On jealousy, envy, sex differences and temperament in humans and dogs

Commentary on **Cook et al.** on *Dog Jealousy*

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Abstract: Cook, Prichard, Spivak, and Berns (2018) find that dogs' levels of trait aggression are positively correlated with their amygdala activation when observing their caregivers giving a food to a fake dog. The authors conclude that this may provide neural evidence in dogs for the experience of jealousy, an emotion that some psychologists consider to be unique to humans. Here we explain the difference between the emotions of jealousy and envy, suggesting some ideas for future experiments that may help disentangle the experience of jealousy from that of envy in dogs. We also propose ideas for future research that may yield a more in-depth understanding of jealousy, and whether jealousy exists, in non-human animals.

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Cook, Prichard, Spivak, and Berns (2018) have conducted an interesting study examining the neural responses of 13 domestic dogs during three events: (1) the dog receiving food from his caregiver; (2) a fake dog receiving food from the real dog's caregiver; and (3) food being deposited in a bucket by the caregiver. Each dog's aggressive temperament was also assessed. The results revealed that dogs with more aggressive temperaments had heightened amygdala activation when the fake dog received food from the caregiver than when the caregiver deposited food into the bucket (condition 1 was simply used to keep the dog in the scanner and attentive to food). Cook et al. suggest that these results "may have some similarity to human jealousy."

Below we offer our thoughts on this research, which we find impressive both conceptually and for its difficult methodology. We hope our comments are taken in the spirit they are offered: thoughts for designing future research to test interesting and important research questions about jealousy in dogs.

What Psychological Response Was Evoked in the Dogs? Is the observed response more due to envy rather than jealousy? Envy is often "directed at another or others, wanting their

qualities, success, or possession. Jealousy involves thinking you will lose, or have lost, some affection or security from another person because of someone or something else — including their interest in an activity that takes time away from you" (Lamia, 2013). We wonder whether affection or attention given to another dog from the caregiver would result in a response more similar to jealousy as observed in humans.

Most dog-owners report that their dog experiences jealousy — and primarily when the owner interacts with a third party (Morris, Doe, & Godsell, 2008). The most commonly reported third party is another human, followed by a dog or another animal. Dogs may recognize that the other human poses more of a threat to the loss of their relationship than the other dog does. A future experiment could compare affection shared between a fake dog and the caregiver with affection between the caregiver and another human. This may suggest that dogs have an awareness that humans are more attached to other humans than they are to dogs, or that dogs prefer human contact to contact from other dogs.

Thoughts about the Experimental Design. Cook et al.'s results are correlational. No evidence is presented that would allow us to know whether the "jealous" condition evoked more amygdala activation than comparison conditions. With the three conditions included in the design, it is understandable why these tests could not be performed. The design needs a "neutral" condition to compare to the psychologically interesting conditions. The condition in which the dog is fed could not serve this purpose, because this condition is not neutral.

The authors seem to think that they could not improve their design to eliminate the alternative explanation that aggressive dogs experience increased amygdala activation in the presence of another dog. That is, the dogs may not have experienced jealousy when the fake-dog received a treat; rather they may have simply experienced arousal as their attention was brought to the fake dog. However, the caretaker could give the fake dog an unpleasant-tasting piece of food (color-coded so that the dog knows that it is unpleasant). This should bring attention to the fake dog without eliciting jealousy/envy.

Comparing a machine (or another human unimportant to the dog) giving food to the fake dog with the caregiver giving the food would also be interesting. This would assist in disentangling whether the increased amygdala activity was due to contact between the caregiver and the fake dog (indicating jealousy), or due to envy/reward inequality. But inclusion of more than three conditions within one experiment may be impossible given the amount of time that dogs can remain relatively motionless and attentive for fMRI scanning.

What Does Amygdala Activation Indicate Psychologically? The amygdala is a complex neural region that can be divided into 13 nuclei and cortical areas (in nonhuman primates), each with distinct psychological and behavioral processes (Freese & Amaral, 2009). At present, fMRI research is unable to localize activity to these individual areas. Moreover, fMRI research with adult humans has revealed that the amygdala response is associated with many psychological processes, including both positive and negative feelings as well as ambivalence (Cunningham & Brosch, 2012).

Cook et al. recognize that the amygdala is involved in a variety of psychological processes and in the end conclude that their research demonstrates that the dogs exposed to the "jealousy" induction were more aroused (rather than that they experienced some more specific psychological state). If the research is only aimed at measuring arousal, then peripheral physiological measures could be used. These measures would be less expensive than fMRI and would not suffer the limitations associated with preventing the dogs from

moving. For instance, measurement of impedance cardiography together with respiration could distinguish sympathetic and parasympathetic nervous system contributions to cardiac activity. Sympathetic nervous system activity is associated with the psychological construct of arousal.

Other Neural Activations? With this rich fMRI dataset, it is surprising that the researchers did not test for activation in other neural regions. Several other neural regions may be related to jealousy. For example, in humans, insula activity is associated with bodily responses in emotions (Craig, 2011); the anterior cingulate cortex is associated with psychological pain related to social rejection (Eisenberger, Lieberman, & Williams, 2003) (if they experienced jealousy, then dogs should have experienced this pain); and the medial prefrontal cortex is involved in social processing (Mitchell, Macrae, & Banaji, 2005).

Past research has revealed that jealousy is associated with relatively greater activation in the left than the right dorsolateral frontal cortical region in humans (Harmon-Jones, Peterson, & Harris, 2009). More recent research using transcranial direct current stimulation (tDCS) to increase activity in the left frontal cortical region has revealed that this region plays a causal role in evoking jealousy (Kelley, Eastwick, Harmon-Jones, & Schmeichel, 2015). Thus, a comparison of left versus right frontal activity may also indicate whether dogs' neural patterns suggest that they experience jealousy akin to that experienced by humans, as well as whether jealousy in dogs is associated with approach motivation.

Sex Differences and Temperaments. As Cook et al. note, some research suggests that men and women differ in which neural regions are activated during jealousy (Takahasi et al., 2006). Cook et al. did not indicate the sex of the dogs used in their research. Inclusion of a larger sample with equal numbers of male and female dogs would permit testing for sex differences in dogs' neural responses to jealousy-evoking events. Such research would add immensely to the human research on sex differences in jealousy; for example, dogs may not have been exposed to as much of the alleged social influence on sex as humans.

The C-BARQ scale (used for aggressiveness) measures 14 traits. Examining the correlation between some of these other traits and neural activations to jealousy would be interesting. In particular, Separation-Related Problems and Attachment/Attention Seeking might relate to more intense jealousy-related responses, or activation in different brain regions associated with jealousy. As mentioned by Cook et al., jealousy is a blend emotion, and thus trait aggression may not be the primary correlate of jealousy in dogs. Non-aggressive dogs may also experience intense feelings of jealousy that are associated with activation in other brain regions. The most frequent behavior demonstrated by dogs experiencing jealousy, according to dog-owners, is pushing against the owner or between the owner and the other person/animal (Morris, Doe, & Godsell, 2008), suggesting that dogs can express jealousy without being aggressive.

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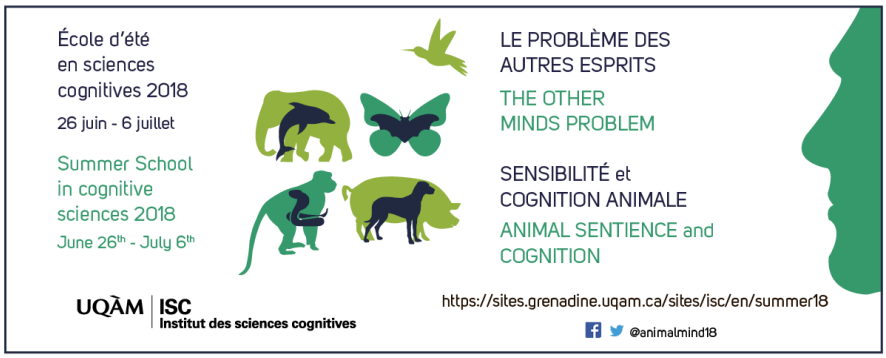

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Overview. Since Descartes, philosophers know there is no way to know for sure what — or whether — others feel (not even if they tell you). Science, however, is not about certainty but about probability and evidence. The 7.5 billion individual members of the human species can tell us what they are feeling. But there are 9 million other species on the planet (20 quintillion individuals), from elephants to jellyfish, with which humans share biological and cognitive ancestry, but not one other species can speak: Which of them can feel — and what do they feel? Their human spokespersons — the comparative psychologists, ethologists, evolutionists, and cognitive neurobiologists who are the world's leading experts in "mind-reading" other species — will provide a sweeping panorama of what it feels like to be an elephant, ape, whale, cow, pig, dog, chicken, bat, fish, lizard, lobster, snail: This growing body of facts about nonhuman sentience has profound implications not only for our understanding of human cognition, but for our treatment of other sentient species.

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WORKSHOP 8: *To be announced*
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