Scientists pinpoint jealousy in the monogamous mind

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Titi monkeys housed at the California National Primate Research Center form lifelong, monogamous pair bonds. A recent study investigated jealousy in pair-bonded primate species, offering insight into human behavior and emotions. Credit: K.West/CNPRC

Jealousy leads to increased brain activity in areas associated with social

pain and pair bonding in monogamous monkeys, finds a study published today in open-access journal *Frontiers in Ecology and Evolution*. The study is the first monogamous primate model for the neurobiology of jealousy, a powerful emotion that is difficult to study in humans and not typically studied in animals.

"Understanding the neurobiology and evolution of emotions can help us understand our own emotions and their consequences," says Dr. Karen Bales from the University of California, USA. "Jealousy is especially interesting given its role in romantic relationships—and also in domestic violence."

Jealousy typically rears its head when we think a rival threatens a valuable relationship—a potential new lover for our spouse, for example, or a new friend for our own BFF. The "green-eyed monster" brings on strong feelings that can include fear, insecurity and anger. Unrestrained jealousy can have negative health effects and in extreme cases can even lead to violence.

But jealousy also plays a positive role in social bonding, by signaling that a relationship may need attention. It may be particularly important for keeping a couple together in monogamous species like humans. However, little is known about the biology of jealousy and its role in the evolution of long-term pair bonding.

"The neurobiology of pair bonding is critical for understanding how monogamy evolved and how it is maintained as a social system" says Bales. "A better understanding of this neurobiology may also provide important clues on how to approach health and welfare problems such as addiction and partner violence, as well as autism."

Most research on pair bonds has used prairie voles, a socially monogamous rodent. However, this may not be as applicable to humans

and other primates.

Bales and her team turned to coppery titi monkeys, a monogamous primate where adults form a strong pair bond. Bonded individuals form an attachment with their partner, show mate-guarding behavior and become distressed when separated—similar to a romantic relationship in people.

"Male titi monkeys show jealousy much like humans and will even physically hold their partner back from interacting with a stranger male," says Bales.

The researchers induced a "jealousy condition" in male monkeys by placing them in view of their female partner with a stranger male. As a "non-jealous" control, on a different day the monkeys were placed in view of a stranger female with a stranger male. After 30 minutes of viewing—during which the behavior of the males was filmed—brain scans were performed to see which areas were activated by each condition. The researchers also measured the levels of various hormones thought to be involved in pair bond formation, mating-related aggression, and social challenge.

The researchers found that in the jealousy condition, the monkeys' brains showed heightened activity in an area associated with social pain in humans, the cingulate cortex. They also saw heightened activity in the lateral septum.

"Previous studies identified the lateral septum as being involved in the formation of pair bonds in primates," says Bales. "Our research indicates that in titi monkeys, this region of the brain also plays a role in maintaining the pair bond."

"Increased activity in the cingulate cortex fits with the view of jealousy

as social rejection," she adds.

The jealous males showed hormonal changes as well, with elevated levels of testosterone and cortisol. Those who spent the longest time looking at their pair mate next to a stranger male showed the highest level of cortisol, an indicator of social stress. The rise in testosterone was expected due to its association with mating-related aggression and competition.

Taken together with the rodent-based model, the titi monkey study suggests that pair bond formation involves areas of the brain involved in social memory and reward, while maintenance of the bond appears to be based on negative reinforcement, that is, avoiding the pain of separation. The locations of these areas differ between rodent and primate brains, but the underlying neurochemistry seems to involve the same hormones.

"Monogamy probably evolved multiple times so it is not surprising that its neurobiology differs between different species," says Bales. "However it seems as though there has been convergent evolution when it comes to the neurochemistry of pair bonding and jealousy."

The question remains as to whether jealousy is the same in female titi monkeys as in males.

"A limitation of our study is that we only looked at males," says Bales. "Female titi monkeys—and humans—also show jealousy, and the neurobiology might be the same or different. Sex differences in the neurobiology of social behavior may ultimately explain questions like why more boys than girls have autism, and why men and women act differently in romantic relationships."

More information: *Frontiers in Ecology and Evolution*, DOI: 10.3389/fevo.2017.00119 , www.frontiersin.org/articles/1 …

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