Dopamine is key to a parasite's ability to unite rat and cat, researcher says

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(PhysOrg.com) -- Who knew cat urine could be sexy? With a dab here and a dab there, you can have male rats swooning over you.

For this unlikely love potion to work, however, the rodents must be infected with a protozoan called Toxoplasma gondii.

This parasite not only invests rats with a permanent suicidal tendency to wander fearlessly into cat territory and certain death, but also makes them mentally and sexually aroused each time their tiny pink noses detect cat smells.

For a long time, scientists have been trying to understand the underlying biology of this odd behavior without any luck. By probing the parasite's DNA, one Stanford researcher may have stumbled across the answer.

"T. gondii knows how to make dopamine," neuroscientist Robert Sapolsky said last week during a talk, "Stress, Parasites and Human Behavior," presented at the annual meeting of the National Association of Science Writers and the Council for the Advancement of Science Writing. The Oct. 24-29 meeting was held at Stanford and the Cabana Hotel in Palo Alto.

Sapolsky, the John A. and Cynthia Fry Gunn Professor, has discovered two genes that play a key role in the synthesis of dopamine, known as the "neurotransmitter of reward"; it is the same chemical that cocaine and others types of psychoactive drugs release in the brain.

Although Sapolsky is not sure if the parasite is secreting the chemical into infected rats or how the mechanism works, he has a good idea about why it is there.

"T. gondii's evolutionary challenge is to figure out how to get the rodent inside the stomach of the cats," Sapolsky said. To do this, it has "evolved the means to take over the reward pathway in the rodent brain."

T. gondii has a two-specie lifecycle beginning with sexual reproduction in the gut of cats. Spores containing fertilized eggs are excreted in the feces. When a rat is infected by ingesting the feces, the parasite migrates from the rat's intestine to the part of the brain that controls fear, where it forms encapsulated cysts and lies dormant for the rest of the host's life—or so it was thought.

"This is when it starts doing stuff to the brain," Sapolsky said.

When an uninfected rat is exposed to cat odor, the fear and anxiety circuits in the brain go crazy, Sapolsky said. But in infected rats, the parasite dampens those signals and instead makes rodents feel positively aroused—both mentally and sexually.

"What this damn parasite knows how to do is make cat urine smell sexy to male rats," Sapolsky said. After being exposed in laboratory tests to different cat scents, infected male rats showed a spike in testosterone levels and their testes became engorged.

In another test, female rats also responded to the change in hormone levels by showing preference toward infected males approximately 95 percent of the time, Sapolsky said, which came as another interesting find.

"One of the rules of evolutionary biology is if you're an animal, you

don't want to mate with anyone full of parasites," Sapolsky said. "Somehow that doesn't happen with T. gondii infection."

Provided by Stanford University