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Canine emotions: Guidelines for research

Response to Commentary on **Kujala** on *Canine Emotions*

Miiamaaria V. Kujala
Department of Neuroscience and Biomedical Engineering, Aalto University, Finland
Department of Equine and Small Animal Medicine, University of Helsinki, Finland

Abstract: In the target article, I called for a discussion on the nature and extent of dogs' emotions. The commentators generally agreed on the existence of dog emotions, but the diversity and quality of dog emotions, as well as the influence of human social cognition on perceiving dog emotions, raised more debate. To respond to the stimulating commentaries, I touch briefly on the philosophy of (canine) mind and discuss further the benefits of comparing cognition across species, secondary emotions, and the shaping of canine emotions by evolution, breeding and experience. I conclude with suggestions for future research guidelines on studies of canine emotion inspired by the discussion.

Miiamaaria V. Kujala (Saarela) is a researcher in comparative cognition at the University of Helsinki, Faculty of Veterinary Medicine, Department of Equine and Small Animal Medicine, Helsinki, Finland; and Aalto University School of Science, Department of Neuroscience and Biomedical Engineering, Espoo, Finland. A social cognitive neuroscientist, her current research interests are social cognition and emotional experience in dogs, non-invasive brain research across species, dog welfare technology, and human perception and interpretation of animals. **Website**

1. Importance of evaluating emotion accurately

I thank the commentators so far for their diverse, thoughtful and stimulating viewpoints from various disciplines. I had emphasized that canine emotions should be accurately estimated; but obviously missing from the target article (**Kujala** 2017) was a statement of *why* accurate estimation of dog emotions is so vital. Underestimation of canine emotions leads to abuse and maltreatment of dogs, thus causing a significant welfare problem. I believe this is more or less understood even by the lay audience. What is perhaps less appreciated is that the overestimation of dog emotions leads to excessively high expectations of dog behavior, which may thereby lead to increasing stress and behavioral problems for the dog: a different kind of welfare problem (as mentioned also by Serpell 2018).

The situation is similar to the treatment of small children; one should not expect a higher level of situational understanding or behavioral control from infants than what they are really capable of. Overestimation is likely with dogs because of their unique adaptation to the human cultural niche: they coexist as our animal companions and "children", triggering the

same kinds of cognitive and emotional functions in adults that children do (e.g., "doggerel"; Hirsh-Pasek & Treiman 1982).

2. Phenomenology of the (canine) mind

As an experimental cognitive neuroscientist, I do not want enter too much into the phenomenological debate because I do not believe we can reach a conclusion there. However, I do wish to clarify some misconceptions. In the target article, I stated that it is impossible to demonstrate that dogs feel emotions; because of this, I was accused of being a dualist by **Morris**. He apparently understood that I considered that feelings are not demonstrable because they are embedded in the hidden "mind" and thus separate from the bodily measures. This was never my intention: I do regard feelings as a product of the body. I simply meant that we currently lack methods to measure this in dogs. So, "undemonstrable" in this case means "unmeasurable", not non-existent. In this regard, I agree with **Cook**: "… consideration of phenomenological feeling does not contribute to the empirical science of emotion", whereas we can rely on physiological measures in the study of emotion. As also pointed out by **Correia Caiero**, we can study how dogs express emotions or read others' emotions without inferences about feeling. Currently, the opinion on whether, and to what extent, dogs experience feelings is difficult to support with scientific data. However, personal opinions matter in the design and execution of experimental research, where I do appreciate the view of **Urfer** that sentience needs to be taken into account when considering the ethical aspects of canine research.

Although we cannot measure the subjective feelings of dogs yet, it is possible that one day we will have enough circumstantial evidence. As **Adolphs** noted, the neuroscientific data on dog emotions are piling up; we find areas in the dog's brain processing emotion that are similar to those previously identified in humans. We still do not have full neurophysiological equivalence for subjective feeling even in humans, but brain areas linked to interoception, emotional processing and executive functions — the insula, amygdala, ventromedial or anterior cingulate cortex — have been associated with subjective feelings (Lane et al. 1998; Davidson & Irwin 1999; Singer et al. 2009). The function of the anterior insula is of special interest, as it is closely linked with behavioral results on subjective awareness, self-awareness and empathy for others' experiences (Singer et al. 2009), whereas the amygdala appears to be crucial for the perception of emotional expressions but not necessary for subjective experience (Anderson & Phelps 2002). In the future, we can expect to see more non-invasive studies analyzing the activity in these regions in dogs.

Concerning the experience of emotions, I cannot agree with **Harris** that the "hallmark of human emotional experience is an interpretation of … biological and physiological signals marked by language". In human infants, emotions develop first, but learning to name and classify one's emotions follows later (Leppänen & Nelson 2009). There is no evidence that language is necessary to experience emotions, though it can play a role in their regulation (Bloom 1998). Language complicates emotions, by adding top-down processing, including extended temporal aspects and imagination as sources.

3. Effect of the human viewpoint

My main point in highlighting the human perspective in the scientific study of canine emotions is that each of us has our own mental capacities and life histories affecting our view of the world. For a drastic example, abused children perceive ambiguous facial expressions as more angry than do children without this traumatic background (Pollak et al. 2000). Less dramatic everyday experiences also affect our perception. I agree with **Morris** that emotions and feelings are a part of the body, thus affecting the behavior, but not all the action potentials traveling in the brain produce any visible or time-locked counterpart in behavior, and not all humans have the capacity to "read" behavior, especially from a non-conspecific (Kujala et al. 2012, 2017; Maréchal et al. 2017).

Let us revisit **Zentall**'s example of growling: a growling dog is interpreted somewhat differently by different people. Experienced dog trainers may say: "But dogs have many different kinds of growls: what the dog feels depends on how he growls". This is partly the point: Dogs do have different kinds of growls. But not everyone can distinguish and interpret them. On average, people appear to distinguish different dog vocalizations (Pongrácz et al. 2005); but the research on children (e.g., Lakestani et al. 2014) shows that interpreting emotion from a non-conspecific is not an innate and infallible humane ability. As **Bräuer, Silva & Schweinberger** remind us, there is always individual variability in the data, and our general results are averages. These individual differences are also reflected in how humans interpret dog emotional expressions (Kujala et al. 2017).

Thus, I would not regard the mere statement of what people do or do not see in animals as evidence of the existence (or absence) of these emotions. Rather, it is highly informative about human perception. I do believe that dogs' emotions are often directly visible in their behavior, hence that they can be detected. However, the detectability is not self-evident: The problem in our interpretation of the behavior of other species is that it is influenced by our species' psychological and experience-based variables.

Although no mentally healthy person regards a rock as a person, anthropomorphism and the social need to connect are embedded in our cognitive functions (Epley et al. 2008). (This was famously highlighted by Wilson the Volleyball in the movie "Cast Away"; Broyles 2000.) **Harris** reminds us that people attribute less secondary emotion to outgroup than to ingroup members (Leyens et al. 2001). This also applies to dogs: Which emotions we think we see in dogs are not automatically correct, but we do tend to over-appreciate people and things we are familiar with. (This so-called in-group bias is ingeniously visualized within the cognitive bias codex by John Manoogian III.)

Franklin wonders about the special place of dogs in stereotypical human thinking: Dogs are often rated as "well-intentioned", "friendly" and "skillful" — more so than other species such as monkeys or cats (Sevillano & Fiske 2016). This attitude may be partly due to in-group bias, but it probably originates from human–dog interaction, the ability of dogs to read and adapt to human behavior, and the bonding that has already been demonstrated at the hormonal level (Odendaal & Meintjes 2003; Miller et al. 2009; Nagasawa et al. 2009; Handlin et al. 2011; Nagasawa et al. 2015).

4. Benefits of comparison in comparative cognition research

Gácsi wonders whether we need to compare dog experiences or emotions to those of humans. The comparison does not mean that dog experiences are only important in relation to humans, and I do acknowledge the importance of considering dog emotions in their own right. As noted in the target article, dogs may have experiences or emotional states that humans do not have. For that we may have no point of comparison in humans. This is also emphasized in some of the commentaries (**Correia Cairo**; **Bräuer et al.**). However, I do believe that partial comparison is a tool in understanding non-human emotions; it is the experience in ourselves that we have as a reference point for the emotional world. **Urfer** also mentions the advantage of the translational aspects of canine emotions in that the aging dog brain has similarities to the aging human brain and canine cognitive decline has commonalities with Alzheimer's disease (Oates 2014; Schütt et al. 2016). As cognitive or emotional malfunction was informative about human sentience for decades before the modern brain-imaging methodologies came into use, translational considerations may provide insight into how dogs perceive the world.

The benefits of the comparative study of dogs and humans have been mentioned by many of the commentaries published so far. Comparable methodology in measuring emotional physiology provides tools for quantifying and understanding the essence of dog emotions (**Adolphs**; **Cook**; **Correia Caiero**); studies with human infants can contribute meaningful concepts and empirical directions for the study of dogs (**Hoehl**). Methods refined from human studies also allow a wider perspective on dogs' positive emotions (**Piotti**).

Enthusiasm for the non-invasive brain imaging of dogs was evident from many commentaries, and I share the enthusiasm. We cannot make exact inferences about human subjective experience just by looking at a brain scan (reverse inferences: Sarter et al. 1996; Poldrack 2006). The same applies to non-humans. Yet brain data might be able to inform us about the processing of the emotional world and suggest how it is experienced. We can give the participant dogs in the non-invasive brain studies the same level of freedom we normally give to the human participants: Should you wish to do so, you can walk out of the door anytime during the measurement. (In our own eye-gaze tracking and non-invasive EEG studies in the University of Helsinki, the participants were more likely to attempt to break into the experiment room than out of it.)

The recent advances in human infant research cited by **Hoehl** highlight intriguing concepts of implicit and explicit processes in infant cognition. She suggests that the study of canine emotions might benefit from distinguishing between implicit processes (non-verbal and efficient, but limited; similar to those observed in pre-verbal infants) and explicit processes (developing later, along with executive functions, and requiring verbal abilities; Apperly & Butterfill 2009). For example, human infants appear to possess an implicit sense of self even though they do not pass the classical mirror self-recognition test. This "minimal self" includes a perceived sense of agency and body ownership (Rochat & Striano 1999). Hoehl suggests, very much in line with Bekoff (2001), that although dogs have not passed the mirror test, more research could address their implicit sense of self.

5. Secondary emotions: Jealousy, guilt and empathy

Secondary emotions elicited discussion from many commentators, since their existence is currently studied in dogs. **Gácsi** wonders about the use of quotation marks when discussing secondary emotions in animal studies; she stresses the adaptive value of secondary emotions. I appreciate their adaptive value in this context, yet I have nothing against the quotation marks — at least early in the research, when we cannot be sure whether the concepts we are dealing with in different species are the same. As research advances, if the evidence continues to support comparability, we can drop the quotation marks. As discussed in the previous section, comparison is a tool of understanding for humans, thus many of the emotional concepts come from the human research. As long as we are not sure about all the qualities of a certain emotion, we should approach its use with caution. Regarding dogs, I stress my point about over- and under-estimation of emotions here. If guardians overestimate the capacity of their dog, they expect too much from their behavior and probably add to their stress, in some cases visible as so-called problem behavior. And of course, as scientists we should aim for precision, in our concepts and knowledge as well as their real-life implications.

In the case of jealousy — discussed in the target article and mentioned by **Gácsi** — I am not sure it is currently a clear case. I agree that jealousy may have adaptive value, and defending resources could belong to the roots of the same biological system. However, as the word jealousy comes from our human experience, I would use it with care. Human defense of one's possessions such as food, a car, or a house, is *not* called jealousy. Jealousy includes the mental involvement of the target, and not only the cost of losing something valuable but also the pain of the person who is losing someone. We do not feel hurt and angry about an apple if someone steals it, but we can feel hurt and angry about a friend if they decide to go to a party with someone other than ourselves. So in the case of dogs, we should find a way to distinguish whether we are seen as an apple or a friend by the dog who looks "jealous" about us. Also, human jealousy has a temporal and imaginary part, where imaginary rivals also function as a source of jealousy; this is yet unknown in the canine domain.

A recent neuroimaging study by Cook and colleagues (2018) associated jealousy with dog aggression via some rather big conceptual leaps. As pointed out in some rather sharp commentaries by Vonk (2018) and Serpell (2018), despite the excellent general methodology for dog neuroimaging, the authors base strong claims on the limited evidence. Besides jealousy, the results can be interpreted as showing nicely the origins of dog aggression in fear — and how the dog's fear of an unknown "puppet dog" habituates with repetition. A recent behavioral study notably failed to find indicators of jealous responses of dogs over faux rivals (Prato Previde et al. 2018). This issue would clearly benefit from carefully clarified concepts and from more fine-tuned and realistic experiments, with adequate controls for alternative explanations. Like all scientific findings, brain-imaging data always need to be replicated with several experimental paradigms testing different aspects of the phenomenon. The first experiments, along with their conclusions, are wisely taken with a grain of salt.

Riemer discusses guilt as an example of an emotion with a functional (and adaptive) value. Amongst group-living species, guilt could have a clear function, motivating reconciliation. Nevertheless, we have no indication of what motivates the reconciliatory actions seen in dogs

(Cools et al. 2008), especially as third-party reconciliation cannot involve guilt, whereas it also improves the group cohesion.

Empathy and its components were much discussed in the commentaries, expressing two main views: Some considered the cognitive (**Boch & Lamm**) and others the emotional (**Karl & Huber**) aspect of empathy; the implicit empathy discussed by **Hoehl** falls closer to the latter. Boch & Lamm stress that emotional contagion and empathy should be differentiated, since emotional contagion lacks the self/other distinction and involves only bottom-up processes, whereas Karl & Huber regard emotional contagion as a fundamental building block of empathy. I agree with Karl & Huber that emotional contagion is an important ingredient of empathy: to have only cognitive top-down processes is a psychopathic-like state: "I understand how you feel but it does not concern me at all" (see Blair 2005). However, Boch & Lamm make the useful point that to gain information about motives underlying dogs' helping behavior, we should do more research on the self–other distinction and top-down regulation in dogs.

6. Development of emotions through evolution, selection and experience

Martin draws attention to the phylogeny and ontogeny of dog emotions: "we should examine how the expression of emotion has been shaped by evolution and experience". This is a very insightful suggestion, as we cannot yet fully distinguish the effect of these two on dog emotions. Martin mentions the role of selection, rearing and the environment, but I would add breeding, to distinguish it from natural selection. To distinguish the evolutionary part, there has been a long line of research on dogs and wolves (Lampe et al. 2017). The developmental aspect was also mentioned by **Adolphs**: "One very interesting question is whether, over time, dogs and other pets actually do acquire the emotions we anthropomorphize in them…. Emotions may in fact be created through learning". This is an intriguing thought, and there is indeed room for developmental and environmental studies in canine emotion research. Nevertheless, I am not yet convinced that social emotions such as Schadenfreude or contempt can be learned without the suitable neural substrates.

7. Future study guidelines: Rigorous studies and cautious interpretations

The commentaries generally shared my concern about the sparse data so far and the need for more carefully designed research. Realistic and ecologically valid methods were called for, as well as suitable, realistic stimuli (**Bräuer et al.**; **Karl & Huber**; **Riemer**). The problem of acting out emotions in studies was mentioned (Karl & Huber; Riemer), as well as the use of playback sounds in testing situations (Riemer) and the need for multimodal stimuli (Bräuer et al.).

There is indeed a need for accurate and provocative stimuli. This is often easier said than done, considering the need to also control for the non-test features of the stimuli. Regarding multimodal and ecological research, the human behavioral and brain sciences have been studying social interactions in realistic situations (Hari & Kujala 2009; Hari et al. 2015). It is difficult to analyse and interpret the ever-so-complicated and artifact-laden data. Different approaches have their roles in the big picture; simplified studies are vital building blocks of

fine-tuned real-life experiments. The stimuli should be well selected, prepared and controlled, and possible artifacts should be considered before experimenting.

Ecological validity needs to be taken into consideration; but with dogs, it is also important to keep the Clever Hans effect in mind to avoid unintentionally teaching a response that affects the results. Modern brain imaging has its own caveats, which are not necessarily evident for people in the field of behavioral research. On the other hand, dog behavior researchers have fine-tuned knowledge that is not necessarily evident for dog guardians or scientists from other disciplines. An interdisciplinary team working on these issues brings added benefit to the research, considering all aspects of the topic.

In the emotion-provoking field of dog research, we should be trying to challenge our expectations rather than just looking for data that fit with them (confirmation bias or observer-expectancy effect). We have an idea of how things might work; the most important task of a scientist is to test whether things can be explained in another, simpler way (echoing the call of **Zentall**). If, in the end, they cannot, then we can trust our hypothesis. But we should first aim to be our own devils' advocates — even if we love our dogs and have no personal doubt about their emotional experiences.

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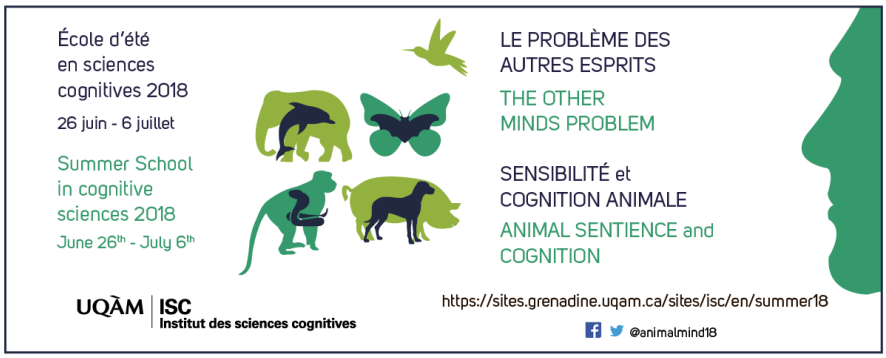

ISC 2018 Summer School in Cognitive Sciences
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The Other Minds Problem: Animal Sentience and Cognition

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
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PANEL 4: Maggots, Frogs and Birds: Flexibility Evolving
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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