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Analysis and Reconstruction of Basal Ganglia Circuit in Salt Preference

Takatoshi Hikida [1], Yuuki Uchida [2], Yuichi Yamashita [2]

[1] Institute for Protein Research, Osaka University,
[2] National Institute of Neuroscience, National Center of Neurology and Psychiatry

Summary

Animals prefer low concentrations of salt and dislike high concentrations of salt. However, it is known that extreme salt reduction leads to a preference for high salt concentrations. The brain basis for these salt concentration-dependent changes in preference has not been clarified.

The basal ganglia control not only motor balance but also reward and aversive behavior, and decision-making. The projection from the striatum and the nucleus accumbens (NAc) to the substantia nigra consists of two main pathways, the direct and the indirect pathway, in the basal ganglia circuit. The direct pathway controls reward behavior, while the indirect pathway controls aversive behavior. In addition, it has been shown that switching between the direct and indirect pathways is due to plasticity induced by dopamine signaling. We have established the licking operant task for mice and showed that the concentration-dependent preference for salt was shown to depending on the internal environment. This can be regarded as a homeostatic mechanism that tries to maintain a constant internal environment. Therefore, this year, we conducted a mathematical model analysis using homeostatic reinforcement learning to theoretically reconstruct the concentration-dependent preference for salt.

First, we used homeostatic reinforcement learning, and showed that homeostatic reinforcement learning is a valid computational theory for salt craving behavior in mice. Next, by treating oral sensation as a predictor of internal state change, we showed that the direct injection of saline solution into the stomach is not a reward for desalinized mice, which can explain the salt craving behavior. In addition, we reproduced the two-bottle choice experiment by using homeostatic reinforcement learning of multidimensional internal states.

As a future work, we will continue the analysis using mathematical models based on homeostatic reinforcement learning and aim to theoretically reconstruct the dopamine fluctuations in the nucleus accumbens involved in the salt concentration-dependent preference.