possibility that an alpha oscillation might work as a clock for visual processing and a spatial delay of iso-luminant boarder is compensated at the alpha rhythm.

In the third part, we present our recent study incepting color perception associated with orientation with fMRI decoded neurofeedback. Although associative learning is essential in cognition, it remains unclear whether it can occur in the early visual cortex, which is a fundamental question to understand visual plasticity. Here, via a newly developed fMRI neurofeedback, we successfully incepted long-lasting color perception associated with orientation into areas V1 and V2. The result provides the first direct evidence that the early visual cortex has the capability to form associative learning.

Hosts:
Justin Gardner, Lab for Human Systems Neuroscience
Kang Cheng, Functional Magnetic Resonance Imaging, RRC
Quantitative modeling of brain activity can provide crucial insights about cortical representations and can form the basis for brain decoding devices. However, most quantitative studies of vision have focused on relatively restricted stimuli and tasks, so it has been unclear how the results might generalize to natural vision. Here I present a framework that facilitates quantitative modeling of brain activity evoked by natural movies. The modeling framework consists of separate components that describe the underlying neural population and the temporal responses of the system. We have used this framework to model data acquired in both neurophysiological and fMRI experiments. These studies have provided new insights about natural visual coding, including a novel optimization performed by MT neurons, the representation of spatiotemporal information in the human early visual system, the semantic representation in the higher-order visual cortex and how they are warped by attention. One advantage of our framework is that it also provides a means to use estimated models to perform brain decoding. To investigate this we constructed a Bayesian decoder by combining estimated models with a natural movie prior. The decoder provides remarkable reconstructions of viewed movies and the semantic contents from human brain activity. This modeling framework is quite general and has many potential applications for modeling and decoding higher-order perception and cognition.

References:

Hosts:
Justin Gardner, Lab for Human Systems Neuroscience
Kang Cheng, Functional Magnetic Resonance Imaging, RRC
MINI SYMPOSIUM

Characterizing choice and neural computations in the framework of statistical decision theory

Dr. Shih-Wei Wu
Assistant Professor
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National Yang-Ming University, Taipei, Taiwan

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A central question in decision-making is to characterize how organisms use information and act on it. In economics, its goal is to mathematically define what rational decision is. How should different sources of information be combined? What is the optimal or rational way of comparing different options? In contrast to this approach, psychologists and behavioral economists tend to focus more on identifying choice patterns that deviate from the predictions of rational models and making sense of them. For example, prospect theory was developed for the purpose of explaining many systematic deviations from expected utility theory, the standard model for choice in economics.

Over the last decades, these fields have accumulated tremendous progress for understanding decision-making at the behavioral level. As neuroscientists, we are often faced with the question as to whether theories built for behavior are appropriate choices for modeling how neural activity gives rise to behavior. In this talk, I will argue that a general theoretical framework that provides predictions on both behavior and neural activity is a good starting point for this pursuit. In this case, statistical decision theory (SDT) emerges as a candidate framework for modeling a wide range of behavior as well as providing predictions on patterns of neuronal activity for decision-related computations. I will first discuss recent applications of SDT to modeling human perception and action. Using SDT as a general framework, I will talk about how this approach can be useful to studying and comparing decision-making across different modalities (e.g. economic, perceptual, and motor decisions), and in characterizing the neural correlates of decision variables. In particular, I will focus on a formal comparison between economic decision-making and motor decision-making. Finally, I will talk about the application of SDT to investigate how incoming sensory information about the reward statistics in the environment is combined with subjects’ prior knowledge, and the neural mechanisms for such integration computations that lead to the formation of value-based choices.

Hosts:
Justin Gardner, Lab for Human Systems Neuroscience