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The Cells and Logic for Salt Detection in the Zebrafish Olfactory System

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Summary

Salt is an essential part of the diet for human and animals. Although in aquatic vertebrate such as fish, their osmotic circumstances are entirely different from the terrestrial vertebrate. Freshwater fish use the gill, which is primary salt detectors, to actively uptake salt from the environment because water diffuses into their body. However, it is not well understood whether other sensory organs involve in monitoring external salt concentrations. Because the olfactory system can detect a variety of chemicals, which evoke fundamental behaviors essential for their survival, we reasoned that fish nose could detect NaCl. In this study, we used genetically encoded calcium indicator GCaMP7, an improved version of GCaMP, and measured salt-evoked neural activity in the olfactory bulb (OB). In transgenic lines with GCaMP expression in the olfactory sensory neurons, we could detect a significant increase of calcium signals in distinct glomeruli of the OB upon application of NaCl or defined odorants such as amino acids (feeding cue), and bile acids (social cue). In situ hybridization analysis with cRNA probes for c-fos, a marker of neuronal activation also revealed that NaCl activates a small population of olfactory sensory neurons located in the apical portion of the olfactory epithelium. These results show that zebrafish can detect NaCl through a small population of olfactory sensory neurons, and the information of NaCl is transferred to the distinct glomeruli in the OB and suggest that olfaction may play a fundamental role in the salt sensory circuit and behavior.