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Can a dog be jealous?

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

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Abstract: Whether humans alone experience complex emotions like jealousy or envy remains hotly debated, partly because of the difficulty of measuring them without a verbal report. Cook, Berns and colleagues use functional brain imaging to identify in dogs neural responses very similar to those evoked by jealousy in humans. When dogs see their caregiver reward a facsimile dog, their amygdala is activated and the strength of this response predicts aggressive behavior — just as jealousy leads to aggression in humans. The authors conclude that dogs feel something very similar to human jealousy. This novel and creative study tackles one of the most vexing challenges in neuroscience — understanding the unstated thoughts and feelings of others — with practical applications that go beyond getting closer to man's best friend. The issue of whether a dog can be jealous nevertheless remains far from settled, as we discuss below.

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The philosopher Thomas Nagel (1974) famously asked whether humans were capable of understanding what it is like to be a bat. He argued that it is not logically tenable to comprehend others' subjective experience, a perspective with a long history in philosophy going back to

Descartes ('I think, therefore I am'; 'I must … conclude that the proposition, *I am, I exist,* is necessarily true whenever it is put forward by *me* or conceived in *my* mind') and Wittgenstein ('What gives us *so much as the idea* that beings, things, can feel?'). Advances in neuroscience have prompted us to reconsider this old proposition (Griffin 2001; Andrews 2014). In a series of studies dating back to 2012, neuroscientist Greg Berns and his colleagues at Emory University have used functional brain imaging to understand what it is like to be a dog. Their prior work has addressed questions familiar to all dog owners: Do our dogs love us? Do they value our praise more than food? Why are some dogs apparently more capable of self-control than others? How well do dogs recognize human faces (for reviews, see Cook et al. 2016; Berns & Cook 2016)?

People often respond aggressively when they are jealous, especially within a romantic relationship (Burk & Seiffge-Krenke 2015; Collibee & Furman 2016). In the current study, Cook et al. (2018) investigated whether a similar link between jealousy and aggression exists in dog–caretaker relationships. The authors trained 13 dogs to lie still in an MRI scanner (which was no small feat!) as their caregiver gave treats to either a realistic fake dog or an empty bucket. The authors focused on measuring activity in the amygdala, a brain region implicated in emotional responses (Adolphs 2001; LeDoux 2003; Barrett & Satpute 2013; Kragel & LaBar 2016) and associated specifically with signaling fear, anxiety, and perceived threats (Rosen & Schulkin 1998; Lang et al. 2000; Fox et al. 2015). They found that dogs scoring higher on the dog–dog aggression scale (measured with the Canine Behavioral Assessment & Research Questionnaire, C-BARQ) (Hsu & Serpell 2003; van den Berg et al. 2010) tended to show higher amygdala activity when watching their caregiver give treats to the fake dog than to the empty bucket. The authors conclude that dogs can experience something like jealousy in a situation that might elicit a similar emotion in children (Volling et al. 2002; Hart 2016). Notably, the heightened amygdala response returned to baseline with repeated exposure to the same caretaker–fake dog interaction, but only for the most aggressive dogs. This finding invites the possibility of using exposure therapy to mitigate "jealous" behaviors in highly aggressive dogs.

As the authors point out, the biological and psychological mechanisms underlying aggression are relatively well understood in mammals (Nelson & Trainor 2007; Rosell & Siever 2015), but jealousy is an indistinct and complex miasma of primary and social emotions, indicating a much broader network of underlying biological mechanisms (Buss 2014). While the current study serves as an important first step in understanding whether dogs feel jealousy the way we do, many unanswered questions remain.

The most important consideration is that this study relies fundamentally on the concept of reverse inference in cognitive neuroscience. This approach first identifies patterns of brain activity in humans — in this case, heightened amygdala response — corresponding to a situation that induces jealousy. Based on this, Berns and colleagues argue that similar patterns of activity in dogs are indicative of similar mental states. If we were comparing people from different cultures, age groups, or clinical backgrounds, this inference would indeed be widely accepted. Yet the extension of the same logic to a different species with which we last shared a common ancestor 80 to 100 million years ago (Blanchette et al. 2004) warrants more caution. This is basically a question of homology — about whether a trait (amygdala activation in an asymmetric social reward context) shared by two species is really the same thing. Answering the question of homology requires careful consideration of whether the trait is shared because of common evolutionary history, emerges from the same primordial developmental sequence, and serves the same function (Platt & Spelke 2009).

Even if dogs are capable of feeling ‘jealous’, it’s unclear whether the caretaker/fake-dog interactions used in this study are effective at eliciting such emotions. A recent study suggested that jealousy cannot be induced in dogs using fake conspecifics (Prato-Previde et al. 2018). In both studies, none of the dogs were overtly aggressive, or even visibly upset, by human/fake-dog interactions, calling into question whether the dogs really felt anything in the current study. It also remains unclear whether the activity evoked in the amygdala was specific to the social identity of the caregiver or merely reflected the negative contrast of a dog witnessing another dog receiving reward. Varying the identity and agency of the reward-giver as parameters is an important step missing from this study.

Another important but unaddressed question is the link between jealousy and aggression. In humans, aggression and jealousy are strongly related, but the causal arrow remains unclear. Indeed, many aggressive behaviors do not arise from jealousy, and, similarly, feeling jealous does not necessarily prompt aggression. In this study, amygdala activation was interpreted to indicate jealousy, but it is well known that the amygdala is associated with many different affective and social processes. Indeed, more studies link the amygdala directly to aggression (Coccaro et al. 2007; Matthies et al. 2012; Bobes et al. 2012; Pardini et al. 2014; Lozier et al. 2014) than to jealousy (Sun et al. 2016), casting doubt on the hypothesis that it is jealousy alone that causes some dogs to act aggressively.

Finally, there is more to aggression than the amygdala. In primates and rodents, aggression is linked to the neurotransmitter systems such as serotonin and dopamine; hormones like oxytocin, vasopressin and steroids; and the genes regulating these systems (Rosell & Siever 2015). A recent study linked endogenous oxytocin and vasopressin levels to aggression in dogs as well (MacLean et al. 2017). We now know that domestic dogs possess the ‘friendliness’ gene that in humans is linked to Williams-Beuren syndrome, a disorder characterized by hyper-social behavior (Haas & Smith 2015; Henrichsen et al. 2011; vonHoldt et al. 2017). In individual dogs or breeds that are overly aggressive, and in extreme and unfortunate cases have to be euthanized for such behavior, what has gone wrong with this system? And what therapeutic options do we have? The current findings of Cook et al. have important and practical implications for identifying the causes of aggression and support the possibility that exposure therapy may remedy aggressive behavior in dogs. Finally, this study brings to our attention the validity of using functional imaging as a tool for communicating with non-speaking individuals, be they preverbal children, brain-damaged patients, or our beloved pets, who may have something important to tell us.

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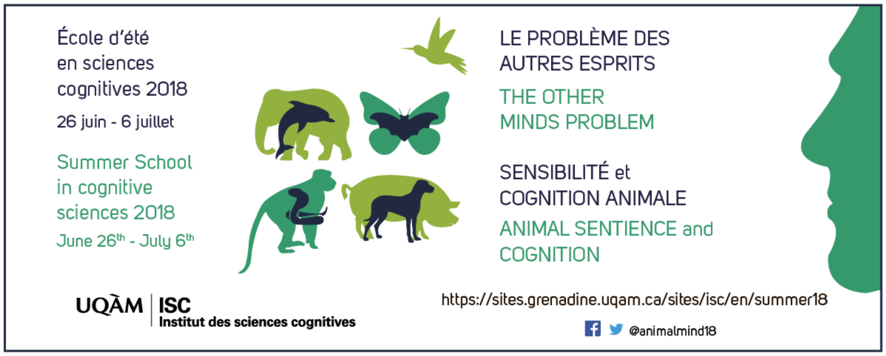

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The Other Minds Problem: Animal Sentience and Cognition

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.

Gregory Berns: Decoding the Dog's Mind with Awake Neuroimaging
Gordon Burghardt: Probing the Umwelt of Reptiles
Jon Sakata: Audience Effects on Communication Signals
PANEL 1: Reptiles, Birds and Mammals
WORKSHOP 1: Kristin Andrews: The "Other" Problems: Mind, Behavior, and Agency
Sarah Brosnan: How Do Primates Feel About Their Social Partners?
Alexander Ophir: The Cognitive Ecology of Monogamy
Michael Hendricks: Integrating Action and Perception in a Small Nervous System
PANEL 2: Primates, Voles and Worms
WORKSHOP 2: Jonathan Birch: Animal Sentience and the Precautionary Principle
Malcolm MacIver: How Sentience Changed After Fish Invaded Land 385 Million Years Ago
Sarah Woolley: Neural Mechanisms of Preference in Female Songbird
Simon Reader: Animal Social Learning: Implications for Understanding Others
PANEL 3: Sea to Land to Air
WORKSHOP 3: Steven M. Wise: Nonhuman Personhood
Tomoko Ohyama: Action Selection in a Small Brain (Drosophila Maggot)
Mike Ryan: "Crazy Love": Nonlinearity and Irrationality in Mate Choice
Louis Lefebvre: Animal Innovation: From Ecology to Neurotransmitters
PANEL 4: Maggots, Frogs and Birds: Flexibility Evolving
SPECIAL EVENT: **Mario Cyr:** Polar Bears
Colin Chapman: Why Do We Want to Think People Are Different?
Vladimir Pradosudov: Chickadee Spatial Cognition
Jonathan Balcombe: The Sentient World of Fishes
PANEL 5: Similarities and Differences
WORKSHOP 5 (part 1): Gary Comstock: A Cow's Concept of Her Future
WORKSHOP 5 (part 2): Jean-Jacques Kona-Boun: Physical and Mental Risks to Cattle and Horses in Rodeos

Joshua Plotnik: Thoughtful Trunks: Application of Elephant Cognition for Elephant Conservation
Lori Marino: Who Are Dolphins?
Larry Young: The Neurobiology of Social Bonding, Empathy and Social Loss in Monogamous Voles
Panel 6: Mammals All, Great and Small
WORKSHOP 6: Lori Marino: The Inconvenient Truth About Thinking Chickens
Andrew Adamatzky: Slime Mould: Cognition Through Computation
Frantisek Baluska & Stefano Mancuso: What a Plant Knows and Perceives
Arthur Reber: A Novel Theory of the Origin of Mind: Conversations With a Caterpillar and a Bacterium
PANEL 7: Microbes, Molds and Plants
WORKSHOP 7: Suzanne Held & Michael Mendl: Pig Cognition and Why It Matters
James Simmons: What Is It Like To Be A Bat?
Debbie Kelly: Spatial Cognition in Food-Storing
Steve Phelps: Social Cognition Across Species
PANEL 8: Social Space
WORKSHOP 8: *To be announced*
Lars Chittka: The Mind of the Bee
Reuven Dukas: Insect Emotions: Mechanisms and Evolutionary Biology
Adam Shriver: Do Human Lesion Studies Tell Us the Cortex is Required for Pain Experiences?
PANEL 9: The Invertebrate Mind
WORKSHOP 9: Delcianna Winders: Nonhuman Animals in Sport and Entertainment
Carel ten Cate: Avian Capacity for Categorization and Abstraction
Jennifer Mather: Do Squid Have a Sense of Self?
Steve Chang: Neurobiology of Monkeys Thinking About Other Monkeys
PANEL 10: Others in Mind
WORKSHOP 10: The Legal Status of Sentient Nonhuman Species