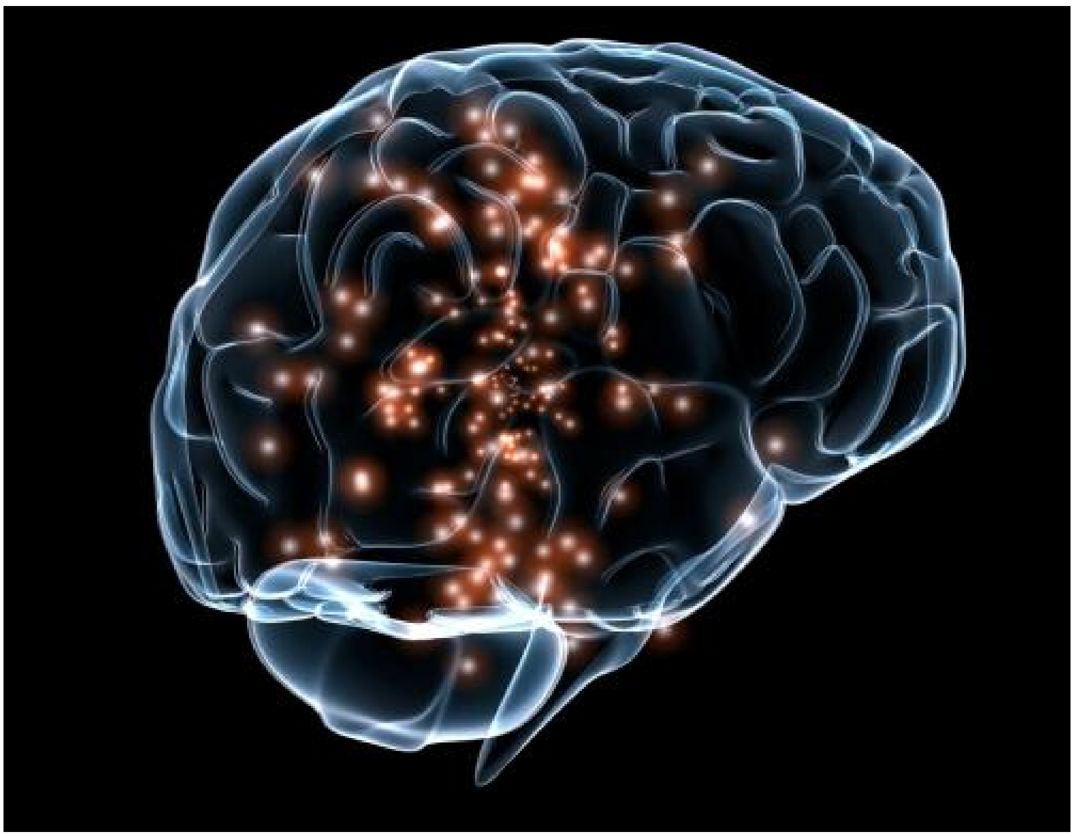
Medical Xpress

Researchers image effects of hunger on the brain's response to food cues

September 14 2016



Credit: Wikimedia Commons

Our brain pays more attention to food when we are hungry than when we are sated. Now a team of scientists at Beth Israel Deaconess Medical Center has shed light on how the needs of the body affect the way the brain processes visual food cues. In two newly-published studies, the researchers examined – with unprecedented resolution – the brain circuits responsible for the differences in the way the brain responds to visual food cues during hunger versus satiety.

"Our goal is to understand how specific brain circuits bias attention to food cues, as these biases are powerful drivers of food consumption," said corresponding author Mark L. Andermann, PhD, of the Division of Endocrinology, Diabetes and Metabolism at BIDMC and Assistant Professor of Medicine at Harvard Medical School. "Ideally, specific cell types within these circuits could be targeted in order to shift attention away from unhealthy cues such as high-calorie food cues. We hope this research will provide strategies to develop better therapies – not cures – to help people help themselves get better."

In a study published in the journal *Neuron*, co-first authors Christian Burgess, PhD, a postdoctoral fellow; Rohan Ramesh, a graduate student, and colleagues in Andermann's lab recorded images of brain activity in mice across different states of hunger and satiety. Mice were trained to discriminate among three visual cues associated with a high-calorie liquid treat, a bitter liquid or nothing at all. In food-restricted mice, just being shown the visual cue associated with the liquid treat provoked a strong response in sets of neurons in three different brain areas. When these same mice were tested after a meal, the same food cue produced a decreased response in the neurons in a subset of these same brain areas. The scientists used this information to map the circuitry controlling motivation-dependent processing of sensory responses.

"Visual information about food cues is processed in sequential stages. We found that later stages of visual processing vary when the mouse is hungry versus sated, while the earlier stages are less state-dependent," Andermann said. "This turns out to be very similar to the situation in humans. We hope this new model that we've developed can be used to study the circuitry underpinning the brain's responses to food cues in health and in obesity."

Specifically, the team's findings suggest that neurons in two regions of the brain – the postrhinal association cortex and the lateral amygdala – help integrate information about external food cues and hunger state. The scientists suggest this same brain circuitry could be involved in integrating other motivational drive states such as thirst.

In experiments published in *Current Biology* last month, graduate student Nick Jikomes and colleagues in Andermann's lab investigated how natural and artificially-induced hunger affects food-seeking behavior, even in threatening contexts.

Mice were placed in an arena where they had been trained to seek food after seeing visual cues associated with either a food reward or a mild shock to the feet. Researchers compared the behavior of well-fed mice to that of mice that had been on a restricted diet for 24 hours. Food-restricted mice avoided shocks much less frequently than fed mice, continuing to seek food even after being shown the visual cue associated with shock. That is, the motivation to eat overpowered the tendency to avoid threats. Conversely, fed mice prioritized avoiding shocks over seeking more food.

The researchers then used a technique called optogenetics to stimulate specific neurons – the agouti-related peptide neurons (AgRP) – known to induce food consumption in sated mice. When AgRP neurons were stimulated in sated mice well before being placed into the experimental arena, the animals behaved like naturally hungry mice, as expected. However, when mice were placed in the threatening arena prior to activation of AgRP neurons, mice behaved more similarly to sated animals, prioritizing shock avoidance over seeking food. The observations suggest AgRP neurons help regulate competing drives, and that, in the face of competing motivations, the one that begins first can often prevail.

"This might serve as means to prioritize the threat of starvation over other potential threats encountered during food-seeking," the researchers wrote. "As such, this work may be helpful in understanding the motivation to restrict food intake in eating disorders such as anorexia, as well as the tug-of-war between the neural circuits driving food-seeking and those driving self-defensive behaviors."

More information: Christian R. Burgess et al. Hunger-Dependent Enhancement of Food Cue Responses in Mouse Postrhinal Cortex and Lateral Amygdala, *Neuron* (2016). DOI: 10.1016/j.neuron.2016.07.032

Nick Jikomes et al. Preemptive Stimulation of AgRP Neurons in Fed Mice Enables Conditioned Food Seeking under Threat, *Current Biology* (2016). DOI: 10.1016/j.cub.2016.07.019

Provided by Beth Israel Deaconess Medical Center