[Presenter]

Akihiro Funamizu
Institute for Quantitative Biosciences (IQB), University of Tokyo

[Title]

Cortical integration of prior values and sensory inputs

[Abstract]

Optimal decision requires integrating the sensory evidence with prior knowledge of action outcomes and/or context estimation. Because many studies often independently test the sensory- and outcome-based decisions as the perceptual and value-based decision making, respectively, it is unclear how the brain integrates the sensory evidence and prior knowledge to guide behavior. We updated our previous behavioral task in head-fixed mice (Funamizu, iScience, 2021) to investigate how the frontal, motor, and sensory cortices are involved in the integration.

In the task, mice selected either a left or right spout depending on the tone frequency to receive a water reward. We randomly presented either a long or short sound stimulus and biased the amount of reward for each option. The choice behavior was less accurate and more biased toward the large-reward side in short- than in long-stimulus trials. In addition, the outcomes based on difficult-frequency- or short-duration-sounds affected the choice in the next trial compared to the outcomes based on easy- or long-sounds, suggesting that the sensory confidence affected the updating of reward expectation. Based on these behavioral results, we modeled the mice choice behaviors with reinforcement learning (RL) model which had reward expectations for left and right choice (i.e., prior values). Using the prior values and sensory inputs, the RL model determined the choice. The model then updated the prior values using the difference between the outcome and sensory-confidence-dependent action value (confidence value) which modulated the prior values with coming sensory inputs.

During the task, we electrophysiologically recorded the neural activity of the medial prefrontal cortex (mPFC), the secondary motor cortex (M2), and the auditory cortex (AC) with Neuropixels 1.0 probe. In summary, we found that the confidence values, choices, and sensory inputs were selectively represented in the mPFC, M2, and AC, respectively. In contrast, the prior values were represented in all the recorded regions. Our results suggest a localized and global computation of task variables required in short- and long-time scales, respectively, in the cerebral cortex.