An olfactory subsystem that detects carbon disulfide and mediates food-related social learning

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Abstract

In mammals, pheromones and other social cues can promote mating or aggression behaviors; can communicate information about social hierarchies, genetic identity and health status; and can contribute to associative learning.

However, the molecular, cellular, and neural mechanisms underlying many olfactory-mediated social interactions remain poorly understood.

Here, we show a specialized olfactory subsystem that includes olfactory sensory neurons (OSNs) expressing the receptor guanylyl cyclase GC-D, the cyclic nucleotide-gated channel subunit CNGA3, and the carbonic anhydrase isofrom CAII (GC-D(+) OSNs) is required for the acquisition of socially transmitted food preferences (STFPs) in mice.

Introduction

Evidence for cAMP-independent olfactory responses

Social Transmission of Food Preferences (STFP)

• Many mammals acquire food preferences from peers
• STFPs require the social odors from the breadth of peers in addition to food odors
• STFP requires the coincidental detection of both a social odor (breath) and a food odor.
• The major components of breath are CO2, CS2, and COG all of which are metabolized by carbonic anhydrase II (CAII).

Experiment 1

GC-D(+) OSNs are Highly Sensitive to Socialchemicals

Experiment 2

Social Transmission of Food Preferences (STFP)

1. Demonstrator mouse is fed food odorized with a novel odor
2. The Demonstrator is replaced into its colony and allowed to interact with “Observer” mice
3. Observers are given a choice to eat food fed to the demonstrator or a novel food

Experiment 3

A Functional GC-D (+) OSN System is required for the activation of Brain regions involved in STFP – associated learning

Discussion

We conclude that GC-D+ OSNs olfactory subsystem mediate the detection of social chemostimuli necessary for the formation of STFPs. Rodents and other animals make use of a diverse repertoire of chemical cues to communicate with conspecifics. While some of these chemostimuli may elicit innate behaviors, it is likely that most only have their full meaning in the context of additional sensory cues or previously learned associations. By linking a specific olfactory subsystem to both the expression of an established social learning behavior and to the detection of a chemostimulus that can elicit that behavior, we highlight the possibility that the subsystem structure of the mammalian main olfactory system may help mammals associate chemostimuli with other sensory cues in a meaningful and organized way.

Conclusions

• A mammalian olfactory subsystem is essential for a type of social learning.
• A food-related social stimulus, CS2, activates specialized olfactory neurons.
• Mice with impaired CS2 responses don’t acquire socially transmitted food preferences.

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