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Exploring the Neural Basis of Salt Preference from Neural Circuit Control and Computational Theory

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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. In the present study, we established the licking operant task for mice and attempted dopamine and calcium imaging of the NAc by fiber photometry to investigate the brain basis of the concentration-dependent preference for salt.

In the dopamine imaging of the NAc, the amount of dopamine change was found to be increased and decreased under the salt-depleted condition and the water-depleted condition, respectively. In contrast, the amount of calcium change in the NAc indirect pathway neurons was found to be decreased and increased under the salt-depleted condition and the water-depleted condition, respectively.

In the future, we would like to clarify the relationship between salt concentration-dependent preference and dopamine changes in the NAc and neural activities in the direct and indirect pathways during normal, low-salt, and high-salt conditions using dopamine and aclsium imaging in the NAc. In addition, we will clarify how the dopaminergic neurons and the direct and indirect pathways control in the salt concentration-dependent preference by target-specific control of neural activity using optogenetics and chemogenetics. We also try computational analysis using a homeostatic machine learning model for salt concentration-dependent preference.