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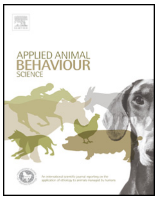

How do humans represent the emotions of dogs? The resemblance between the human representation of the *canine* and the human affective space

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ABSTRACT

As (critical) anthropomorphism provides a useful hypothesis for looking at animal behavior, people's reports about how they see animals' emotions can provide a start point in the direction of experiment-oriented studies. It has been shown that humans attribute a wide range of emotions to animals. The concept of 'affective space' is often used to model human emotional states in a dimensional way. However, there has been no study carried out on how humans may construct non-human animals' affective space. Our aim was to assess owners' attribution of emotions to their dogs (*Canis familiaris*), and to construct the affective space for dogs. We used two questionnaires to investigate owners' opinion about (1) the emotions that humans can recognize in dogs and dogs can recognize in humans, and (2) the behavior elements that characterize certain emotions. The first questionnaire revealed that humans are reported to perceive a wide range of emotions in dogs. The reported contingencies between behavior elements and emotions in the second questionnaire were analyzed using correspondence analysis. The resulting two-dimensional affective space 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.

1. Introduction

'*Pleasant is useful*' – said Cabanac (1992) and today, many researchers agree that emotions have adaptive values in terms of survival and that they have their roots in the animal kingdom according to the evolutionary continuity between non-human animals (in the following: animals) and humans (e.g. Darwin, 1872; Panksepp, 1994; Plutchik, 2001). According to Panksepp's definition (1994, 1998) emotions are 'processes which are likely to have evolved from basic mechanisms that gave animals the ability to avoid harm or punishments and to seek valuable resources or reward' (see also Boissy et al., 2007). In contrast to hardwired, inflexible behavior responses, emotions lead to a more flexible way of reacting (Frijda et al., 1989).

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Additionally, emotions motivate behavior and are functional in communication and social bonding (Rolls, 2000), and enhance memory (Paul et al., 2005).

After decades of behaviorism when it was unacceptable to study or even to assign emotions to animals, research on animal emotion has started, although there is still no clear consensus about the appropriateness of attributing emotions to animals (Hauser, 2000). Researchers still often avoid the usage of the term 'emotion' with respect to animals because direct evidence is lacking (but see Bekoff, 2000).

Emotions are usually thought to include a subjective component (a 'feeling' which William James considered the essence of emotion; James, 1916) (e.g. Scherer, 2009) which in humans can be expressed verbally, but in animal research we have to rely on behavioral and/or physiological responses and to infer indirectly from these. Thus, the study of animal emotions always implies an uncertainty. However, as Panksepp (2005) argued, if a similar stimulus induces a similar behavioral, physiological and neurological response in non-human animals and in humans, we can assume that similar mechanisms play a role in both of them. Studying animal emotions has some methodological difficulties, as well, e.g. it is not easy to find the proper behavioral context for a certain emotion for a certain species.

Despite these difficulties in methodology and in interpretation, recently, affective neuroscience, which is interested in neural structures underlying emotional processes, and animal welfare have shown increased interest in studying emotion in animals. As animal welfare is concerned with animals' suffering and well-being, study of animal emotions is especially important for this field. However, most research is still restricted to negative emotions, such as fear, stress or pain (Boissy et al., 2007).

It is debated whether an emotion is a position in a continuum or whether emotions are distinct states. Scientists who claim that emotions are separated states with distinctive behavioral and physiological correlates support the existence of a small number of basic or primary emotions such as fear, happiness, sadness, disgust or anger (Ekman, 1992; Plutchik, 2001). As basic emotions are viewed as biologically based states that are evolutionary adaptive (they contributed to survival in the past), the attribution of basic emotion to animals is more supported among scientist (e.g. Ekman, 1992; Izard, 1992; Plutchik, 2001). Complex or secondary emotions (such as jealousy or guilt), which are believed to be a mixture of primary ones (and in most cases to contain a self-conscious or self-evaluative element), are less frequently attributed to non-human animals (but see Harris and Prouvost, 2014). Although extensive anecdotic data is available on secondary emotions in many species (Masson and McCarthy, 1996), few empirical studies have been carried out in the topic. The existing studies show a mixed picture about whether the attribution of secondary emotions to animals has an experimental support or is mere anthropomorphism (e.g. jealousy in titi (*Callicebus moloch*) and squirrel (*Saimiri sciureus*) monkeys (Cubicciotti and Mason, 1978); guilt or jealousy in dogs (*Canis familiaris*) (Horowitz, 2009, Hecht et al., 2012; Harris and Prouvost, 2014), or empathy in chimpanzees (*Pan troglodytes*) (Parr, 2001) and in mice (*Mus* sp.) (Langford et al., 2006)).

Besides the behavioral studies, another alternative method to observe animal emotion could be to rely on systematized collection of reports of humans who have direct access to animals. This is especially true for people who share their life with domestic animals, especially pets. From the viewpoint of animal welfare, the concepts of the lay public about animal emotions are important because animal welfare is a socially constructed idea (Watanabe, 2007). New animal welfare measurements are needed and for this purpose people' view on animal's behavior and emotions has to be evaluated (Wemelsfelder et al., 2000). Qualitative assessment of animal behavior (by terms like anxiety, fear, etc.) usually used by the lay public when expressing concerns about animal suffering is often dismissed as anthropomorphic and unscientific. However, these terms may reflect observable and biological valid aspects of animal behavior which is supported by the finding that people show significant agreement in their spontaneous qualitative assessment of animal's expressive behavior (Fleming et al., 2013; Phythian et al., 2013; Walker et al., 2010; Wemelsfelder et al., 2000).

Questionnaires have been frequently used in human psychology, for example in personality studies, where people often have to give reports about others (family members, friends, or children) (e.g. Cohen et al., 1977) similarly to the case when owners have to describe their pets (e.g. Kubinyi et al., 2009). Questionnaire studies have the advantage of gaining large amount of data, they are less invasive and they save money and time.

Morris et al. (2008) carried out a questionnaire study to collect data on emotional behavior in various animals via owners report. In their first study they asked owners of dogs, cats, horses, rodents and birds, whether their pets have ever experienced certain emotions. Their questionnaire listed 10 primary and seven secondary emotions. The results showed that owners attributed emotions to their pets with high frequency (including many secondary emotions). However, this analysis lacked quantitative methods (there was only a qualitative, descriptive statistics).

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 makes 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'.

The dimensional model of the affective space (e.g. Cabanac, 2002; Russell, 1980) assumes that emotions are not discrete phenomena (in contrast to e.g. Panksepp, 1994), but they can be located in an abstract space constituted by two or more dimensions. This implies that the differences among emotions are not qualitative but quantitative. It is assumed that in humans affective experience or affective behavior can be reduced to some underlying dimensions. Emotions that are regarded as more similar according to one or more characteristics are placed closer to each other in the affective space.

Although, many such studies (for reviews, see Russell, 1980) used very different type of data, such as self-reported feelings or neural activity parameters to film or music clips (Christie and Friedman, 2004), semantic description or similarity ratings of emotional terms (e.g. Fontaine et al., 2007; Russell et al., 1989), ratings of facial expression of emotion (e.g. Calder et al., 2001; Russell and Bullock, 1985) or ratings of arm movements (Pollick et al., 2001), the results were quite similar. Most investigations revealed two (bipolar) dimensions: arousal/activation or behavioral activity and pleasantness or valence (e.g. Christie and Friedman, 2004; Pollick et al., 2001; Russell et al., 1989; Stephens, 2007). In some cases additional dimensions were also reported such as potency/control, predictability or approach/avoidance (Fontaine et al., 2007; Wallbott, 1998).

The domestic dog (*C. familiaris)* is the most popular pet (along with the cat; see surveys, e.g. American Pet Products Association, 2011), and owners spend a lot of time with them. Thus they may have substantial experience on emotional behavior of dogs. Owners know that body language of the dog indicates different emotional states and they attribute a wide range of emotions to their dogs (Morris et al., 2008). Thus we have reasons to believe that dogs are good subjects for investigating how animal emotion is represented by humans.

Humans agree in many aspects of dog behavior when they try to interpret it. Human observers show a relatively high agreement with each other or with dog-experts in their assessment of dogs' emotional expressive behavior (Walker et al., 2010; Tami and Gallagher, 2009), although some behaviors were less easy to identify than others (Tami and Gallagher, 2009). Dog-owners attribute the same emotions to dogs in a large percentage and they agree on the situational and behavioral aspects of emotions (Morris et al., 2008). Similarly, humans are able to identify above chance level the emotional content of barks (Pongrácz et al., 2005) which are seen as behavioral manifestations of inner states in dogs (e.g. Cohen and Fox, 1976).

By integrating animal-questionnaire studies and the human dimensional approaches and techniques, we wanted to see whether humans' attribution of emotions to family dogs results in a similar emotional space to those found in the human studies.

Here we report two studies aimed at revealing the human point of view on dog emotions in a quantitative manner. In Study 1 we collected data in a Hungarian sample of dog 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. We predicted that owners would think that humans can recognize many emotions in dogs, especially the basic emotions – similarly to Morris et al.'s (2008) results. We assumed that humans would also think that dogs can recognize many human emotions (although not as many as humans can recognize in dogs), especially the basic ones, again – in agreement with findings that dogs can discriminate some human emotions (Morisaki et al., 2009; Nagasawa et al., 2011; Racca et al., 2010). In Study 2 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. Owners had to tell which behavior elements characterize dogs during certain emotional states. The data from the second questionnaire was entered into a statistical model in order to see whether these emotions occupy a similar affective space to that revealed for humans. We predicted that we would find similar underlying dimensions as the ones found in human dimensional studies.

2. Method

2.1. Subjects

Dog-owners were recruited from the dog-owner database of the Department of Ethology (Budapest, Hungary). They were either asked by email to fill in the questionnaires; or were invited to the department with their dog to participate in behavior tests and then additionally asked to fill out the questionnaires. Dog-owners were asked to fill out one or two of the questionnaires: the Emotion Reporting Questionnaire (ERQ) and/or the Emotional Behavior Questionnaire (EBQ). There were eight versions of the EBQ: with eight different emotions which owners had to characterize (see below).

83 owners filled out the ERQ (11 men, 68 women, the gender of four owners is missing). 125 owners filled out the EBQ (18 men, 101 women, the gender of six owners is missing). Owners got three out of the eight different EBQ's (they had to characterize three emotions) resulting 50 ± 2 (mean $\pm$ SD) questionnaires/emotion. The participating owners had various pure breed dogs and mongrels.

The filling out of the questionnaires took approximately 15 min. Owners were not paid for their participation in the test.

2.2. Questionnaires used

2.2.1. Emotion Reporting Questionnaire (ERQ)

The questionnaire (see Appendix 1) was based on the same set of emotions listed by Morris et al. (2008) (10 primary emotions based on Ortony and Turner, 1990: anger, fear, surprise, joy/happiness, sadness, anxiety, disgust, interest, love/affection, and curiosity; seven secondary emotions based on Lewis, 2002; Tangney and Fischer, 1995: empathy, shame, pride, grief, guilt, jealousy, and embarrassment). Owners had to indicate for the 17 emotions separately whether they think humans can recognize that emotion in dogs. We phrased the question in this way (and not as 'which emotions do dogs possess' or 'which emotions you experienced in your dog' or as Morris et al. asked: 'is your dog ever. . .?') because we wanted to ask the question also in the reversed way: we were also interested in owners' opinion about what kind of emotions dogs can recognize in humans. So we asked two symmetrical questions ('Which emotions do you think *humans can recognize in dogs/dogs can recognize in humans*?', see Appendix 1). We used the same set of emotions for the two questions.

2.2.2. Emotional Behavior Questionnaire (EBQ)

By the means of the EBQ we wanted to reveal whether owners rely consistently on behavioral cues in their attribution of dog emotions. We tested this idea for eight emotions (sadness, fear, disgust, surprise, anger, joy, shame, jealousy), and for each of them 33 behavior elements were listed (Appendix 2). Owners had to mark which of them are characteristic for the dog during the respective emotional state. The eight emotions include the six primary emotions (sadness, fear, disgust, surprise, anger, joy) according to Ekman (1992), and two secondary emotions: shame/guilt and jealousy. Guilt and jealousy were the two secondary emotions that dog-owners reported most frequently in the study of Morris et al. (2008), and Horowitz (2009) found also that owners readily attribute guilt to their dogs in an experimental study (see also Hecht et al., 2012). The behaviors listed belonged to one of the following categories: distance (from the owner), head and body posture, tail posture and wagging, ear posture, vocalization, looking (at the owner), activity of moving, contact (with the owner).

Most of these categories and behavior elements listed are regularly defined as part of the ethogram for dogs or wolves (e.g. Döring et al., 2009; Feddersen-Petersen, 2000; Goodwin, 1997; Ley et al., 2007; McLeod, 1996; Scott and Fuller, 1965; Tami and Gallagher, 2009). Head and body posture, ear and tail posture and tail movement have been frequently used for indicating signs of aggression, fear or confidence (Schenkel, 1947; Scott and Fuller, 1965; Fox, 1969, 1973; Kiley-Worthington, 1976). In addition we included behaviors (distance, looking, contact) related to affiliative tendencies of dogs toward their owners. These behaviors were found to be useful indicators of attachment (Topál et al., 1998) and dependency (Topál et al., 1997). The categories contained three to six behavior units, and for each category owner could suggest additional behavior units if they felt none of the listed ones appropriate.

2.3. Statistical analysis

During the analysis of the ERQ 'yes' and 'no' votes for each emotion were summed ('yes' was given to a certain emotion if the dog owner thought humans recognize it in dogs or dogs recognize it in humans and 'no' was given if the emotion was not selected). For the comparison of owners' view on primary versus secondary emotion-recognition we summed all 'yes' and 'no' votes for primary emotions and for secondary emotions separately. We compared the level of average emotion-recognition (how many dog emotions subjects think that people can recognize) in our Hungarian sample and the level of average emotion-attribution to dogs in the English sample in Morris et al.'s (2008) study. For this comparison the total number of 'yes' and 'no' votes given by the English and Hungarian dog-owners (to all of the 17 emotions) were compared by using Fisher exact test. Fisher exact tests were also conducted for comparing owners' view on the recognition of primary versus secondary emotions (by humans and dogs, too), and owners' view on dogs' and humans' emotion recognition abilities.

In the data of the EBQ we had two categorical (nominal) variables with several response categories: emotions had 8 values (categories), and behavior elements had 33 values. To explore the relationships among our categorical variables correspondence analysis was conducted using R 2.12.0 statistical software (Ihaka and Gentleman, 1996) package anacor (De Leeuw and Mair, 2009). Correspondence analysis (CA) is a multivariate descriptive method based on a data matrix with non-negative elements (e.g. frequencies formed by categorical data). It is conceptually similar to principal component analysis, but applies to categorical rather than continuous data. In a similar manner to principal component analysis, it provides a means of displaying or summarizing a set of data in two- or three-dimensional graphical form. It is traditionally applied to contingency tables–in our case contingency table is formed by the contingencies of the different categories of the two variables, that is, the overall frequencies with which subjects (as a total) reported a certain behavior element for a certain emotion (the contingency table can be seen in Appendix 2). CA decomposes the chi-squared statistics associated with this contingency table into orthogonal factors. From a contingency table we can see the similarities and differences among the categories (e.g. the emotions), but multidimensional similarities are difficult to comprehend. The goal of CA is to find a lower-dimensional space in which to position the row and column points (emotions and behavior elements, in our case) in a manner that retains all, or almost all, of the information about the similarities/differences between the columns/rows. The graphical representations of the results produced by CA illustrate the most important relationships among the variables' categories (Sourial et al., 2010). The measure of association used in CA is the chi-square distance between the response categories. The closer the response categories are located to each other, the more similar they are to each other. In the biplot a joint display of points represents the rows and columns of a table, and the scalar products between row and column points reconstruct the original data in the table. To visualize the distances between the row or column profiles separately, symmetric maps were used (both variables were in principal coordinates). To be able to interpret row–column relationships asymmetric maps were used, where the two clouds of points have different normalization/scaling. The column points are represented as profiles in principal coordinates and the row points (behavioral elements) as vertices in standard coordinates because we were more interested in the column analysis (emotions). In this map the column points are at weighted averages of the row points using the elements of the column profiles as weights. This way we can get information about the distances between the column profiles and the optimal row–column relationships as well (Greenacre, 2010).

3. Results

3.1. Emotion Reporting Questionnaire

Owners think that people can recognize many (72.9% on average) of the listed emotions in dogs, ranging from 39% (empathy) to 99% (fear) (Fig. 1, black columns). Dog-owners in Morris et al.'s (2008) study attributed emotions to their dogs in a similar ratio (72% on average, ranging from 30% to 99%). The levels of attribution/recognition of emotions to/in dogs did not differ significantly between Hungarian (in total 1028 'Yes' and 417 'No' votes) and English (4141'Yes' and 1588 'No' votes – from Morris et al., 2008) nations (Fisher-test: $p = 0.394$, odds ratio = 0.9).

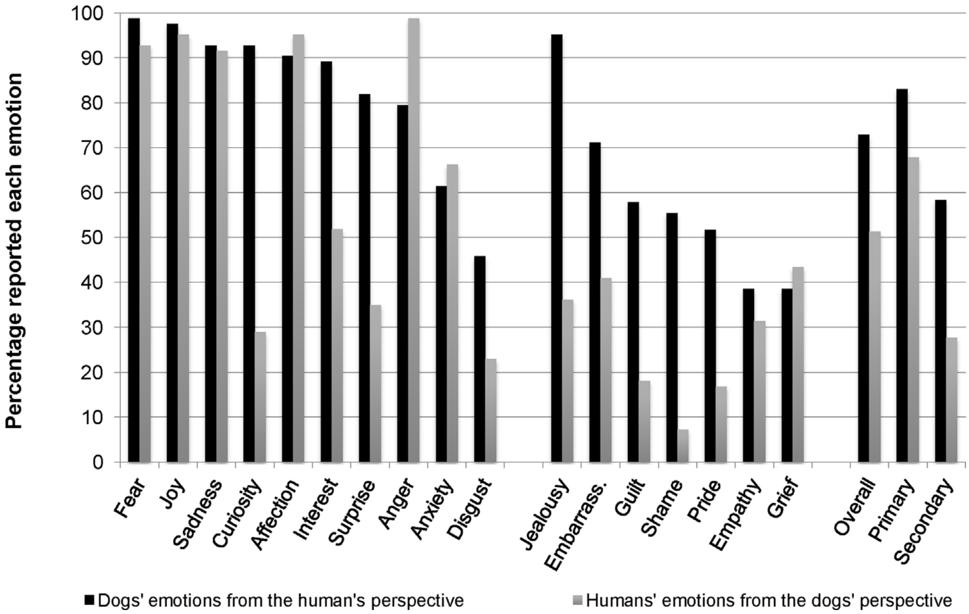

Fig. 1. Percentage of people reporting that the listed primary (first ten) and secondary (last seven) emotions (based on Morris et al., 2008) (and emotions as a total) humans can recognize in dogs (black columns), and dogs can recognize in humans (gray columns).

Based on responses to the questionnaire it was also possible to compare how much – according to the responders – humans and dogs recognize each other's emotions (see Fig. 1). Subjects reported that humans can recognize 72.9% of dogs' emotions on average (1028 yes and 383 no), while 51.3% of human emotions (724 yes and 687 no) were reported to be recognizable by dogs. This means that according to the owners humans are able to recognize emotion in dogs with a 2.6 times greater odds compared to recognizing emotions in humans by dogs (Fisher-test, $p<0.001$).

Owners think that humans recognize 83% (141 no and 689 yes) of the primary emotions (based on Morris et al.'s list) and 58.4% (242 no and 339 yes) of the secondary emotions in dogs (see black columns in Fig. 1). The odds of recognizing primary feelings in dogs by humans is 3.5 times greater, compared to recognizing secondary feelings (Fisher-test, $p<0.001$).

According to the human responders dogs recognize on average 67.8% (267 no and 563 yes) of the primary human emotions versus 27.7% (420 no and 161 yes) of the secondary emotions. The odds of recognizing human primary emotions by dogs (according to the human responders' opinion) is 4.8 times greater (Fisher-test, $p<0.001$) compared to recognizing secondary emotions.

3.2. Emotional Behavior Questionnaire (EBQ)

Contingency table was computed from the overall frequencies with which subjects (as a total) reported a certain behavior element for a certain emotion (i.e. from the contingencies between behavior elements and emotions). The contingency table can be seen in Appendix 2. The correspondence analysis of the EBQ shows that the first dimension ($\chi^2=905.92$) accounts for 55.5% of the total χ^2-value (i.e. inertia), and the second explains 16.3% ($\chi^2=266.97$). Two dimensions together account for 71.8% so we chose to include only the first two dimensions in our interpretations. On the graphical representation the column plot including 95% confidence ellipsoids (Fig. 2) and the joint plot (Fig. 3) is shown, where both emotions and behavior elements are visualized simultaneously.

The most prominent (more than 40% of dog-owners selected it) behavior elements which were selected for a given emotion can be seen in Table 1.

On the first dimension of column plot joy and anger are on the very right side and shame and sadness are on the very left of this dimension. In the joint plot on the right side fast body-movements and fast tail-movements are located, while on the left side we can find elements such as no movement or slow movement and no tail-wagging or slow tail-wagging. Thus, Dimension 1 can be interpreted as 'activity'.

On Dimension 2 joy, jealousy and fear are in the lower part of the axis, and anger is positioned in the upper part. In parallel, high body posture, high head posture, high tail-posture and a forward posture of the ears are placed at the upper part in Fig. 3. In contrast, low head and tail posture, and pulled-back ears are located at the lower section. In accordance with the location of the emotions and the signifying behaviors we interpret this dimension as 'assertiveness'.

The ellipsoids (which represent 95% confidence) of shame and sadness overlap which could be interpreted that these emotions share similar place in the human representation of dogs' affective space. Similarly, there is an overlap in the ellipsoids of sadness and disgust or surprise and anger too.

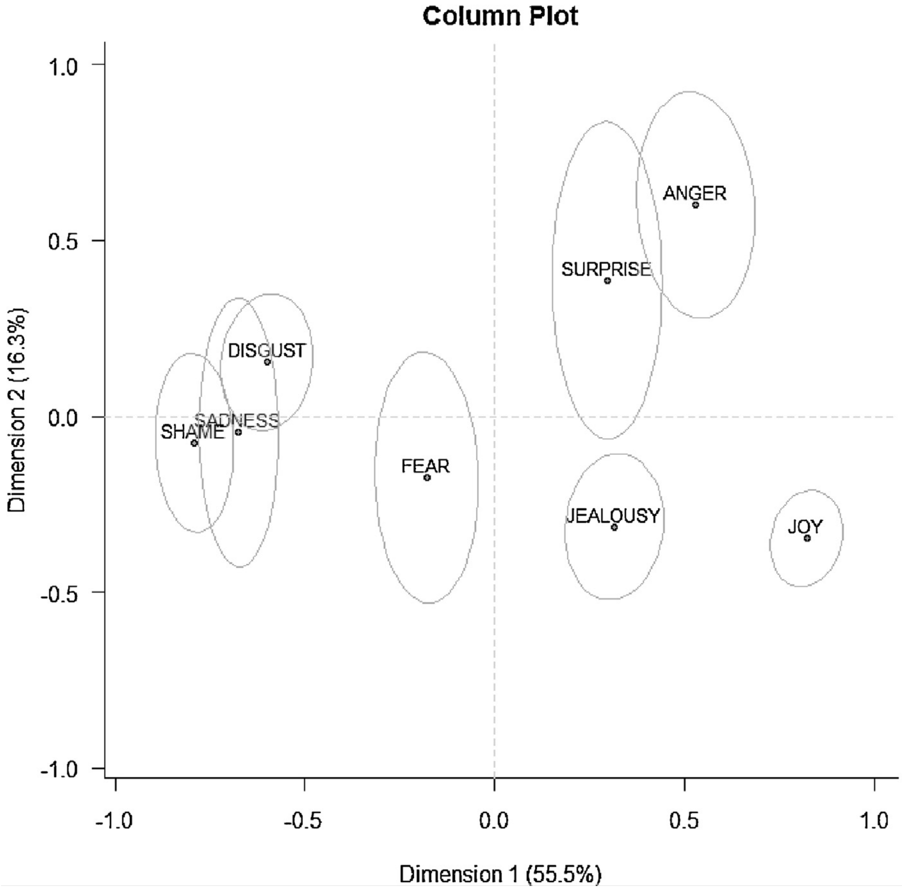

Fig. 2. The results of the Correspondence Analysis of the Emotional Behavior Questionnaire are shown. Distances of the eight emotions represent the degree of similarity between them. Dimension 1 was interpreted as 'activity', Dimension 2 as 'assertiveness'. The ellipsoids represent 95% confidence.

4. Discussion

4.1. Emotion Reporting Questionnaire

The Emotion Reporting Questionnaire showed that according to the owners humans recognize a wide range of emotions in dogs. Our results are in accordance with the results of Morris et al. (2008) who found that dog-owners attributed emotions to their dogs in a similar ratio as in our study. Similarly to Morris and his colleagues who found that humans are more willing to attribute primary emotions to dogs than secondary ones we also found that–according to the subjects- humans recognize more primary emotions in dogs than secondary ones. Nevertheless, they thought that humans can perceive even the secondary emotions of dogs in a large percentage (58.4%). Based on the owners' responses the present findings suggest that the inter-specific emotion-recognition processes are not symmetrical: it suggests that humans recognize more emotions in dogs than in reverse. This is especially true for secondary emotions. Dogs are considered to perceive a large percent of primary human emotions (67.8%), but they are reported to recognize secondary ones only in 27.7% of the cases. Experimental studies showed that human primary emotions are discriminated by dogs (Buttelmann and Tomasello, 2013; Deputte and Doll, 2011; Merola et al., 2014; Morisaki et al., 2009; Nagasawa et al., 2011; Racca et al., 2010; Ruffman and Morris-Trainor, 2011; Turcsán et al., 2014), but there are no data on such abilities of dogs in connection with secondary emotions. Secondary emotions are also called complex emotions as they can be a mixture of two primary emotions (Plutchik, 2001) or can contain a self-conscious or self-evaluative element (Fischer and Tangney, 1995; Morris et al., 2008). Hence, it is not likely that dogs can recognize human secondary emotions. In contrast, humans may have the mental capacity to represent and attribute not only primary, but also secondary emotions to dogs (independently whether the emotion really exists or not; see Horowitz, 2009 or Hecht et al., 2012).

4.2. Emotional Behavior Questionnaire

By the means of the correspondence analysis we revealed how humans represent the emotions of dogs in the affective space. The dimensions of the Emotional Behavior Questionnaire had a good explanatory value. We have identified activity and assertiveness as the two main dimensions.

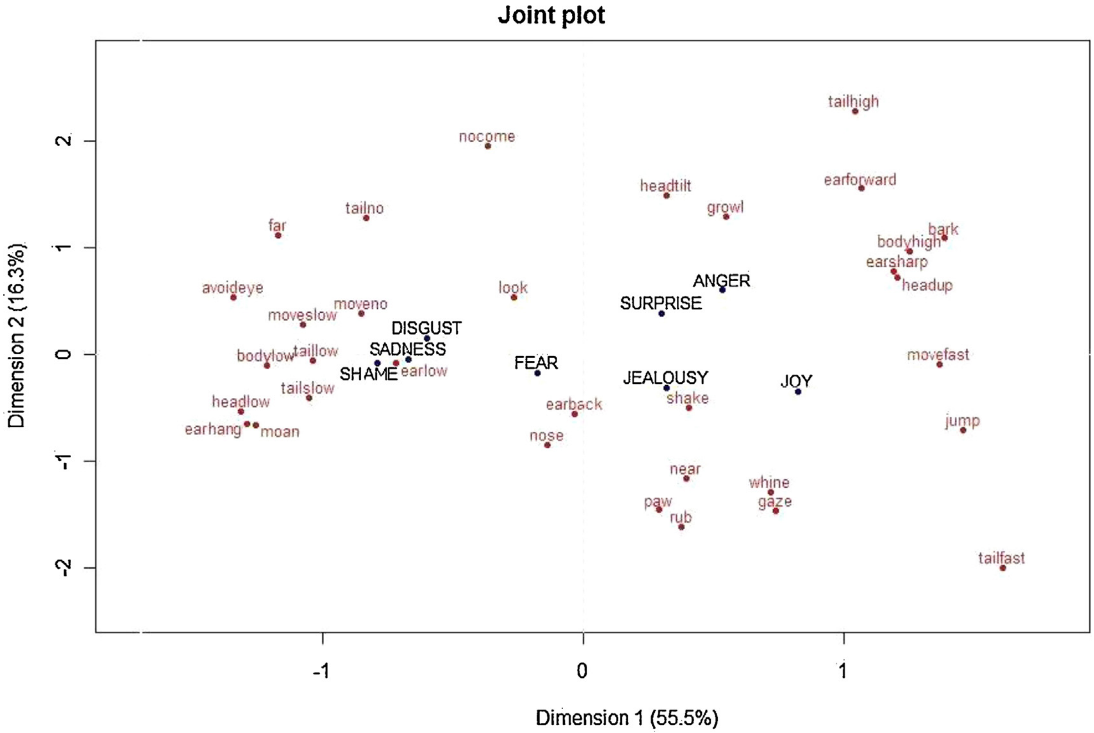

Fig. 3. The asymmetric joint plot (where both emotions and behavior elements are visualized simultaneously) results of the Correspondence Analysis of the Emotional Behavior Questionnaire are shown. Dimension 1 was interpreted as 'activity', Dimension 2 as 'assertiveness'. Emotions with capital letter are referring to the emotions in Fig. 2. Abbreviations of behavior elements with small letters are defined in Table 1.

Activity refers to movement intensity. It is related to the concept 'arousal' (or 'activation') which is one of the most commonly found factors in human studies on emotion that use ordination techniques (e.g. Christie and Friedman, 2004; Pollick et al., 2001; Russell et al., 1989; Stephens, 2007). Arousal is a physiological and psychological state of activation, specifically, a reactivity to stimuli, sensory alertness and mobility. In contrast, activity reflects a behavioral activation rather than a physiological/psychological arousal. Although arousal can be accompanied by behavioral activity, the two factors often diverge. For example, fear is characterized by high arousal but the behavioral manifestation depends on the context, ranging from escaping to freezing.

The position of the emotions in the affective space reported in the present study is in accordance with this: joy and anger (which are positioned at one side of the affective space, see Fig. 2.) correspond with high behavioral activity, and shame and sadness (which are located on the opposite side) are characterized with slow or little movement. Fear is close to the middle section because this emotion can entail either active (escape) or passive (freezing) forms. In the human literature, one study that observed expressive body movements (Wallbott, 1998), found also an activity-passivity dimension. This is not a physiological/psychological activation, but a behavioral (movement) activity. Indeed, the emotions in their study are ordered on this dimension in a very similar way as in our study (except for shame): joy and anger entail the highest activity, sadness and disgust the lowest and fear is in between.

Our second dimension is assertiveness, which is realized by erectness or expansion of the body. Erectness was linked to occupying a dominant position in stable social groups both in case of animals (e.g. dogs or wolves: Scott and Fuller, 1965; Fox, 1973; Kiley-Worthington, 1976) and in case of humans (Eibl-Eibesfeldt, 1984). In Wallbott's study (1998) it was found that in humans, emotions such as shame and sadness are often associated with a collapsed body, while pride or anger is rarely associated with such a body state. Weisfeld and Beresford (1982) showed that students' successfulness were associated with the erectness of their body posture.

Regarding the 'affective space' studies, assertiveness can be linked to potency, control or 'dominance' as described in the human literature. In line with this, the model by Osgood et al. (1971) which is applied to psychological meaning (and not only to emotions), consists of three dimensions: evaluation, activity and potency. According to Mehrabian and Russell's emotional model (1974) the main dimensions of the affective space are pleasure, arousal and dominance (PAD model). However, note that the reference to dominance in these cases is questionable because 'dominance' is not a feature of the individual (Drews, 1993) but describes a relationship between two group members. Thus, in order to avoid confusion one may want to retain the use of concept of dominance for social networks. The individual character that is typified by a tendency to control social partners should be labeled as assertiveness.

Table 1
The most prominent behavior elements chosen for the specific emotion (more than 40% of dog-owners selected it).

Emotion	The most prominent behavior elements chosen for the given emotion (more than 40% of dog-owners selected it) (*the abbreviations used in the graphical representation are written in italics*)
Shame	Hangs its head (*headlow*), Contracts itself (*bodylow*), Moves slowly (*moveslow*), Tries to be far from me (*far*).
Sadness	Hangs its head (*headlow*), Contracts itself (*bodylow*), Keeps glancing at me (*look*), The tail does not move (*tailno*), Hangs the ears (*earhang*), Touches me with nose (*nose*), Motionless (*moveno*), Moans (*moan*), Moves slowly (*moveslow*).
Disgust	Contracts itself (*bodylow*), Moves slowly (*moveslow*), Hangs its head (*headlow*), Keeps glancing at me (*look*) and The tail does not move (*tailno*)
Fear	Remains close to me (*near*), Pulls its tail between the legs (*taillow*), Keeps glancing at me (*look*), Hangs its head (*headlow*), Contracts itself (*bodylow*)
Surprise	Draws itself up (*bodyhigh*), Keeps glancing at me (*look*), Cocks the ears (*earsharp*), Lifts its head up (*headup*), Motionless (*moveno*)
Anger	Lifts its head up (*headup*), Moves actively (*movefast*), Barks (*bark*), Draws itself up (*bodyhigh*) and Keeps glancing at me (*look*)
Jealousy	Remains close to me (*near*), Touches me with nose (*nose*), Moves actively (*movefast*), Draws itself up (*bodyhigh*), Lifts its head up (*headup*), Rubs me (*rub*), Keeps staring at me (*gaze*)
Joy	Moves actively (*movefast*), Wags it quickly (*tailfast*), Lifts its head up (*headup*), Jumps on me (*jump*), Remains close to me (*near*), Keeps staring at me (*gaze*), Barks (*bark*), Draws itself up (*bodyhigh*), Rubs me (*rub*), Whines (*whine*), Cocks the ears (*earsharp*)

4.3. Similarities and differences between humans' representation of the Canine and their own affective space

Our results show that there are marked similarities in the way humans represent their own affective space (as reflected in the literature, see earlier) and the emotions of dogs. Activity and assertiveness may underlie the affective space of humans and dogs too (although arousal was found more frequently in the human dimensional studies than activity). There are several non-exclusive explanations explaining these similarities.

First, humans may rely on cognitive mechanisms to use their own existing affective space to represent dogs' emotions. This is generally referred to as anthropomorphism when people attributing spontaneously human mental features to animals (Wynne, 2007). Accordingly, the features of the affective space we found in dogs may reflect humans' anthropomorphism. In general humans are prone to anthropomorphize about dogs, in Western societies the majority of dog owners regard dogs as family members (Berryman, 1985; Kubinyi et al., 2009), and, for example, Rasmussen and Rajecki (1995) report that people see only quantitative difference between a 6-year-old boy and a dog. The finding of Morris et al. (2008) also support humans' tendency to attribute a wide range of specific emotions to dogs the existence of which is questionable (Horowitz, 2009; Hecht et al., 2012).

Second, humans also have the chance to gain experience through ontogenetic ritualization that is, when they interact directly with animals, specifically with dogs. However, the fact that people are similarly capable of judging emotional behavior of dogs irrespectively of their experience with dogs (Molnár et al., 2009; Pongrácz et al., 2005; Tami and Gallagher, 2009) suggests that in the recognition of dogs' emotion, direct learning may play a minor role.

Thirdly, similarity in the affective space of dogs and humans may reflect a biological basis (Plutchik, 2001), based on evolutionary (e.g. mammalian) homologies between the two species. This notion can be supported by correspondence in the brain structures underlying emotional behavior in mammals (Panksepp, 2005), and that mammals (including humans) share some similar patterns in their emotion expression (e.g. van Hooff, 1972; Morton, 1977). In reference to dog barking, for example, the Morton's rule (i.e. that auditory signals of different species show some parallel physical features) can explain why people with different amount of experience with dogs can identify equally well the behavioral context and attribute motivational state of a dog bark after listening to from play backs of this vocalization (Pongrácz et al., 2005).

In addition, one cannot exclude that domestication might have favored convergent processes in emotional behavior of dogs and humans (Miklósi, 2007). For example, a recent experimental study found functionally human-like jealousy in family dogs displayed toward their owners (Harris and Prouvost, 2014).

There are also differences in the way humans represent human affective space and the affective space of dogs (as reflected in our results). In the human studies arousal has been found to be the most prominent dimension which is connected to but is not the same as activity. Besides, pleasantness or valence seems not so important in the construction of dog's affective space as it is in the representation of human emotions. These differences can be attributed to the followings.

Firstly, in spite of some similar emotional reactions, dogs and humans have obviously different means to express their emotions, because of the different composition of the body. For example, while facial expression plays a critical role in emotion recognition and social interaction in humans (Schmidt and Cohn, 2001), the emotional or social behavior of Canids is characterized mainly of behavior elements associated with other part of the body (e.g. tail, ear) or whole body postures (Schenkel, 1947; van Hooff and Wensing, 1987; Tami and Gallagher, 2009). Most of the human dimensional studies which deal with behavior as stimulus actually concentrate on facial expressions. The only study (Wallbott, 1998) in which whole body movements were measured found a more similar dimension to ours: activity-passivity (and not arousal).

Secondly, while in most of the human dimensional studies the data is somehow connected to conscious experience or the verbal construction of emotion and only a few deals with behavior, in the present study dogs' emotions were located in the space by the means of behavior elements. It is plausible that valence is not manifested in behavior, and especially, in body movements. In parallel with this, the only study that measured affective space by the means of whole body movements in humans neither found valence as a dimension, but approach-withdrawal instead (Wallbott, 1998).

5. Conclusion

Our study is the first that utilizes the dimensional approach of emotion in connection with non-human animals. One can assume that the usage of human reports on animal emotions has the risk that such insights are influenced by anthropomorphism. The problem of anthropomorphism has been debated for long and arguments both in favor and against it have been put forward (e.g. Wynne, 2007). We support a balanced view, that is, (critical) anthropomorphism (Burghardt, 1991) can provide useful hypotheses for looking at animal behavior and these types of studies represent only the first step in this direction, which should be followed by more experiment-oriented approaches.

The present results suggest that humans represent dogs' emotions in a similar way to their own emotions. These similarities can be the result of mere anthropomorphism, but other factors as homology between the two species, domestication or ontogenetic ritualization can also play an important role. From the viewpoint of animal welfare it is a crucial question whether animals have similar emotional states as humans. But it is also crucial what humans think of it. The fact that humans represent animal emotions similarly to their own help understanding why the human public may be sensitive to welfare issues that affect the emotional behavior of animals. As animal welfare is a socially constructed idea, assessing "folk animal psychology" is important in order to establish a consensus about animal welfare (Watanabe, 2007). Qualitative assessment of animals' emotions by lay people can be a useful tool in welfare measurement (Wemelsfelder et al., 2000). And if our study is a step in the direction of more experiment-oriented observations of animal emotions, the contribution to animal welfare will be even more.

Conflict of interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.applanim.2014.11.003.

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