Got smell? Research shows that accurate taste perception relies on a functioning olfactory system

22 December 2009

As anyone suffering through a head cold knows, food tastes wrong when the nose is clogged, an experience that leads many to conclude that the sense of taste operates normally only when the olfactory system is also in good working order. Evidence that the taste system influences olfactory perception, however, has been vanishingly rare—until now. In a novel study this week in *Nature Neuroscience*, Brandeis researchers report just such an influence.

Neuroscientist Don Katz and colleagues discovered that if the taste cortex in rats is inactivated when a rat first smells an odor, at least a food odor, then the rat subsequently will only recognize the food associated with that odor if the taste cortex is again inactivated.

"We discovered that rats use their taste system to smell with, so when you knock out the taste cortex, even for an hour, as we did, you alter their sense of smell," explained Katz. The researchers wrote that "this is the only example of state dependency in neural circuit function of which we are aware."

Katz and his colleagues used a multi-step training process to test the interdependence of the taste and olfactory systems. In the first step, a demonstrator rat that had just eaten chow flavored with one of four spices was introduced to a subject rat, which then smelled the demonstrator rat's breath.

In the second step, the subject rat was offered two choices of chow: one dish with the same flavor previously consumed by the demonstrator rat and another with a different flavor. The subject rat reliably preferred the food that it had previously smelled on the demonstrator rat's breath the day before. The researchers concluded that the social "smell test" of rat's breath is a good enough cue for rats to prefer one food over another.

At the outset they predicted that the rat's sense of smell would not be affected by changes in its taste system. "But we were wrong," said Katz. "Most surprisingly, the rats whose taste cortex was knocked out again the next day preferred the chow that they had experienced in an altered state, with no taste cortex.

"We discovered in this experiment that the sensory systems don't work in isolation from each other, said Katz. "One part of the cortex takes direct input from the nose, and one part from the tongue, and while it's convenient to think that the nose and taste receptors operate independently, they don't."

Katz actually tested two possible explanations for the basic result: First, taste cortex might be an integral component of how the animal processes smells. Alternatively, it might be that taste cortex changes, or modulates, olfactory circuits rather than coding them, fundamentally changing perception of smell at that point in time. Such "incorrect" memories of smell apparently last across at least a week of the rats' lives, and perhaps forever.

The Katz lab is now using brain recordings to pinpoint which parts of the olfactory system are affected when taste cortex is silenced, and to characterize the nature of the interaction between the taste and smell systems during feeding.

"I am hoping that ultimately this discovery will help drive us to an entirely different approach to brain function," said Katz. "It doesn't make sense to probe one system separately from the other. Just like in a chorus, you can't appreciate the fullness of the music if you hear only the bass or the tenor in isolation."