Symposium 4: Sensory/motor information processing in the brain of non-human primates (Wed July 28, 16:40-18:40 JST)
Chairs: Dajun Xing (Beijing Normal Univ, China) and Yong Gu (Inst. of Neurosci., Shanghai, China)

16:40-17:10 Dajun Xing (Beijing Normal Univ. China)
Laminar subnetworks of response suppression in macaque primary visual cortex

17:10-17:40 Joonyeol Lee (Sungkyunkwan Univ Cntr for Neurosci Imaging Res, Korea)
Effect of prior expectation on the neural responses in area MT during a sensory-motor behavior

17:40-18:10 Yong Gu (Inst of Neurosci, Chinese Academy of Sciences, China)
Synchrony of visual and nonvisual cues for multisensory heading perception

18:10-18:40 Hironori Kumano (Dept of Integr Physiol, Grad Sch Med, Univ of Yamanashi, Japan)
Neural mechanism of flexible visual decision making

Symposium 4 Speaker 1
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Laminar subnetworks of response suppression in macaque primary visual cortex

Based on anatomy and neurophysiology, our view of the cerebral cortex has changed. Instead of viewing the cortex as a single network, we now conceive of the cortical laminae as a stack of loosely interconnected but distinct neuronal networks. Each lamina has different neural circuits and response properties. Studying the laminar pattern of neural activity is crucial for understanding the processing of neural signals in the cerebral cortex. It has been thought that cortical inhibition plays an important role in information processing in the brain. However, the mechanisms by which inhibition and excitation are coordinated to generate functions in the six layers of the cortex remain unclear. Here, we measured laminar-specific responses to stimulus orientations in primary visual cortex (V1) of awake monkeys. We distinguished inhibitory effects (suppression) from excitation, by taking advantage of the separability of excitation and inhibition in the orientation and time domains. We found two distinct types of suppression governing different layers. Fast suppression (FS) was strongest in input layers, and slow suppression (SS) was three times stronger in output layers. Interestingly, the two types of suppression were correlated with different functional properties measured with drifting gratings. FS was primarily correlated with orientation selectivity in input layers whereas SS was primarily correlated with surround suppression in output layers. The earliest SS in layer 1 indicates the origin of cortical feedback for SS, in contrast to the feed-forward/recurrent origin of FS. Our results reveal two V1 laminar sub-networks with different response suppression that may provide a general framework for laminar processing in other sensory cortices. The laminar-specific neural activity and suppression highlighted in V1 provide a general framework for laminar processing in other sensory cortices.

Symposium 4 Speaker 2
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Effect of prior expectation on the neural responses in area MT during a sensory-motor behavior

We are constantly interacting with our environments. When the incoming sensory input is strong, our behavioral response is robust and reliable. However, when the sensory input is weak and vague, we employ other cognitive factors, such as prior knowledge of incoming sensory input, to compensate for unreliable sensory information and enhance the reliability of our behavioral responses. The Bayesian inference framework has been used to explain the optimal integration of sensory with the prior expectation in various behavioral conditions, including motion-guided oculomotor behaviors.
In this study, we trained monkeys on a smooth pursuit eye movement task. We controlled the strength of sensory input and monkeys' prior expectations for incoming motion direction independently to investigate if the integration of prior expectation and sensory evidence follows the Bayes rule. From the behavioral results, we found that the reliability of the pursuit direction was enhanced by the prior expectation only when the sensory motion information was weak and unreliable. This result is consistent with the prediction of the Bayesian inference hypothesis and was quantitatively explained by the Bayesian observer model. To further understand the underlying neural mechanisms of this optimal integration of sensory with prior expectation signals, we collected neural activities from area MT. We found that the single neural responses were significantly reduced by the prior expectation only when the sensory input was weak. Also, the amount of response reduction depended on the difference between the stimulus direction and the preferred direction of a given neuron: the reduction was stronger when the angular difference was larger. These results provide a neural account for how prior expectation modulates the sensory representation to increase behavioral reliability in the smooth pursuit eye movements.

Symposium 4 Speaker 3:
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Synchrony of visual and nonvisual cues for multisensory heading perception

Visual motion, such as optic flow provides a powerful cue for perception of heading direction during self-motion in the environment, yet the brain often integrates it with other nonvisual cues, such as inertial motion to improve heading estimate. Whereas visual signals are mainly coded in a velocity quantity in central neurons, inertial motion is instead coded either by velocity or acceleration, generating alternative models of temporal-congruent, and temporal-incongruent, respectively. To examine which model the brain exactly employs for multisensory heading perception, here we conducted a novel experimental paradigm by manipulating temporal offset between the two sensory inputs. We surprisingly found that the macaques' best heading performance did not occur under natural condition of synchronous inputs, but rather when visual cues were adjusted to lead nonvisual cues by a large offset of 250-500 milliseconds. This behavior parallels with what we found in the frontal and posterior parietal areas, but not in the extrastriate visual cortex. Thus our study disentangled alternative models by providing new evidence favoring the temporal-incongruent model. These results also drive us to revisit neural circuit mediating integration of visual and nonvisual cues for multisensory heading perception.

Symposium 4 Speaker 4:
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Neural mechanism of flexible visual decision making

To make flexible decisions in an ever-changing environment, the brain needs to integrate behaviorally relevant information while discarding irrelevant information depending on context. However, the neural computations that mediate this selective integration remain unclear. Here, I will describe recent electrophysiological and psychophysical experiments to investigate this issue in monkeys performing a task switching. In this task switching, the monkeys switched between a direction discrimination task (upward or downward) and a depth discrimination task (far or near). The two tasks were randomly interleaved from trial to trial. Difficulty of the tasks was varied by changing the percentage of coherently moving dots (motion coherence) or binocularly correlated dots (binocular correlation) in the random-dot stimulus. Neurons in the lateral intraparietal area (LIP) showed the build-up activity depending on both motion coherence and binocular correlation. The rate of the build-up activity was larger for the relevant compared to the irrelevant stimulus feature, suggesting that LIP neurons integrate relevant information depending on context. Using time-varying sensory evidence, we found that the late irrelevant evidence exerted larger effect on the monkey's choice than the early irrelevant evidence. This is consistent with the idea that task irrelevant information fail to accumulate and leak away. These findings suggest that flexible decision making is accomplished via context-dependent control of integration leakage of relevant and irrelevant information.