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Neural Basis of Salt Preference and Salt Overdose/Desalination

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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 attempted dopamine imaging of the NAc and calcium imaging of the direct and indirect pathways 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 after salty reward consumption under the NaCl depleted condition. This suggests that dopamine in the NAc is involved in the concentration-dependent preference for salt under low-salt conditions.

Since dopamine binds to D1 dopamine receptors in the direct pathway neurons and D2 dopamine receptors in the indirect pathway neurons in the NAc, we newly established calcium imaging of the direct and indirect pathway neurons. First, we confirmed calcium changes in the reward and aversive learning task, in which functional separation between the direct and indirect pathways has been known. In the sucrose reward learning task, we observed an increase in the amount of calcium change in the direct pathway neurons. On the other hand, in the aversive learning task, we observed an increase in calcium changes specifically in the indirect pathway neurons. The functional separation of the direct and indirect pathways indicates that we have established calcium imaging specific to the direct and indirect pathway neurons.

In the future, we would like to clarify the relationship between salt concentration-dependent preference and dopamine changes in the NAc during normal, low-salt, and high-salt conditions using dopamine imaging. In addition, we will clarify how the direct and indirect pathways are involved in the salt concentration-dependent preference by calcium imaging.