THESIS OF DOCTORAL DISSERTATION

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Emotional communication between dogs and humans

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Introduction

Today, many researchers agree that emotions have their roots in the animal kingdom according to the evolutionary continuity between non-human animals and humans (e.g. Panksepp, 1994; Plutchik, 2001). However, there is still no clear consensus about the appropriateness of attributing emotions to animals (Hauser, 2000) and the empirical studies of animal emotions are still limited. The domestic dog (*Canis familiaris*) is one of the most common domesticated pet animal (Wynne et al., 2011), which offers an opportunity to study them in their natural niche: the human environment (Miklósi et al., 2004; 2007; Topál et al., 2009). Although recently dogs became the subject of scientific interest, their emotional behavior remained mainly unexplored, except for sporadic investigations (e.g. Quaranta et al., 2007; Horowitz, 2009; Harris and Prouvost, 2014).

Besides these experimental studies there are some investigations on humans' view of dogs' emotions or emotional expressive behavior. As (critical) anthropomorphism (Burghardt, 1991) provide useful hypothesis for looking at animal behavior, people's report about how they see animals' emotions can provide a start point in the direction of experiment-oriented studies. Morris et al. (2008) found that humans attribute a wide range of emotions to animals, however, this study lacked quantitative analysis. There exists no direct or indirect (questionnaire based) *quantitative* study on the full range of emotions in any animal species. Such research is more prevalent in humans that make also efforts to reveal certain patterns and regularities (similarities and dissimilarities) among emotions in order to discuss them in a coherent framework, which is often referred to as an 'affective space' (a dimensional model of emotion; e.g. Russell, 1980).

Dogs and humans have been living together for at least 14.000 years, and domestication might have predisposed dogs to form attachment relationships with humans (e.g. Topál et al, 1998). Humans also form an attachment relationship with their dogs (Archer and Ireland, 2011). Dogs show functionally analogue behaviours to human infants in the Strange Situation Test (Topál et al., 1998; Prato-Previde et al., 2003), that is, they seek the proximity of the owner and show stress-response during separation from him/her. Dogs utilize the owner as a "secure base" for exploring the environment (Prato-Previde et al., 2003).

Although the stress-related behavior to separation is an adaptive response of the attached individual (Bowlby, 1969), normal maturation results in increased tolerance of separation. However, both in humans and in dogs some in the course of development some individuals

maintain a lower threshold for the activation of the attachment system which is often considered to be problematic (abnormal), due to its extreme degree, form and consequences.

Separation-related disorder (SRD) is a common behavior problem in dogs, when the problematic behavior occurs exclusively in the owner's absence or virtual absence. Owners of dogs with SRD complain most frequently about destructive behavior displayed at home, excessive vocalization, or inappropriate elimination (Sherman, 2008). In the veterinary literature questionnaires are often used (e.g. McGreevy and Masters, 2008) to measure separation behavior and separation-related disorder in dogs, but so far the questionnaires have not been validated by the means of behavior tests.

Some authors (e.g. Sherman, 2008) suggest that dogs with separation-related disorder are "hyper-attached" to the owner, however, this concept does not exist in human developmental psychology and has not yet been defined in terms of behavior. Results on separation anxiety (an analogue psychiatric problem to SRD) in children suggest that these children have an insecure attachment style (Dallaire and Weinraub, 2005). Insecure attachment in children, on the other hand, is related to the parents' caregiving behavior, adult attachment style and personality (e.g. George and Solomon, 1996). Specifically, maternal responsiveness/ sensitivity seems to be the primary predictor of a child's secure attachment (Ainsworth et al., 1971).

In case of dogs, it seems that owners' behavior, personality and attitude to the dog may contribute to a variety of behavior problems in the dog (e.g. O'Farrell, 1997). One study found some evidence that the dog's SRD is also associated with certain behavioral or attitude characteristics of the owner (Jagoe and Serpell, 1996). The question whether dogs' SRD is associated with owners' caregiving behavior (e.g. responsiveness), attachment style or personality has not been investigated so far, nor has been studied whether SRD dogs have an insecure attachment style similarly to human infants with separation anxiety.

Social robotics is a rapidly emerging field of science aiming to design robots that can be immersed in human social networks and are able to interact with humans in a meaningful way (Fong et al., 2003). The robot's expression of emotions facilitates the human-robot interaction (Fong et al., 2003) and may contribute to the long-term engagement of humans towards artificial companions. As dogs achieve a relatively complex level of social interaction with humans (Miklósi and Gácsi, 2012), human-dog interaction has been suggested as a framework to model human-robot interactions (Miklósi and Gácsi, 2012). We (Lakatos et al., in press)

assume that dogs' emotional behavior provide an appropriate animal model for building the expressive behaviors of social robots.

Aims and questions

The following studies aimed to take different perspectives on how we can conceptualize emotional behavior in dogs, using different methodological approaches.

In Study 1 our aim was to obtain a detailed picture about dogs' emotions (the whole spectrum if possible) relying on the receiver's (humans) perspective. Questionnaire data supplied by the owners (see also Morris et al.'s, 2008) were analyzed quantitatively in order to see whether the affective space of dogs (as represented by humans) is similar to the human affective space (as reflected in earlier studies). So far, the dimensional approach of emotion (the "affective space") has not been applied to animal emotions, so our study is the first in this field.

In Study 2 we combined the humans' perspective with experimental validation of the dogs' expressive behavior. Our aim was to observe dogs' emotional behavior related to their relationship (attachment) with the owner: separation and greeting behavior. We addressed the question whether owners can judge correctly the separation and greeting behavior of their dog, and also the separation-related disorder of the dog.

In Study 3 we tested whether dogs' separation-related disorder is associated with their owners' own attachment style and personality. Such associations were found between human infants' separation anxiety and parents' personality, attachment and other characteristics. Dogs could serve as a behavioral model for infant-parent attachment, and these results also help in managing separation-related disorder in dogs.

In Study 4 we investigated whether emotional behavior of dogs can provide a model for expressive behavior of social robots. We studied whether humans attribute emotions and how they react to a robot equipped with dog-like emotional expressive behavior. This study is the first that tests human subjects' behavioral reaction to dog-like emotional expressions of a robot in a human-robot interaction test.

Methods

Study 1 consisted of two questionnaires aimed at revealing the human point of view on dog emotions in a quantitative manner. In the first questionnaire study we collected data in a Hungarian sample of dog *(Canis familiaris)* owners by the means of the same emotion list that

was used by Morris et al. (2008). Owners had to decide which emotions they think humans can recognize in dogs and dogs can recognize in humans (Emotion Reporting Questionnaire, ERQ). In the second questionnaire study we asked the owners to characterize a small set of emotions by the means of a list which contained non-exclusive emotional-expressive behavior patterns of dogs (Emotional Behavior Questionnaire, EBQ). Owners had to tell which behavior elements characterize dogs during certain emotional states. The data from the EBQ were entered into a statistical model (correspondence analysis) to see whether these emotions occupy a similar affective space to that revealed for humans.

In Study 2 we have constructed a questionnaire (Separation Questionnaire) to investigate the separation behavior in a sample of family dogs (N=45) and in parallel we have observed dogs' separation-related behavior in a simple behavioral test (Separation and greeting test, S&G). We recorded the dogs' behavior during the separation from and reunion (greeting) with the owner. We investigated the association between questionnaire and behavior items, and compared the behavior of dogs with and without owner-reported SRD. We also observed whether separation duration affects the behavior of the dogs.

In Study 3 we have investigated whether owners' attachment style, personality traits and the personality of the dog influence the occurrence of SRD in the dog. In an internet-based survey (N=1508) dog-owners filled in four questionnaires: demographic and separation questions (to determine SRD), Big Five Inventory (BFI), Dog Big Five Inventory (DBFI) and Adult Attachment Scale (AAS). In order to increase the validity of the results two separate parallel studies were performed in Hungary and Germany, using the same methodology.

In Study 4 we examined humans' ability to recognize two basic emotions expressed by a robot in a human-robot interaction test (Emotion Attribution Test). We provided our companion robot with two kinds of emotional behavior ("happiness" and "fear") using the behavior of dogs as inspiration. People (N=48) interacted with the robot in a play situation, with two kinds of ball, to one of which the robot expressed preference ("happiness") , and to the other non-preference ("fear"). We studied whether people attribute the appropriate emotion to the robot (Robot Anthropomorphizing Questionnaire, RAQ), and interact with it accordingly in the behavior test. We also examined whether interacting with the robot can change the subjects' attitude towards robots in general (Negative Attitudes towards Robots Scale, NARS).

Results and discussion

Study 1. The first questionnaire (ERQ) revealed that humans are reported to perceive a wide range of emotions in dogs, even secondary ones. Dogs are also reported to recognize many human emotions, although not as many as humans recognize in dogs. The correspondence analysis on the reported contingencies between behavior elements and emotions in the EBQ resulted in a two-dimensional affective space which showed similarity to those found in human studies: the two dimensions were interpreted as 'activity' and 'assertiveness'.

The results suggest that humans represent dogs' emotions in a partly similar way to their own. These similarities could reflect anthropomorphism and/or homologies in the expression of emotional states. The understanding of how humans represent animal emotions could provide both a step in the direction of experimental studies of animal emotions and also an important knowledge about 'folk animal psychology' which shapes the socially constructed concept of animal welfare.

Study 2. We found that dogs which were rated by their owner to be more "anxious" during separation and "happier" at reunion (Separation Questionnaire), showed more activity and stress-related behavior during separation, and more affection toward the owner during greeting (S&G test). Dogs with owner-reported SRD showed more stress-related behavior in the S&G test, they spent less time near the owner's chair during separation, and were more active during greeting than dogs without SRD. The two groups of dogs did not differ in affectionate behavior shown toward the owner. Non-affected dogs' activity decreased with increasing separation duration, but dogs with SRD did not show this change in their separation behavior.

Our results show that owners' have a realistic view on their dogs' separation behavior. In addition, dogs with SRD may not be "hyper-attached" to their owners because they do not show more affection during greeting. Moreover, dogs with SRD do not show preference for the owners' objects left behind and they cannot be easily calmed by the returning owner. Thus, it seems that the owner does not constitute a secure base for SRD dogs. We suppose that these dogs have an attachment style analogue to the human insecure, ambivalent type.

Study 3. We found that with owners' higher score on attachment avoidance the occurrence of SRD in the dog increases. Dogs scored higher on the neuroticism scale were more prone to develop SRD.

Our results suggest that owners' attachment avoidance may facilitate the development of SRD in dogs. We assume that avoidant owners are less responsive to the dog's needs and do not provide a secure base for the dog when needed. As a result dog form an insecure attachment and may develop SRD.

Study 4. We found that subjects played more (or exclusively) with the ball toward which the robot had previously expressed "happiness". When they had to name the emotions they experienced in the robot, the two most frequently reported emotions were the expected ones ("happiness" and "fear"). Additionally, subjects decreased their negative attitudes toward robots (NARS) after the interaction with the robot.

The results show that dog-inspired behavior of the robot was a suitable medium for making people attribute emotional states to the robot. Robots built on these principles of emotional behavior could have the potential to become a long term social companion for humans.

Summary of the most important findings

- Humans represent dogs' emotions in a partly similar way to their own.
- Owners' have a realistic view on their dogs' separation and greeting behavior, and they can judge whether their dog has a separation-related disorder.
- Dogs with separation-related disorder may not be "hyper-attached" to their owners because they do not show more affection during greeting, instead we suggest that they have an insecure, ambivalent attachment style.
- Dogs with separation-related disorder do not use the owner as a secure base (which also strengthens the assumption that they have an insecure, ambivalent attachment style).
- With owners' higher score on attachment avoidance the occurrence of SRD in the dog increases.
- People readily attribute emotional states to a robot equipped with dog-inspired behavior and can recognize the expected two basic emotions.
- People attitude toward robots improves after an interaction with an emotionally behaving robot.

Publications in connection with the dissertation:

Konok, V., Dóka, A., Miklósi, Á. (2011). The behavior of the domestic dog (Canis familiaris) during separation from and reunion with the owner: A questionnaire and an experimental study. Appl. Anim. Behav. Sci. 135, 300–308.

Lakatos, G., Gácsi, M., Konok, V., Brúder, I., Bereczky, B., Korondi, P., Miklósi, Á. (accepted). Emotion attribution to a non-humanoid robot in different social situations. PlosOne.

Other publications:

Lakatos, G., Janiak, M., Malek, L., Muszynski, R., Konok, V., Tchon, K., Miklósi, Á. (2014). Sensing sociality in dogs: what may make an interactive robot social? *Animal Cognition,* 17: 387-397.

Oral and poster presentations on national and international conferences:

Lakatos, G., Ferencz, V., Konok, V., Janiak, M., Malek, L., Muszynski, R., Tchon, K., Miklósi, Á. (2010) Dogs' comprehension of pointing signals presented by a robot. 2nd Canine Science Forum, 2010, July 25-27, Vienna, Austria.

Konok, V., Miklósi, Á. (2011) The behavior of the domestic dog (Canis familiaris) during separation from and reunion with the owner – a questionnaire and an experimental study. ISAE regional meeting, 2011. June 1-4., Kostelec nad Černými Lesy, Czech Republic.

Konok, V., Miklósi, Á. (2011) Attribution of emotion to animals, and its relevance to the development of emotional behaviour in robots. CogInfoCom, 2011, July 7-9., Budapest.

Konok, V., Dóka, A., Miklósi, Á. (2011) A kutya (Canis familiaris) viselkedése a gazdától való szeparáció és az újratalálkozás során- egy kérdőíves és egy kísérletes vizsgálat. A Magyar Etológus Társaság XII. Kongresszusa, Debrecen, 2011. nov.25.-26.

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