

How the Brain Understands Food and Appetite [Excerpt]

In his new book, neuroscientist David Linden explores the biological basis of food, sex and the other things in life that bring us pleasure

By David Linden | July 2, 2011 | 3

Editor's Note: The following is an excerpt from a chapter in the book Compass of Pleasure: How Our Brains Make Fatty Foods, Orgasm, Exercise, Marijuana, Generosity, Vodka, Learning, and Gambling Feel So Good by David Linden. Copyright (c) 2001 by David Linden.

In studies where the food intake and energy expenditure of subjects are carefully monitored over a period of weeks to months (which tends to average out day-to-day fluctuations) a remarkable balance between calories consumed and calories burned was observed. When various mammals, from mice to monkeys, are either overfed or starved for a few weeks, their weight soon returns to normal levels when free access to food is resumed. Crucially, our mammalian bodies seem to be able to regulate feeding based on the amount of energy available in the food we consume, not just on the volume of that food. One example of many: When groups of rats were fed nutrient solutions of varying concentrations, they adjusted the volume consumed to achieve a constant inflow of calories. It's a lot like the thermostat in your house: When its thermometer registers a drop in temperature, it sends a signal to the heater to warm the house until the desired set point is reached.

These observations suggest that the brain must receive signals from the body that indicate its weight and that the brain makes use of the signals to modulate appetite and energy expenditure in order to maintain an individual's weight within a fairly narrow range. The signals are received in a structure at the base of the brain called the hypothalamus. The hypothalamus is involved in the control of many basic, subconscious drives and reflexes including sex, feeding, aggression, drinking, and regulation of body temperature. When rats received lesions in a particular subregion of the hypothalamus called the ventromedial area, they became obese. They behaved as if they were starving and compensated with an increase in food intake and a decrease in energy expenditure. Conversely, when a different part of the hypothalamus, called the lateral area, was destroyed, the rats behaved as if they had been overfed. They reduced food intake and increased energy use and thereby became dangerously lean. This is not just a rat trick: These experiments have been replicated in a wide variety of mammals, and humans who sustain damage to the ventromedial hypothalamus (usually from a tumor of the adjacent pituitary gland) will also increase their food intake and become obese.

This model raises one obvious question: How does your hypothalamus know how much you weigh? Let's step back and play God for a moment. If you wanted to build this system, how would you do it? By

measuring blood glucose? Fat deposits? Core body temperature? Pressure on the soles of the feet?

This all remained a mystery until 1994, when Jeffrey Friedman and his colleagues at Rockefeller University reported their observations of two strains of mutant mouse, one called obese and the other called db. (These mutations were not created by scientists using genetic tricks but arose spontaneously in a breeding colony.) Both strains of mice were extremely fat, a trait that was passed on to their offspring in a simple, dominant pattern of inheritance, like eye color. This suggested that obesity in both obese and db mouse strains resulted from a mutation in a single gene in each case. Friedman's group was able to track down the mutation in the obese mice and found that it blocked production of a particular protein hormone, which they named leptin. The leptin protein is only secreted by fat cells. When similar analysis was performed on the db mice, it was found that the disrupted db gene was responsible for encoding a protein that functions as a leptin receptor: When it binds circulating leptin at the cell surface, it sets in motion a biochemical cascade inside the cell. Most provocatively, the leptin receptor is expressed strongly on neurons in those areas of the hypothalamus that cause obesity or leanness when destroyed.

So with Friedman's key findings we now have a reasonable hypothesis for how the hypothalamus can sense body weight and use that information to maintain it within a narrow range. When weight is gained, the amount of body fat increases, and since fat cells secrete leptin in proportion to their mass, leptin levels will consequently rise. Leptin circulates in the blood and crosses into the brain, where it is sensed by leptin receptors expressed on neurons in the hypothalamus. Activation of those neurons by leptin suppresses appetite and increases energy expenditure. When weight is lost, the system works in the opposite direction: Less fat means reduced levels of circulating leptin, increased appetite, and reduced energy expenditure.

Fonte: http://www.scientificamerican.com/article.cfm?id=compass-of-pleasure&WT.mc_id=SA_Twitter_sciam