Neuroscience of instinct: How animals overcome fear to obtain food (w/ Video)

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Pictured is a LEGO Mindstorms robot programmed to simulate predatory attack on a rat seeking food in a semi-naturalistic environment. The findings demonstrate that without the functioning amygdala and consequently devoid of fear, the animal's foraging behavior becomes perilously maladaptive, whereas an overactive amygdala hinders foraging decision even under safe circumstances. Credit: Image courtesy of June-Seek Choi and Jeansok Kim.

(PhysOrg.com) -- When crossing a street, we look to the left and right for cars and stay put on the sidewalk if we see a car close enough and traveling fast enough to hit us before we're able to reach the other side. It's an almost automatic decision, as though we instinctively know how to keep ourselves safe.

Now neuroscientists have found that other animals are capable of making similar instinctive safety decisions. In a study published online the week of Nov. 29 in the Proceedings of the National Academy of Sciences, University of Washington researcher Jeansok Kim demonstrates that rats weigh their odds of safely retrieving food pellets

placed at varying distances from a perceived predator.

"When animals go out to forage, they're taking a risk," said Kim, a UW psychology professor. "They're leaving the safety of their nests, venturing out where there may be predators that could eat them."

But staying in the nest is not a safe option either, rats need to get out and find food. How do they decide whether it's safe to leave the nest? Kim and co-author June-Seek Choi, a visiting professor in the UW psychology department from Korea University, studied how the amygdala – known to be an important brain area for perceiving and reacting to fear – was involved in the rats' decisions to risk their safety for food.

In humans, impaired amygdala activity has been linked to risky decision-making, such as gambling. And an overactive amygdala could explain anxiety disorders, including post-traumatic stress disorder and phobias.

Kim and Choi trained male rats to retrieve a food pellet placed at varying distances from a safety zone, or nest. The rats, hungry from a restricted food supply for several days, quickly learned to retrieve the food pellets. (See a video of rats foraging, watch "Foraging baseline day 5" below).

The researchers introduced a "predator," an alligator-shaped robot that was programmed to snap its jaws and surge at the rats. With a body made of gray LEGO blocks and fangs of bright orange LEGOS, the LEGO Mindstorms Robogator was about twice the size of the rats. The researchers programmed the robot to lurch forward about 9 inches, open and shut its mouth and then return to its resting spot far away from the rats' nest.

With the robot in place, the rats began foraging as usual. When they

neared the food, the Robogator quickly moved toward the rats and snapped its jaws. The rats scurried back to the safety of the nest and then momentarily froze – a typical fear response.

Still hungry, the rats paced back in forth in the nest areas, hidden from the Robogator (see video "Robot encounter day 1: Pre-amygdalar lesion"). Slowly they re-emerged and cautiously approached the food, while the Robogator continued its aggressive movements whenever the rats neared the food pellet. Most rats learned that they could safely retrieve the food pellet placed closest, 10 inches, from their nest and not intersect the robot's path. None of the rats obtained the pellet nearer the Robogator, about 30 inches from the nest.

Kim compared the rats' decision-making process to the classic math problem that asks when two trains leaving at different times from different places and traveling at different speeds will pass each other. With a predator nearby, Kim said, rats gauge how quickly they can run to the food, how quickly the predator moves and how far away the pellet is from the rat and from the predator. If they judge that there's a chance the rat and robot will cross paths, they don't attempt to get the food.

"Like when people cross the street, we just tend to automatically have a sense of what is safe," Kim said. "I think that most animals have that capability in their nervous system. Through our amygdala, we instinctively know what keeps us safe."

Overactive amygdala could explain anxiety disorders and irrational fears in humans, Kim said. Brain imaging studies show heightened amygdala activity in patients with post-traumatic stress disorder. Underactive amygdala could be linked to risk-taking and impulsive behaviors.

To study this in rats, the researchers created amygdala lesions and observed the rats' subsequent interactions with the robot. Rats with

lesions were unperturbed by the Robogator, and when food was placed near the predator the rats ran straight for the food, barely flinching when the Robogator lunged and snapped (see video "Robot encounter day 2: Post-amygdalar lesion" below). The same was true when the researchers inactivated the amygdala with the chemical muscimol.

When Kim and Choi increased the amygdala activity, the rats showed greater fear. Even when the food was at a safe distance from the robot, rats treated with the drug bicuculline, which increases neural activity, were too afraid to venture out for the pellet.

"Because humans share many biological and behavioral features with animals, experimental studies with rats provide valuable information toward understanding the physiological as well as the psychological aspects of fear," Kim said.

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