fMRI Targets Circuitry Tied to Food Cravings

The orbitofrontal cortex decodes sensory signals from the brain to determine food's 'reward' value.

BY DOUG BRUNK

NEW ORLEANS — Scientists are on the cusp of understanding the role of sensory factors related to food intake control, and the orbitofrontal cortex appears to be hub of activity.

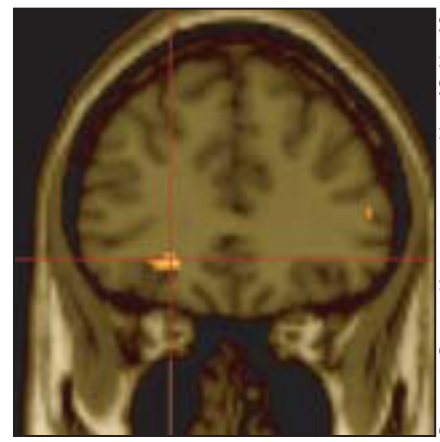
"In food intake control, sensory factors such as taste, smell, sight, and texture are first decoded in the brain as being taste and smell, independently of reward," Dr. Edmund T. Rolls said at the annual scientific sessions of the American Diabetes Association. "Then they project into structures such as the orbitofrontal cortex, which decodes them in terms of their reward value. It is there that neurons determine if the food tastes pleasant, or smells pleasant, or looks pleasant. That is a crucial part of the brain for sending signals to make us want to eat: because of food reward."

Dr. Rolls said that functional magnetic resonance imaging (fMRI) is helping scientists track the complex circuitry involved in food cravings and food reward. When someone finds a food pleasant, for example, fMRI reveals blood oxygen level–dependent (BOLD) signals in the orbitofrontal cortex, where scores of neurons are tuned into the sensory properties of food "like a wonderfully sensitive antenna," he said. "The reason, I think, that you have neurons like that is so that during a meal you could have a response to one food as a reward. When you have eaten it, you no longer like that food, but then you will still like other foods. You compute that property very simply by having these neurons that respond to different combinations of foods."

The concept is known as sensory-specific satiety: the notion that when you eat, your appetite can go down for one food, but remain high for other foods.

The reward decoding in parts of the brain such as the orbitofrontal cortex "is crucial to understand and may be different in obese people," added Dr. Rolls, of the Oxford (England) Centre for Computational Neuroscience Research.

"Also, when we see, taste, or smell food, we're going to get autonomic responses, changes in insulin and changes in glucose. So understanding this circuitry and how it could be different in some individuals is also important to understanding obesity."



CEREBRAL CORTEX, KRINGELBACH ET AL. VOL. 13, NO. 10, OXFORD UNIVERSITY PRESS, LONDON, 1064-1071, 2003

The yellow signal (left side) correlates with the pleasantness ratings of foods.

In one study conducted by Dr. Rolls and his associates, participants rated the pleasantness of the flavor of chocolate milk and tomato juice, then half of the participants consumed chocolate milk to satiety and the other half consumed tomato juice to satiety, after which all of them underwent brain fMRI. The researchers found that the pleasantness of the flavor of the food eaten to satiety decreased, and that the decrease in pleasantness was reflected in decreased neuronal activation in the orbitofrontal cortex (Cereb. Cortex 2003;13:1064-71).

"The initial BOLD signal response indicates that the food is pleasant," Dr. Rolls said. "As you feed to satiety, one of those foods becomes less pleasant, and the orbitofrontal cortex is no longer activated."

Other fMRI studies have demonstrated that when fat is placed into the mouth, some neurons increase their firing rate to about 15 times per second. "There seems to be a sensing of texture reward in the orbitofrontal cortex, as well as olfactory reward, taste reward, visual reward, and temperature," he said.

Dr. Rolls concluded his remarks by expressing doubt that endocrine or genetic factors directly contributed to the spike in obesity that has occurred over the past 3 decades.

"We think it is these sensory input signals and the rewards they produce that drive people to eat too much," he said. "Palatability is another factor. Food companies produce highly palatable foods; that will tend to produce an imbalance with respect to our evolutionary old satiety signals. Food variety, portion size, and stress-induced eating are also factors."

Dr. Rolls had no conflicts of interest to disclose. ■

Nature of Vitamin D's Role in Weight Loss Yet Unknown

BY JOYCE FRIEDEN

WASHINGTON — People who are insufficient in vitamin D lose less weight on a low-calorie diet than do those with higher vitamin D levels, a small study has found. But whether or not the low vitamin D level is the cause of less weight loss remains unclear.

"Vitamin D deficiency is closely linked with obesity," Dr. Shalamar Sibley of the University of Minnesota, Minneapolis, the study's lead author, said at the annual meeting of the Endocrine Society. "But the cause-and-effect nature of this relationship is unclear. This association may be due to sequestration of vitamin D in adipose tissue, and this is a likely contributor. But the other way to look at the question is, is it possible that the lack of vitamin D is promoting obesity or inhibiting weight loss?"

'Vitamin D deficiency is closely linked with obesity. But the cause-and-effect nature of this relationship is unclear.'

Several small studies have addressed this issue, according to Dr. Sibley.

One study of 60 overweight or obese women comparing a cereal diet with a vegetable diet found that women with higher baseline levels of 25-hydroxyvitamin D lost more weight than did those with lower levels (Br. J. Nutr. 2008;100:269-72).

Another study of 24 overweight women designed to look at the effects of dietary versus supplemental calcium on total energy expenditure with a hypocaloric diet found that women with higher 25-hydroxyvitamin D levels showed increased thermic activity following meal consumption, compared with those with lower vitamin D levels (Obesity 2008;16:1566-72).

To further explore the issue, Dr. Sibley and colleagues recruited 20 women and 18 men with a body mass index of at least 27 kg/m^2 (range 27-57) to participate in an 11-week weight-loss program in which patients consumed a 750-calorie deficit/day diet. Most (32) were white; the average age was 40, Dr. Sibley said.

Participants were screened at baseline to assess usual dietary intake, physical activity, and anthropomorphic and body composition measurements, including height, weight, fat and tissue mass (with dual-energy x-ray absorptiometry), abdominal fat mass distribution (with single-slice CT), and plasma 25-hydroxyvitamin D and 1,25-dihydroxyvitamin D. On average, participants were in the "insufficient" range for vitamin D, but were not outright deficient, Dr. Sibley said.

At the end of the study, women had lost an average of about 4 kg and men about 7 kg. The researchers found levels of both forms of vitamin D at baseline predicted the magnitude of weight loss, after adjustment for sex.

Dr. Sibley added that 1,25-dihydroxyvitamin D "did in fact predict abdominal fat loss in particular, and both forms [of vitamin D] predicted subsequent fat mass loss in abdominal subcutaneous compartments."

Furthermore, "no significant correlations between baseline BMI, age, or season with baseline vitamin D concentrations or weight loss" were shown, according to Dr. Sibley.

In addition, 1,25-dihydroxyvitamin D levels did not change from baseline to post–weight loss; neither did 25-hydroxyvitamin D levels, she said. Both 1,25-dihydroxy and 25-hydroxyvitamin D levels were closely correlated with each other, both at baseline and after weight loss.

The study's limitations were that it was observational, and that the results could be confounded by the "healthy cohort" effect, she said.

The study was sponsored by the National Institutes of Health, the University of Minnesota, and the Pennock Family Endowment.

Dr. Sibley said he had no relevant conflicts of interest to disclose. ■

DATA WATCH

States With the Highest Rates of Adult Diabetes

	Percentage of Adults With Diabetes	Ranking: Diabetes	Ranking: Obesity
West Virginia	11.6%	1	3
Mississippi	11.1%	2	1
Tennessee	11.0%	3	4
Alabama	10.5%	4	2
Oklahoma	10.1%	5	6
Louisiana	10.0%	6	8
Kentucky	9.9%	7	7
South Carolina	9.8%	8	5
Georgia	9.7%	9	14
Texas	9.3%	10	14

Source: Robert Wood Johnson Foundation, "F as in Fat: How Obesity Policies Are Failing in America 2009."

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