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Summary

Social referencing and understanding of human emotional expressions in dogs.

Introduction

The literature on dog cognition and in particular social cognition has grown incredibly in recent years, however no studies have focused on the process of Social referencing in dog-human communication and interaction, and only few preliminary studies have investigated dogs' understanding of human emotions.

Social referencing is a process characterized by the use of another person's perceptions and interpretation of a situation to form one's own understanding and guide action. Human infants use this process to go beyond the information given by an informant to construct a more general interpretation of the meaning of a stimulus and they can successfully link the emotions expressed to a referent object.

Social referencing has been investigated not only in humans, but also in a few primate species, namely chimpanzees and barbary macaques, although with mixed results. In fact, results from primate studies are overall ambiguous, with the strongest evidence of social referencing coming from human-raised chimpanzees, where it is exhibited with their human caretaker. There is, however, more consistent evidence that non-human primates can refer conspecific and human emotional expressions to a referent object.

The dog-human relationship is a very special one and the more recent literature shows that the dog-human bond is similar in many respect to an infantile attachment. Furthermore, studies suggest that dogs are sensitive to a number of behaviours potentially revealing the person's attentional states; can follow a number of human referential cues, and, preliminary evidence, seems

to suggest that they can also discriminate between some expressions of human emotions. Finally there is also some evidence that dogs can communicate intentionally and referentially with humans (although this is still a matter of some controversy). Considering the above, dogs are particularly good candidates for the comparative investigation of social referencing and of the ability to understand human's emotional expressions as referring to specific objects.

Four studies are presented in this thesis which aimed to investigate Social referencing in dog-human dyads and dogs' capacity to understand the referential nature of a person's emotional message. The aims of the present research were to add to the literature on dogs' socio-cognitive abilities and of human-dog communication by studying (1) the presence of Social referencing, both referential looking and behavioural regulation, in dogs towards humans, (2) the potential selectivity of this process, based on the relationship with the informant (owner vs. stranger), (3) the effect of a particular kind of training experiences (i.e. water rescue training) on this process, and (4) the ability of dogs to refer different emotional expressions toward two objects. To answer these questions we carried out four different experiments:

Study 1

Social referencing in dog-human dyads was investigated using the "new object paradigm". As no study has been carried out on dogs on this topic so far, we set up a new procedure suitable to this species, that was similar to the one used in the infant. In particular in our "new object paradigm" we presented dogs with a new and potentially scary object (a fan with plastic ribbons attached to it) in presence of their owner as the informant.

The aim was to evaluate whether, in a social referencing paradigm, dogs would show referential looking and behavioural regulation toward the owner acting as the informant and hence approach the object more having witnessed a positive vs. a negative message.

We tested 75 dog-owner dyads at the Canis Sapiens Lab of the University of Milan. There were two different groups of dogs: in one group the owner was delivering a positive emotional message towards the object, whereas in the second group the owner delivered a negative emotional message.

The results of this first study showed that dogs, like human infants, use referential looking towards a familiar person (their owner) in a situation of ambiguity. However, differently from infants, dogs showed no clear evidence of behavioural regulation after receiving an emotional message from the owner.

Study 2

Since the results obtained in the first study showed a clear presence of referential looking in dogs, but not clear evidence of behavioural regulation toward the owner, we modified the testing procedure to further evaluate behavioural regulation. We investigated the presence of Social referencing in dogs with the same potentially scary object (a fan with plastic ribbons attached on it) in presence of their owner vs. a stranger.

The study had two main aims. First, since results obtained in the first study provided only unclear evidence of behavioural regulation toward the object, we wanted to see whether using a procedure more closely resembling the one used with infants we would be able to find evidence of behavioural regulation. The second aim was to assess the influence of the informant's identity on social referencing. Selectivity is an important aspect of children's Social referencing: they seem to use referential looking toward both a familiar and an unfamiliar person, but they regulate their behaviour only when a familiar person is the informant or when she/he is present in the experimental set-up together with the unfamiliar informant.

We tested 90 dog-owner dyads and there were four groups of dogs: two groups were tested with the owner as the informant (either expressing a positive or a negative emotion), and two were tested with a stranger as informant (either expressing a positive or a negative emotion).

Results provided clear evidence that dogs use referential looking not only towards their owner but also towards a stranger, with no difference between the two persons. Furthermore, dogs regulated their behaviour towards the object after receiving a positive or a negative emotional expression by the owner, but not when the stranger was acting as the informant.

Study 3

Since in Study 2, besides referential looking, we found a clear evidence of behavioural regulation with the owner, whereas no clear results emerged with the stranger acting as the informant, we tested dogs exposed to a particular type of training: water rescue dogs. In fact, during their training these dogs become used to focusing their attention on unfamiliar person. Thus we investigated the presence of Social referencing in dog-human dyads using the same procedure and scary object as in study 2 but with a stranger acting as the informant.

For this study we tested 22 dog-owner dyads: the group of trained water rescue dogs were tested with their owners in Naples (Università degli Studi di Napoli “Federico II”), while the breed, age and sex matched control group was tested in Milano at the Canis Sapiens Lab of the University.

Dogs of both groups showed referential looking toward the stranger and this result supports those obtained in study 2. However, highly trained water rescue dogs did not change their behaviour towards the object (behavioural regulation) when the stranger was exhibiting a positive emotional expression towards it. Surprisingly, the control (untrained) group dogs did change their behaviour toward the ambiguous object, approaching it more than the trained dogs when the positive emotional message was given by the stranger. These findings are discussed in relation to our previous results (in Study 2) where no such effect was found with the stranger acting as the informant (we believe the likely cause is the breed of dogs tested in Study 3) and in relation to the potential inhibitory effect of training on dogs’ behavioural regulation in this context.

Study 4

In the previous three studies dogs were tested always in the presence of only one object (the potentially scary fan), and, although the informant's message always referred to that object, the goal of these studies was not strictly to assess whether dogs were capable of appropriately referring the human's emotional expression to the object itself.

So far only one study has tested dogs' ability to attribute a human's emotional reaction (facial expression and short vocalization) to a specific object (i.e. to grasp that emotions can be referred to something in the outside world). Thus the aim of this study was to assess dog's understanding of human emotional expression as referential. In particular, we evaluated if dogs can discriminate between three different emotional expressions (fear, happiness and neutral) and whether they have a perception that a human's (owner vs. stranger) emotional expression can refer to specific objects in the environment.

We tested 95 dog-owner dyads at the *Canis Sapiens* Lab of the University of Milan. We adapted a procedure used with infants, and more recently also with chimpanzees and dogs, in which the informant expresses two different emotions towards two identical (hidden) objects. In a control group, the same procedure is adopted but in the absence of the objects ("no-object" condition). After observing the emotional expressions being conveyed by the informant (owner vs. stranger) dogs were free to approach the objects.

Dogs showed a clear preference for the hidden object eliciting the positive emotion, compared to one eliciting the negative one when the owner was acting; on the contrary no preference emerged when the stranger was acting as informant. Furthermore, dogs didn't show a choice behaviour when the owner was expressing the emotion in the "no-object condition". A follow-up study, contrasting the positive and negative emotion in turn with a neutral one, showed that dogs tended to approach the object eliciting a positive emotion rather than avoid the one eliciting a negative reaction.

Taken together these results, show that dogs do in fact appreciate that an emotional message can relate to a specific object if the owner is the informant but they do not do so if the stranger is the

informant. Furthermore, their performance seems to be based on approaching the positive stimulus rather than avoiding the negative one. Together these results suggest that prior experience with their owner using positive emotional expressions, has allowed dogs to associate these emotions to particular objects. Finally, considering the non-specific behaviours exhibited by dogs in the no-object control group, dogs may even have come to *expect* that an emotional message refers to a specific object.

Conclusions

The experiments presented in the current thesis reveal some new and interesting aspects of dog social cognition and communication with humans. On the one hand they provide the first evidence of social referencing in dogs: they show that dogs, like infants, can show referential looking and behavioural regulation in ambiguous situations when the emotional message is delivered by the owner, or by a stranger (in presence of the owner). Finally, these findings suggest that dogs have some understanding that emotional expressions are referential, in the sense of being directed to specific stimuli in the environment as has been reported for infants and non human primates.

Chapter 1

Social referencing

Social referencing is a process characterized by the use of another person's perceptions and interpretation of a situation to form one's own understanding about that situation and guide action (Feinman 1982). In the classic paradigm an infant and their mother are presented with a potentially ambiguous toy. The mother is instructed to either provide a positive or a negative message about the object, and the infant's behaviour towards it is observed.

According to a number of authors Social referencing can provide the basis for the early development of emotional communication (Klennert et al. 1983) but also be a source of extrinsic regulation of emotions (Thomposon 1994, Walden 1991). In infants social referencing may take a secondary role in information gathering as language emerges (Adamson e Bakeman 1982) and can also permit the successful transmission of culture (Tomasello 1999, Tomasello et al. 1993). From a functional perspective, the importance of social referencing is that, like all social learning processes, it allows an individual to avoid making costly errors associated with trial-and-error learning (Roberts et al. 2008). However, according to a number of authors (Feinman 1982, Sorce et al. 1985), social referencing is a constructive process in which the infant goes beyond the information given to construct a more general interpretation of the meaning of the stimulus. Social referencing occurs throughout an individual's lifespan with no age limitation, as unknown and uncertain stimuli/ circumstances are frequent during lifetime; however, it develops early in infancy and represents a really important process, as infants are confronted daily with novel objects, people and situations. The appraisal of any novel situation, especially in infancy, is of extreme importance for their welfare and in the evaluation of the consequences of their own actions (Klennert et al. 1983). In particular this process is especially important towards the end of the 1st year, when infants

begin independent locomotion and become relatively self-sufficient in exploring their surroundings (Vaish et al. 2008).

Social referencing has two essential features: it can occur when the individual does not respond directly to the stimuli, but converts sensation into meaning (showing not just a request of reassurance (Clyman 1986)) and react on the basis of such interpretation; second, individual perception is influenced by others' interpretation of the situation (Feinman 1982). Furthermore, social referencing seems to be selective as there is greater reliance on the opinions of some individuals than others. The selectivity is particularly salient when an individual receives contradictory messages from two or more informants: for example, when a stranger enters a room infants look more to their mother than to their father, suggesting that the mother is a preferred source of information about the situation (Field 1979). The literature on infant attachment seems to imply that attachment figures are a favoured source of information about the world (Ainsworth 1979). However, some studies show that other figures having a relationship with the infant, like the father, the siblings, and also a familiarized stranger could be the informant (Dickstein and Parker 1988, Feinman et al. 1992); in addition, if the mother is present in the experimental room, even a stranger can be considered as an informant (Stenberg 2011), although this does not occur in the absence of the mother (Zarbatany and Lamb 1985, Bradshaw et al. 1987).

Furthermore, the uncertainty of the objects or of the situation seems to be important for social referencing to occur: for example in a study by Gunnar and Stone (1984) one-year old infants were influenced by social referencing to mothers when an ambiguous toys was presented, but not when a pleasant or aversive toy was presented. Hence the ambiguity of the object is important, in fact, the more ambiguous the object and the greater the difficulty the subject has in assessing it, the more frequently he /she will engage in Social referencing behaviour.

Social referencing includes two distinct components: the subject referentially looking towards the informant, i.e. alternating the gaze from the informant to the object/event, and the subject's behavioural regulation based on the emotional information received from the informant.

Referential looking, has been defined as looks to the informant that immediately (i.e. within 2s) follows/preceded a look to the novel object/situation: it shows an information seeking process specifically directed at the informant (Clayman and Emde 1986) and seems to occur both towards a familiar person and an unfamiliar one (Camras and Sachs 1991, Zarbatani and Lamb 1985, Stenberg 2011). It is important to highlight that referential looking is aimed at seeking information and not, like other types of looks, at searching for reassurance. This topic is one, which as we will see in chapter 2, has been extensively investigated varying the identity of the informant.

The second component of social referencing is behavioural regulation, where the subject is influenced by the positive or negative emotional expression (typically conveyed through facial and vocal means) of the informant. Adults constantly use social signals such as emotional expressions to guide other's behaviour in ambiguous or dangerous situations, and they often do so without conscious control. While the individual's subsequent behaviour may reproduce the other person's actions, the outcome behaviour of social referencing does not always result in imitation: imitation and social referencing are not isomorphic and imitation of a specific model's response can occur without inference as to the valence of the object (Feinman 1982).

It is also important to notice that Social referencing is a process that can be easily confused with mood modification. Mood modification is the reflection of an affective message on the subject's mood (Campos 1983, Klinnert et al. 1983, Stenberg and Hagekull 1997). The subject does not necessarily interpret the message as having something to do with the referent (i.e. a toy), but rather the informant creates a certain emotional climate which will modify the subject's overall mood and shape his/her behaviour not only towards the object, but also towards other objects and people or the situation in general (Walden e Ogan 1988, Feinman 1982, Stenberg and Hagekull 1997). Instead behavioural regulation refers to behaviour which, after receiving the emotional message, is specifically directed towards the referent (be it object, person or situation) and to nothing else (Feinman 1982). This particular distinction was investigated in a number of studies in which the presence of two different stimuli, only one being the target of the emotion, was used.

From these studies it emerges that infants are capable of understanding that the message specifically refer to the intended object (Hornik et al 1987, Rapacholi 1998, Stenberg and Hagekull 1997).

Experimental set-up

Social referencing has been studied using a number of different paradigms which mostly involve infants or non-human primates being presented with an ambiguous object, situation or person and the caregiver expressing either positive or negative emotions towards it (ambiguous object: Mumme et al. 1996; Kim et al. 2010; visual cliff: Sorce et al. 1985; Vaish and Striano 2004; stranger: Feiring et al. 1984; de Rosnay et al. 2006).



Figure 1: Experimental set-up before the ambiguous object was presented

Ambiguous object.

This kind of experimental apparatus is the most used in Social referencing studies, and with non-human primates is the only one used so far (Itakura 1995, Tomonaga et al. 2004, Russell et al. 1997, Roberts et al. 2008). Usually the infant is in an experimental room with the mother playing with some toys, when an ambiguous object (noisy and moving) suddenly appears. The reaction of the baby towards the object and the looking behaviour towards the mother (or the referent) is observed. Following this, the mum expresses one of a number of possible emotions towards the

object and the behavioural regulation of the infant is evaluated. The most used objects have been remote controlled infant toys like a robot and a moving cow (Mumme et al. 1996), a moving Santa Clause (Walden and Ogan 1998) or a toy car (Russell et al. 1997). A plastic snake has been used with non-human primates as they are fearful of this animals (Roberts et al. 2008).

The ambiguous object is the most used experimental paradigm, although the infant's immediate reaction to the object is not always standard and may vary greatly from one individual to the next (differently from the infant's reaction to the individual cliff for example, see below).

Visual cliff

Is an apparatus that using a large sheet of protective glass, forms an apparent "drop-off", or cliff. It is made of clear, very hard glass and is divided into two sides. On one side (the shallow side) there is a checkered pattern immediately under the surface of the glass. On the other side, a similar checkered pattern is positioned at a variable distance beneath the glass to create the illusion of a drop-off (Klinnert et al. 1983). Gibson and Walk used this apparatus for the first time to investigate depth perception in a variety of different animal species, and found that the avoidance behaviour of the cliff shown by rats, chicks, kittens, lambs, dogs, pigs and goats is instinctive. As infants too refuse to crawl out onto the glass covering the drop-off, this apparatus was used also in Social referencing studies with the mother expressing different emotions towards the cliff and the infant's crossing behaviour being evaluated. The *Visual cliff* paradigm has been shown to be a good experimental apparatus in allowing an evaluation of the mother's influence on her infant's behaviour: if the infant was placed on the shallow side of the apparatus he didn't look towards the mum and had no problem in moving or crossing the apparatus, while if he/she was put on the deep side, most subjects didn't cross the cliff and looked referentially to the mother. Following this, infants showed clear behavioural modification after the emotional expression received: crossing it or not depending on the mother's emotional expression (Sorce et al. 1985).

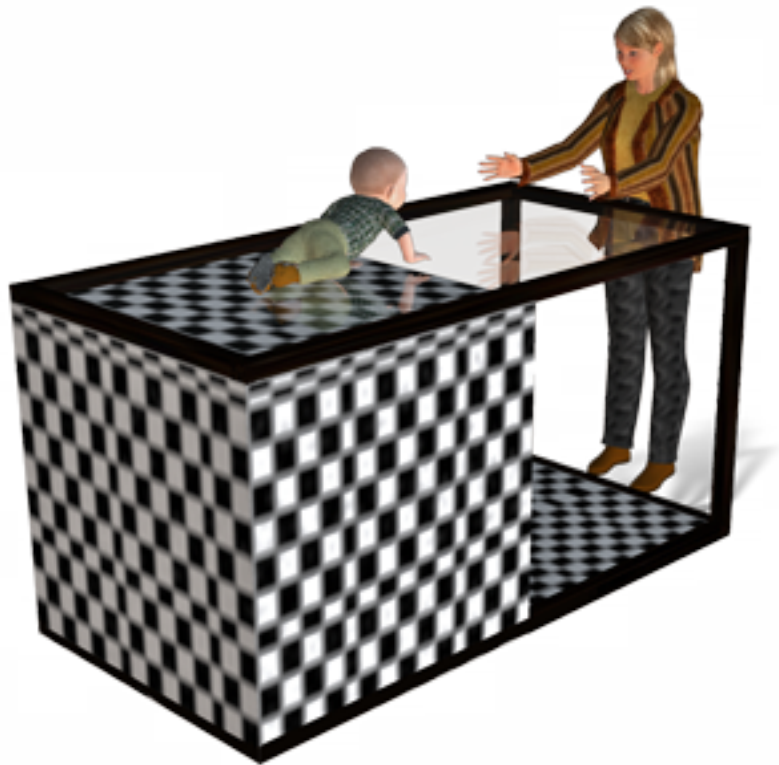


Figure 2: Visual cliff apparatus

A stranger.

Feinman and Lewis (1983) were the first researchers that studied Social referencing not towards an object or a situation but towards a stranger. They exposed 10 month-old infants in a situation in which a stranger approached them in the presence of the mother that provided nonverbal either positive or neutral messages each time the stranger approached the infant. Infants smiled more often in the positive than in the neutral message situation and offered the toy to the stranger more often in the positive message situation. After this initial study a number of other authors used this paradigm (Feinman et al. 1983, Klinnert et al. 1984) and this procedure has been adopted in later studies to evaluate how the social phobia of the mother could be transmitted to her infant (Murray et al. 2008; de Rosnay 2006). So, interestingly, this paradigm is the first that shows how Social referencing is an important mechanism that can influence the development of the individual's social relationship.

Chapter 2

The ontogeny of social referencing

Social referencing in infants

Research on social referencing suggests that somewhere between 9 and 18 months of age, infants start to use other's (the mother's or a stranger's) affective expressions to regulate their behaviour toward novel objects or ambiguous situations or persons (Boccia and Campos, 1989; Campos and Sternberg, 1981; Feinman and Lewis, 1983; Hertenstein and Campos, 2004; Kim et al. 2010; Klinnert, 1984; Moses et al. 2001; Mumme and Fernald, 2003; Sorce, et al. 1985; Vaish and Striano, 2004; Walden and Baxter, 1989; Zaratany and Lamb, 1985). Typically, by 12 months of age infants are able to link specific objects or events with another person's emotional message (Hertenstein and Campos, 2004; Moses et al., 2001; Mumme and Fernald, 2003) and actively seek out emotional information from others to guide their actions toward those objects and events (Campos and Sternberg, 1981; Feinamn, 1982).

Specifically, during the first year infants begin to evaluate events and act on their appraisals, engage in more sophisticated social and communicative interactions with caregivers, imitate unfamiliar behaviours, and distinguish and appropriately react to emotional expressions (Feinman and Lewis, 1983; Moore & Corkum, 1994); all these aspects are involved in social referencing.

Overall, the infant literature shows that infants look at the informant (generally their caregiver) and change their behaviour according to the emotional messages received: when receiving a positive message they reach closer to the object/person/situation and interact with it faster, or cross the visual cliff faster, than when receiving a negative one. Conversely, when negative emotional

information is conveyed they play less with the toy/person, look longer/more frequently at the care-giver, and are slower to move towards the care-giver, and they do not cross the cliff.

As early as 6 months human infants look to others in an ambiguous situation (Walden and Ogan 1988). Towards the end of the first year of life, looking behaviour becomes increasingly referential, or coordinated between the person and the object (Striano and Rochat 2000). In social referencing, the infant's quizzical or puzzled looks directed at the face of the referee during the presentation of the stimulus have been considered one way of gathering information from the referee about the situation. Infants, in fact, look referentially towards their mother but also towards a familiar care-taker or a stranger (e.g. Clyman et al., 1986; Feinman et al., 1992). The message delivered by the informant can hence be considered unsolicited if it is given regardless of whether or not the infant has displayed puzzled looks at the him/her (e.g., Hornik et al. 1987), or solicited when the message follows the infant's looking behaviour (e.g., Klinnert et al. 1983).

Infants at this age also start to regulate their behaviour in line with the emotional message received. For example, Sorce and colleagues (1985) found that one-year-old infants were more likely to cross a visual cliff after their mothers portrayed happy facial expressions, than when they displayed facial expressions of fear. Of the 19 infants whose mother smiled, 14 crossed the deep side, while of the 17 infants tested with the shift from a smiling face to a fear face, no infant crossed. Similarly, Vaish and Striano (2004) reported that infants crossed the cliff faster during a voice-plus-face positive condition, even if they compared this situation only with the face-only condition and not with the voice only condition, and the emotional expression was only positive.

Klinnert (1981) found that 12-month-old babies moved closest to the mother when she adopted a fearful expression, while they moved away faster from her when she showed joy, and maintained an intermediate distance from her when she appeared neutral. Stenberg also found that infants played more with the toy when receiving a positive emotional message, while they spent less time with it in the negative message condition (Stenberg and Hagekull 1997). Rosen and colleagues (1992) found that infants were more attracted by the toy when mothers displayed a happy

rather than a fear message: the interesting aspect of this study was that they found an effect of the unconstrained, opposed to trained, emotional message expressed by the mother, thus showing that if the expression was more natural infants were more attracted to the toy.

According to some authors infants respond more immediately to negative than positive maternal communication (Hornik et al 1987; Gunnar and Stone 1984). Feinman (1983) found that 10 month-olds were less friendly towards a stranger with their mother displaying a negative emotion (facial, vocal and gestural message) toward him, while when the mother's communication was positive, they showed a much more positive behaviour towards the stranger. Furthermore, the neutral expression seems to be closer to the positive one at this age: in particular, the comparison between the neutral expression and the negative one showed that infants in the negative message situation played less with the stimulus toy, whereas no difference between positive and neutral message emerged (Hornik et al. 1987, Mumme et al. 1966). It is worth noting that the effect of the emotional message on the infant's behaviour is not always immediate. In fact in some studies it was observed that infants needed time after the messages had ceased to show a change in their own behaviour towards the referent object (Gunnar and Stone 1984 and Hornik et al. 1987).

By 16 months of age infants respond differently to objects referenced with emotional expressions of a similar (i.e. fearful vs. sad) or different valence, indicating further refinement of social cognitive competencies (Martin et al. 2008). In fact Klinnert et al. (1984) found that 18 month-olds were more likely to reference their mother's face and to do so more quickly than younger babies, however their behaviour toward the unfamiliar toys was not regulated by the mother's smiling, fearful, and neutral facial expression, maybe because the older babies used their mother as a "base" from which to intermittently explore the toys and did not rely on her expression to modulate their behaviour. Furthermore, in Walden and Ogan (1988) older infants (10-22 months) showed a preference for looking toward the mother's face, while this was less frequent in the younger ones (6-9 months), maybe because the oldest ones understood that the facial expression provides a significant source of information about events. Moreover, younger infants looked more

often and longer when their parents expressed positive emotions, whereas the older ones did the same also in the fearful condition: it is possible that the youngest had not detected the fearful effect of the parental communication or that the message referred specifically to the toy. The younger age group spent more time touching the toy that had been associated with the positive message, whereas children in the older group spent more time in contact with the toy in the negative message group. This final result has been explained with the fact that older infants will have had previous experience with fearful parental communication, and that in an experimental situation, parents could have lacked acoustic and/or expressive quality, making the children have doubts about the sincerity or urgency of the situation. Furthermore, the parent did not do anything to prevent the children contacting the object, further revealing the “untrue” nature of the situation.

Very few studies have tested infants younger than 6 months. Interestingly, Hoehl et al. 2008 showed that by 3 months infants allocated increased attention toward objects that were potentially dangerous, namely objects that had been gaze cued by an adult with a fearful expression and not a neutral expression. This study is the first to demonstrate 3 months olds’ sensitivity to fearful expressions together with referential eye gaze. However, alternative explanations for these results should be considered: for example it could be that a fearful face attracts infants attention away from the object more than the neutral one and thus, when presented again, objects that had been gaze cued by a fearful face may be more novel and attract more attention compared to objects that had been accompanied by a neutral face. Therefore further studies are needed to evaluate at which age referential looking really appears.

Communication modalities: voice and facial expressions

Infants are sensitive to facial and vocal emotional expressions from a very early age. As young as 7 months of age they can discriminate facial expressions of happiness, fear, and anger (Kobiella, Grossmann, Reid, & Striano, 2008; Nelson & Dolgin, 1985; Nelson, Morse, & Leavitt, 1979) as well as different affect-laden intonation patterns (Soken and Pick 1999); in fact, 5-month-

olds can already successfully distinguish between sad and happy vocal expressions (Walker-Andrews & Grolnick, 1983). Hence a number of studies in the Social Referencing literature have specifically focused on the effect of conveying the emotional expression via different modalities (i.e. face, voice and face plus voice).

As regards the differential influence of the modality in which emotional expressions are conveyed, Sorce et al. (1985) used the visual cliff paradigm showing that a fearful facial expression of the mother (with no vocal assistance) stopped all the 17 (12 month old) infants tested in the study from crossing over the drop-off, while the positive face (a happy face) encouraged 14 infants out of 19 to cross it. The majority of social referencing studies assessing the influence of the different modalities of conveying emotional expressions used a novel toy rather than the visual cliff to create an ambiguous situation. Results towards an ambiguous object when the emotional expression is conveyed only by face are still not clear: Mumme et al. (1996), found that 12-13 month old infants looked longer at their mother (but only females showed this) if she exhibited a fear face rather than a happy face but they did not show greater behavioural inhibition in response to the fear facial expression compared to the positive one (Klennert et al. 1983, Mumme et al. 1996). This could be due to the different set-up used in the experiments. As suggested by Hirshberg and Svejda (1990), it is possible that the visual cliff situation elicited the optimal level of uncertainty in infants, for the unfamiliarity of the apparatus and for the depth; on the contrary, in situations that do not appear particularly dangerous, such as an object, the facial expression alone may not be sufficient to obtain a behavioural response and vocal or physical intervention are needed to facilitate the infant's response. On the other hand two studies found behavioural regulation occurring when a female adult (not the mother), displayed the emotional signal by face alone. Both studies found that in the happy-face condition infants approach the toy more quickly and more closely than in the fear-face condition (Camras and Sachs 1991 and Klennert 1984). So maybe with a message delivered from a stranger and not from the mother, the facial expression alone could be sufficient to obtain a behavioural response.

In contrast, vocal expression alone (Mumme et al. 1996 (with 12-13 months old), Kim et al. 2010 (with 18-20 months old)), and in combination with the facial expression, regulates infants' behaviours more powerfully than facial expressions alone (Mumme et al. 1996). Using a visual cliff paradigm, Vaish and Striano (2004) (with 11-12 months old), reported that infants crossed the cliff faster during a voice-only condition and a voice plus face condition than during a face-only condition. Svejda (1981) (with 12 months old) found that a fearful or angry voice were more likely to disrupt infant's behaviour towards novel toys than a happy voice, suggesting that the voice alone may be sufficient to modulate infant's behaviour. Mumme et al. (1996) confirmed this hypothesis showing that when the mother expressed fear vocally infants showed a decrease in toy exploration and tended to show an increase in negative affect looking even longer to the mother, but the same effect was not found with the positive expression. These two studies show how voice alone could be effective in the negative emotion condition, but not in the positive one. Conversely Kim et al., (2010) found that the voice alone can indeed change the infant's behaviour toward an object even when it is positive. In this study when a positive emotional message was conveyed vocally infants showed more approaching behaviour towards the ambiguous toy.

Based on the studies reported here it is clear that for infants from the age of 11 to 20 months the vocal expression is particularly salient, in fact it is interesting to note that in most studies assessing the effect of the vocal component alone, the informant's facial expression was still visible to the subjects. Hence even though the facial expression was neutral, the vocal expression (whether positive or negative) appeared to carry sufficient weight to influence the infant's behaviour. However, in potentially more stressful situations, such as the visual cliff, and when the stranger acted as the informant, the facial expression alone had an effect. This suggests that when the infant is in an uncertain condition, they are capable of using also the facial expression alone to guide their behaviour.

Although as reported above the vocal expression of emotions appears to carry particular weight in influencing infant's behaviour, most studies show that if the mother displays both facial

and vocal emotions the effect on the infants' behaviour is always more consistent (Vaish and Striano 2004, Mumme et al. 1996). In sum, it seems that the voice has the most powerful effect in infant social referencing paradigms, but that the use of multiple communicative channels together is more likely to regulate the infant's behaviour.

Gender differences

A few studies have also evaluated gender differences in social referencing (Mumme et al. 1996, Hall 1978, Rosen et al. 1992) and so far limited differences have been reported between boys and girls in a Social Referencing paradigm. Some empirical evidence suggests that at 1 year of age, girls are more socially oriented toward their mothers (e.g., Gunnar and Donahue, 1980; Wasserman & Lewis, 1985) and more wary (eg., Gunnar and Stone, 1984; Maccoby and Jacklin 1980) than boys. Rosen et al. (1992) found that the mother's emotional message (facial and vocal), affected only female infants. In particular, male infants stayed closer to the toy than to their mother in both the happy and fear conditions, while females stayed closer to the toy in the happy condition only. In the fear condition the mean distances from the toy and the mother for female infants were not significantly different. In the neutral-face condition girls showed the greatest decrease in looking toward mother and toy proximity, may be because for them the neutral face was more disturbing. This could be in line with Malatesta et al. (1989) that showed that usually mothers show a greater expressivity toward girls than towards boys.

Furthermore, the girls in the fear-face condition (with no vocal message being conveyed) increased toy proximity to the object (Mumme et al. 1996), even if they should be more accurate than males in decoding emotional expressions (Hall 1978, Malatesta et al. 1989). The reason for this difference in the infant's behaviour appears to be that the mothers' fearful messages to girls were significantly less intense than fearful messages to boys. So, contrary to what would be expected based on Malatesta et al.'s work, no evidence was found that mothers would present more intense fearful messages to their daughters than to their sons (Mumme et al. 1996). The specificity

of this gender effect to fearful messages is nevertheless conceptually interesting, especially in light of the unexpected finding that girls' but not boys' distance from the toy was modulated by maternal messages (Hall 1978). This pattern of findings both suggests that there may be early differences in how mothers and sons and mothers and daughters negotiate the affective meaning of novel objects that a mother thinks her infant might best avoid (Deaux & Major, 1987), and that differential infant sensitivity to emotional expressions may make a crucial contribution to these differences (Rosen et al. 1992). Overall these results do not show clearly how the infant's gender can influence the social referencing process, even if, in general, females seem to be more sensitive than males.

Informant identity: caregiver vs. stranger

Social referencing is a process characterized by the use of another person's (an informant) perceptions and interpretation of a situation to form one's own understanding of that situation and guide action. The identity of the informant seems to have an important role in this process. In fact a general postulate of the Social referencing is that it is a selective process in the sense that infants selectively reference (seek and utilize information from) their mother, or another familiar person, rather a stranger. However, a number of studies have used the presence of the stranger as the informant as a means to test whether the infant's looking behaviour was more a comfort-seeking or an information seeking behaviour. The reasoning behind this approach being that if infants are looking to seek comfort, they should do so preferentially towards the mother, even if she is not the one giving the information about the object/situation. On the contrary if infant's looking carry a motivation to gain more information about the situation, it should be directed towards the stranger who is acting towards the stimuli.

A number of studies have looked at this aspect of social referencing where the emotional message towards an ambiguous object (the only experimental set-up used for this topic) was conveyed either by a stranger or a familiar person. Two questions are normally addressed by the

studies: 1. Whether referential looking occurs equally towards a stranger and a familiar person and 2. Whether behavioural regulation occurs to the same degree regardless of the informant's identity.

As regards the first question, towards the end of the first year of life, infant's looking behaviour becomes increasingly referential, or coordinated between the people and the objects (Striano and Rochat 2000). A number of studies have shown that referential looking occurs equally with a stranger or the mother acting as the informant (Zarbatany and Lamb 1985, Walden and Geunyoung 2005, Stenberg 2011). Furthermore, it seems that at one year of age infants may be able to read signals of expertise (Feinman 1992), i.e., discriminate between persons who have or do not have relevant information to provide, and prefer to turn to those who seem to possess relevant information about the situation over those who do not (Stenberg 2011). These results support the hypothesis that infant looking behaviour, during circumstances of ambiguity, should not be interpreted in the framework of attachment theory (like in Baldwin & Moses, 1996) but rather should be considered as a search for relevant information in an ambiguous context. According to attachment theory, evolutionarily based behaviours designed to obtain security and comfort are directed to a specific person, namely the attachment figure (e.g., Ainsworth, 1979). In this perspective infant's looking behaviour during a social referencing paradigm should be interpreted as availability checking, proximity seeking, or comfort seeking, rather than as a search for information about the particular situation. However, considering the studies showing that the looking behaviours occurs equally towards a stranger than towards an attachment figure, and more so towards an expert-stranger than both a familiar and inexperienced-stranger, it seems more likely that the infant's looking behaviour is a search for information rather than comfort.

Furthermore, it is interesting to note that looking behaviour seems also to be influenced by the attentiveness of the informant: infants that did not receive information from the mother looked more at the experimenter than those whose mother had delivered guidance (Stenberg 2003) and at 10 months of age infants looked at the experimenter less if he/she was not attentive (Striano and Rochat 2000). These results provide further evidence that referential looking is not a mere form of

comfort seeking, but rather the search for information about the specific situation. Furthermore, it seems to suggest that this behaviour could be the expression of a rudimentary understanding of others intentions, and not just the result of an associative learning process (Striano and Rochat 2000).

Some authors highlighted that this interest for the experimenter (the stranger) could be explained in terms of an preference for the novelty (Walden and Kim 2005, Stenberg 2009, Stenberg and Hagekull 2007), or that it can suggests that infants might have been sensitive to signals of competence (the knowledge of the situation and of the place for example where the test is presented) in the behaviour of the experimenter (Stenberg 2009, Stenberg and Hagekull 2007). To evaluate if the novelty of the experimenter during the unfamiliar object presentation could influence infant's looking, Stenberg (2011) exposed the infants to a condition with two different strangers (the novel one and the less novel one): she found that infants showed no more looking behaviour towards the novel stranger, but, on the contrary, showed this behaviour more towards the less novel experimenter (maybe because they started to be familiar with her). This shows that the 'novelty effect' does not seem to play a role in the choice of whom to direct referential looking. The author also evaluated if the expertise of the stranger could influence infants' looking behaviour and found that infants looked more at the expert experimenter than the non-expert one. Thus, it seems that this factor, (the expertise) has the greater weight in influencing infants' looking preference.

As regards the second question, i.e. the influence of the informant's identity on the infant's behavioural regulation, it appears that infants will modify their behaviour in accordance with a stranger's emotional message, but only if the mother is also present in the room (presumably because she serves as a 'secure base').

In fact, two studies when the mother was not present in the experimental setup found no evidence of behavioural regulation based on the experimenter's emotional message (both positive and negative) compared with the same situation with the mother acting as informant (Zarbatany and Lamb 1985; Bradshaw et al. 1987). In these studies, however, there were two methodological

aspects that may have made the infants grow wary: the infants had to separate from their mothers during the procedure and the procedure was preceded by having the infants confronted with several unusual events. Both these aspects could well explain the lack of behavioural regulation observed.

In the presence of the mother, with a stranger acting as informant, infants appropriately altered their response to a novel toy in accordance with the adult's affective message especially if the adult displayed clear-cut signs that she was indeed referring to the toys (Moses 2001). Stenberg (2011) found similar results comparing (with the mother present) a less novel experimenter with a more novel one. In this situation the infants played significantly more with the toy and tended to touch the toy more when the positive expression was delivered by the less novel than the more novel experimenter. Friend (2003) found evidence of behavioural regulation in 4 years old children using an affective message recorded by a stranger and presented on a video monitor about a novel object: they approached more rapidly and played longer when the message were approving than when they were disapproving.

Familiarity of the informant is therefore important, and in fact the only study in which the infants were reported to modify their behaviour, in the absence of their parents, was when the informant was a caretaker that had an already established a relationship with the infant (Camras and Sachs 1991). In this case behavioural modification was seen to occur and also relate to the everyday expressiveness of the caretaker. In fact caretakers who were more expressive overall were referenced more during fear episode and infants were more responsive to them than to less expressive caretakers (Camras and Sachs1991).

Another aspect that has been reported to affect behavioural regulation with a stranger is the infant's age. As reported earlier, with the mother absent in the room when the stranger acted as the informant, no behavioural regulation emerged. However, one study with older children showed interesting results also with the stranger acting as the informant. In particular, Walden (1993), in a contest of affective information by a stranger towards an object, found that none of the children between 2 and 5 years of age ever touched the toy in the fearful condition. However, children older

than 5 years interacted with the object after a positive or neutral message, but in a somewhat more cautious manner than after the negative one. While when told that the stimulus was frightening older children approached the stimulus quickly and frequently. As mentioned previously, this same counterintuitive effect has been shown with the mother as informant as well (Walden and Ogan 1988). One hypothesis for this finding is that the older children may have developed a more independent and/or complex strategy for evaluating environmental stimuli and that at this age something ‘frightening’ may hold a particular attraction for its ‘forbidden’ character. What is interesting is that even in this case the stranger was not a “real stranger” because he was familiar to the children (authors mention, but do not specify in great detail, that the stranger was a person in the children’s school), and this could explain the “stranger effect” found, that was not present in the other studies with the stranger as informant.

In sum, overall the literature on the effect of an unfamiliar person acting as the informant in a social referencing paradigm showed that in the first year of life, infants show referential looking towards the stranger in a similar manner as towards the mother, but only if the mother is present in the experimental set-up do infants regulate their behaviour in accordance with the emotional message received by the stranger.

The valence of the emotional message (positive, negative and neutral)

The most used comparison in a social referencing paradigm has been a positive (happy) vs. a negative (fearful, disgust) emotion. Overall the literature shows that infants look at the informant and change their behaviour according to the emotional messages received: when receiving a positive message they reach closer to the object/person/situation and interact with it faster, or cross the visual cliff faster, than when receiving a negative one. Conversely, when negative emotional information is conveyed they play less with the toy/person, look longer/more frequently at the care-giver, and move slower towards the care-giver, and they do not cross the cliff.

Comparatively fewer studies have however addressed whether in fact children are mostly responding to the positive or the negative emotion, hence comparing each one with a neutral expression. Most studies that included a neutral expression showed that infants react to it in a manner similar to their reaction towards a positive message. Hornik et al. (1987) found that 12-13 month-olds infants in the comparison between the neutral, positive expression and the negative one, played less with the stimulus toy in the negative message situation, whereas no difference was found between positive and neutral message. Similar results were found by Mumme et al. (1966) where only the fear condition showed a change in the behaviour of the infants (12-13 months). Walden (1993), found similar results with older children (above 5 years of age) who interacted with the object after a positive or neutral message, but in a somewhat more cautious manner after the negative one.

On the other hand Klinnert et al. (1981) found that 12 month old babies moved closest to the mother when she adopted a fearful expression, while they moved faster away from her when she showed joy and maintained an intermediate distance from her when she appeared neutral. While Rosen in the neutral-face condition found that girls showed the greatest decrease in looking towards the mother and toy proximity.

What emerges from these studies is that overall, the negative emotion may be more salient in the learning process, probably because one cannot risk learning slowly about imminent dangers (Clare 1992 and Rozin and Nemeroff 1990). Furthermore, the fact that negative signals are used infrequently (Mumme et al.1966), may increase their impact when they do occur. Another possibility is that the neutral valence of the emotion is still not clear at this age for the infant, potentially because it is not so frequently used, but being less expressive does not have the same impact on the infant's behaviour.

Understanding the referentiality of the emotional message

Most studies on Social referencing have not been specifically designed to assess whether referential understanding guides infants' interpretation of the emotional messages. Only in a few studies, in fact (Honik et al., 1995, Stanberg and Hagekull 1997, Walden & Ogan 1988), were infants presented with two novel objects simultaneously, to better understand if they could refer the expressed emotion towards a specific object. In these studies the infant showed their capability to appreciate the specificity of the emotional signals directed towards different objects. In Hornik et al. (1995) the infants' (12 months) response to objects about which the informant conveyed affective information (referents) were compared with the reaction to other objects that were not targets of the informant's communication (non referent). The authors reported that the informant's affective message had an effect upon infants' behaviour towards the referent object in that following the negative (disgust) reaction of the mother, infants played less specifically with the referent toy.

Similarly, Stanberg and Hagekull (1997) found that infants played more with the specific toy eliciting a positive message than with the toy eliciting no message. Furthermore, they spent less time interacting with the toy eliciting a negative message than with the no-message toy. Finally, in the general positive message condition, where two objects were present, but the message did not refer to anyone in particular infants showed a high level of exploratory activity, but played less with toys compared to when they were referred to.

A particular testing situation was then proposed by Walden and Ogan (1988) who, after the parents' emotional expressions toward a positive and a negative object, allowed the infants to freely interact with both objects at the same time. Interestingly, some age differences were found with the older infants (14-22 months) looking most in the fearful condition and touching for longer the fearful object (associated with the negative emotion), and the youngest (9-12 months) looking most in the positive emotional condition and spending more time with the object associated with the positive emotional message. In sum, this research shows the presence of referential understanding,

because infants were free to focus on whichever object they pleased and their behaviour was affected by the referential message received.

To better understand infant's perception of referential behaviour a number of other studies focused on this topic using different experimental setups. For example, Repacholi (1998) showed infants (14-18 months) two boxes (each containing a hidden object) and in sequence signalled pleasure towards the content of one box and disgust towards the other. Infants chose the positive contents of the boxes. Furthermore, Moses (2001) found that infants (12-18 months) followed the affect of the referential emotional message of an experimenter to one of two available novel objects. On hearing the emotion, infants checked the experimenter's face, followed the gaze toward the appropriate object and showed the greatest behavioural change towards it. This indicates that infants can indeed recognize the significance of referential cues for determining whether a given emotional outburst is relevant to something immediately present.

In sum these results show that infants can successfully link the emotions expressed by an informant to a referent object thereby enabling them to acquire knowledge about the outside world, purely through observation of others emotional responses (Moses 2001). Understanding emotions is not a mere perception of a particular physical stimulus, but is the understanding of people, people's mind and interaction contexts (Kim et al. 2010). Social referencing is hence a process that helps humans, and especially infants, to avoid making costly errors associated with trial-and-error learning (Roberts et al 2008) and to go beyond the information given from others to construct a more general interpretation of the meaning of the environment.

Social referencing in non human primates

Social referencing has been investigated not only in humans, and especially infants, but also in a few primate species, namely Chimpanzees and Barbary Macaques, although with mixed results. Primates express emotions through vocalization, facial expressions and body posture (van Lawick Goodall 1968) and they seek comfort from others when they are frightened or distressed (Goodall 1986, Veira and Bard 1994). Furthermore, primates can observationally learn both from conspecifics and humans where to find food and if it is safe and palatable (Falcone et al 2012, Darby and Riopelle 1959, Subiaul et al. 2007), as well as which stimuli they should show fear of (i.e. a snake; Cook e Mineka 1987, Mineka and Cook 1986). Observational conditioning is not dissimilar to the behavioural regulation aspect of social referencing, although the referential looking behaviour is normally not tested in these studies. The same social referencing paradigm used with infants has however been used in a few studies with non-human primates, and it is these we turn to.

The first study on Social referencing in chimpanzees was carried out by Itakura (1995) on 6 mother-infant dyads. He investigated the responses of captive mother-infant pairs of chimpanzees to novel objects, and found that the infants engaged the mother more often with contact seeking behaviour (looking at the mother or returning to the mother) in the presence of a novel object than in its absence; furthermore they followed their mother more when she withdrew from it, than when she did not. Unfortunately, in this study no clear evidence of referential looking was found. Later, Russell et al. (1997) found good evidence of social referencing between human-reared chimpanzees and their human caregivers: chimpanzees looked referentially and adjusted their behaviour according to whether they had received a “happy” or “fearful” message from the caregiver towards an ambiguous object (4 different objects were used for this study). However, Tomonaga et al. (2004) found no evidence of referential looking in captive mother-infant pairs of chimpanzees in a novel object situation. Even if he found that after watching the mother manipulate the object, the infant often tried to touch it they seldom look back to the mother whilst doing so.

Roberts et al. (2008) investigated looking behaviour between 15 Barbary macaque (*Macaca sylvanus*) infants and their mothers in the presence of a rubber snake and in the absence of the snake: they found that only 2 of 15 infants looked referentially at their mother when confronted with a toy snake for the first time. Interestingly they found that older infants (aged 5 to 12 months) looked more at the mother than younger infants (aged 3 to 4.5 months). However, these results are not comparable with those obtained in other studies on chimpanzee, because in this experimental situation the mother could not look at the object, as this was visible only to the infant: so it is difficult to evaluate how this procedural aspect might have affected infants' referential looking.

Taken together results from primate studies provide overall ambiguous results, with the strongest evidence of Social referencing coming from human-raised chimpanzees, where this behaviour (both referential looking and behavioural regulation) is exhibited towards their human care-taker. This could be explained in terms of "enculturation" and not as a species-specific behaviour. Enculturation is a term used to refer to apes raised in a human environment, with a wide exposure to artefact and social/communicative interactions (Call and Tomasello 1996). This process has been shown to affect social cognition, including the use of imperative and occasional declarative pointing and joint attention (Call and Tomasello 1996; Furlong et al. 2008; Carpenter and Tomasello 1995) and so it could affect even the social referencing paradigm. However, the number of studies is still limited and other studies are necessary to better understand the role of Social referencing in non human primate intraspecific communication.

What is interesting to note here, is that even if the social referencing process needs further investigation, some authors found that capuchin monkeys (*Cebus apella*) appear to recognize the relationship between others' emotional reactions and specific objects responsible for these reactions. Recently, Morimoto and Fujita (2011) investigated whether this species recognized objects as elicitors of others' emotional expressions by allowing observer monkeys to witness a conspecific opening two identical boxes which either elicited a positive or a negative reaction. The observers preferred the container that evoked positive expressions in the demonstrator and avoided

the one evoking negative reactions. However, there were no difference between the positive and the neutral reaction. Furthermore, Buttelmann et al. (2009), following the general paradigm of Repacholi (1998), presented chimpanzees with a choice between two boxes, after seeing a human experimenter express disgust towards one and happiness towards the other. Chimpanzees like infants showed a marked preference for the box eliciting a positive reaction compared to the negative one, but, again there was no difference in the chimpanzees choice when exposed to the positive and the neutral reaction.

In summary, social referencing in primates so far has been shown especially when human caregiver act as the informant, but results with conspecifics are still unclear. What so far seems more clear, is that non human primates (apes and monkeys) can refer conspecific and human emotional expressions to a referent object. However, more studies are needed and what still needs investigation is the presence, in a social referencing paradigm of referential looking to obtain information and the behavioural regulation after the emotional message is conveyed.

Chapter 3

Why dogs?

The dog (*Canis lupus familiaris*) is a social species that has been sharing the human environment for longer than any other domestic species, occupying a close social anthropogenic niche since at least 12.000 years (Davis and Vall 1978). In fact, dogs are the first animals domesticated by humans (Clutton-Brock 1999) and no other domestic species has enjoyed such a widespread and close contact with humans. Archaeological evidence shows that their domestication started at least 12000 years ago, whereas more recent molecular genetic evidence indicates that their domestication process initiated somewhere between 35000 and 60000 years ago (Miklosi et al., 2000; 2004; Vilá et al., 1997; Davis and Valla 1978; Savolainen et al., 2002).

Dogs originated from the ancient wolf (*Canis lupus*) or some extinct relative, a wolflike species (Clutton-Brock, 1999; Coppinger and Coppinger, 2001; Olsen, 1985) and went through an adaptation process to the human living environment: in fact, recent studies seem to suggest that overall dogs are more inclined than wolves to both look at humans and follow humans' communicative gestures (Lakatos 2011, Hare et al. 1998, Soproni et al. 2001, Miklosi et al. 2003).

Besides deriving from a highly social species, that shares many characteristics of the complex social systems known in primates, dogs' natural environment has been the human society and human selection has further favoured the evolution of dogs' social cognitive abilities (Cooper et al., 2003): for the above mentioned reasons dogs represent an important model for studying social cognition and better understand the evolution of human social intelligence. In the last fifteen years dogs have become the object of study by many cognitive researchers, and the number of published studies on dogs has grown (Cooper et al. 2003, Miklosi et al 2004) (Figure 1).

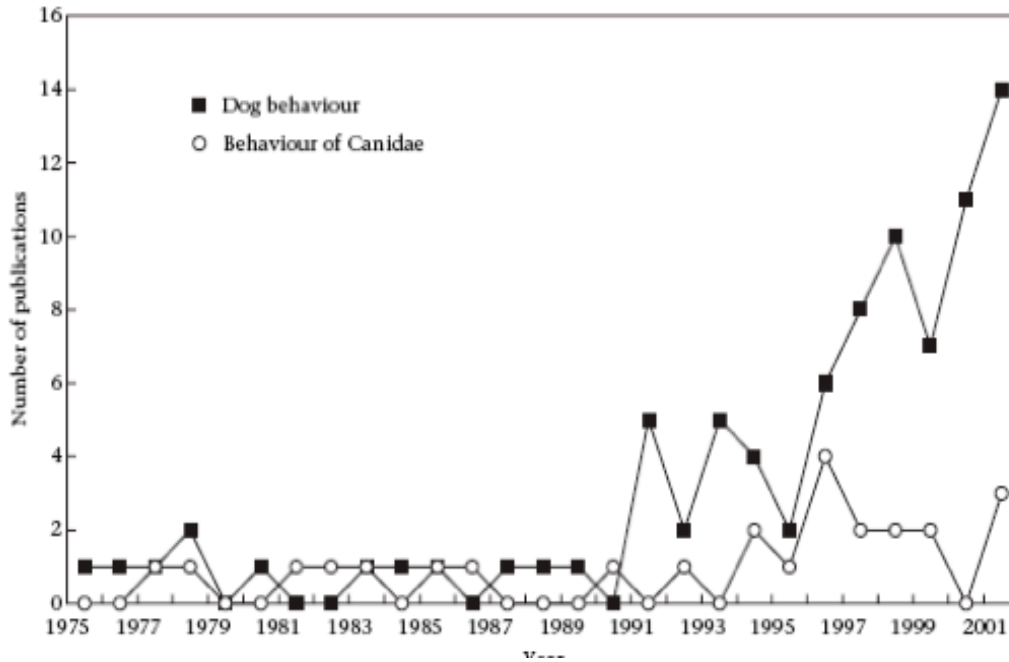


Figure 1: the increase in published papers on dog and canid behaviour from Miklosi et al (2004).

A further important aspect of dog studies is that they are carried out in the dogs' natural environment which is characterized by constant interactions with humans: thus dogs are naturally 'encultured' animals. Enculturation is a term used to refer to apes raised in a human environment, with a wide exposure to artefact and social/communicative interactions (Call and Tomasello 1996): it is the lifelong opportunity to experience human contact and interact with our species and offers an opportunity to get extensive experience to interpret human behaviour and social cues.

Based on a growing literature showing dogs' sophisticated cognitive abilities in the social domain, a number of researchers have suggested that dogs, may represent a case of 'convergent evolution' (Hare et al., 2002; Kaminski et al., 2005; Miklosi et al., 1998). The processes of 'convergent evolution' can be defined as the existence of similar behavioural/morphological/cognitive traits in species that are genetically far from one another, but exposed to similar environmental/social pressures (Emery and Clayton, 2004). In this respect, the studies on apes, chimpanzees in particular, which look at similarities with humans as a result of genetic vicinity, and the studies on dogs, looking at similarities with humans as the potential results

of environmental (including social) vicinity, complement each other in drawing a more comprehensive picture as to what it is that makes us human.

Most studies on dogs cognitive abilities have been carried out focusing on social cognition and within these many have focused on dog-human communication and relationship with two main aims: to understand dogs' communication towards people, and to investigate dogs' understanding of and sensitivity to human communication (both verbal and non verbal). In social animals the ability to express emotions but also to recognize other's emotional states and their meaning through a variety of observable signals (i.e. vocalizations, body postures and facial expressions) is essential; understanding the meanings of others' emotional expressions is not only fundamental for adjusting behaviourally to the emotional state of others, but also to reach an efficient monitoring of the environment. In fact, others' emotional reactions can be used as a source of information about environmental events allowing the observing individual to cope flexibly with the external world for example by gaining access to valuable resources or avoiding potential dangers. However an understanding of other's emotions can also facilitate group cohesion (Racca et al. 2012) and promote the development of social competence (Nelson and Russell 2011). Emotion recognition has been shown to be essential in human infant–adult communication and appears to be important also in dog–human communication, which relies on non verbal cues (vocalizations, body postures and facial expressions).

The number of studies looking at dog-human communication in the last 15 years has increased dramatically, however for the purpose of this introductory review we will focus specifically on studies directly relevant to the aims of my research. Hence two broad areas will be covered: dogs understanding of human communication and how dogs themselves communicate with humans. More specifically, pertaining to the first area we will review studies looking at dog's understanding of human a) attentional states, b) referential communication and c) emotions. Whereas in the second area we will focus on research looking at whether dogs themselves communicate referentially towards humans. Finally, the last section will look at studies showing

that a number of factors (e.g. dogs training, audience identity etc.) can influence dog-human communication (both understanding and production).

Understanding of human communication

Dogs' understanding of humans' attentional states

Recognition of another's attention is the first step in the communicative context when the sender of the signals must ascertain the receiver's ability to attend to it. This is particularly true when communication is based on a visual as opposed to an auditory modality. The first attempt to understand whether dogs are capable of discerning the attentional state of humans was carried out by Hare et al (1998) using a simple experimental paradigm in which dogs and the experimenter played a game of 'fetch' but on half of the 36 trials the researcher was sitting facing the dog whilst in the other half he sat turning his back to the dog. Although only 2 subjects were tested, this first study suggests both dogs were indeed sensitive to the experimenters attentional stance, since they systematically brought the ball back so as to face the experimenter and not to his back. A more systematic study was carried out by Gácsi et al (2004). Using a larger sample (17 dogs), the authors tested the dogs' ability to retrieve a ball either in a game context (the fetch game as used by Hare et al 1998) or in a more formal context in which dogs had to simply bring an object back to the owner. In the game situation the owners would be standing whilst in the 'bring' situation owners would either be sitting in a chair or on the ground. In both game and formal contexts the owner would be either 1. facing or 2. back turned to the dog and either 1. blindfolded or 2. not blindfolded. Overall results were varied. Dogs performed particularly badly in the 'game' situation, although they indeed appear to discriminate between back turned and facing in the more formal 'bring' situation, particularly when owners were seated on the ground. The same authors in a second study (Gácsi et al. 2005) investigated the same issue using different experimental paradigm in which dogs could choose whether to beg food from an attentive vs. inattentive researcher, i.e.

respectively head orientation towards vs. away from the dog, and seeing vs. blindfolded. Dogs showed preferential begging from the attentive human in both situations and there was a correlation between the dogs behaviour in the first and second experimental paradigm suggesting dogs understood the underlying concept and were capable of adapting their behaviour accordingly. The begging paradigm with head oriented towards vs. away was used also by Virányi et al (2004) with equally significant results.

Another experimental paradigm which has been used to investigate dogs' understanding of human attention has involved the dog's tendency to obey a person's (owner or stranger) specific commands according to the latter's attentional state. Thus, Call et al. (2003) created a situation in which dogs were told they were not allowed to take a bit of food on the ground, and then did one of a number of things amongst which leave the room, sit looking at the dog, sit turning their back to the dog, sit with eyes either open or closed etc. Results clearly showed that when humans were looking at them dogs retrieved less food and approached it in a more indirect manner leading authors to conclude that they were in fact sensitive to the attentional state of the observer.

Bräuer et al (2004), added an interesting variant to the above described paradigm by inserting in the room one of a number of different barriers (large, small and with a transparent window), in specific positions which would or would not allow dogs to obtain the food undetected by the experimenter. Results showed that dogs retrieved the forbidden food significantly more often in those conditions in which the researcher could not see the dog. Thus they were capable of taking into account the experimenter's visual perspective and act accordingly.

Virányi et al (2004) also investigated dog's comprehension of attention by analysing whether dogs would respond differently to an owner's recorded command ('Down') depending on his attentional state (i.e. facing the dog, facing another person, facing somewhere in between and with owner behind a barrier). Dogs performed significantly better in the 'face to face' condition. Interestingly, their performance in the 'in-between situation' was mixed. Thus in an ambivalent

situation in which the owners behaviour was not unequivocal the behaviour of the dog reflects a certain amount of hesitation.

Scwhab and Huber (2006) compared the two situations thus carrying out a study including both the performance of a simple command (lie down) and the food avoidance scenario. Tests were carried out in a more naturalistic context, with the owner (as opposed to a stranger as in Call et al 2003) performing everyday behaviours (such as reading a book or watching TV) and at the dog's home. Results essentially confirm previous results (Call et al's 2003; Virányi et al's 2004) providing complementary evidence that dogs are indeed able to discriminate between attentional states in humans.

Finally Marshall-Pescini et al. (submitted) in an unsolvable task paradigm, showed that dogs appeared to take into account the attentional stance of an actor, since they alternated their gaze less if the experimenter had her back turned to the task. This is further supported by results showing that in this specie, subjects in the inattentive group took longer to look at the experimenter, gazed at her less frequently and for a shorter time than subjects in the attentive group.

Gaunet (2010) carried out the only study that found no presence of dogs' sensitivity to human attentional states. Gaunet presented guide dogs and control dogs with a communicative task which involved their owner (sighted or blind). The results showed that in commonly experienced interactive situations, dogs do not show sensitivity to their owner's visual attentional state. But in this special situation (blind people) the author suggested that the visual status of the owner could be too subtle a behavioural cue to be used by (all) dogs and that guide dogs are raised and continue to live surrounded by sighted people.

Horowitz (2008) took an innovative approach to the study of attention by analysing 'attention-getting' behaviours and play signals in dog-to-dog dyadic play. What emerged from her study is that dogs were capable of taking into account another dog's state of attention during interactions. Thus for example play signals were predominantly carried out by the sender only to an 'attending' dog, whereas attention-getting behaviours were carried out only to non-attending dogs,

and these signals varied both in intensity and repetition according to the state and perseverance of the recipients inattention.

Although all authors appear to agree on the seemingly convincing evidence of dog's understanding of attentional states, it cannot be said that any one study can exclude the possibility that dogs have quite simply learned an association between certain human signals and their consequences, in their very close and extensive experience of people. Udell et al. (2010) for example tested shelter and pet dogs (as well as wolves) in a begging paradigm with a variety of attentive vs. inattentive conditions, which could be considered more or less familiar to the canines tested. They hypothesized that if experience is predominantly responsible for dogs' performance in these begging tests, then shelter dogs should perform more poorly than pet dogs, and pet dogs should perform better in conditions more familiar to them. This was in fact the case.

However, considering all the studies together the picture is certainly more convincing since there does seem to be great consistency in the understanding of human's attentional states across many variants (blindfolds, body postures, head orientation, visual barriers) and situations (commands, games), although familiarity may non-the-less have a role in dogs' understanding of when humans are attending to them.

Dogs' understanding of referential gestures

Another interesting group of studies has focused on dogs' capacity to utilize human gestural cues, like pointing (Lakatos 2011) (Figure 2). The experimental paradigm usually used in these studies involves a human researcher hiding food outside the dog's view in one of several locations (typically under identical flower pots), and then giving particular social cues (usually the pointing) to indicate the correct location of the food. Pointing is a human-specific signal, which is referent for its nature and is omnipresent in our everyday interaction (Kita 2003). Dogs have been reported to be very skilful in comprehending a variety of human pointing gesture in many different studies (Hare et al 1998, McKinley and Sambrook 2000, Miklosi et al 1998, Soproni 2002). They can

choose on the basis of proximal and distal pointing, and Soproni showed that they are able to rely also on relatively novel gestural forms of the human communicative pointing gesture. The direction of the arm more than the movement of it seems to be the central part for the understanding of the communication (Hare et al. 1998, Soproni 2002). Furthermore, they can follow it even if the olfactory and the visual information contradict the pointing (Lakatos et al. 2009). Pointing seems to be even more powerful when accompanied to eye-gaze, whereas gaze alone tends to be harder for dogs to follow (Hare et al. 2002).

Dogs' ability to follow referential gestures extends to head turning (Miklósi et al 1998), nodding (Miklósi et al 1998), bowing (Miklósi et al 1998), and a human placing a token on the target location (Agnetta et al 2000; Hare et al. 1998; Riedel et al 2006). As for gazing however, the picture is more mixed.

In the case of gaze cues when the experimenter signals the location of the hidden food by looking at it without any other body movements, dogs' performance is not as striking. However, results vary considerably depending on the methods used (Hare et al., 1998; Agnetta et al., 2000, McFinley and Sambrook, 2000; Brauer et al., 2006). For an example, it seems that they can comprehend a static, ostensive gaze as a cue more easily than a momentary glance (Brauer et al., 2006). McKinley and Sambrook (2000), found that some dogs appear to respond to eye gaze alone as a cue. Two dogs in this study were significantly more likely to choose the object the experimenter was looking at, whilst other dogs fell below the threshold of significance. However, their generally increased choice of the correct cup resulted in significance at the group level, suggesting that the subjects overall were at least partly attending to this cue. Agnetta et al. 2000 found that in a situation not involving food, dogs did not follow the human gaze direction. In fact, in this study the experimenter looked at the dogs and gained its attention, then the experimenter attempted to direct the subject's gaze to one of three predetermined locations (straight up, directly to the left, or directly to the right of the dog) by turning his head and looking at that location.

Interestingly even wolves seem to follow the gaze of humans and conspecifics, but it seems

that this ability change in different condition: gaze following around a barrier appears in wolves only at the age of 6 months, while gaze following of the human demonstrator into distant space is present already at 14 weeks when wolves were first tested (Range and Viranyi 2011).

In sum results show that domestic dogs and wolves can follow the human gaze, but it seems that this ability depends on a number of factor: test paradigm, and potentially also the dog's prior experience. Further studies in this field would be important to understand this processes more fully.

As with dogs' understanding of human attentional states, also as regards their understanding of referential communication there is an on-going debate as to the mechanisms responsible. According to a number of authors dogs show an innate sensitivity to such gestures which may have been selected through domestication (Hare et al 2002, Gasci et al 2009a), however according to others an associative explanation may be sufficient to account for the data (McKinley and Sambrook 2000). In support for the first view a number of studies have shown that even very young puppies can follow human gestures (Hare et al 2002, Hare et al. 2005, Agnetta et al 2000). Furthermore Hare et al. (2002) compared puppies with normal socialization experiences with humans with puppies less exposed to the human environment and they didn't find a significant differences between the two groups to in their ability to follow human gestures. Gasci et al. (2009a) tested 180 dogs of different ages (from 2 months to adults) in order to investigate their performance with the distal momentary pointing gestures. The results, analysed at both the group and the individual level, showed no difference in the performance according to age, indicating that in dogs the comprehension of the human momentary distal pointing may require only very limited and rapid early learning for its full development.

Furthermore human-raised wolves, despite comparable experience with dogs, are less sensitive to these gestures (Viranyi et al. 2008, Gasci et al. 2005, Agnetta et al. 2000. Hare et al. 2002). However, a number of other studies have found contrasting results, with puppies not following pointing (Wayne et al. 2008, Dorey et al. 2010), shelter dogs performing more poorly

than pet dogs (Udell et al. 2010), and wolves performing like some dogs (Gacsi et al. 2009a, Udell et al. 2008).

Overall, pet dogs are undeniably very good at following human referential gestures, but the origins of this ability are still debated.



Figure 2: Example of pointing task

Dogs' understanding of human emotions.

Recently a number of studies have focused on dog's ability to discriminate between different human emotions and their ability to take advantage of these emotions to interpret the outside world. Dogs seem to discriminate between human faces since in a visual paired-comparison task when presented with two pictures simultaneously, dogs looked at the novel human face longer than at the familiar one (who was not the dog's owner) (Racca et al. 2009). Furthermore, dogs seem to discriminate not only between different faces, but also between owner's emotional facial expressions: in fact, they looked longer at their owner's face when the owner felt happy than when they were sad (Morisaki et al. 2009).

Nagasawa et al. (2011) investigated dog's ability to discriminate between smiling and neutral faces of both their owner and unfamiliar people. After a training phase involving nine dogs learning to discriminate between a set of photographs of their owner's smiling and a blank face, five dogs were successful in the discrimination task and performed significantly above chance. In the test phase, when presented with 10 new sets of photographs of the owner's smiling and blank face (not previously seen), dogs selected the owner's smiling face significantly more often than expected by chance. Furthermore, when shown sets of smiling and blank face photographs of unfamiliar persons (10 males and 10 females) dogs were able to discriminate smiling faces from blank faces of unfamiliar persons of the same gender as their owners, but their accuracy was significantly lower in the case of unfamiliar persons of the opposite gender to that of the owner. Overall, these results suggest that dogs can learn to discriminate human smiling faces from blank faces by looking at photographs.

Other studies show that dogs seem to react differently to actors performing a range of emotional facial expressions (anger and fear) compared to neutral ones (Deputte and Doll 2010) and are sensitive to the tone of voice (gentle vs. harsh) used by a human in an obedience task (Fukusawa et al. 2005), a pointing task (Scheider et al. 2011) and when evaluating a third party interaction in a begging paradigm (Marshall-Pescini et al. 2011).

So far only one study (Buttelmann and Tomasello 2012) has focused on dogs' ability to use the emotional reaction (facial expression and short vocalization) of a human stranger, towards two boxes containing food, to select between these boxes. Buttelmann and Tomasello (2012) found a slight evidence that dogs, having observed an experimenter show happiness towards the content of one box and disgust towards the content of the other box, selected the box eliciting a happy expression. However, dogs performed at chance level in the Happy-Neutral condition, possibly because the two emotion were less distinct (Figure 3).



Figure 3 The emotional expressions shown by the experimenter: a “Happy” when finding a piece of sausage inside the box; b “Disgusted” when finding garlic inside the box; and c “Neutral” when finding bedding material inside the box. All expressions are pictured as seen by the subject

Overall, studies on dog’s understanding of human emotions show that dogs seem to discriminate between different facial emotion expressions and be sensitive to different tone of voice. Furthermore, only one study (Buttelmann et al 2012) investigated whether dogs may understand that human emotional expressions may be referential (i.e. be ‘about’ something in the environment).

Considering the literature covered so far on dogs understanding of human communication, although a lot of studies show that dogs are sensitive to the attentional state of humans and that

they can use many referential communicative cues, only a limited number have investigated dogs' ability to recognize between different emotional expressions and use human emotional expressions to guide their own behaviour. Current research will cover these three aspects pertaining to dogs' understanding of human communication.

Dogs' communication towards humans: can it be referential?

Dogs have a lot of signals that they can use to communicate with others. During social behaviour and social interactions they use different communicative media: vocalizations, gazing and body language (e.g. jumping, running back and forth, etc.). However, the question that has interested researchers most is whether dogs can communicate towards humans in an intentional and referential manner. The most used experimental paradigm is a situation in which dogs have witnessed a person hiding a desired toy or food in an out-of-reach location. After this hiding episode the person leaves the room, and another 'ignorant' person (owner or researcher) enters the room. The question is whether dogs exhibit 'showing' behaviours indicating to the ignorant person where the food/toy has been hidden. A number of control groups in these studies have been used to assess whether dogs' behaviour is specifically directed to the person. The main elements of the "showing" behaviour are that the dog (1) displays directional signals related to the external event and (2) displays signals aimed at directing the receiver's attention to the external event.

The first attempt to study referential communication between dogs and humans was carried out by Hare et al., (1998) in which dogs could witness a person A entering a room and hiding some food and then leaving again. Shortly after that, Person B entered the same room. Depending on the condition Person B would either look at the dog, turn his back to the dog or be blindfolded. It emerged that dogs' response to these different experimental situations did not vary, however there was evidence of showing behaviour since dogs would look at the location of the hidden food (directional signal to external event) and bark whilst alternating their gaze from the external event

to the person (direct the receivers attention). In fact, the person (Person B) was capable to choose the correct location on 81.5% of trials based on the understanding the dogs' behaviour. Although promising, the results of this study were seriously hampered by the limited number of subjects (one dog) tested and the lack of control conditions to monitor the dog's behaviour in the absence of the experimenter in the room.

Thus, Miklósi et al. (2000) carried out a more thorough and systematic investigation of 'showing' behaviour in dogs, using the same 'hiding-food' paradigm, but with a somewhat larger sample size (10 dogs) and the owner as opposed to stranger as the 'receiver'. Furthermore, the study introduced two important control conditions, i.e. (1) the dog was left alone for a comparable time period after the experimenter hid the food and (2) the experimenter, instead of hiding food entered the room and petted the dog, who was then left with its owner. Results showed that dog's were sensitive to the situation in that in the 'hiding' condition, when the owner returned to the room, half of the dogs started vocalizing (which they had done in no prior condition), their looking time towards both the owner and the baited location increased significantly compared to the 'alone condition,' and gaze alternation between the food location and the owner emerged (which was absent in the 'petting' condition).

Virányi et al (2006), took the question one step further by presenting dogs with conditions in which they would be asked to discriminate as to what a person had or had not seen being hidden in a specific situation. As a comparison 2.5 year old children were also tested. Thus both a toy and a stick (necessary to retrieve the toy) were hidden in various out-of-reach locations in a room, however depending on the condition, the dog's helper (i.e. the person who retrieved the object for the dog) would witness the hiding either of both, none, or only one of the two objects. The question was whether dogs would be sensitive to what the helper had witnessed and thus would adapt their communicative behaviour accordingly (i.e. looking at the location of the toy only when the helper had not witnessed it being baited etc.). One week pre-training phase was carried out in which the owners created situations in which during play the ball would roll into a specific out-of-reach

location. Dogs would thus witness the owner trying to retrieve the toy, failing, and then using a stick to do so. Results showed that whereas infants were capable of discriminating between situations, thus indicating the appropriate object in accordance with what the helper had or had not witnessed, dogs hardly ever indicated the stick location, preferentially indicating the toy location instead. However dogs did discriminate between when the helper had or had not witnessed the toy being hidden, in that they indicated its location significantly less in the latter situation. Authors concluded that dogs showed less sophistication in communication than infants, however it is possible that, despite the pre-training phase, they failed to appreciate the functional connection between the stick and the toy, thus considering the former barely relevant in the situation, whereas of course children would by this age have had multiple experience with tools.

Taken together results from these studies have led most authors to conclude that dogs are indeed capable of displaying 'showing' behaviour, and hence appear to communicate with humans in a referential manner however, it is yet unclear whether these types of 'communicative' behaviour, i.e. 'attention-getters' and gaze alteration may have simply been inadvertently shaped through human reinforcement during the dog's life.

A recent study by Kaminski et al. (2011) used a similar paradigm to that described above, and investigated the flexibility of dogs' 'showing behaviour towards humans, by hiding either object that were of interest only to the person, or object that were of interest only to the dog, or objects of interest to both dog and person. Based on the dogs' showing behaviour towards the hidden objects, the human found the target more frequently in situations where dogs requested an object for themselves than in situations where the human needed information, although this seemed to be different when the person the dogs were interacting with was their owner. In the latter case, dogs seemed to be motivated to indicate the location of an object even when there was no direct benefit for them. The lack of flexibility exhibited by dogs in this study may support the notion that gaze alternation is a behaviour elicited by specific trigger situations as a way to use humans as social tools to obtain a desired goal and that dogs have learned to do so during their daily

interaction with people. Although, further research will be necessary to probe the flexibility of dog's showing behaviour in different context, and hence draw some conclusions on whether it is in fact exhibited only in a 'requesting' context.

Another experimental paradigm which has been used to explore dogs' communicative behaviour towards humans is the 'impossible task paradigm'. This paradigm was first used by Miklosi et al. (2003) when presenting dogs and wolves with a problem solving situation to obtain food. After some trials in which the problem could be solved independently by the animals, the task became unsolvable. In the unsolvable phase, dogs looked back earlier and spent more time gazing at the human compared with wolves. From this study authors concluded that over the course of domestication and subsequent selection, dogs may have ended up with a particular predisposition for communication with humans. Human-directed gazing, and gaze alternation in particular, have been considered in these contexts to be a requesting gesture whereby dogs, having realized that they could no longer obtain the desired object, turn back to their human partner to ask for intervention (Miklósi et al. 2000, 2003, 2004; Gaunet 2010; Viranyi et al. 2006; Passalacqua et al. 2011; Marshall-Pescini et al. 2009).

The same task was used by Passalacqua et al. (2011), to investigate the ontogeny and potential breed group differences in this 'looking back' behaviour. Results showed that at 2 months no breed-group differences in looking behaviour towards humans emerged, and this behaviour was only present in about 50% of the pups tested. Breed group differences however emerged slightly at 4.5 months and more significantly in adult dogs with the Hunting/Herding group gazing at humans for longer periods than dogs in the Primitive and Molossoid groups when the task became unsolvable. Furthermore, adults were faster at looking back towards humans, and did so for longer than 4-month old puppies in all breed groups. Hence it seems that exposure to a household environment and humans communicating may be necessary for this behaviours to emerge, since it started to become more evident at 4.5 months once pups were in the human home. Furthermore, it

appears that selection for cooperative work such as hunting and herding may have affected dogs' inclination to look towards humans.

Finally, in a more recent study Marshall-Pescini et al. (submitted), investigated whether dogs and toddlers would use human-directed gazing behaviour and gaze alternation and whether they would take into account the attentional stance of the audience when communicating with them. Hence they used the unsolvable task paradigm and varied, in the crucial unsolvable trial, the attentional stance of the audience (facing vs. back turned). Both dogs and toddlers preferentially directed their gazing behaviour towards the attentive audience, suggesting a basic understanding in both species that for communication to work, the audience needs to be looking towards them.

Overall, what emerges from these studies is that dogs can communicate with humans intentionally and referentially in at least one context, i.e. when they want to obtain something out of their reach. What is still not clear is if, besides communicating to obtain an out of reach object dogs will also direct their communication towards humans in other contexts, for example when needing information on a specific object or context. Hence this is one of the questions which will be addressed in my research.

Factors affecting dog-human communication

Several aspects have been shown to influence dog-human communication: here we consider the effect of the dogs' training and the kind of relationship with the human (owner vs. stranger) on dogs' understanding of human communication and their use of human-directed gazing behaviour as a communicative tool.

Training

Dogs have been historically trained to perform a variety of tasks ranging from the more classic ones such as hunting, herding and guarding (Coppinger and Sneider 1995) to more recent

ones, related either to sport and competition (i.e. agility, freestyle), or to specific work activities in collaboration with humans (i.e. searching dogs, water rescue dogs, guide dogs, military working dogs). Furthermore, although today the majority of dogs are kept as companion animals, an increasing number of pet owners take their pets to training schools to avoid the onset of undesirable behaviours (Rooney, 2011, Yin et al. 2007, Bennet 2006).

A number of studies have looked at how training experiences affect dogs' behaviour in different test situations and tasks involving human-dog communication

Only a couple of studies looked at the effect of training on dogs' inclination to follow referential gestures. McKinley and Sambrook (2000) showed that gun-dogs who had been trained to follow manual cues, performed significantly better than pet group in the comprehension of pointing. However, Prato-Previde et al. (2008) reported that highly trained dogs, regardless of the specific type of trained activity, were less dependent on their owners for solving a problem and less prone to follow their owners' misleading indications in a food choice task than untrained dogs.

A number of studies have looked at whether training may affect dogs' gazing behaviour towards humans. Marshall-Pescini et al. (2008) found that when attempting to solve a novel task untrained pet dogs, looked at a person more than pet dogs trained in various disciplines (agility, search and rescue, schutzhund, freestyle, gun-dog working trials). In a later study the same authors also showed that the particular type of training received can affect dogs' performance and gazing behaviour in an unsolvable task (Marshall-Pescini et al., 2009) with agility dogs looking at the owner for longer and more frequently compared to search and rescue dogs and untrained dogs when facing an unsolvable situation; and search and rescue dogs exhibiting more barking behaviour together with gaze alternation. Similarly, Gaunet (2008) using the 'unsolvable task paradigm' and comparing pet and guide dogs for the blind people found no differences in either the gazing or gaze alternation behaviour between the two groups, although guide dogs performed a noisy mouth-licking behaviour combined with gazing, which may have emerged as a supplementary attention-getting signal directed at their blind owners; in a second study Gaunet (2010) in an "asking toy"

paradigm, reported the same the presence of gazing behaviour toward the blind owner in guide dogs, even if this results suggested that these dogs were not able to perceive the attentional status of the owner.

Overall study on this topic are still scarce and more are needed to better understand the effect of the training on dog-human communication. In fact only one study looked at the effect of training on dogs comprehension of human communication and results on dog's communication towards humans are somewhat unclear. Hence this will be one of the questions which will be addressed in my research.

Audience/Communicator identity

A few studies indicate that dogs' understanding of human communicative cues and their use of communicative cues towards people may be affected by the identity of the informant/recipient. In particular, the relationship between dogs and their owners appears to be relevant. Dogs in fact have been shown to create a strong attachment bond to their care-givers, which in a number of aspects is similar to the human mother-infant relationship. Furthermore, there is also evidence suggesting that like children, dogs use their care-giver as a 'secure base' from which to explore the environment, while a stranger had not the same effect (Topal et al. 1998; Prato-Previde et al. 2003; Palmer & Custance 2008; Fallani et al 2006). This bond seems to influence dog-human communication.

A number of studies have looked at the dogs' comprehension of human communicative cues by the owner vs. a stranger. Elgier et al. 2009 found that dogs that received a pointing cue to an empty container from their owner compared to a stranger, took longer to extinguish their response when the owner was performing the cuing task compared with a stranger. Conversely Marshall-Pescini et al. (2010) found that when facing a choice between large vs. small quantity of the same food or between foods of different palatability dogs would be equally misled by the owner and a stranger in choosing the less appealing stimulus.

Very few studies have looked at the potential effect of audience identity on dogs' communication towards humans. Kaminski et al. 2011 found that dogs were more likely to inform their owner than a stranger about the location of a hidden object which was of interest only to the person. While Marshall-Pescini et al. (2009) found that type of training could affect the person dogs' chose to communicate with in an unsolvable task, in fact agility dogs looked at the owner more frequently than both search and rescue and untrained pet dogs. Furthermore, in general in an unsolvable task paradigm, dogs prefer looking towards the owner than the experimenter (Marshall-Pescini et al submitted).

Tóth et al. (2008) did not find differences in the playing styles of dogs with respect to the owner or to a stranger. In fact in a two-by-two within-subject design she observed 68 family dogs' behaviour when playing two different types of games (ball game and tugging) with two different play partners (owner or unfamiliar experimenter) in order to categorize each dog's playing style measuring the tendency for possession, willingness to retrieve, behaviours related to fear/avoidance and aggression, and occurrence of play bows. Dogs did not behave differently towards the owner vs. a stranger in this situation.

The potential effect of the identity of the human partner has also been looked at in social learning studies. Range et al. (2009) in a study on social attention towards a model demonstrating food-directed behaviour found that dogs tended to look longer at the model when he/she was the owner rather than a stranger but not significantly. Whereas, Pongracz et al. (2001) found that owners and strangers were equally effective as demonstrators in a detour task.

Overall, these contradictory results suggest that the relationship of the dog with the person who emits the cues could influence its' performance, but this influence might be context and task dependent. This aspect will also be investigated in the following studies.

In conclusion, although dogs have been the subjects of a lot of cognitive studies in recent years, there are still several open questions to investigate. In particular, the ability of dogs to use human's emotional cues, their capacity to use gaze to get information from humans (and not only to

ask for objects) or the different valence of the relationship with humans (i.e. owner vs stranger) on communication, have been poorly investigated so far.

Chapter 4

Research aims and structure

Although the literature on dog cognition and in particular social cognition has increased greatly in recent years, no study have focused on the process of Social referencing in dog-human communication and interaction, and only few preliminary studies have investigated dogs' understanding of human emotions (Buttelman and Tomasello 2012, Nagasawa et al. 2011). The use of the Social referencing paradigm may be particularly interesting since it can start answering a number of questions emerging from the literature. First, it can start addressing whether dogs may in fact look towards humans not just in a context in which they want to obtain a desired toy/food, but also in a situation in which they may need specific information about the situation to decide how to act. Second, since most social referencing paradigms involve the use of at least two emotional expressions (e.g. happiness and fear), its use may add to the rather scarce literature on dogs' understanding of human emotional expressions. Third, the emotional messages delivered by the actors in the classic social referencing paradigm typically refer to a specific object (or person), hence the nature of the communication is referential, it is 'about' something. Using this paradigm (and a variation thereof see Chapter 8) will provide further information on dogs' understanding of human referential communication.

Hence, the aim of the present dissertation is to investigate and reveal further aspects of dog socio-cognitive abilities and of human-dog communication by studying (1) the presence of Social referencing, both referential looking and behavioural regulation, in dogs towards humans, (2) the potential selectivity of this process, based on the relationship with the informant (owner vs.

stranger), (3) the effect of particular kinds of training experiences (i.e. water rescue training) on this process, and (4) dogs' ability to understand human emotional expression as referential.

To answer these questions we carried out four different experiments that will be described in the next chapters.

In the first study (Study I, Cap. 5), we investigated the presence of Social referencing in dog-human dyads. As no study has been carried out on dogs using this paradigm, we set up a new procedure suitable with dogs, that was similar to the one used in the infant literature (Walden and Ogan 1998, Mumme et al. 1966). In particular we selected the "new object paradigm" and presented dogs with a new and potentially scary object (a fan with plastic ribbons attached on it) in presence of their owner. In line with the studies carried out with infants we tested two different groups of dogs: in one group the owner was delivering a positive emotional message towards the object, whereas in the second group the owner delivered a negative emotional message. The aim was to evaluate whether, in a social referencing paradigm, dogs would show referential looking and behavioural regulation toward the owner acting as the informant and hence approach the object more having witnessed a positive vs. a negative message.

The second study (Study II, Cap. 6) had two main aims. First, since results obtained in the first study showed a clear presence of referential looking towards the informant, but no such clear evidence of behavioural regulation toward the object, we changed the testing procedure to better/further evaluate the presence of behavioural regulation. The second aim was to assess the influence of informant identity on dog's social referencing. In fact in the human infant literature, informant identity is an important aspect in children's Social referencing behaviour: they seem to use referential looking toward both a familiar and an unfamiliar person, but they regulate their behaviour only when a familiar person is the informant or when she/he is present in the experimental set-up and an unfamiliar person is informant (Moses et al. 2001, Stenberg 2011). Furthermore, a number of studies have shown an effect of the person's identity on dogs'

communicative behaviour (Kaminski et al. 2011, Elgier et al. 2009). Hence, in the current study the same object was used as in the first study, but the identity of the informant varied. Four groups of dogs were tested: two groups were tested with the owner as the informant (either expressing a positive or a negative emotion), and two were tested with a stranger as informant (either expressing a positive or a negative emotion).

In the third study (Study 3, Cap. 7) the effect of a particular kind of training experience (i.e. water rescue training) on dogs' social referencing behaviour with a stranger as an informant was evaluated. Training has been shown to affect dog-human communication in a number of studies (Prato-Previde et al., 2008; Ittyerah and Gaunet, 2009; Marshall-Pescini et al., 2008, 2009), although other studies have shown no such influence (Gaunet, 2008, 2009). Furthermore, since in Study II, we found clear evidence of behavioural regulation with the owner as the informant but not with the stranger as the informant, we chose to test a particular type of trained dogs that, during their training focus specifically on strangers i.e. water rescue dogs. Hence, in the current study we tested a group of water-rescue trained dogs and a breed, age and sex matched control group, in the social referencing paradigm adopted previously, with a stranger acting as the informant.

In the fourth study (Study IV, Cap. 8) we aimed to assess dog's understanding of human emotional expression as referential, i.e. as referring to a specific object. In the previous three studies dogs were tested always in the presence of only one object (the potentially scary fan), and, although the informant's message always referred to that object, the goal of these studies was not strictly to assess whether dogs were capable of appropriately referring the human's emotional expression to the object itself. In fact, as has been highlighted also in studies with humans, to investigate this issue it is necessary to provide subjects with more than one potentially referred-to object. Hence to investigate this issue further with dogs, we adapted a procedure used with infants (Repacholi 1998), and more recently also with chimpanzees and dogs (Buttelmann et al. 2009, Buttelmann and Tomassello 2012) in which the informant expresses two different emotions (in our case happiness and fear) toward two identical (hidden) objects.

Finally in the last chapter of the dissertation (General conclusion, Cap. 9), the results obtained in the different studies are discussed in light of the available literature on social referencing and understanding of human emotional expressions in dogs, and highlight future lines of investigation and studies needed to better understand the dog-human emotional communication.

Chapter 5

Social referencing in dog-owner dyads?

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Introduction

Social referencing is a process characterized by the use of another person's perceptions and interpretation of a situation to form one's own understanding and guide action (Feinman 1982). From a functional perspective, the importance of social referencing is that, like all social learning processes, it allows an individual to avoid making costly errors associated with trial-and-error learning (Russell et al. 1997). However, according to a number of authors, social referencing is a constructive process in which the infant goes beyond the information given to construct a more general interpretation of the meaning of the stimulus, whereas imitation of a specific model's response can occur without such inferences (Walden and Ogan 1988).

Social referencing includes two distinct components: the subject referentially looking towards the informant, i.e. alternating their gaze from the individual to the object or event, and the subject's behavioural regulation based on the emotional information received from the informant (Russell et al. 1997). Referential looking has been defined as looks to the caregiver that immediately (i.e. within 2 s) follow a look to the novel object/situation (Russell et al. 1997). This criterium is important since, it is considered the best way to distinguish between referential looks, aimed at seeking information, and other types of looks, for example search for reassurance (which would not be expected to necessarily include alternation from the owner to the novel object; Clyman and Emde 1986). Furthermore, in infants, two kinds of referential gestures (pointing) have

been identified: protoimperative where the infant points to obtain a desired object (thus using the adult as a social tool to solve a problem) and protodeclarative where pointing to an object seems to be aimed at either obtaining or sharing adult attention (Bates et al. 1975). In both cases, infants often alternate gaze between adult and object (Liszkowski et al. 2004). Thus, infants use gaze alternation to make sure that the other person's attention is directed at the object (Bates et al. 1975; Franco and Butterworth 1996) and perhaps to receive information about the situation.

The second component of social referencing is behavioural regulation, where the subject is influenced by the positive or negative emotional expression (typically conveyed through facial and vocal means; Mumme et al. 1966; Morton 1977) of the model. Adults constantly use social signals such as emotional expressions to guide other's behaviour in ambiguous or dangerous situations and they often do so without conscious control (Hoehl et al. 2008). However, this process is thought to be particularly important in infancy (Feinman 1982), since infant's capacity for vicarious learning provides them with the ability to use the affective reaction of another, and in particular the mother, as a means to appraise the environment (Feiring et al. 1984).

Social referencing has been studied using a number of different paradigms which mostly involve infants being pre- sented with an ambiguous object, situation or person and the care-giver expressing either positive or negative emotions towards it (ambiguous object: Mumme et al. 1966; Kim et al. 2010; visual cliff: Sorce et al. 1985; Vaish and Striano 2004; stranger: Feiring et al. 1984; de Rosnay et al. 2006).

Most studies have shown social referencing (both referential looking and behavioural regulation) in infants of 12 months of age (Mumme et al. 1966; de Rosnay et al. 2006; Vaish and Striano 2004), with infants playing less with the toy, looking longer/more frequently to the care-giver, and moving towards the caregiver slower when negative emotional information is conveyed by vocal and facial expressions (Hornik et al. 1987; Gunnar and Stone 1984; Klinnert et al. 1983). However, a more recent study shows that social referencing can occur as young as 3 months of age with infants spontaneously turning to their caregiver when confronted with an ambiguous situation

and using the caregiver's referential emotional cues to adjust their looking behaviour (Hoehl et al. 2008).

This process has been investigated not only in humans, but also in a few primate species, namely chimpanzees and barbary macaques, although with mixed results. Russell et al. (1997) found good evidence of social referencing between human-reared chimpanzees and their human care-givers: chimpanzees looked referentially and adjusted their behaviour according to whether they had received a "happy" or "fearful" message from the caregiver. Furthermore, Itakura (1995) found that infant chimpanzees sought contact with their mother more often in the presence than in the absence of a novel object, and followed their mother more when she withdrew from it than when she did not. However, Tomonaga et al. (2004) found no evidence of referential looking in captive mother–infant pairs of chimpanzees, whereas Roberts et al. (2008) found that only 2 of 15 infant barbary macaques looked referentially at their mother when confronted with a toy snake for the first time. Results from primate studies are overall ambiguous, with the strongest evidence coming from human-raised chimpanzees, where social referencing is exhibited with their human caretaker.

No study, to our knowledge, has been carried out on social referencing in domestic dogs. Dogs are a social species that have been sharing the human environment for at least 12.000 years (Davis and Valla 1978). Differently from their (similarly raised) wolf ancestor, dogs seem to be more inclined to both follow human communicative gestures (Virányi et al. 2008; Gásci et al. 2010) and look to humans if they cannot obtain a desired object (Miklósi et al. 2003). Furthermore, a number of studies suggest that dogs are sensitive to the direction of the human body/gaze (Kaminski et al. 2009; Gásci et al. 2004; Call et al. 2003; Virányi et al. 2004), appear to communicate with humans intentionally and referentially in a variety of situations (although so far only in a 'requesting' context: Miklósi et al. 2000; Marshall-Pescini et al. 2009), can discriminate between familiar and unfamiliar faces as well as between smiling and neutral faces (Racca et al. 2010; Nagasawa et al. 2011). Finally, dogs (but not human-raised wolves, Topál et al. 2005) have

been shown to create a strong attachment bond to their caregivers, similar to the human mother–infant relationship (Topál et al. 1998; Prato-Previde et al. 2003) suggesting that like children, dogs use their caregiver as a ‘secure base’ from which to explore the environment (Palmer and Custance 2008).

The purpose of the current study was to (1) evaluate the presence of referential looking in dogs’ communication with people in a context which did not involve requesting an object/food; (2) investigate whether the human’s voice and facial expressions alone can influence dogs’ behaviour when confronted with an ambiguous stimulus (what is known in the infant literature as ‘the behavioural regulation’ element of social referencing); (3) assess whether our subjects’ behaviour towards the ambiguous stimulus would be influenced by the owner’s more overt behavioural reaction, i.e., either approaching or shying away from the object. To describe the latter aspect, we use the term ‘observational conditioning’, i.e., learning the positive or negative value of an object or event by observing another individuals’ behaviour (Whiten et al. 2004; Zentall 2006). Behavioural regulation and observational conditioning may in fact refer to the same process (in human and non-human species respectively); however, in the current study, we use the term ‘behavioural regulation’ as in the infant literature to refer to the subject’s ability to base their reaction exclusively on the demonstrators’ vocal and facial expression of emotion, and we use ‘observational conditioning’ to refer to the subject learning the value of the object based on the demonstrators’ more overt approach versus avoidance behaviour.

Firstly, to assess the potential presence of referential looking dogs were confronted with an ambiguous stimulus in the presence of their silent and neutral owner. Second, to evaluate the behavioural regulation aspect of social referencing, we measured the behaviour of dogs when the owner delivered either a positive or a negative message about the ambiguous stimulus using only their voice and facial expression. Finally, in the latter stage of the experiment, we evaluated whether dogs would learn the value of the object (through a process of observational conditioning) based on the owners either approaching or avoiding the stimulus. In the positive condition, the

owners used their voice, facial expression and at a later stage, they used body movement, to express happy emotions about the novel object, whereas in the negative condition, the owner expressed fearful emotions and avoidance behaviour. Dog-owner dyads were randomly assigned to either the positive or negative message group. If dogs use human-directed gazing behaviour not only to request for a desired object (Miklósi et al. 2000; Marshall-Pescini et al. 2009), but also to obtain information about a new ambiguous situation we would expect dogs in our study to look at the novel object and rapidly look at the owner. If dogs use humans' vocal and facial emotional expressions to guide their behaviour, we would expect them to show a different pattern of behaviour in the positive versus negative condition. More specifically, we predict that, similarly to infants, in the negative condition dogs will look at the owner more, stay further away from the stimulus and move less than dogs in the positive condition.

Method

Participants

Seventy-five dog-owner dyads participated in the study. Dogs ranged in age from 1 year to 12 years (Means 4.2 years SD 2.74). Thirty-six dogs were male and thirty-nine were female. All dogs were pets and lived at home with their owners. 43 were pure-breed (see Appendix) and 32 mixed-breed. Dog-owner dyads were randomly assigned to the positive and negative message group.

Stimulus Selection

The experimental stimulus was the same for all dogs in both conditions (positive and negative): a 50 cm tall and 34 cm wide electric fan, with plastic green ribbons attached to it (Figure 1). This stimulus was selected following pretesting of a number of different objects (amongst which a 'dancing' fur toy, a remote control car and large black box which made a rattling noise) with a group of 10 dogs (which were not then used in the study). Infant studies suggest that the most

appropriate stimulus for social referencing studies, should elicit a mild fear reaction. Among the objects presented, the fan was chosen since it was the object with which most dogs' exhibited a cautious reaction, i.e. neither very positive (approaching directly and touching) nor very negative (running in the opposite direction or strong stress such as trembling, or hiding). Furthermore it, did not elicit predatory behaviour.



Figure 1: Electric fan used as experimental stimulus

Procedure

The dogs were individually tested in an unfamiliar (3 x 4 m) room of the laboratory *Canis Sapiens* of the University of Milan. On arrival dogs were given 5 minutes to freely explore the empty testing room, while the experimenter explained the procedure to the owner.

The test lasted 1 minute and was divided into four phases lasting 15 seconds each. During the entire test the fan, placed at the far end of the room (see Figure 2), was in motion. Each test phase was characterized by the owner behaving in a different way. Owners were thoroughly briefed prior to the test, but to further guide them through the experimental procedure a portable Mac computer was placed on the window ledge of the testing room, with a Keynote presentation that gave instructions at the appropriate times. Furthermore, since in phase 3 and 4 owners were

required to move to specific locations in the room, coloured sticky tape was placed in the appropriate spots (Figure 2). Each dog was allocated to one group only and thus exposed either to the positive or negative message.

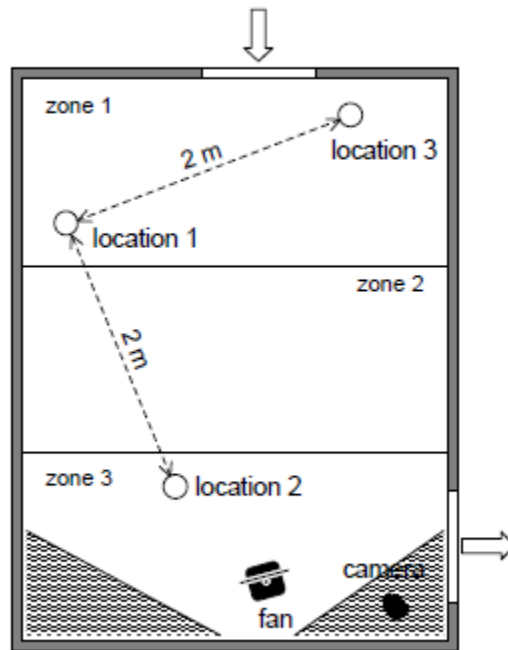


Figure 2: Experimental setting and owner's locations during the different phases of the test. The grey area shows the two blind spots in the room in which subjects' behaviour could not be recorded (out of sight).

The study was carried out in 4 phases:

- Phase 1 (Ph 1): was the same for both the positive and negative groups. The owner entered the room holding the dog by its collar. As soon as the owner closed the door the researcher activated the fan by remote control (from the adjacent room). The owner and dog stopped at location 1, facing the fan, where the dog was released and allowed to move freely around the room. The owner remained silent looking at the fan with a neutral facial expression.
- Phase 2 (Ph 2): regardless of the dog's behaviour, the owner whilst remaining in the same position (location 1) talked throughout the phase, using either a happy (positive group) or fearful (negative group) voice and facial expression.

- Phase 3 (Ph 3): in the positive group the owner approached the fan reaching location 2 and crouched down facing the fan, whilst still talking in a happy voice and expressing a positive emotion; in the negative group the owner moved away from the fan reaching location 3, crouching down whilst talking with a fearful voice and expressing a negative emotion.
- Phase 4 (Ph 4): the owner in the positive group, whilst still crouching down in location 2 and talking in a positive manner, touched the fan and ribbons for the entire 15 seconds. In the negative group, the owner stayed crouched down in location 3 but turned his/her back to the fan whilst continuing to talk with a negative tone of voice.

In both groups, in phases 2, 3 and 4 the owners were instructed to continue talking throughout the entire phase and to communicate with their dogs as they would normally, using typical phrases such as “that’s lovely”, “so beautiful” or “that’s ugly”, “that’s scary”, accompanied by either a smiley happy face or a scared worried expression. They were explicitly told not to use the dog’s name and potential commands such as “look, go, come, touch, away”. They were instructed to convey, through facial and vocal expression, the feeling either that the dog could safely and happily approach the object or that the object was dangerous and fearsome for the dog. After the test ended, the researcher switched the fan off, entered the room with a handful of treats, and together with the owner sat next to the fan, giving the dog treats when it came into proximity of the fan. All dogs, regardless of condition, received this treatment so that they would not become sensitive to fans.

Data collection and analysis

The test was recorded by a video camera (Panasonic NV-GS330), and analysed using Solomon Coder (beta 081122, Copyright 2006-2008 by Andràs Péter).

Given the test depended heavily on the owner’s ability to convey a positive vs. negative message to the dog, we chose to independently evaluate their performance in Phase 2. Thus, a blind

coder, unaware of the purpose of the study was asked to code the owner's vocal message (no images were shown). A 5-point scale was provided for each message. The coder was asked to evaluate the vocalizations in terms of the positive or negative emotion being expressed by the tone of voice independent of the words being used. A second blind coder analysed 25% of trials, randomly selected and Spearman correlations showed a good level of agreement for vocal content ($r=0.89$, $p=0.001$).

Two non-mutually exclusive categories of behaviour were recorded: Action and Gaze. Furthermore, the location of dogs in the room during each phase of the test was recorded (Zone) (see Table 1). All behaviours were recorded as durations (in seconds) and the percentage of time spent carrying out a specific behaviour in each phase was calculated. Following Russell et al. (1997), referential looking was defined as a gaze towards the owner that was preceded -within 2 seconds- by a look to the fan, and gaze alternation as a consecutive sequence of three looking behaviours (fan-owner-fan or owner-fan-owner). Chi-square tests were used to compare the number of dogs that carried out referential looking and gaze alternation between groups.

ACTION	
Interact owner	dog is in physical contact with the owner
Interact fan	dog is in physical contact with the fan
Static	dog is in any position which does not involve movement i.e. standing, sitting or lying
Locomotion	any behaviour involving moving around the room whether walking with head down/sniffing, or pacing whilst looking at the owner/object
Out of sight	when the dog entered a blind spot in the room and was thus not visible when looking at the videos
GAZE	
Gazing at fan	dog's head is oriented towards the fan
Gazing at owner	dog's head is oriented towards the owner
Gazing other	dog's head oriented to any other object or location in the room
ZONE	
the room was divided into three equivalent areas (1,3 x 3m). (Figure 2)	
Zone 1	close to the door farthest from the fan
Zone 2	intermediate between door and fan
Zone 3	close to the fan

Table 1. Ethogram of all the behaviour analysed

The dogs' behaviours was analysed by the first author (I.M.). A second independent blind coder analysed 25% of the data and Spearman correlations were calculated for the main behavioural categories (Gaze Fan: $r=0.84$, $p=0.000$; Interact Owner: $r=0.87$, $p=0.000$; Interact Fan: $r=0.93$, $p=0.000$; Zone 1 $r=0.95$, $p=0.000$: Zone 2: $r=0.89$, $p=0.000$; Zone 3: $r=0.95$, $p=0.000$).

As behavioural data were not normally distributed non-parametric statistical analyses were used to compare the duration of the dogs' behaviour between groups (Mann-Whitney test) and to evaluate the owners' message in the positive and negative group. Referential Looking and Gaze alternation were analyzed only in Phase 1, whereas all the other behaviours were analyzed in all other phases.

Results

Of the seventy-five dogs tested, seventeen dogs (8 male and 9 female) were excluded from all analyses, because of procedural errors committed by the owners during testing.

Of the remaining fifty-eight dogs, 16 (12 male and 4 female) approached and touched the fan during the first 15 seconds of the test (Phase 1), exhibiting a confident and positive attitude towards the stimulus. These dogs were included in the analyses of referential looking behaviour towards the owner (Phase 1), but were excluded from further analyses of social referencing, since a pre-condition for this test is that dogs' show an ambiguous (or mildly fearful) behaviour towards the stimulus object (Feinman et al. 1992; Gunnar and Stone 1984, Rosen et al. 1992).

Evaluation of the owners' message

35 of the 39 messages delivered by the owner were coded as congruent to the allocated group in terms of their vocal content. The comparison between the scores on the 5-point scale between the positive and negative group showed a highly significant difference thus confirming that the emotions conveyed by the owners' tone of voice were congruent with that instructed (Mann-Whitney: $N_1=21$, $N_2=18$: $z=5.33$; $p<0.001$).

Referential Looking and Gaze alternation

The first aim of the study was to assess whether dogs carry out referential looking towards the owner when confronted with an ambiguous situation/stimulus. To this aim, we analysed dogs' behaviour in Phase 1 (regardless of group since this first phase was the same for all dogs) on the basis of their reaction to the fan and subsequent looking behaviour towards the owner.

Of the 16 dogs who showed a confident, positive approach to the fan, 7 (43%) carried out referential looking towards the owner at least once (and a maximum of 5 times). Of the 42 dogs who did not behave confidently towards the fan, 35 (83%) showed referential looking, at least once (and a maximum of 7 times). Thus, significantly more non-confident dogs carried out referential looking towards the owner than dogs behaving confidently towards the stimulus ($\chi^2= 9.09$; $p=0.002$).

As regards gaze alternation 31 out of 42 dogs (73%) in the non-confident group showed at least one gaze alternation sequence (fan-owner-fan or owner-fan-owner), whereas 7 out of 16 dogs (43%) in the confident group showed at least one gaze alternation sequence ($\chi^2= 4.63$; $p=0.03$).

Between Group Comparison

Having established that when confronted with an ambiguous stimulus dogs look at the owner we aimed to assess whether they would be affected by their owners' positive vs. negative emotional expressions. Of the 42 dogs that showed an ambiguous approach towards the fan in Phase 1, 3 dogs never looked at the owner and were hence excluded from subsequent analyses. This left 18 dogs (11 F and 7 M) in the positive and 21 dogs (13 F and 8 M) in the negative group. Exclusion of the dogs that did not look back was in line with the approach taken by Stenberg and Hagekull (1997) in their infant study. However, analyses including these dogs were also carried out, revealing the same pattern of results.

In Phase 2 dogs in the negative group spent significantly more time exhibiting a Static behaviour than dogs in the positive group (Table 2; Figure 3a). However, no other significant difference emerged in neither Actions, Gazing nor Zone use (Table 2, Figure 3a and 3b).

	Phase 2				Phase 3				Phase 4			
	Pos	Neg	z	P	Pos	Neg	z	P	Pos	Neg	z	P
Gaze owner	15.4	36.2	-1.26	0.20	17.1	28.1	-1.91	0.05	11.3	14.2	-1.29	0.19
Gaze fan	17.8	21.7	-0.69	0.49	8.3	23.1	0.59	0.55	21.9	16.3	0.84	0.39
Gaze other	12.1	11.9	0.59	0.55	5.5	10.1	-0.4	0.68	9.6	3.8	1.17	0.23
Interact owner	0	0	1.15	0.24	0	15.8	-2.20	0.027	0	11.1	-2.89	0.003
Static	36.0	60.6	-2.62	0.008	36.1	44.8	0.22	0.82	35.0	56.2	-0.74	0.45
Locomotion	39.9	31.2	-1.32	0.18	20.2	30.3	-1.21	0.22	26.2	17.1	1.23	0.21
Zone 1	41.7	81.7	-1.55	0.12	7.4	94.2	-4.47	p<0.01	0	100	-4.6	p<0.01
Zone 2	27.7	1.3	1.68	0.09	27.3	5.8	2.64	0.008	19.4	0	2.98	0.002
Zone 3	0	0	0.52	0.52	39.8	0	4.36	p<0.01	60.7	0	5.16	p<0.01

Table 2. Median duration (in %) of all behaviours and comparison between the positive ($n = 18$) and negative ($n = 21$) group of dogs (Mann–Whitney = test) during phases 2, 3 and 4. Figures in bold highlight where significant differences emerged between group

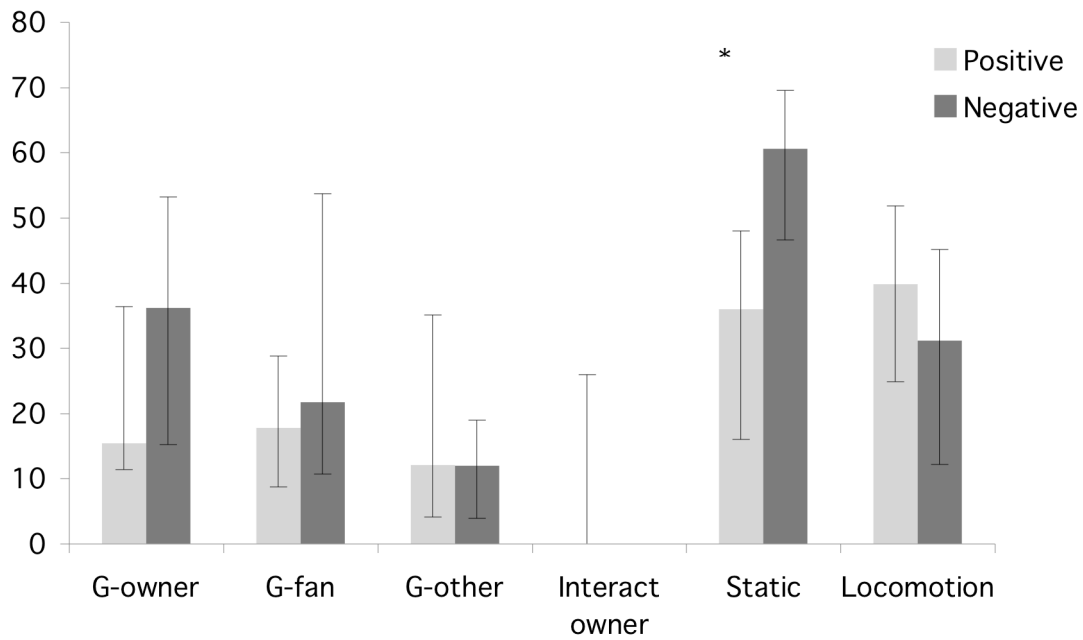


Figure 3a

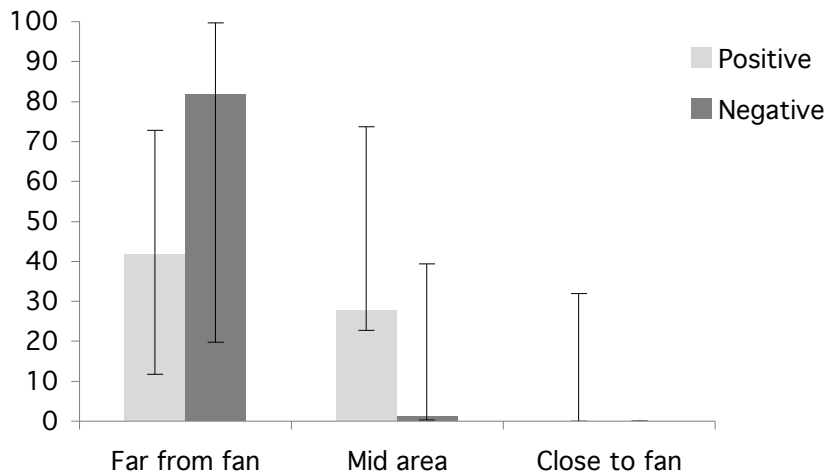


Figure 3b

Figure 3: a) Median duration (in %) of main behaviours analyzed in the positive and negative group of dogs during phase 2. Bars represent interquartile ranges and * $p < 0.05$. b) Median duration (in %) of time spent by positive and negative group of dogs in the three different zones (Zone 1= far from fan; Zone 2= mid area; Zone 3= close to fan) during phase 2. Bars represent interquartile ranges and * $p < 0.05$.

In Phase 3 dogs in the negative group spent significantly more time Interacting with the owner than dogs in the positive group. Dogs in the positive group spent more time in Zone 2 and 3 than dogs in the negative group, whereas dogs in the positive group spent less time in Zone 1 than dogs in the negative group. No significant differences emerged in gazing behaviours between groups (Table 2).

In Phase 4 dogs in the negative group spent more time interacting with the owner than dogs in the positive group (Table 2; Figure 4a). No differences emerged in gazing behaviour. However, in this phase dogs in the positive group spent less time in Zone 1, but stayed longer in Zone 2 and 3 than dogs in the negative group (Table 2; Figure 4b).

Given that zone use and interaction with the owner are not independent, a correlation (Spearman test) was carried out to look at the relationship between these measures for each group and phase separately. No significance emerged, hence the zone use and interaction with the owner conveyed different information relating to the dog's behaviour in the test (Positive group: Phase 2: zone 1 $r=0.1$, $p=0.66$; zone 2 $r=0.22$, $p=0.37$, zone 3 $r=0.37$ $p=0.12$; Phase 3: zone 1 $r=0.14$, $p=0.57$; zone 2 $r=0$, $p=0.99$; zone 3 $r=0.28$, $p=0.25$; Phase 4: zone 1 $r=0.32$, $p=0.19$; zone 2 $r=0$, $p=0.98$; zone 3 $r=0.14$, $p=0.56$; Negative group: Phase 2: zone 1 $r=0.39$, $p=0.08$; zone 2 $r=0.39$, $p=0.08$, zone 3 $r=0.19$ $p=0.39$; Phase 3: zone 1 $r=0.08$, $p=0.72$; zone 2 $r=0.05$, $p=0.82$; zone 3 $r=0.26$, $p=0.24$; Phase 4: zone 1 $r=0.16$, $p=0.46$; zone 2 $r=0.16$, $p=0.46$; zone 3 $r=0.24$, $p=0.27$).

Interaction with the fan occurred very rarely, not allowing for statistical analyses. In fact one dog in the negative group touched the fan in Phase 2, whereas four dogs in the positive group touched the fan in either Phase 3 or 4.

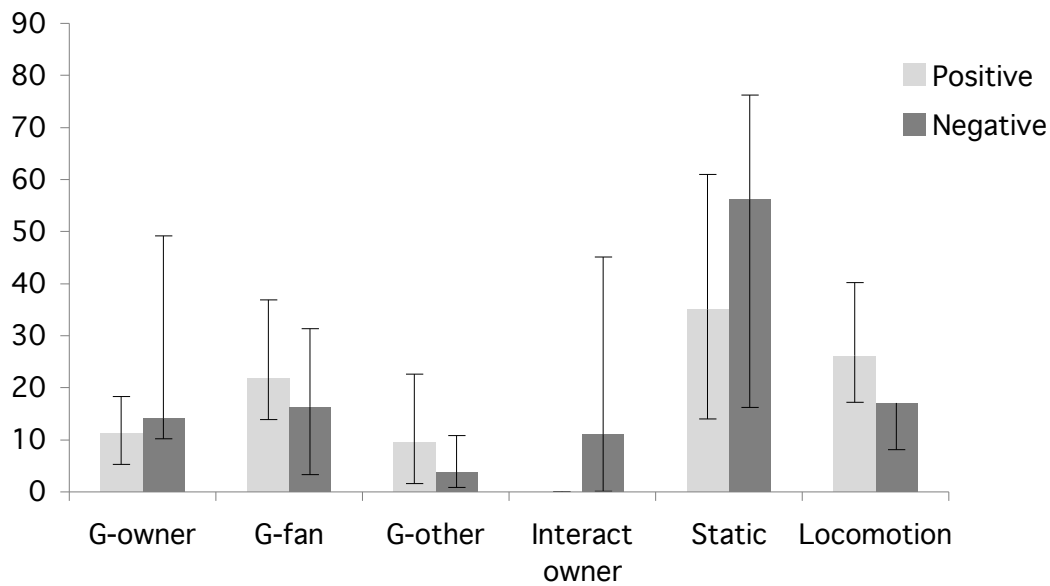


Figure 4a

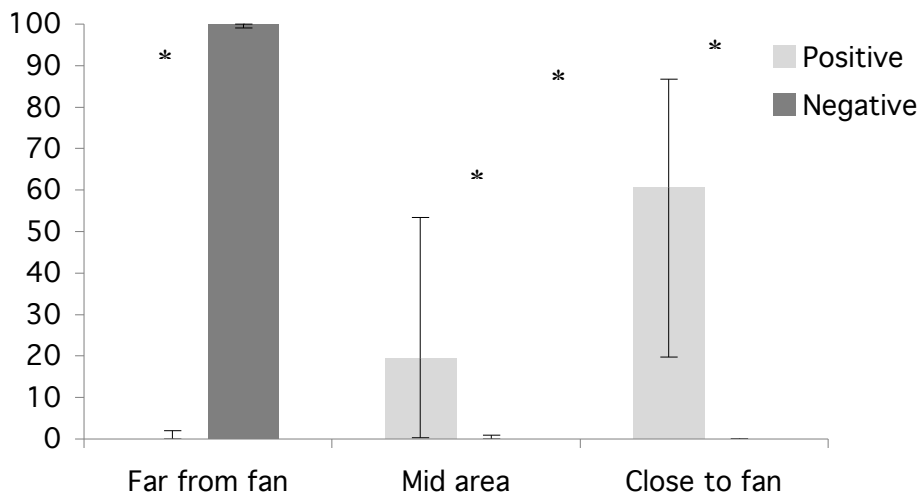


Figure 4b

Figure 4: a) Median duration (in %) of main behaviours analyzed in the positive and negative group of dogs during phase 4. Bars represent interquartile ranges and * $p < 0.05$. b) Mean duration of time spent by positive and negative group of dogs in the three different zones (Zone 1= far from fan; Zone 2= mid area; Zone 3= close to fan) during phase 4. Bars represent interquartile ranges and * $p < 0.05$.

Given the wide age range of our subjects we carried out a correlation (Spearman test) to assess whether this variable would affect their behaviour (gaze and interact owner), however no significant results emerged (Positive group: gaze $r=0.05$, $p=0.58$; interact $r=0.11$, $p=0.24$; Negative group: gaze $r=0.11$, $p=0.21$; interact $r=0.03$, $p=0.69$).

Discussion

The aim of the current study was to assess the potential presence of social referencing, i.e., the ability to seek and use another persons' perceptions and interpretation of an ambiguous situation to guide action (Feinman 1982), in domestic dogs. Given no previous study on this topic with this species, we chose to assess the presence of each element of social referencing progressively, i.e., referential looking to the owner, behavioural regulation based on the owners' vocal and facial emotional reactions, and finally observational conditioning once the owner has manifested more overt approach or avoidance behaviour towards the ambiguous object (i.e., the fan).

All dogs looked at the fan when the test started and the majority of dogs (83%) showed referential looking since they looked to the fan and immediately after to their owner (Russell et al. 1997) suggesting that, faced with an ambiguous stimulus, dogs search for additional information from their owner. This conclusion seems to be further supported by the fact that significantly more dogs, showing a non-confident reaction to the fan (83%), showed referential looking compared with dogs exhibiting a confident response to the object (43%). It is still possible that the less confident dogs were simply looking to the owner for reassurance; however, this seems unlikely since only 3 of the 35 dogs looking referentially to the owner then sought contact with him/her, whereas most (31) dogs showed gaze alternation behaviour, thus looking back to the focus of their owner's attention (the fan).

A number of recent studies have reported functionally referential communication in dogs

indicating that dogs use gaze and gaze alternation as a communicative tool in a variety of situations in order to request human intervention in unsolvable situations, i.e., out of reach toys or food (Hare et al. 1998; Miklósi et al. 2000, 2005; Gaunet 2008, 2010; Marshall-Pescini et al. 2009). Borrowing from the infant literature on referential pointing, studies on dogs showing referential looking and gaze alternation to obtain an object/ food seem to suggest this behaviour is equivalent to a protoimperative gesture. In the current study, however, it is unlikely that dogs looked at the owner to request for the fan. Thus, another motivation seems to drive this behaviour. However, as has been highlighted for infant studies, a lack of an imperative motive is not sufficient to claim a protodeclarative one (Liszkowski et al. 2004). The overwhelming presence of gaze alternation seems to suggest that at the very least dogs confronted with a strange object, seek out and monitor the direction of their owners' gaze, but further studies will be needed to assess whether dogs' gaze alternation behaviour may be exhibited both as a protoimperative and protodeclarative gesture.

Nevertheless, referential looking in other species tested in a social referencing paradigm has been less consistent. In infant macaques, a low percentage (13%) displayed referential looking towards their mother (Roberts et al. 2008), and no such behaviour was found in mother–infant chimpanzee dyads (Tomonaga et al. 2004). However, interestingly, all 17 chimpanzees tested by Russell et al. (1997) looked referentially at their human caregiver, and in infant studies, between 69 and 100% of subjects display spontaneous referential looking (Baldwin and Moses 1996). Thus, dogs, similarly to human-raised chimpanzees and human infants, seem to use this behaviour frequently towards their human caregiver.

This similarity between dogs and human-raised chimpanzees in gazing at humans in a situation of uncertainty is interesting on a number of accounts. Firstly, results are in line with evidence showing that both dogs and human-reared chimpanzees form a strong attachment bond with their human caregiver who plays the role of a 'secure base' when facing new and potentially stressful situations (Topál et al. 1998; Prato-Previde et al. 2003; Palmer and Custance 2008; Bard 1991). Furthermore, results are interesting in view of the concept of 'enculturation'. Enculturation

is a term used to refer to apes raised in a human environment, with a wide exposure to artefact and social/communicative interactions (Call and Tomasello 1996). In a broad sense, the same term can be applied to pet dogs. In the ape literature, this process has been shown to affect social cognition, including the use of imperative and occasional declarative pointing and joint attention (Call and Tomasello 1996; Furlong et al. 2008; Carpenter and Tomasello 1995). The current view on dog's socio-cognitive abilities is that they have been inadvertently selected for during domestication but are also influenced by living in constant contact with humans (Hare et al. 2002; Miklósi et al. 2003; Reid 2009; Udell et al. 2008). Thus, it is likely that both phylogenetic and ontogenetic factors are involved in the use of referential looking as a communicative behaviour. It remains an open question whether 'enculturated' wolves may use referential looking in a similar way in a social referencing paradigm, and hence how much domestication per se has influenced this process.

Our second objective in this study was to examine the influence of the owner's vocal and facial expression on the dogs' behaviour towards the ambiguous object (behavioural regulation). Results show a difference between the positive and negative group of dogs in Phase 2, where only the voice and facial expression of the owner could influence the dogs' behaviour, with dogs in the negative group showing more Static behaviour (standing, sitting or lying) than dogs in the positive group. Thus, similarly to infants (Zumbahlen and Crawley 1996), a negative emotional message seems to inhibit movement also in dogs. However, whereas in infant studies the positive emotional message increased the approach to the stimuli (Stenberg and Hagekull 1997), no such effect was found in our study. There are a number of potential explanations for this.

First, dogs seem to be able to recognize overt friendly or threatening/scolding behaviour from the owner or a stranger (Horowitz 2009; Vas et al. 2005), however differently from human infants and human-raised chimpanzees, they may have been unable to detect the caregiver's use of more subtle facial and vocal emotional expressions. We think this is unlikely given that a recent study suggests that dogs are in fact capable of discriminating between smiling and neutral faces (Nagasawa et al. 2011), and preliminary data suggest that adult dogs can also recognize facial

expressions of emotions when exhibited by a trained actor (Deputte and Doll 2011) and angry versus happy voices (Ruffman and Morris-Trainor 2011). In terms of the use of vocal expression, it has been shown that mothers and dog owners both use ‘baby-talk’ in similar ways towards their infant/dog (Mitchell 2001, 2004; Prato-Previde et al. 2006). Thus, in the current study, we chose to present the same methodology adopted in infant studies; however, whereas the emotional valence of the messages expressed by the owner and evaluated by two independent coders were considered appropriate in terms of their positive versus negative grouping, the coders’ agreement on the intensity of the message was low. This suggests that there was high variability between owners in the way they vocally delivered positive and negative messages. The same problem is common in the infant studies; nevertheless, social referencing is widely demonstrated in humans (Kim et al. 2010; Vaish and Striano 2004) and thus, we do not think that the variability of the owner’s message is responsible for the relatively mild social referencing effect found in dogs.

A final possibility is that even though we chose an object which elicited a cautious reaction (i.e., neither too positive nor too negative) in a pilot sample of dogs, the fan was in fact too scary for most dogs, so that even if the dogs in the positive group did perceive their owners’ positive attitude, they were unlikely to approach. However, given that almost a third of dogs tested approached the fan independently in the first phase, as did most dogs in the positive group once the owners approached it, this explanation seems unlikely.

There were nonetheless two important differences between the current procedures and the infant studies which may have affected the current results. In the infant studies, mothers immediately delivered the message as soon as their child looked at them; furthermore, the ‘scary object’ was switched of whilst the mother continued delivering her message (Walden and Ogan 1988; Mumme et al. 1966; Kim et al. 2010). In our own study, the first time dogs looked at the owner they received no overt response (in Phase 1) which may have conveyed a mixed message about the value of the object. Furthermore, the scary object was switched of only at the end of the test, not allowing us to evaluate whether with a lower intensity of the scary stimulus dogs would

have approached the object. Thus, having ascertained in the current study that dogs do look at the owner when confronted with a strange object it would now be interesting to explore the behavioural regulation aspect further by using social referencing paradigms even more similar to the infant literature, and perhaps standardizing the human's emotional output by, for example, using a trained actor.

The final question that we set out to address was how the approach versus avoidance behaviour of the owner would influence the dogs' reaction to the fan. Our results clearly show that this aspect of the owners' behaviour was very relevant. During the final phases (Phases 3 and 4), dogs in the positive and negative group exhibited an opposite use of the space available, mirroring their owner's movements. In both these phases, dogs in the positive group moved closer to the fan (from Zone 1 to 3) following the owner's approach, and the only four dogs that touched the fan were all in this group. In the negative group, dogs spent most of their time in the zone furthest from the fan (Zone 1), and did so even more when the owner crouched down and expressed a fear response. It is possible that the dog's mirroring behaviour was simply an attempt to stay close to their owner in a moderately stressful situation (secure base effect). However, in the positive group, dogs interacted with the owner less than in the negative group; if dogs in both groups were just seeking proximity to the owners because of the perceived stressful situation, we would not have expected a difference between them. Thus, it seems that once explicit either approach or avoidance behaviour was manifested, dogs were highly influenced by their owner in their reaction to the ambiguous object through a process of observational conditioning (although other social learning mechanisms such as local enhancement cannot be excluded).

The more frequent interaction with the owner in the negative group may have been caused by the dogs feeling more cautious and needing reassurance; however, it may also be due to the 'strangeness' of the owners' behaviour. In fact, as has been suggested in the infant literature (Mumme et al. 1966), it is probable that infants (and dogs) will have experienced their caregiver showing positive emotions and encouragement towards novel objects more often than negative ones.

Given observational conditioning is a form of social learning, our results are in line with a number of previous studies showing that dogs can learn both an object manipulation and spatial task observing a human demonstrator (Kubinyi et al. 2003; Miller et al. 2009; Pongrácz et al. 2003), and appear to be positively influenced by the use of the human voice during the demonstration (Pongrácz et al. 2004). Moreover, they are in agreement with studies showing that dogs' performance can be influenced by the presence and action of a human social partner rendering a particular location/stimulus more salient (Prato-Previde et al. 2008; Marshall-Pescini et al. 2010).

In conclusion, the current study is the first to show that dogs use referential looking to the owner not only when they require an object or food (i.e., in a protoimperative manner) but also when confronted with a novel, potentially scary object in their environment. Only mixed evidence emerged for behavioural regulation since overall dogs modified their behaviour in accordance with their owner's positive or negative emotional reaction only slightly, when these were communicated only through vocal and facial expressions. However, a strong reaction was elicited by owners when their emotional expression included overt approach versus avoidance. In this case, dogs closely mirrored their owner's behaviour. Additional studies, using different procedures and stimuli, will be necessary to further investigate and clarify the occurrence of behavioural regulation in dogs and to evaluate which aspects of human communication are more significant in influencing the dogs' behaviour.

Appendix

Azawakh 1, Dachshund 1, Beagle 3, Bichon Frise 2, Border Collie 1, Boxer 2, Bulldog 1, Cau de agua 1, Cocker Spaniel 2, Dalmatian 1, Doberman 2, Argentinean Dogo 2, Epagneul Breton 3, Golden Retriever 8, Siberian Husky 2, Labrador Retriever 2, Lagotto 1, German Shepherd 2, Setter Irish 1, Shiba Inu 1, Shitzu 1, Schnauzer 1, Terranova 1, West Highland Terrier

Chapter 6

Dogs' social referencing towards owners and strangers

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Introduction

Social referencing is a process whereby individuals use another's emotional cue towards a novel object/event to guide their own future behaviour towards it (Vaish and Woodward 2010). From a functional perspective, the importance of social referencing is that, like all social learning processes, it allows an individual to avoid making costly errors associated with trial-and-error learning (Russell et al 1997). Social referencing includes two distinct components: the subject's referential looking at the informant (i.e. looks immediately preceded and/or followed by a look to the novel object), and the subject's behavioural regulation based on the emotional information received from the informant (Russell et al 1997). Many studies have shown social referencing in toddlers and infants (Mumme et al 1966, deRosnay et al. 2006, Vaish and Striano 2004, Hoel et al 2008) Overall results show that infants look at the informant (generally their care-giver) and change their behaviour according to the emotional messages received: when receiving a positive message they reach closer to the object and interact with it faster than when receiving a negative one (Walden and Ogan 1988, Camras and Sachs 1991, Klinnert et al 1983); conversely when negative emotional information is conveyed they play less with the toy, look longer/more frequently at the care- giver, and move slower towards the care-giver (Hornik et al 1987, Gunnar and Stone 1984).

Studies have also looked at social referencing in infants when the emotional message towards an ambiguous object was conveyed either by a stranger or a familiar person (Camras and

Sachs 1991, Klinnert et al 1983, Zaratany and Lamb 1985, Stenberg and Hagekull 2007). According to a number of authors, the fact that infants under circumstances of ambiguity look at a stranger as much as at the caregiver (acting as the informant) shows that referential looking is not a mere form of comfort seeking, but rather the search for information about the specific situation (Walden and Geunyoung 2005, Stenberg 2003). In fact a number of studies have shown that referential looking occurs equally with a stranger or the mother acting as the informant (Camras and Sachs 1991, Klinnert et al 1983, Klinnert et al 1986, Zaratany and Lamb 1985, Stenberg and Hagekull 1997). However, behavioural regulation in accordance with the stranger's emotional message occurs only if the mother is also present in the room (presumably because she serves as a 'secure base' (Klinnert et al 1983)); in this case infants approach the mother more when fear signals are being delivered, whereas they approach the object more when receiving a positive message from the stranger (Klinnert et al 1986). But if infants are alone with the stranger they do not regulate their behaviour, suggesting that this process may vary according to the relationship with the informant and the presence of a bonded figure (Zaratany and Lamb 1985).

There is mixed evidence of social referencing in other species. A number of studies (Tomonaga et al 2004, Roberts et al. 2008) found no evidence of referential looking in captive mother-infant pairs of chimpanzees and infant Barbary macaques. However, other studies (Russell et al. 1997, Itakura 1995) found evidence of some aspects of social referencing in chimpanzees. In one study (Russell et al. 1997), human-reared chimpanzees showed referential looking towards their human caregiver and looked longer at the objects when a happy message was delivered, whereas they withdrew from the object more frequently when receiving a fearful message. In the other study (Itakura 1995), infant chimpanzees looked towards and returned to their mother when the object was first presented: however, it was not possible to establish whether behavioural regulation based only on the voice and facial expression of the mother occurred since her movements were not restricted. Finally, capuchin monkeys have been shown to appropriately associate the emotional valence of a conspecific's expression towards an object (Morimoto and Fujita 2012). Having

observed a conspecific open two identical boxes, which either elicited a positive or a negative reaction, subjects approached the ‘positive box’.

In a previous study, we found good evidence that domestic dogs look referentially towards the owner when confronted with an ambiguous object, but there was only slight evidence of behavioural regulation (Merola et al. 2012). This paucity of results in terms of behavioural regulation is somewhat surprising given that dogs have been shown to: (i), discriminate between smiling and neutral human faces (Nagasawa et al. 2011) and potentially also more diverse facial expressions (Deputte and Doll 2011); (ii), be positively influenced by a human demonstrator talking, both in a social learning task (Pongrätz et al. 2004) and in a classic two-object choice pointing task (Kaminski et al. 2012); and (iii), be sensitive to the tone of voice (gentle vs. harsh) used by a human in an obedience task (Fukuzawa et al. 2005), a pointing task (Scheider et al. 2011), and when evaluating a third party interaction in a begging paradigm (Marshall-Pescini et al. 2011). Taken together these findings suggest that dogs have at least some basic sensitivity towards humans’ emotional messages, even when these are conveyed only through facial and vocal means.

Thus, the limited behavioural regulation that emerged in our previous study may have been caused by small, but potentially important differences between our procedure and that used to test infants. In infant studies mothers immediately deliver the emotional message after their child looks at them; furthermore, towards the end of the test the ‘noisy/movable scary toy’ is normally switched off whilst the mother continues delivering her message (Mumme et al 1966, Walden and Ogan 1998, Kim et al. 2010), making it less intimidating for the child to eventually approach. In our previous study, owners were asked to stay silent for the first 15 seconds of the test, regardless of the dogs’ looking behaviour. This allowed us to assess whether dogs would look back to the owner not only to obtain food or a desired toy (as has been shown in numerous studies (Miklosi et al. 2000, Miklosi et al. 2003, Gaunet 2008, Marshall-Pescini et al. 2009, Viranyi et al 2006), but also when facing a new and potentially scary object. However, this procedure implied that the first time dogs looked at the owner they received no overt response, which may have conveyed an unclear message about the

value of the object. Furthermore, owners did not alternate their gaze between the dogs and the object, omitting a potentially important cue displaying the communicative intent of the informant (Kaminski et al. 2012). Finally, differently from infant studies, our ‘strange object’ was switched off only at the end of the test. Hence, we were unable to evaluate whether, when the stimulus is made less scary and the informant continues delivering the emotional message, the dog’s behaviour changes in accordance with the emotion expressed.

The first aim of the current study was to assess whether when facing an ambiguous stimulus dogs, like infants (Camras and Sachs 1991, Klinnert et al 1983, Klinnert et al 1986, Zaratany and Lamb 1985, Stenberg and Hagekull 1997), will use referential looking towards the informant regardless of their level of familiarity (stranger vs. owner). Based on infant studies, this would allow us to show that the dogs’ looking behaviour cannot be explained in terms of comfort seeking from the attachment figure, but represents a search for information from the person actively involved in the situation. The second aim was to test dogs with a social referencing procedure closely mirroring that used with infants, to evaluate whether the poverty of the behavioural regulation response observed in the previous study with the owner as the informant may have been due to methodological differences.

Finally, we aimed at assessing whether behavioural regulation would vary according to the dog’s relationship with the informant (stranger vs. owner). A number of studies suggest that dogs form a strong attachment bond with their owners, similar to the human mother-infant relationship (Topal et al. 1998, Prato-Previde et al. 2003), and that, like children, they use their owner as a ‘secure base’ (Palmer and Custance 2008). Furthermore, two studies indicate that dogs’ comprehension and use of communicative cues is influenced by the identity of the informant/recipient. In one study, dogs were more likely to inform their owner than a stranger about the location of a hidden object which was of interest only to the person (Kaminski et al. 2011); in the other, dogs that received a pointing cue to an empty container from their owner compared to a stranger, took longer to extinguish their response when the owner was performing the cuing task

(Elgier et al. 2009). There is also some evidence that the quality of the dog-owner bond may affect the dogs' problem solving abilities (Topal et al. 1997, Prato-Previde et al. 2008), and that in some situations dogs show clear preferential visual attention towards their owner (Mongillo et al 2010). Taken together these results suggest that, at least in some situations, dogs show differential behaviours depending on the identity of the person they observe or interact with.

In the current study, to assess the influence of the informant's identity on dogs' referential looking, either the owner or the stranger acted as the informant (whilst the non-acting person sat quietly in the testing room, reading a magazine). To evaluate the presence of behavioural regulation, dogs' behaviour was measured when the informant delivered the message (positive or negative) about the ambiguous stimulus that, following the infant procedure, was subsequently switched off. Hence, dog-owner dyads were randomly assigned to one of four groups: owner-positive, owner-negative, stranger-positive, stranger-negative. Between groups comparison allowed us to assess the presence of referential looking and behavioural regulation and whether they differed according to the identity of the informant.

Given dogs' use of referential looking to the owner in a social referencing paradigm (Russell et al. 1997) and the use of gaze alternation as a communicative tool also towards strangers in a variety of requesting situations (Miklosi et al. 2000, Miklosi et al. 2003, Gaunet 2008, Marshall-Pescini et al. 2009, Kaminski et al. 2011, Gaunet 2010), we hypothesized that dogs would use referential looking also towards a stranger when confronted with a novel, ambiguous object. Furthermore, considering the evidence of some behavioural regulation in our previous social referencing study (Merola et al. 2012) and the procedural modifications of the current study, we hypothesized a differential pattern of behaviour for dogs in the positive vs. negative message groups. More specifically we predicted that, similarly to infants, dogs in the negative message groups (owner-negative, stranger-negative) would look at the informant more often, stay further away from the object, and generally move less than those in the positive message groups (owner-positive, stranger-positive), whereas dogs in the latter groups would move closer to the object and interact

with it more (especially when it was turned off). Finally, considering previous studies on the dog-owner relationship, we expected a differential pattern of behaviours in dogs tested with the stranger as the informant, compared to dogs tested with the owner as the informant. In line with the infant literature, we predicted that both with the owner and stranger acting as informant dogs would approach the object more in the positive than the negative group, but they would stay closer to the owner in the negative message groups.

Method

Subjects

Ninety dogs (37 males, 53 females; mean 4.7 years SD 3.29 range: 1-13; 61 pure breed, 29 mixed breed- see Text 1) and their owners participated in the study. Dog-owner dyads were semi-randomly assigned to one of four groups, balancing for sex and age. Thus, 44 dogs participated in the study with their owners as the informant: of these 26 were tested with the owner conveying a positive emotional message (owner-positive group) and 18 with the owner giving a negative emotional message (owner-negative group) about the object. Forty-six dogs were tested with the same female stranger (IM) acting as the informant: of these 21 witnessed the stranger giving a positive message (stranger-positive group) and 25 a negative message (stranger-negative group). All dogs were pets and lived at home with their owners.

Stimulus Selection

The experimental stimulus was the same for all dogs in all groups: a 50 cm tall and 34 cm wide electric fan, with plastic green ribbons attached to it (Figure 1). This stimulus was selected in our previous study because it elicited a mild fear reaction, similarly to stimuli used in infant studies. This object evokes in most dogs a cautious reaction, i.e. neither very positive (approaching directly and touching) nor very negative (running in the opposite direction or strong stress such as

trembling, or hiding).

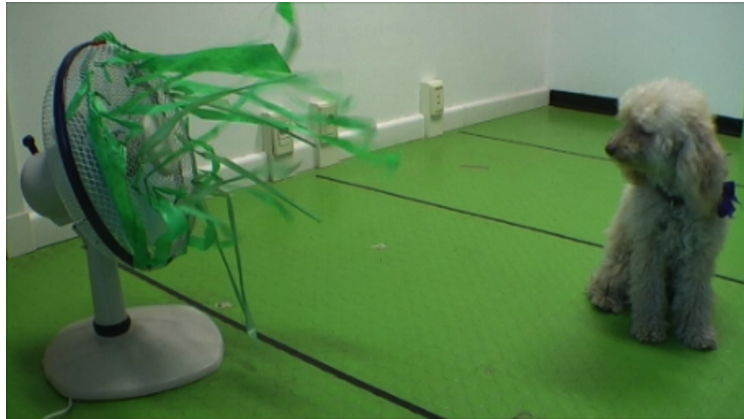


Figure 1. Experimental object. A fan with plastic green ribbons attached to it (and a curious subject).

Procedure

The dogs were individually tested in an unfamiliar (2.5 x 3.5 m) room of the laboratory *Canis Sapiens* of the University of Milan. On arrival dogs were given 5 minutes to freely explore the empty testing room, while the experimenter explained the procedure to the owner. During this time the experimenter ignored the dog completely.

The test lasted 50 seconds and was divided into two phases lasting 25 seconds each. During the entire test the fan remained placed at the far end of the room (see Figure 2).

Dogs were tested either with the owner or with the stranger conveying either a positive or negative message towards the fan. Owner and stranger were always both present in the room (as in infant studies e.g.), however the person who was not acting sat quietly in a chair facing away from the fan/dog and reading a magazine for the entire duration of the test.

Figure 2

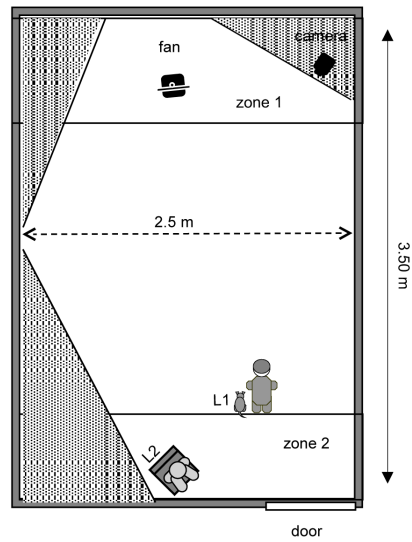


Figure 2. Experimental set up. The experimental room showing the Fan-zone (Zone 1: 230 x 85cm) and the Door-zone (Zone 2: 230 x 85cm). The dog is represented next to the informant (the standing person) in the location where it was first released (L1). Both the informant and the seated person remained in the same position throughout the test.

Each dog was allocated to one group only and thus exposed either to the positive or negative message, with either the stranger or owner delivering it.

The test phases were identical for all groups:

Phase 1 (Ph 1): the informant entered the room holding the dog by its collar and stopped at location 1. At the same time the other person (owner or stranger depending on group allocation) sat on a chair in the room reading a book with their back to the fan (at location 2), without moving until the end of the test. As soon as the informant closed the door, the fan was activated by remote control. The informant and dog stopped at location 1, facing the fan, where the dog was released and allowed to move freely around the room. The informant remained silent looking at the fan until the dog looked back at her/him the first time. From this moment the informant started to respond alternating their gaze between the dog and the fan every time the dog looked at her/him, and, depending on group allocation, using either a happy (positive message) or fearful (negative message) voice and facial expression.

Phase 2 (Ph 2): the experimenter turned off the fan using the remote control. The informant whilst remaining in the same position (location 1) continued to respond to the dog every time it looked at her/him, using either a happy (positive message) or fearful (negative message) voice and facial expression.

In both the positive and negative group, in phases 1 and 2 the owners and stranger were instructed to deliver their message only when the dogs were looking at them. They were also asked to alternate their gaze between the object and the dog whilst delivering the message and to communicate using typical phrases such as “that’s lovely”, “so beautiful” or “that’s ugly”, “that’s scary”, accompanied by either a smiley happy face or a scared worried expression. They were explicitly told not to use the dog’s name and potential commands such as “look, go, come, touch, away”. They were instructed to convey, through facial and vocal expression, the feeling either that the dog could safely and happily approach the object or that the object was dangerous and fearsome for the dog. After the test ended the experimenter went out of the room to get some pieces of food,

and together with the owner sat next to the fan, giving the dog treats when it came in proximity of the fan. All dogs received this treatment so that they would not become sensitive to fans.

Data collection and analysis

The test was recorded by a video camera (Panasonic NV-GS330), and analysed using Solomon Coder (beta 081122, Copyright 2006-2008 by Andràs Péter). All the statistical analyses were carried out with IBM SPSS Statistics 19.

Following, referential looking was defined as a gaze towards the informant that was preceded/followed -within 2 seconds- by a look to the fan and gaze alternation as a consecutive sequence of three looking behaviours (fan-informant-fan or informant-fan-informant). Referential looking was analyzed only in Ph 1, whereas the latency to interact and reach the fan-zone only in Ph 2. All the other behaviours were analyzed in both phases. Two non-mutually exclusive categories of behaviour were recorded: Action and Gaze. Furthermore, the location of dogs in two areas of the room, the Fan-zone and the Door-zone, was recorded (Table 1). The Fan-zone (2.30 x 85 cm) was the area closest to the fan and the Door-zone (2.30 x 85 cm) the area furthest from the fan (see Figure 2).

The dogs' behaviour was coded from video by the first author (I.M.). A second independent blind coder analysed 25% of the data and Spearman correlations were calculated for the main behavioural categories (Gaze Own: $r=0.79$, $p=0.000$; Gaze Exp: $r=0.83$, $p=0.000$; Approaching Fan: $r=0.95$, $p=0.000$; Door Zone $r=0.93$, $p=0.000$).

To evaluate whether informant identity, message valence and test phase affected the dogs' behaviours a Generalized Estimating Equation (GEE) with Bonferroni corrected posthoc tests was used with the following predictor variables: informant (owner vs. stranger), message (positive vs. negative) and test phase (Ph 1 and Ph 2). The frequency of gazing at the owner and the stranger and the duration of all the actions, and zone use (see Table 1) were used as dependent variables.

ACTION	
Interact fan	the dog is in physical contact with the fan
Interact informant	the dog is in physical contact with the informant
Interact seated person	the dog is in physical contact with the seated person
Static	dog is in any position which does not involve movement i.e. standing, sitting or lying
Locomotion	the dog is in motion e.g. exploration of the room, approaching a person or simply walking around
Approach fan	the dog's face is oriented towards the fan and there is a reduction in the distance between itself and the fan
GAZE	
Gaze seated person	the dog's head is oriented towards the person that was inactive during the test
Gaze informant	the dog's head is oriented towards the person that was giving the messages (positive or negative)
ZONE	
Door zone	An area of 230x85cm closest to the door and farthest from the fan
Fan zone	An area of 230x85cm closest to the fan and farthest from the door

Table 1: Behavioural categories. Three non-mutually exclusive categories were used: action, gaze and areas of the room used by the dogs; within each category mutually exclusive behaviours and their descriptions are outlined.

Furthermore, latencies to reach the Fan-zone and Interact with the fan in phase 2 of the test were analyzed using a Generalized Linear Model (GLM) with Bonferroni corrected posthoc tests with the informant (owner vs. stranger) and message (positive vs. negative) as predictor variables. The same model was used to compare the duration of the messages delivered by the informant in the 4 groups, and to compare the frequencies of gaze alternation between fan and the owner when s/he was the informant vs. the seated person.

Chi-square tests were used to compare the number of dogs that showed referential looking and gaze alternation towards the informant in the owner vs. stranger group and the number of dogs that interacted with the fan in the positive vs. negative message group. Finally, a Wilcoxon test was used to compare the frequency of gazing at the informant vs. the seated person.

Results

Of the ninety dogs tested, eight dogs (2 males and 6 females) were excluded from all analyses, because of procedural errors committed by the owners during testing.

Of the remaining eighty-two dogs, twenty-five (14 males and 11 females) approached and touched the fan during the first 25 seconds of the test (Ph 1), exhibiting a confident and positive attitude towards the stimulus. These dogs were excluded from further analyses of social referencing, since a pre-condition for this test is that dogs show an ambiguous (or mildly fearful) behaviour towards the stimulus object, and because the more experience a subject has had with a particular object the less receptive he will be to social referencing regarding that object.

Of the remaining fifty-seven dogs, 3 never looked back at the informant, and hence never received a message. These dogs were included in the analyses for referential looking and gaze alternation but, in line with the approach taken by and in their infant studies, they were excluded from the analyses of behavioural regulation.

Referential looking and Gaze alternation

To assess whether dogs carried out referential looking and gaze alternation towards the informant when confronted with an ambiguous stimulus we analysed dogs' gazing behaviour in Ph 1. Twenty-two of 29 (76%) dogs in the owner group (positive and negative) and 17 of 28 (60%) dogs in the stranger group (positive and negative) showed referential looking towards the informant. This difference was shown not to be significant ($\chi=1.5$; $p=0.22$).

Gaze alternation, defined as a 3-way interaction (i.e. person-fan-person or fan-person-fan), was coded both between the object and the informant and between the object and the seated person. Considering positive and negative message groups together, gaze alternation between fan and informant was shown by 18 dogs in the owner-informant group (62%) and 15 dogs in the stranger-informant group (52%). This difference was shown not to be significant ($\chi=0.4$; $p=0.5$).

Conversely, considering positive and negative message groups together, gaze alternation between the fan and the seated person was exhibited by 12 dogs in the owner-seated group (37%) and 2 dog in the stranger-seated group (3%).. This difference was shown to be significant ($\chi=9.94$; $p=0.002$).

To assess whether dogs took into consideration the attentiveness of the person, we compared the frequencies of gaze alternation between fan and the owner when s/he was the informant vs. the seated person. Dogs' gaze alternation was significantly higher when the owner was the informant than when s/he was seated and inattentive (mean informant =1.7, seated =0.5, Wald = 15, $p<0.001$). The same analysis was carried out when the stranger was either the informant or the seated person, and similar results emerged (mean informant =0.9, seated =0.24, Wald = 8.7, $p=0.003$).

To evaluate whether the dogs' looking behaviour was directed specifically to the informant, gaze frequency to the informant and the seated person were compared for the stranger/informant group and the owner/informant group separately. In the stranger-informant group dogs looked at the seated owner and stranger equally (Wilcoxon $z=0.9$, $p=0.4$), whereas in the owner-informant group dogs looked significantly more at the owner than the seated stranger (Wilcoxon $z=3.9$, $p<0.001$).

Behavioural regulation

Having established that dogs use referential looking also towards a stranger when confronted with an ambiguous object, we assessed whether the dogs' reaction would be affected by the valence of the emotional expression delivered and by the informant's identity.

Of the 54 dogs that showed an ambiguous approach towards the fan in Ph1, twenty-seven (10 males and 17 females) were in the owner group and twenty-seven (10 males and 17 females) in the stranger group. In the owner group fourteen dogs (5 males and 9 females) were tested with the positive message and thirteen (5 males and 8 females) with the negative message; in the stranger group twelve dogs (5 males and 7 females) were tested with the positive message and fifteen (5 males and 10 females) with the negative message.

Significant differences emerged in Gazing towards the informant (GEE informant x message x test phase, Wald=43.4, $p < 0.001$, see Figure 3) and in Gazing towards the seated person (GEE informant x message x test phase Wald=29.32 $p = 0.000$). In all groups dogs looked at the informant more often in Ph 1 than Ph 2 (stranger-positive: phase 1 vs. 2, $p < 0.001$; stranger-negative: phase 1 vs. 2, $p = 0.018$; owner-positive: phase 1 vs. 2 $p = 0.003$; owner-negative: phase 1 vs. 2 $p = 0.01$). In the positive message group dogs gazed at the informant more often if s/he was the owner rather than the stranger; this occurred in both phases (phase 1: mean owner = 5.07 vs. stranger = 2.83, $p < 0.001$; phase 2: mean owner = 2.57 vs. stranger = 1, $p = 0.01$). When the informant was the owner, dogs in the positive message group looked at him/her more often than dogs in the negative message group (mean owner-positive = 5.07 vs. mean owner-negative = 3.15, $p = 0.01$) but only in Ph 1. No such difference emerged in the stranger group. In the negative message group dogs looked at the seated person more often s/he was the owner rather than the stranger (mean owner = 2.17 vs. mean stranger 1, $p < 0.001$) but only in Ph 1.

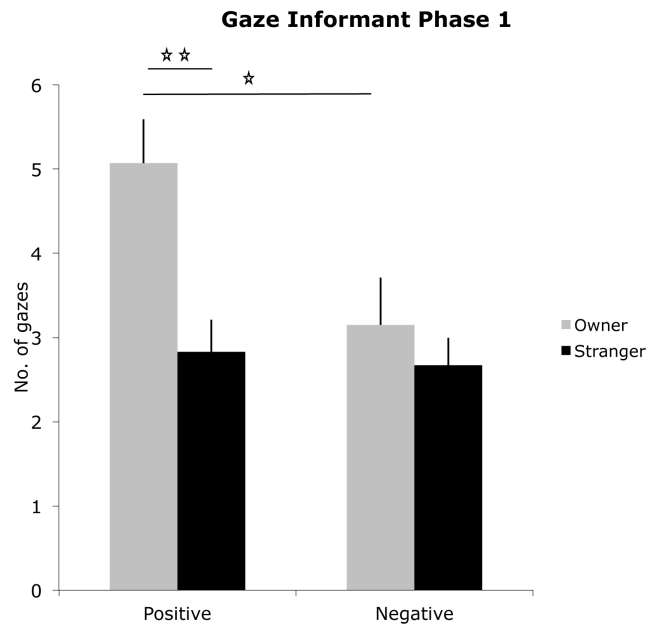


Figure 3. Gaze informant. Mean frequency of gazes directed towards the informant during Phase 1 for dogs in the owner-positive, owner-negative, stranger-positive and stranger-negative groups. The bar represents the standard error (SE).

Significant differences emerged in the time spent in the Door-zone (farthest from the fan) (GEE informant x message x test Wald=16.52, $p=0.02$) and in the Fan-zone (closest to the fan) (GEE informant x message x test Wald=18.77, $p=0.005$) (Figure 4 and 5). When the informant was the stranger, dogs in the negative message group spent more time in the Door-zone compared to dogs in the positive message group in both phases (Ph 1: mean negative group = 10.18 vs. positive group = 5.16, $p=0.02$; Ph 2: mean negative group = 14.44 vs. mean positive group = 3.75, $p=0.002$). In Ph 1, dogs that received a negative message, spent longer in the Door-zone when the informant was the stranger than when s/he was the owner (mean stranger-negative group = 10.18 vs. owner-negative group = 5.47, $p=0.043$). During Ph 2 dogs in the positive message group, spent more time

in the Fan-zone if the informant was the owner rather than the stranger (mean owner-positive = 4.06 vs. stranger-positive = 0.37, $p=0.003$). Furthermore, in the group of dogs tested with the owner as the informant, dogs receiving a positive message spent more time in the Fan-zone than dogs receiving the negative message (mean owner-positive = 4.06 vs. owner-negative = 0.4, $p=0.003$).

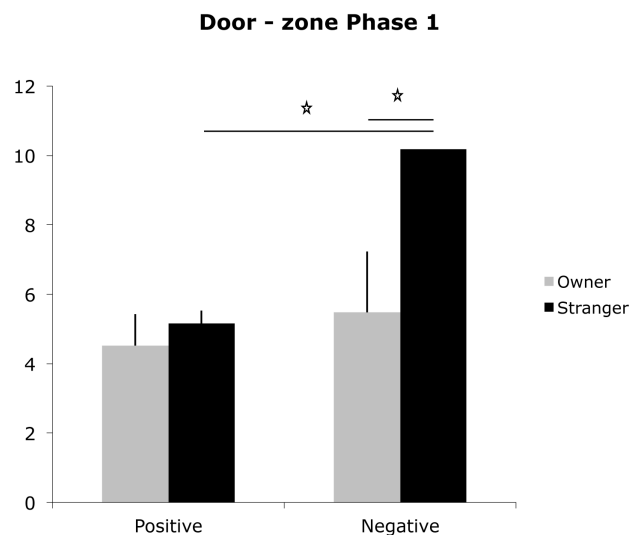


Figure 4. Door - zone. Mean duration (in seconds) of time spent closest to the door (hence farthest from the fan) in Phase 1 for dogs in the owner-positive, stranger-positive and owner-negative, stranger-negative groups. The bar represents the standard error (SE); * $p<0.05$, ** $p<0.001$.

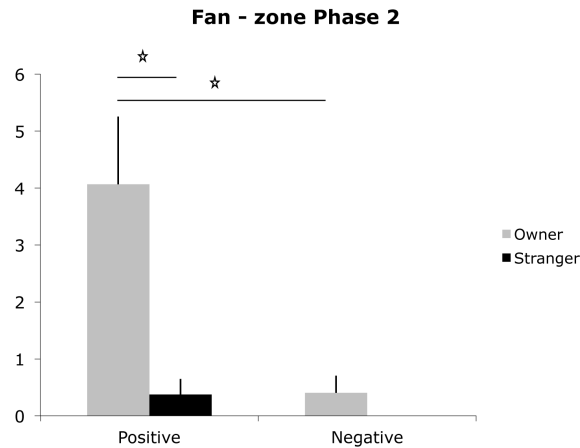


Figure 5. Fan - zone. Mean duration (in seconds) of time spent closest to the fan in Phase 2 for dogs in the owner-positive, stranger-positive, owner-negative and stranger-negative groups. The bar represents the standard error (SE); * $p < 0.05$, ** $p < 0.001$.

Significant differences emerged in Approaching the fan (GEE informant x message x test Wald=83.97, $p=0.001$). During Ph 2 dogs in the positive message group, spent more time approaching the fan if the informant was the owner than if it was the stranger (mean owner-positive = 2.75 vs. stranger-positive = 1.1 $p=0.045$). Furthermore, in the group of dogs tested with the owner as the informant, dogs receiving a positive message spent longer approaching the fan than dogs receiving a negative message (mean owner-positive = 2.75 vs. owner-negative = 0.64, $p=0.002$).

There were also differences in Static behaviour (GEE informant x message x test Wald=32.72, $p=0.001$). In Ph 2, dogs tested with the stranger as the informant spent more time being static if the message they received was negative than if it was positive (mean stranger-

positive = 10.81 vs. stranger-negative = 18.25, $p=0.01$). An overall difference emerged in the dogs' frequency to interact with the seated person (GEE informant x message x test Wald=14.35, $p=0.045$) and with the informant (GEE informant x message x test Wald=14.30, $p=0.03$), but subsequent post-hoc tests were unable to detect where these differences occurred.

Furthermore, in Ph 2 significant differences emerged in the latency to reach the Fan-zone in relation to informant identity (Wald 9.14, $p=0.002$) and message valence (Wald 13.89, $p<0.001$). When the informant was the owner, dogs in the positive message group reached the Fan-zone faster than with the stranger as the informant (mean owner-positive = 28.84 vs. stranger-positive = 50.97, $p=0.005$). Furthermore, when the informant was the owner, dogs in the negative group took longer to enter the Fan-zone than dogs in the positive group (mean owner-positive = 28.82 vs. owner-negative = 54.21, $p=0.001$). Moreover, in this phase significant differences emerged in the latency to interact with the fan in relation to informant identity (Wald 10.98 $p=0.001$) and message valence (Wald 4.78 $p=0.029$). In the positive message group dogs tested with the owner as the informant touched the fan sooner compared with dogs tested with the stranger as the informant (mean owner-positive = 35.1 vs. stranger-positive = 60, $p=0.001$). Furthermore, when the informant was the owner, dogs in the negative group took longer to interact with the fan than dogs in the positive group (mean owner-positive = 35.1 vs. owner-negative = 55.44, $p=0.002$).

In the positive message groups a greater number of dogs interacted with the fan when the informant was the owner rather than the stranger (Fisher exact: owner group = 8 vs. stranger group = 0, $\chi^2 = 9.39$, $p=0.002$); no such difference was found between negative message groups (Fisher exact owner group = 3 vs. stranger group 1, $\chi^2 = 1.08$, $p=0.24$) where very few dogs touched the fan.

Finally, to assess whether the different patterns of behaviour in the positive and negative message groups may have been caused by the different amount of time spent delivering the messages, we compared mean duration of messages in the four groups: no significant differences

emerged (Wald=1.85, p=0.6).

Discussion

Social referencing is a process that could be useful in a variety of everyday life situations, such as meeting a new person, facing a new and ambiguous situation or a strange object. Given the dependent nature of dogs' relationship to humans (Topal et al. 1998, Prato-Previde et al. 2003) adult dogs, like young children, may benefit from the ability to assess people's reaction to novel situations/stimuli and act accordingly. The aim of the current study was to assess the potential presence of social referencing in dog-human interactions. Given our previous study on this topic demonstrating the presence of referential looking towards the owner (Merola et al. 2012), we investigated the potential presence of this behaviour also towards a stranger; furthermore, using the same procedure adopted in infants' studies, we aimed at assessing the presence of behavioural regulation based only on the owners'/strangers' vocal and facial emotional reactions to the object, and evaluated potential differences in the dogs' reaction to the message depending on informant identity.

A number of studies have reported functionally referential communication in dogs, indicating that dogs use gaze and gaze alternation as a communicative tool in a variety of situations in order to request for out of reach toys or food (Miklosi et al. 2000, Miklosi et al. 2003, Gaunet 2008, Marshall-Pescini et al. 2009, Kaminski et al. 2011, Gaunet 2010). Preliminary evidence also suggests that dogs, besides using gaze for requesting purposes, look at their owners to monitor their reaction to a strange object (Merola et al. 2012). Current results confirm those of our previous study, with 76% of dogs looking back to the owner when confronted with a strange object, and extends them by showing that this behaviour occurs equally frequently when a stranger acts as the informant (60% of dogs looking back to the stranger). The pattern of gaze alternation between informant and ambiguous object is also unaffected by informant identity (62% owner vs. 52% stranger). These findings are similar to those emerging from the infant social referencing literature and showing that,

in a similar situation, infants look referentially towards their mother (88%) but also towards a stranger (83%) or a familiar care-taker (86%) (Camras and Sachs 1991, Klinnert et al 1986, Stenberg and Hagekull 1997). According to a number of authors (Walden and Geunyoung 2005, Stenberg 2003) looking at a stranger as much as at a familiar care-giver (acting as the informant) indicates that looking behaviour cannot be considered just a form of comfort seeking due to the activation of the attachment system, but rather it should be interpreted as a search for information about the specific context.

In a subsequent study with infants, however, a different set up was used to assess whether infants would preferentially look at a stranger actively informing them about the situation or at the inattentive mother, when both were present in the room (Stenberg and Hagekull 2007). Also in this scenario infants preferred looking at the active stranger, further excluding the possibility that looking was a comfort-seeking behaviour. In contrast, results from our study show that when the informant is a stranger and the owner is inattentive, dogs look at both to the same extent. Hence, differently from infants, dogs seem to look at the stranger-informant but also seek out the owner by looking towards him/her. Whether this behaviour is aimed at obtaining information also from the owner, or is a form of comfort seeking, remains an open question.

A further objective of this study was to examine the influence of the informant's vocal and facial expression on the dogs' behaviour towards the ambiguous object (the behavioural regulation aspect of social referencing). Results showed that dogs were affected by the positive vs. negative message received but in different ways according to the informant's identity. When the owner acted as the informant dogs in the positive group looked at him/her more often than dogs in the negative group, and also spent more time approaching the fan and in the Fan-zone. Conversely, dogs in the negative group took longer to reach the Fan-zone and interact with the fan. These findings are in many ways similar to those found in infants. Indeed, when tested with their caregiver (mother/owner), both dogs and infants that received a positive message moved closer to the object and interacted with it sooner than individuals who had received a negative message (Walden and

Ogan 1998, Klinnert et al 1983), whereas the latter interacted less with the object and showed reduced explorative behaviour (Mumme et al. 1996, Klinnert et al 1983, Hornik et al 1997, Gunnar and Stone 1984). Hence, using an experimental paradigm closely mirroring that used with children (i.e. conveying the message from the subject's first look and reducing the scariness of the object by switching it off whilst still conveying the message) we found evidence of behavioural regulation in dog-owner dyads. The only substantial difference between our results and those reported in the infant literature is that whereas infants looked more to the mother if she delivered a negative message (Walden and Ogan 1998), our dogs looked more often to the owner if s/he delivered a positive message. This pattern was also seen in 6–9 months old infants, who showed referential looking to the mother and an increased duration of looks with a positive rather than a negative message; however, at this age there was no evidence of behavioural regulation, probably due to the infants' inability to detect the fearful affect of the parental communication (Walden and Ogan 1998). In our situation this explanation is unlikely since the dogs behaviour was affected by message valence. One potentially important difference between our own and most infant studies, is that whereas children were tested with novel, movable toys, we used an object that was potentially more intimidating for dogs. Hence it is possible that dogs correctly interpreted their owner's encouraging message as an indication to explore the object further but, being uncertain about the object, they looked back more frequently to check that the owner was sure that approaching was a good idea.

Results assessing the effectiveness of the message when delivered by a stranger showed that, although dogs in both message groups looked referentially to the stranger as often as to the owner, they did not approach and interact more with the fan in the positive compared to the negative group. Interestingly, dogs in the negative message group spent more time in the area close to the door (i.e. close to the seated owner), exhibiting more static behaviour and looking more often to the seated owner. Similarly to what has been found with infants, maintaining proximity with the owner may be an expression of comfort-seeking. Taken together these results suggest that probably dogs were sensitive to the emotional expression of the stranger (in line with (Deputte and Doll 2011, Ruffman

and Morris-Trainor 2011)), but the way they changed their behaviour was dependant on their relationship with the informant. Indeed when a positive message was being conveyed significantly more dogs interacted with the fan if the owner rather than the stranger was the informant. These results are partially in accordance with those emerging from the infant literature. Like our dogs, infants tested with a stranger as the informant, will seek the mother more when receiving a negative message: however, differently from our dogs, they will approach the object more when receiving a positive message from the stranger (Klennert et al. 1986, Stenberg and Hagekull 2007, Stenberg 2003, Stenberg 2011). There are two possible explanations for dogs' not approaching the object: firstly, as was mentioned above, the stimulus used in infant studies was inherently more attractive, whereas we chose an object which most dogs found a bit intimidating. The motivation to explore it may hence have been quite low, and only be activated by the owner's encouragement. Another possibility is the difference in the owner/mother engagement in the scene. In infant studies, mothers are present and attentive to the interaction that is occurring between the stranger, child and object, whereas in our own study the owner was reading a magazine and facing away from the scene. It is possible that whereas the attentive mother provided infants with enough reassurance that 'all was well' when the stranger gave a positive message, the inattentive owner was an element of uncertainty which inhibited dog's potential reaction to the stranger's positive message. Future studies will be needed to address these points, however results from the current study show that although the behaviour of dogs was different depending on informant identity, a clear difference emerged depending on the message sent, showing that dogs were indeed able to distinguish the informant's emotional message.

A possible factor influencing the differential behaviour of dogs in the different groups is the duration of the vocal and facial messages expressed by the informants, however these resulted to be similar across all four groups.

Another possibility is that dogs were affected by the general mood of the informant (and more specifically the owner), rather than understanding that the emotional message referred to a

specific object. Mood modification (*sensu* (Stenberg and Hagekull 1997)) is a process by which the observer is affected by the emotions of the actor and hence mirrors those same emotions (deWaal 2008). Whereas a number of infant studies devised experimental paradigms to tease these processes apart (Stenberg and Hagekull 1997), the current study did not set out to do so. However, it should be noted that, when tested with the owner, the behavioural changes enacted by dogs could potentially have been directed either at the object or the seated stranger. If dogs had not been sensitive to the referential nature of their owner's communication we would have expected an increased interaction with the seated person in the positive group, and avoidance in the negative group but this was not the case: dogs' behavioural changes were specifically directed to the fan and the area around it.

Finally, results appear interesting also in relation to debates about 'joint attention'. According to a number of authors gaze alternation behaviour manifested by the subject between the object and the sharer of attention is a necessary but also sufficient condition to show joint attention (Leavens and Racine 2009). Hence, according to this view, in a social referencing paradigm, infants (and in our case dogs) show joint attention towards the object with the caregiver who comments on it. However, more recently, a number of researchers have redefined joint attention, by emphasizing the 'jointness' aspect (Carpenter and Tomasello 1995, Carpenter and Call in press). According to these authors attending to the same thing that one's partner is attending to is not enough for joint attention; rather there needs to be (i), a motivation to share attention and interest with others with no other more instrumental goal; and (b), that both individuals know together that they are sharing attention. According to this view social referencing does not necessarily require joint attention, since the subject may simply exploit the knowledge of the informant without necessarily being engaged in sharing attention with him/her, i.e. without the 'knowing together' element of joint attention. In the current study we adopted a stringent definition of gaze alternation, requiring dogs to carry out a 3-way behaviour (fan-informant-fan, or informant-fan-informant) and, although we did not set out to test the 'jointness' hypothesis, there may be a

number of elements of interest relating to it. Firstly, the motivation behind the dogs' gaze alternation behaviour in general could not be considered a desire to obtain the object since dogs were somewhat intimidated by it. Secondly and more importantly, there was an active search on the dogs' part to involve the owner when s/he was inactive by gaze alternating between him/her and the fan. If dogs simply wanted owners to attend to them, they did not need to gaze alternate towards the object, other attention-getting behaviours or gazing to the owner alone would have been sufficient. Taken together these results seem to suggest that dogs "wanted their owner" to attend to the same object they were attending to, possibly because the stranger's feedback was not sufficient or relevant enough for them. Third, a different pattern of gaze alternation was evident with the owner and the stranger depending on his/her attentional stance. Dogs gaze alternated more frequently when the person was the informant and hence was also gaze alternating between them and the object than when s/he was seated and inattentive, suggesting that they could recognize when this behaviour was mutual. In light of these preliminary results it will be very interesting to design studies capable of teasing apart the motivation behind dogs' human-directed looking behaviour.

In sum, the current study shows that dogs look back not just to request for a desired object/food but also to check their owner's (but also a stranger's) reaction to an ambiguous object. Furthermore, it is the first study to show that dogs will modify their behaviour towards an object depending on the informants' positive vs. negative message. Hence, dogs use social referencing in their interactions with humans, but when confronted with a potentially scary object, their behaviour towards it seems to be selective and dependent on the relationship with the informant.

Chapter 7

Social referencing: trained dogs are less affected than pet dogs by the stranger's message.

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Introduction

A considerable number of studies have revealed that dogs are special in communicating and interacting with humans, and some authors suggest that domestication might have resulted in a genetic predisposition for human-directed communication in dogs (Soproni et al., 2001, Hare et al. 2002; Miklósi et al. 2003; Hare & Tomasello 2005), further shaped through subsequent selection processes resulting in dogs with specific morphologic, cognitive and behavioural characteristics (Christiansen et al 2001, Scott and Fuller 1965, Wilsson and Sundgren 1997, Passalacqua 2011, Gácsi 2009). At the same time it is now also clear that life experiences, such as training, play an important role in shaping dogs' behaviour towards people and the environment (Reid 2009; Udell 2010; Gácsi 2009a).

Dogs have been historically trained to perform a variety of tasks ranging from the more classic ones such as hunting, herding and guarding (Coppinger and Sneider 1995) to more recent ones, related either to sport and competition (i.e. agility, freestyle) or to specific work activities in collaboration with humans (i.e. searching dogs, water rescue dogs, guide dogs, military working dogs). Furthermore, although today the majority of dogs are kept as companion animals, an increasing number of pet owners take their pets to training schools to avoid the onset of undesirable behaviours (Rooney, 2011, Yin et al. 2007, Bennet 2006).

In recent years several studies have investigated the effects of training experiences on dogs' behaviour in different test situations and tasks. Taken together, these studies show that training affects dogs' performance in problem solving and socio-cognitive tasks and in their social relationships with humans (Gaunet, 2008; Prato-Previde et al., 2008; Ittyerah and Gaunet, 2009; Marshall-Pescini et al., 2008, 2009, Gácsi 2009).

In particular, different training regimes have been shown to influence dogs' individual problem solving abilities and their inclination to seek for help by looking at humans (McKinley and Sambrook, 2000; Osthaus et al. 2003, 2005; Prato-Previde et al. 2008, Marshall-Pescini et al. 2008, 2009, Range et al. 2009).

For example, as regards looking behaviour, Marshall-Pescini et al. (2009) found that agility dogs looked at the owner for longer compared to search & rescue dogs when facing an unsolvable situation; on the contrary, Gaunet (2008) using the 'unsolvable task paradigm' and comparing pet and guide dogs for the blind found no differences in either the gazing or gaze alternation behaviour between the two groups, although guide dogs performed a noisy mouth-licking behaviour combined with gazing, which may have emerged as a supplementary attention-getting signal directed at their blind owners.

There is also some evidence that training influences the dog-human bond by modulating the expression of attachment behaviours of dogs towards their owner as shown when adopting the Strange Situation Test (Fallani et al., 2006; 2007; Valsecchi et al., 2010). In this test, guide dogs and search and rescue dogs like pet dogs, showed that they establish with their blind owner/handler a good and secure affectional bond, but as a consequence of training they show a more controlled behavioural reaction to the distress of the testing condition (Fallani et al. 2007, Mariti et al. 2011). Furthermore, a recent study carried out on water rescue dogs, specifically trained to cooperate with their human partner to rescue drowning people, suggests that, as a consequence of their specific training experience, these dogs show more interest in the unfamiliar person during the test, with a

higher frequency of proximity seeking behaviour (i.e. approach, follow, orient) towards the stranger than breed-matched pet dogs (D'Aniello et al. 2013, submitted).

Given the studies showing an influence of training on dogs' performance in human-directed communication and socio-cognitive tasks, in the present study we evaluated the effects of a particular training experience on dog-human interaction using a social referencing paradigm. Social referencing can be defined as a process whereby individuals (humans and non) use the emotional information provided by an informant (con- or inter- specific) about a novel referent to guide their own behaviour towards it (Vaish & Woodward 2010). Thus, it represents a way to bypass individual experience taking advantage of another individual's knowledge. A number of studies have investigated whether in infants the two different components of social referencing, namely referential looking and behavioural regulation, occur equally when the emotional message towards the potentially scary stimulus is conveyed by a stranger or a familiar person (Klennert et al. 1983; Camas & Sachs 1991; Zaratany & Lamb 1985; Walden & Geunyoung 2005; Stenberg and Hagekull 2007). Results show that in infants' referential looking occurs both with the mother and a stranger acting as the informant (Klennert et al. 1983; Camas & Sachs 1991; Stenberg & Hagekull 1997; Klennert et al. 1983; Zaratany & Lamb 1985) and that behavioural regulation (based on the stranger's message) can occur also when the stranger is the informant, but only if the mother is present during the test (Sigman & Kasari, 1994).

So far two studies have investigated social referencing in dog-human interactions (Merola et al., 2012, Merola et al., 2012a) providing evidence that dogs engage in communication with humans not only when unable to reach/obtain a desired object (Miklósi et al., 2000, 2003), but potentially also to gather information about an unfamiliar situation/object (i.e. information gathering). One of these studies showed that, similarly to what has been observed in infants, dogs look referentially both at their owner and a stranger acting as the informant, however, behavioural regulation seemed to be more selective and dependent on the relationship with the informant, since it occurred more explicitly when the owner was the informant. In fact, when the informant was the stranger, dogs

changed their behaviour on the basis of the negative emotional message, approaching their owner more than dogs in the positive message group. However, when a positive message was conveyed, whereas dogs tested with their owners approached the fan, dogs tested with the stranger did not (Merola et al., 2012a).

Water rescue training is aimed at creating human-dog dyads specialized in rescuing people who are drowning. It involves the formation of dog-human dyads, cooperating with coast guards and port authorities in patrolling bathing areas and acting as a team when necessary. The main purpose of this type of training is to promote strong cooperation and synchronization between dog and owner that can persist in stressful and challenging situations. A second goal of the training is to focus the dogs' attention on unknown people who scream for help and wave their arms, simulating people in distress (during the land obedience stage) and after simulating drowning (during the water stage). Therefore, a successful training program will produce water rescue dogs that, not only are strongly bonded with their owner, with whom they work in a cooperative manner, but that also have strong positive attitudes towards strangers, without being scared or aggressive towards them (D'Aniello et al., 2013, submitted).

The purpose of the current study was to assess whether in a social referencing paradigm, with a stranger acting as the informant, water rescue dogs specifically trained to focus their attention towards strangers would differ in referential looking and behavioural regulation, as compared to pet dogs. To reach this aim, water rescue dogs and a control group matched for age and breed that had received only basic training were tested using the same procedure and ambiguous stimulus as in Merola et al. (2012a).

The infant literature suggests that behavioural regulation in terms of behavioural changes toward the object is more evident when a positive emotional message is delivered whereas with a negative message, infants (and dogs) look to the familiar person more and stay closer to him/her without showing proactive behaviours towards the referent (Stenberg and Hagekull, 1997, Walden and Hogan 1988, Klinnert et al. 1983). Given the difficulty in recruiting trained water rescue dogs,

due to the limited number of certified dog-human dyads, the study was carried out with a stranger-informant giving only the positive message.

Considering water rescue dog training is aimed at increasing the attention and the positive attitude of the dogs toward a stranger, and the evidence emerging from the SST of this greater propensity to interact with stranger, we hypothesized that overall trained dogs would show more referential looking toward the stranger and regulate their behaviour in accordance to the stranger positive message approaching the ambiguous object more than untrained dogs.

Method

Subjects

Eleven water rescue dogs (6 Labrador Retriever and 5 Golden Retriever, 3 males and 8 females, mean age 4.8 yrs SD 2.2 range: 3-10; Trained group) recruited at the Italian School of Water Rescue Dogs (Scuola Italiana Cani Salvataggio - SICS Water Rescue Certificate®) in Naples and eleven age and breed matched pet dogs (6 Labrador Retriever and 5 Golden Retriever, 2 males and 9 females, mean age 5.3 yrs SD 2.4 range: 2-10; Pet group) with no work training but just basic training (basic agility, obedience) and their owners participated in the study. All dogs lived within the human household with their owners. Seven trained dogs had participated in two previous studies (SST and unsolvable task paradigm; both studies were carried out about a year before the current study); 3 control dogs were selected from the *Canis sapiens* Lab database and had participated in a number of studies (1 participated in the SST), but none involving the social referencing paradigm; the remaining control dogs had never participated in a study before.

Stimulus

The experimental stimulus was the same for all dogs in both groups and consisted of a 56 cm tall and 45 cm wide electric fan, with black, white and silver (aluminium) plastic ribbons attached to it (Figure 1). This stimulus closely resembled the one used in previous studies, but was made

noisier in order to increase the likelihood that it would evoke a cautious/mild fear reaction also in trained water rescue dogs. The fan was connected with a remote control to turn it on and off.



Figure 1: The ambiguous object (a fan with plastic ribbons attached to it).

Procedure

The dogs were individually tested in two comparable unfamiliar (3.9 x 3.4 m) rooms: one at the University of Naples and one at the *Canis Sapiens* laboratory of the University of Milan. On arrival dogs were given 5 minutes to freely explore the empty testing room with their owners.

The test lasted 60 seconds and was divided into two phases lasting 30 seconds each. During the entire test the fan was placed at the far end of the room. The room was divided into 3 different equivalent areas (Zones), marked on the floor with coloured sticky tape: Owner zone, Stranger zone and Fan zone (see Figure 2).

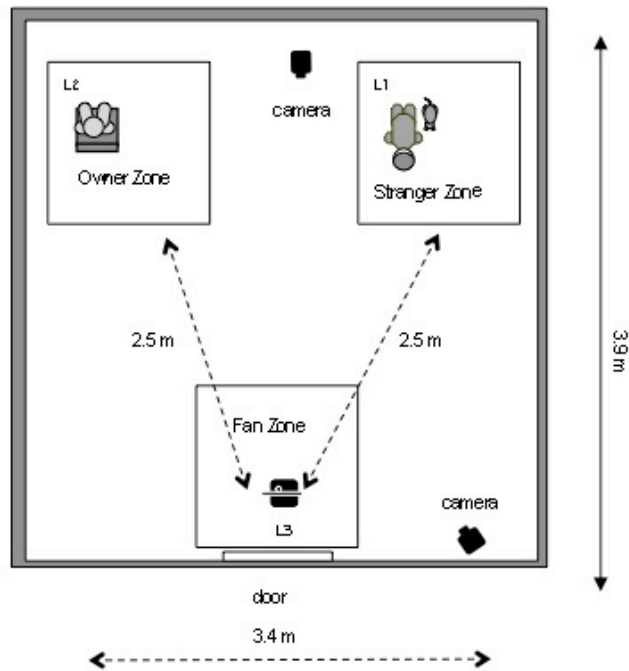


Figure 2: The experimental setup.

Both groups of dogs were tested with the same female stranger (IM) acting as the informant and conveying a positive emotional message towards the fan. Owner and stranger were always both present in the room (as in Merola et al., 2012a), but the owner was not acting and simply sat quietly in a chair.

The test phases were identical for both groups:

Phase 1: the stranger-informant (E1) entered the room holding the dog by its collar and stopped at Location 1. At the same time the owner sat on a chair in the room at Location 2, reading a book, with the back to the fan and without moving until the end of the test (see figure 2). Once the stranger (E1), the owner and the dog were in position, the fan was located in front of the door by a second experimenter (E2), that put it on the floor from behind the door, remaining invisible to the dog (Location 3) and then she closed the door. E1 activated the fan by remote control as soon as the door was closed by E2 and then the dog was released and allowed to move freely around the room. E1 remained silent looking at the fan until the dog looked back at her the first time. From this moment she started to respond alternating the gaze between the dog and the fan every time the dog looked at her, and using a happy voice and facial expression to deliver a positive message.

Phase 2: E1 turned off the fan using the remote control and whilst remaining in the same position (Location 1) continued to respond to the dog every time it looked at her, using a happy voice and facial expression. She delivered the message only when the dog was looking at her, alternating the gaze between the dog and the fan and uttering the phrase “oh that’s lovely, is really nice” accompanied by a smiley happy face. She conveyed, through facial and vocal expressions, the feeling that the dog could safely and happily approach the object, but she never used the dog’s name or potential commands such as “look, go, touch”. After the test ended the experimenter went out of the room to get some pieces of food, and together with the owner sat next to the fan, giving the dog treats when it came in proximity of the fan. All dogs received this treatment to avoid that they would become sensitive to fans.

Data collection and analysis

The test was recorded by two video cameras, (Panasonic NV-GS330) in order to record all the dog's movements, its facial expression and stress signals, and was analysed using Solomon Coder (beta 081122, Copyright 2006-2008 by András Péter).

As in previous studies referential looking was defined as a gaze towards the experimenter that was immediately preceded/followed by a look to the fan, and gaze alternation as a consecutive sequence of three looking behaviours (fan-experimenter-fan or experimenter-fan-experimenter). Referential Looking and Gaze alternation were analysed only in Phase 1.

Three non-mutually exclusive categories of behaviour were recorded: Gaze, Action and Stress. Furthermore, the location of dogs in the room during each phase of the test was recorded (Zone, see Table 1). Gaze behaviours were collected as frequencies (number of occurrences), Action behaviours as durations (in seconds) and the frequency and latency of Stress behaviours were scored. Zone was recorded as duration (time spent in a specific zone in seconds) and latency (time to enter with forepaws into a specific zone). All these behaviours were analysed in both phases.

As behavioural data were not normally distributed, non-parametric statistical analyses were used to compare durations, frequencies and latencies of the dogs' behaviours between groups (Mann-Whitney test). Furthermore, a Wilcoxon test was used to evaluate the frequencies of gazing behaviour towards the owner vs. the stranger in each group. A Spearman rho was carried out to evaluate the correlation between the frequency of stress signals and looking at the owner. Chi-square tests were used to compare the number of dogs that carried out referential looking and gaze alternation between groups and that interacted with the fan.

The dogs' behaviours were coded from video by the first author (I.M.). A second independent coder analysed 25% of the data and the Alfa Cronbach correlation calculated for the duration of the main behaviours were found to be good to excellent (Locomotion $\alpha=0.98$; Static α

=0.98; Owner Zone $\alpha=0.99$; Stranger Zone $\alpha=1$; Fan Zone $\alpha=1$; Interact Fan: $\alpha=0.78$; Interact Stranger: $\alpha=0.95$; Interact owner: $\alpha=0.99$).

GAZE	
Gazing at fan	dog's head is oriented towards the fan
Gazing at stranger	dog's head is oriented towards the stranger
Gazing at owner	dog's head is oriented towards the owner
ACTION	
Interact fan	dog is in physical contact with the fan
Interact stranger	dog is in physical contact with the stranger
Interact owner	dog is in physical contact with the owner
Static	dog is in any position which does not involves movement i.e. standing, sitting or lying
Locomotion	any behaviour involving moving around the room whether walking with head down/sniffing, or pacing whilst looking at the owner/object
STRESS	
Stress	lips licking and yawning
ZONE	
	the room was divided into three equivalent areas (Figure 2)
Owner Zone	Zone around the owner (1,3x1,3 m)
Fan Zone	Zone around the fan (1,3x1,3 m)
Stranger Zone	Zone around the stranger (1,3x1,3 m)

Table 1: Categories and behaviours coded.

Results

Of the twenty-two dogs tested, six dogs (5 females and 1 male, 2 of the Trained and 4 of Pet group) approached and touched the fan during the first 30 seconds of the test (Phase 1), exhibiting a confident and positive attitude towards the stimulus (27%). These dogs were excluded from the analyses since a pre-condition for this test was that dogs showed an ambiguous (or mildly fearful) behaviour towards the stimulus object.

Of the remaining sixteen dogs, 1 dog (male) in the Trained group never looked back at the stranger, and hence never received the positive message; this dog was considered in the analyses for referential looking and gaze alternation but, in line with our previous study (Merola et al., 2012a), it was excluded from the analyses of behavioural regulation.

Referential Looking and Gaze alternation

To assess whether trained dogs carried out more referential looking and gaze alternation towards the stranger than pet dogs, when confronted with the ambiguous stimulus, we analysed gazing behaviour of the dogs in Phase 1.

Of the 16 dogs (9 Trained and 7 Pet) considered, 15 (93%) showed referential looking towards the stranger at least once (and a maximum of 9 times): of these 8 were in the Trained group and 7 in the Pet group ($\chi^2 = 0.83$; $p=0.36$).

As regards gaze alternation, 13 out of 16 dogs (81%) showed at least one gaze alternation sequence and a maximum of 3 times (i.e. fan-stranger-fan or stranger-fan-stranger): of these 7 were trained dogs and 6 pet dogs ($\chi^2 = 0.16$; $p=0.68$).

Behavioural regulation

Having established that both trained water rescue dogs and pet dogs showed referential looking towards the stranger when confronted with an ambiguous stimulus, we evaluated whether they would be differently affected by the stranger's positive emotional expressions.

Of the 16 dogs that showed an ambiguous approach towards the fan in Phase 1, one dog never looked at the stranger and was removed. Of the remaining 15 dogs, 8 were in the Trained group (6 F and 2 M) and 7 in the Pet group (6 F and 1 M).

There were no significant differences between groups in Gaze behaviour towards the stranger in both test phases; however, in Phase 1 Trained dogs tended to gaze more often towards their owner compared to Pet dog ($z=0.58$, $p=0.054$). Furthermore, in the Trained group dogs gazed at the owner more often than at the stranger in Phase 1 ($z=2.37$, $p=0.01$) but not in Phase 2 ($z=0.43$, $p=0.66$), while no difference in this behaviour was found in the Pet group in neither phase (Phase 1 $z=1.37$, $p=0.16$ Phase 1 $z=0.94$, $p=0.34$) (Figure 3).

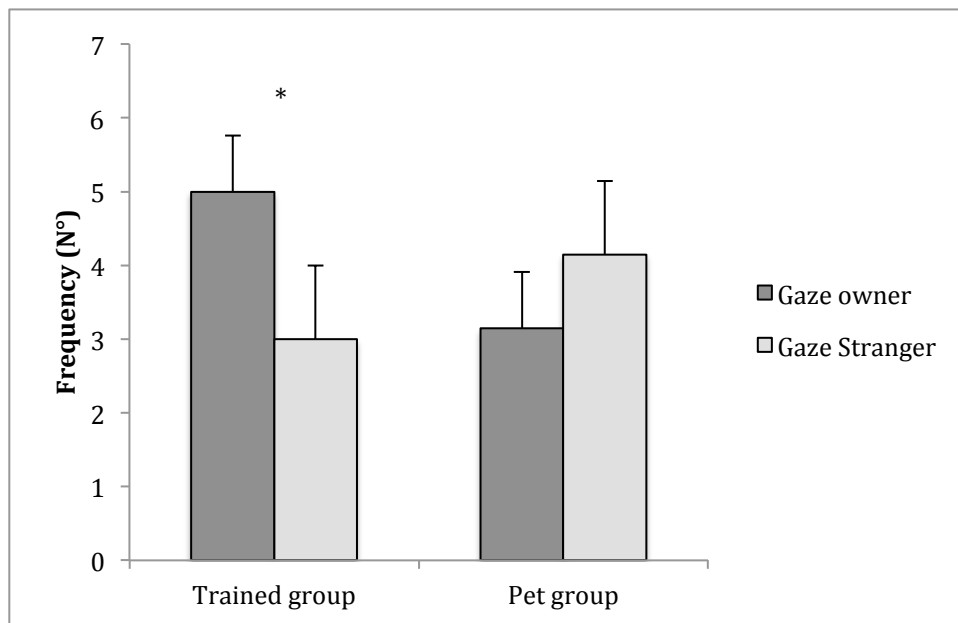


Figure 3: Mean frequency of gazing behaviour towards the owner and the stranger in the trained and pet group in Phase 1. Bars represent Standard Errors and *P < 0.05.

In Phase 2 there were significant differences between the two groups in Static behaviour, Locomotion and Interaction with the fan. Dogs in the Trained group spent more time being static

than dogs in the Pet group ($z=1.97$, $p=0.04$), whereas Pet dogs engaged more in Locomotion than Trained ones ($z=2.21$, $p=0.02$) (Figure 4). Interaction with the fan occurred rarely in both groups: in fact, no dog in the trained group touched the fan in Phases 1 and 2, whereas three dogs (42%) in the Pet group touched it (1 both in Phase 1 and 2 and 2 just in Phase 2) ($\chi^2=4.2$; $p=0.03$).

Stress behaviour was different between the two groups: Trained dogs showed Stress behaviours sooner than Pet dogs in Phase 1 ($z=2.17$, $p=0.02$) and exhibited stress behaviours more often than Pet dogs in Phase 2 ($z=2.25$, $p=0.02$). No significant correlation emerged between stress signals and looking to the owner ($N=16$, Phase 1: $r=0.22$, $p=0.4$; Phase 2: $r=0.18$, $p=0.48$).

Finally in Phase 2 Pet dogs spent more time in the Fan Zone ($z=1.98$, $p=0.04$), and reached the Stranger Zone faster than Trained dog ($z=2.21$, $p=0.02$) (Figure 4).

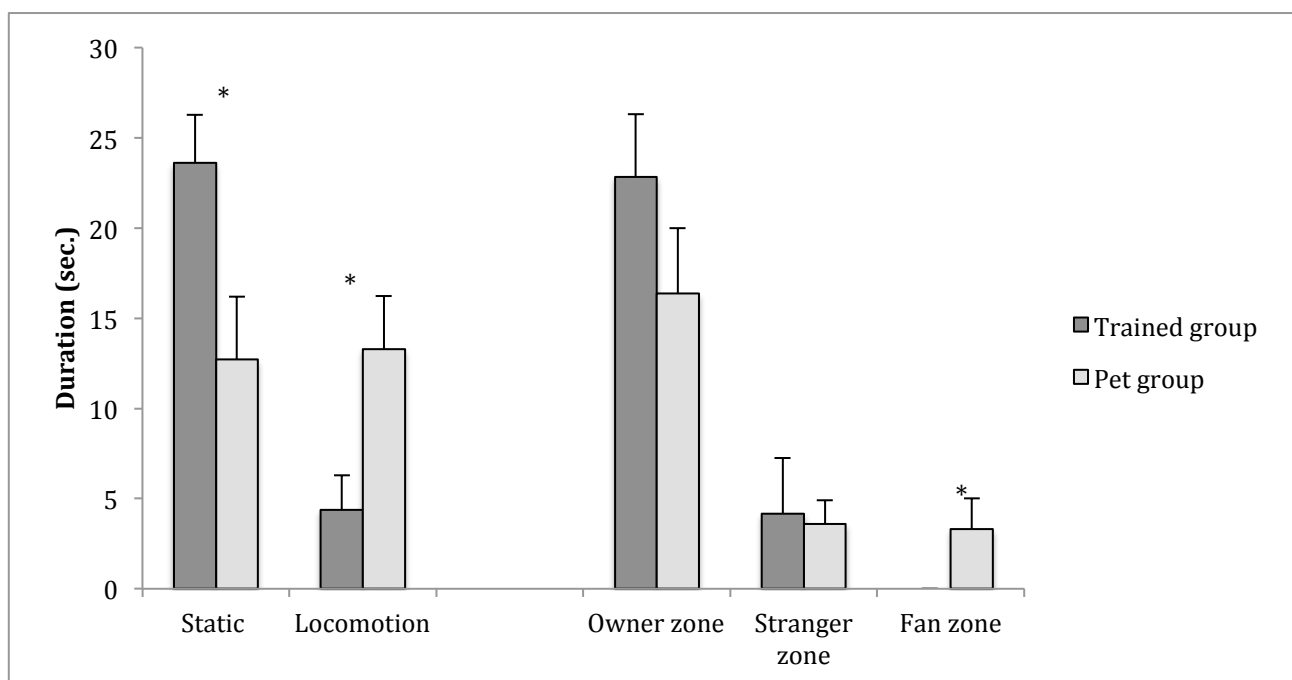


Figure 4: Mean duration of behaviours and zone use, for trained and pet dogs in Phase 2. Bars represent Standard Errors and *P < 0.05.

Discussion

Certified water rescue dogs need to be strongly bonded with their owner, with whom they work in a cooperative manner, but also to have strong positive attitudes towards strangers. Recently, D'Aniello et al. 2013, (submitted) found evidence of this attitude towards unknown people, with trained rescue dogs tested in a mild stressful situation (i.e. the SST) being more interactive towards strangers than dogs in a breed matched control group.

In this study we tested whether, due to their particular training, water rescue dogs would be more prone than pet dogs to show referential looking and behavioural regulation when a stranger was providing a positive message towards an ambiguous object.

Differently from our hypothesis, no significant differences between the two groups emerged in referential looking, since most of the dogs (93%) looked referentially towards the stranger and alternated their gaze between the stranger and the object (81%). These results are in line with those of Merola et al. (2012a) in showing that dogs engage in referential looking when a stranger acts as the informant in a social referencing paradigm, but do not provide evidence that water rescue training affects this behaviour. Interestingly, in the current study the overall percentage of dogs that showed referential looking and gaze alternation was higher than that observed in Merola et al.'s (2012a) study (Referential looking: 93% vs 60%; Gaze Alteration: 81% vs 52%). The percentage in this study is more in line with the infant social referencing literature, reporting more than 80% of infants looking referentially towards a stranger (i.e. Camas and Sachs 1991, Klinnert et al. 1983, Stenberg and Hagekull 1997). In the infant literature a preferential looking behaviour towards the stranger, when also the mother is present, is considered to be a good indication that the infant is not seeking for comfort, but rather is looking for information about the object (Stenberg and Hagekull 1997). To further confirm this interpretation, studies with infants varied the expertise of the stranger, confirming that it is in fact this aspect which influences the focus of the infants gazing behaviour (Stenberg 2011). In contrast to results from the infant literature, both in this and our

previous study (Merola et al., 2012; Merola et al., 2012a) we found that pet dogs looked towards the stranger and the inattentive owner to the same extent. An interesting result is that the Trained group dogs looked more frequently at the owner than the stranger in the first phase of the test, and distributed their looking behaviour equally between them in the second phase. This may depend on dogs' training, in that in a situation perceived as potentially 'dangerous' these dogs may expect their owners' instructions as to what needs to be done. In this respect, it may suggest that dogs are in fact looking for information. Trained dogs also emitted more stress signals than pet dogs, which would lend support to a comfort-seeking interpretation of looking to the owner, although in fact when all dogs were considered together, no correlation emerged between the frequency of stress signals and of looking to the owner (in neither Phase 1 nor Phase 2). Overall it cannot be excluded that gazing towards the owner (with no preferential looking to the stranger in either group), may simply be a comfort-seeking behaviour, and further studies, specifically aimed at teasing apart these alternatives will have to be carried out to clarify this point.

The difference between this study and the previous one, in the percentage of dogs showing referential looking and gaze alternation, could depend on training, as most dogs in the current study were trained (100% in the Trained group; 60% in the Pet group) although at different levels. In support of this hypothesis there is some evidence that training can affect dogs' looking behaviour towards humans in 'difficult' or 'unclear' situations (e.g. Marshall-Pescini et al., 2009, Gaunet 2008, 2009). However, in the Pet group of the current study and the pet dogs tested with strangers in the previous one, the percentage of dogs with basic training was the same (i.e. 60%), yet looking behaviour and gaze alternation were different, being higher in the current group (Pet group current study: referential looking 93% and gaze alternation 81%; pet group tested with stranger previous study: referential looking 60% and gaze alternation 52%); thus, training does not appear to be the best interpretation for these results. An alternative explanation is that breed had an effect on dogs' referential looking behaviour. Dogs in this study were all Retrievers compared to only 9% Retrievers in the pet group tested with the stranger in our previous study, and Retrievers are one of

the breed groups that have historically been selected for close cooperative work with people (Gácsi et al., 2009; Wobber et al., 2009). Some studies indicate that, compared to other breeds, Retrievers show more human-directed gazing behaviour (Passalacqua et al., 2011) and a slower extinction of this behaviour after it has been reinforced (Jacovcevic et al., 2010). Furthermore, they are reported to be highly sociable (Wilsson and Sundgren, 1997; Svartberg 2006) and there is also some evidence of an association between gazing behaviour and sociability-related tendencies in dogs (Jacovcevic et al., 2012). Hence, it is probable that the higher frequency of referential gazing and gaze alternation in the current study, compared to the previous one, was a result of the breed being tested.

Trained and untrained dogs in the current study did not differ in terms of their initial confidence towards the unfamiliar stimulus, since a comparable number of dogs in each group approached and touched the fan at the start of the test. This suggests that this type of training does not influence the initial explorative tendencies towards a novel, somewhat scary object. However, compared to pet dogs, trained dogs tended to look more often towards the owner, showed more Static behaviour and exhibited Stress signals more often and earlier. Furthermore, they looked more towards the owner than the stranger in Phase 1 of the test. Thus, it appears that Trained dogs were not more confident towards the situation but rather more stressed, compared to Pet dogs. We are inclined to believe that, due to their training, water rescue dogs not only form a strong relationship with their owner, but also become more dependent/reliant on him/her. However, this dependency hypothesis is somewhat in contrast with results from the SST in which these same dogs were tested (D'Aniello et al. 2013, submitted) but they did not show more frequent stress-related behaviours than pet dogs in the absence of the owner.

What may in fact be occurring is that dogs in the social referencing paradigm perceive a threat, and it is in these particular contexts that water rescue dogs expect their owner's support and cooperation. Hence, in the current test where the owner was present in the room but giving no attention to neither the dog nor the situation, dogs may have felt the lack of support and owner-

engagement more acutely than pet dogs, displaying more stress signals and looking at the owner more insistently (perhaps as a comfort-seeking strategy or possibly with the expectation that some 'command' would be imparted).

The finding that trained dogs were more static than pet dogs in our social referencing paradigm is in line with previous studies reporting that both trained rescue dogs (D'Aniello et al. 2013, submitted) and guide dogs (Fallani et al., 2006) were more passive than pet dogs in the Strange Situation Test. Trained dogs in general are required to spend long periods inactive near their owners and/or acquire a more controlled behaviour even when exposed to new environments. Hence, it is possible that the behaviour emerging in the tests is a result of this kind of training. In the current study we also found that trained dogs showed more stress signals than pet dogs, suggesting that being in a passive/static position does not necessarily reflect a relaxed emotional state. Unfortunately, previous studies with trained dogs in the SST did not record the occurrence of stress signals. However, in the SST guide dogs, when separated from their blind owner, showed a more controlled behavioral reaction that, however, was not accompanied by a decrease in cardiac activation (Fallani et al., 2007). Hence, it seems that although training may have affected the type of behaviours exhibited by dogs (i.e. showing more static and passive behaviours than pet dogs both in the SST and SR tests), there was either negative or no effect on the underlying emotional state. In fact trained dogs were at least as stressed as pet dogs in the SST and more so in the current test paradigm. What could be interesting in future studies is to evaluate physiological changes (e.g. heart rate, cortisol levels) as well as behaviour to further investigate the potential correlation or divergence in these responses.

Interestingly, while the dogs tested with the stranger in our previous work (Merola et al., 2012a) did not approach or interact with the object in the positive message group, in the pet group of the current study a number of dogs did approach and touch the fan (42%). In fact, the behaviour of the pet dogs in the current study was more like the behaviour of dogs previously tested with their owner (where 29% touched the fan) than of the dog tested with the stranger (where none touched

the fan). This result is intriguing. As no behavioural regulation emerged in our trained dogs and the percentage of dogs with basic training in our pet group was comparable to the sample of trained dogs in the previous study (Merola et al. 2012a), it is unlikely that training is responsible for these results. Results may however, have been affected again by the breed tested.

One possibility is that retrievers in general show a higher level of arousal than other pet dogs, coinciding with increased motor activity, which, only as a side effect, resulted in our current sample of pet dogs spending more time in proximity with the fan. However, if a general level of arousal is the sole factor differentiating this sample from the previous one (and our current sample of trained dogs) we would expect a difference in the use of all the Zones in the room (i.e. a greater use also of the Owner and the Stranger Zone), and potentially a higher frequency of touching the object before the message was delivered. This was not however the case, since only differences in the use of the Fan Zone emerged, suggesting that it was actions directed at the target object which differed among groups.

Furthermore, it is important to note that the current sample of dogs was both more inclined to seek the stranger out (referential looking) and change their behaviour following the stranger's emotional message. Retrievers are dogs that score high in sociability, approaching and seeking human contact significantly more than dogs of other breeds (Wilson and Sundgren 1997) and showing a tendency to be friendly towards unfamiliar people (Svartberg, 2006); thus, it is possible that their tendency to be sociable, besides affecting their gazing behaviour towards the stranger, also influenced their inclination to modify their behaviour towards the ambiguous object in accordance with the stranger's emotional expression. If this is the case, it seems that the training received by water rescue dogs, despite its focus on unfamiliar persons, modulated this sociability or inhibited dogs' sociable behaviour in our testing condition.

Current findings are interesting but the number of dogs tested was limited, due to the difficulty in recruiting certified water rescue dogs. A larger sample size should be tested to better understand how training and breed affect social referencing in water rescue dogs and in dogs in

general. It would also be interesting to use a social referencing paradigm to test dogs of different breeds with no training and/or a particular breed with different type of training to better evaluate the effect of these two variables. In summary, our results provide further evidence that Social Referencing occurs in dogs even when the human informant is an unfamiliar person. Results suggest that high levels of training for water rescue may affect dogs' response in this setting, in particular inhibiting their inclination to modify their behaviour in accordance with the stranger's emotional message. Furthermore, they point to a potential effect of breed both in referential looking and behavioural regulation.

Chapter 8

Dogs' comprehension of referential emotional expressions: familiar people and familiar emotions are easier.

Introduction

Recognizing emotional meaning in others' expressions is not only fundamental for adjusting behaviourally to the emotional states of others and thus facilitate group cohesion (Racca et al. 2012), it also enables efficient monitoring of the environment allowing observers to use others' emotions to cope flexibly with events in the external world and access resources (Nelson and Russell 2011). The ability to recognize others' emotions is especially important in human infants during their communication with adults when language has not yet been acquired and much of the communication is just of an emotional nature (Repacholi 1998). For this same reason sensitivity to another's emotions may be important in interspecies communication. Darwin (1872) postulated continuity in the emotional expressions of humans and non-human animals, however this topic has been investigated relatively little, and almost nothing is known as regards interspecific understanding of emotions.

Human infants can discriminate between certain facial expressions such as fear and happiness (Nelson 1987), or happiness, sadness and surprise (Field et al 1982) even as young as 2-3 months of age. In particular, it seems that in the first months of their life they attend preferentially to expressions conveying a positive message, also showing increased gaze aversion, less smiling and more negative affect during still-face compared to normal face-to-face interaction (e.g., Mesman et al. 2009, Gusella, et al, 1988; Kisilevsky et al., 1998; Toda and Fogel, 1993).

After the age of 7 months they switch to looking at fearful expressions more (Vaish et al. 2008). Furthermore, at this age they can perceive the similarity between displays of the same emotion when produced by different people or when displays vary in intensity (Repacholi 1998).

At around 10 months of age infants also start to use the observed emotions to guide their own behaviour. In a social referencing paradigm they have been shown to use the (positive vs. negative) emotional message received to guide their actions towards objects, a novel situation (e.g. the visual cliff), or an unfamiliar person (Feiring et al. 1984; de Rosnay et al. 2006, Mumme et al. 1966, Feinman and Lewis 1983).

In the classic social referencing paradigm, however it is difficult to discern whether the infant's change in behaviour is due to an understanding that the informant's emotions actually refer to a specific object. In fact a simpler mechanism such as mood modification or emotional contagion whereby the infant contagiously expresses the same emotion observed in the adult, may account for the infant's change in behaviour in most studies. Few studies addressed this issue in more detail. In Hornik et al. (1987) the infants' (12 months) response to objects about which the informant conveyed affective information (referents) were compared with the reaction to other objects that were not targets of the informant's communication (non referent). The authors reported that the informant's affective message had an effect upon infants' behaviour towards the referent object, in that following the negative (disgust) reaction of the mother, infants played less specifically with the referent toy. Similarly, Stanberg and Hagekull (1997) found that infants played more with the specific toy eliciting a positive message than with the toy eliciting no message. Furthermore, they spent less time interacting with the toy eliciting a negative message than with the no-message toy. A particular testing situation was then proposed by Walden and Ogan (1988) who, after the parents' emotional expressions toward a positive and a negative object, allowed the infants to freely interact with both objects at the same time. Interestingly, some age differences were found with the older infants (14-22 months) looking most in the fearful condition and touching for longer the fearful object (associated with the negative emotion), and the youngest (9-12 months) looking most in the

positive emotional condition and spending more time with the object associated with the positive emotional message. In sum, this research shows the presence of referential understanding, because infants were free to focus on whichever object they pleased and their behaviour was affected by the referential message received.

Repacholi et al. (1998) carried out a study using a different experimental set-up in which infants were given the choice between looking into two identical boxes after watching the experimenter express disgust towards the content of one and happiness towards the content of the other. Infants at 14-18 months showed a marked preference for the box eliciting a positive emotion, suggesting there is an understanding at this age of the referential nature of the message being expressed. Furthermore, Moses et al. 2001 carried out a variant on this study, involving directing the emotional message towards one of a choice of toys and found that infants as young as 12 months changed their behaviour specifically towards the object the informant referred to by using such cues as eye-gaze, and bodily direction.

Dogs having been domesticated a relatively long time ago, between 35000 and 100000 years ago (Miklosi et al. 2004; Vilá et al., 1997; Savolainen et al., 2002), and given they occupy the same social anthropogenic niche as humans since this time, would benefit considerably from an appropriate reading of human communication. In fact, according to a number of authors, the domestication process has specifically acted upon dogs' abilities to understand human communication (Soproni et al., 2001, Hare et al. 2002; Miklósi et al. 2003; Hare & Tomasello 2005).

However, relatively few studies have been carried out on dog's ability to recognize human emotions, so far they have been shown to discriminate between smiling and neutral human faces (Nagasawa et al. 2011), they looked longer at their owner faces when the owners felt happy than when they were sad (Morisaki et al. 2009), they react differently to actors performing a range of emotional facial expressions (anger and fear) compared to neutral ones (Deputte and Doll 2011) and are sensitive to the tone of voice (gentle vs. harsh) used by a human in an obedience task

(Fukusawa et al. 2005), a pointing task (Scheider et al. 2011) and when evaluating a third party interaction in a begging paradigm (Marshall-Pescini et al. 2011).

Furthermore, dogs seem to use human emotions to regulate their behaviour towards an external object/situation. In fact, they will either approach or stay away from an object depending on the positive or negative emotional message received by the owner in a social referencing paradigm, although this behaviour is less clear if the message is conveyed by a stranger (Merola et al. 2012, 2012a). However, what has not clearly emerged from these studies is whether the dogs' change in behaviour is intentionally directed specifically towards the target object hence with an understanding of the referential quality of the emotional message received (henceforth 'object referencing'), or whether it may in fact be caused by a process of mood modification or emotional contagion. In that, a positive message may simply increase the dog's arousal status causing it to move around the room more, which as a side effect would then coincide with an increased proximity to the target object. Whereas, through a process of emotional contagion a negative message may decrease the overall activity of the dogs and hence reduce the likelihood of their approaching the target object. In fact, if only one stimulus is used, as in most studies on social referencing, it cannot be concluded that dogs/infants truly understand the referential quality of the affective message (Repacholi 1998).

The only study, to our knowledge, that partially addressed the possibility of object referencing, asked dogs to select between two boxes containing food, based just on the experimenter's emotional reaction to its content (Buttelmann and Tomasello 2012). What emerged was slight evidence that dogs can distinguish between an emotion of happiness and disgust, since they preferentially chose the container eliciting a happy reaction from the experimenter, but they performed at chance level when the two emotions were less distinct (Happy-Neutral). Buttelmann and Tomasello study, raises the possibility that dogs do in fact understand the referential nature of emotional messages, however, strong evidence for this is lacking. Partly this may be due to the use of a stranger, instead of the owner delivering the message, since, as shown by our social

referencing study dogs appeared much more inclined to modify their behaviour in accordance with their owners' rather than a strangers' emotional message (Merola et al. 2012). Furthermore, whereas a number of studies have already shown dogs' ability to distinguish between happy and fearful human expressions (Deputte and Doll 2011, Merola et al. 2012, 2012a), disgust is an emotion that has, so far, received little attention in the dog-human communication literature, and it is not immediately obvious whether this particular emotion is used in conspecific communication, which would potentially make it even harder to distinguish across species. Finally, differently from studies in infants (Mumme et al. 1966, Hornik et al. 1987), none of the studies with dogs directly investigated whether the behavioural changes shown following the emotional messages (whether in terms of choice of object or approach/distance maintenance in the social referencing paradigm) is a result of an avoidance of the negative emotion or a preference for the positive one.

Hence, the aims of the current study were to (1) assess whether dogs would understand the referential quality of the emotional messages delivered by a person (2) investigate if the owner or the stranger would be more comprehensible to dogs and affect their behaviour differently and (3) clarify which of the basic two emotions fear and happiness, was more comprehensible to dogs.

To address the first question, in experiment 1, we presented dogs with two cardboard barriers, behind which were hidden two identical baby toys. Owners expressed happiness whilst interacting with one toy and fear whilst interacting with the other, using both their voice and facial/body expression. In a control group, dogs were presented with the same scenario, but neither barriers nor toys were present; hence, owners simply expressed the same emotions in two different locations in the testing room. If dogs do in fact have some understanding that the owner's emotions refer to a specific object, we expect dogs to choose the box that elicited a happy rather than a fearful expression, but to remain next to the owner, or simply explore the room showing no preference for neither location if no object is present where the emotion was expressed. To address our second question, i.e. whether dogs would be more inclined to modify their behaviour in response to their owner's rather than a stranger's emotional expression, with a third group of dogs we had the

experimenter express a fearful and a happy expression for each toy whilst the owner stood quietly next to the dog. Finally, in experiment 2, we used the same setup described above, but with one group of dogs we asked owners to express a positive emotion and a neutral one, whereas with a second group, owners were asked to express a negative and a neutral emotion. If dogs have an understanding of both the fearful and the positive emotions elicited by the owner, we would expect them to choose the positive eliciting stimuli in the first group and the neutral one in the second.

Experiment 1

Methods

Subjects

55 dogs (25 males, 30 females; mean 6.01years SD 3.23range: 1-13; 29 pure breed, 26 mixed breed see Appendix) and their owners participated in the study. Dogs were semi-randomly allocated to one of three groups: 18 in the owner group (6 male and 12 female), 17 in the no-objects group (9 male and 8 female), and 20 in the stranger group (10 male and 10 female).

Apparatus & Testing room

Two parts of the same baby toy (see Figure 1), that made a slight papery noise when manipulated, were used to evoke the interest of the dogs during the emotional expression of the owner/stranger. The two objects were placed inside two identical 50x36 cm cardboard boxes, positioned in an up-right manner, so that the open side was directed away from the dog (both 1.6 m away from it).

The boxes hence worked like screens hiding the content but not the owner/stranger's face (see Figure 2).



Figure 1. The two identical baby toys



Figure 2. The two boxes working like screen

The exact position of the boxes was marked using black sticky tape on the floor. Testing took place in a 4.5 x 3.5 m room (see Figure 3). A video camera was placed so as to capture the dog's behaviour both during the owner/stranger's demonstration and when free to move around.

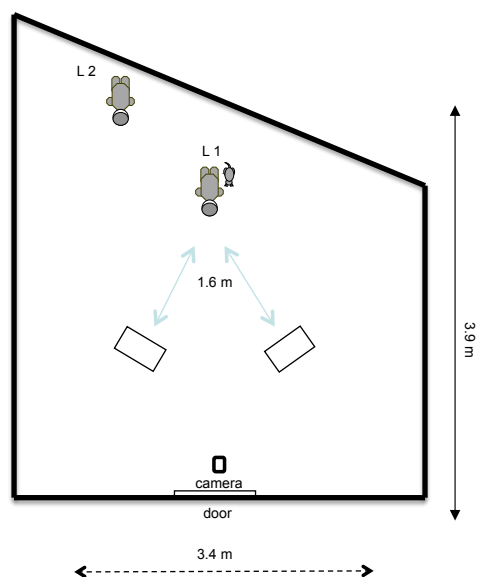


Figure 3. Testing room

Procedure

All dogs entered the room with their owners and were allowed to explore the empty room for 5 minutes whilst the owners were briefed on procedure. After this both dog and owner left the room briefly whilst the experimenter positioned the two boxes and also left the room.

Owner/Stranger Group

The owner and the experimenter entered the room holding the dog on leash and attached the leash to a hook in the wall in front of the two boxes (and equidistant from both). Depending on the group allocation either the owner or the stranger (who was always the same i.e. IM) stood next to the dog, called its name and walked down the midline of the room between the two boxes. When in line with the back of the boxes (and 2 m from the dog) the owner/stranger turned around to face the dog and called its name again. Then s/he went to the first box, crouched next to it, touched the object inside it expressing the instructed emotion (negative, positive) whilst looking at the dog over the top of the barrier and repeated this sequence of behaviours twice; then s/he went to the middle position called the dog again and went to the second box and again crouched next to it, touching the object and expressing the second instructed emotion whilst looking at the dog (again repeating this sequence twice). Both owner and stranger were always present in the room. The first box to be visited and the order of the emotional messages conveyed were counterbalanced across dogs in each group. Then the owner/stranger went back to the dog, patted the dog briefly, released the dog and its behaviour was recorded for 60 seconds. The owner and the stranger during this time looked at the floor standing still and ignoring the situation.

When expressing a positive emotion the owners were told to sound as if they were very enthusiastic and interested in the toy “ooh nice, really nice”. For the happy vocalizations, the *Oh* was high-pitched, smooth, and somewhat drawn out, and the *how delightful* was spoken with a relaxed voice that dramatically rose and then fell in pitch. In the negative emotion the owners were told to sound as if their dog were about to do something dangerous or they had just witnessed something shocking. For the fear vocalizations, the *Oh!* was a gasping inhalation and the *how ugly* was spoken rapidly with a tense voice that was sharp and slightly high in pitch. The owner was told also to act out the emotions using their body language, crouching more towards the object/box in the positive emotional expression and jumping back from the box in the negative emotional

expression. The experimenter acting as the stranger followed the same guidelines.

No object group

The procedure was the same as for the other groups, but there were no boxes and no toys and the emotion was always expressed by the owner. Black tape was placed on the floor to mark the exact location of the boxes used in the other groups. The owner used the same emotional expressions (positive vs. negative) expressed in the same locations in which the boxes had been placed in the other groups. To balance the sound of the toy, when the owner crouched down in each location s/he touched with one hand the toy hiding in his/her pocket while the other hand was touching the floor.

Data collection and Analyses

The test was recorded by a video camera (Panasonic NV-GS330), and analysed using Solomon Coder (beta 081122, Copyright 2006-2008 by Andràs Péter). All the statistical analyses were carried out with IBM SPSS Statistics 19. The dogs' behaviour was evaluated both in the observation and in the choice phase.

In the observational phase the dogs' duration of looking at the owner/stranger when the latter was expressing the positive vs. negative emotion in each group was coded and compared using a within sample Wilcoxon test. Furthermore, the frequency of a number of behaviours manifested by the dogs whilst witnessing the demonstrations were coded: 1. As a measure of the dog's arousal, pulling on the leash towards the demonstrator was coded in a single category and 2. as a measure of fear/discomfort the dog's lowered posture (dog crouch on the floor for a moment or put down the head with the hear) were also coded in a single category .

Finally, three observers looked at the video of each dog whilst covering up with sheets of paper the owner's actions and, based only the dog's behaviour whilst watching the owner/stranger delivering the two messages, they tried to 'guess' which box elicited the positive vs. negative

emotion in the owner. This particular evaluation was made because we sought to capture whether for each dog there was a change in its overall reaction from observing one and then the other emotion, and hence whether based on this change it was possible to identify what emotions were being expressed by the owner/stranger. If disagreement emerged between the three coders, the majority decision was used. A binomial test was used to evaluate the overall accuracy in identifying the position in which the owners expressed the positive emotions.

In the choice phase the dogs' behaviour was analysed in terms of the first box/location chosen. Thus, in the owner/stranger group the dog's first choice was considered as the first box touched by its nose, however we also coded the number of dogs who then walked around the barrier and touched/sniffed its content (i.e. the toy) (see figure 4).



Figure 4. A dog walking around the barrier and touching/sniffing its content

In the no-object group the dog's first choice was the first location visited, however this was coded in two ways, considering dogs that entered the marked area and touched their nose to the ground and dogs that entered the marked area with their paws whilst walking through but without stopping nor putting their nose to the ground. Considering all our predictions were directional a one-tailed binomial test was carried out in each group to test whether dogs preferred to approach

the positive eliciting box first. Furthermore, in the owner group and in the no object group the latency from being unleashed to touching both boxes was calculated for each dog. A Wilcoxon was carried out to evaluate in each group whether dogs took longer to approach the positive vs. the negative message-eliciting box.

Two analyses were also carried out to evaluate the quality of the emotional messages delivered by the owners/stranger. Firstly, using a Wilcoxon test, we evaluated whether the duration of the positive and negative messages delivered were comparable in each group. Second, a person unrelated to the study (who did not know what was being tested), was asked to listen to the owner and stranger's emotional expression, without viewing the video and to evaluate on a 5 point-scale the intensity of the positive and negative expression and whether, according to the coder the difference between the two emotions was clear (where 1 represented very good emotional valence and clear difference between emotions and 5 very poor emotional valence and unclear difference between emotional messages).

The dogs' behaviours during the observation phase and their first choice were coded by the first author (I.M.), however a second independent coder blind to group allocation (hence they watched videos with the owner covered up) coded 25% of the total data. Alfa Cronbach was calculated for the main behavioural categories and were found to be excellent (Duration of Gaze Positive: $\alpha=0.94$; Gaze Negative: $\alpha=0.99$; Gaze Experimenter: $\alpha=0.95$; Gaze Experimenter: $\alpha=0.90$). Furthermore, the inter-observer reliability on first choice data was 100%.

Results

Of the 55 dogs tested, two dogs (2 females) were excluded from all analyses, because of procedural errors committed during testing (i.e. the owner lifter the toy above the barrier and showed it to the dog). Of the remaining 53 dogs: 17 were in the owner group, 17 in the no-object group, and 19 in the stranger group.

Observational phase

No differences were found in the time spent by dogs looking at the demonstrator expressing the positive vs. negative emotion in any of the groups: Owner group ($z=0.44$, $p=0.65$); No-object group ($z=0.21$, $p=0.82$); Stranger group ($z=0.51$, $p=0.60$). Furthermore, there were no differences in the behaviours manifested by dogs when watching the demonstrator perform the positive vs. negative emotions in any of the groups (owner group: dog's arousal ($z=0.73$, $p=0.46$) fear/discomfort ($z=1.21$, $p=0.22$); no object group: dog's arousal ($z=0.73$, $p=0.46$) fear discomfort (only two dogs showed this behaviour so statistical analysis could not be carried out); stranger group: dog's arousal ($z=0.59$, 0.55) fear discomfort (only two dogs showed this behaviour so statistical analysis could not be carried out).

Based on watching only the dogs' behaviours, the blind observers identified the correct box/position in which the owner expressed the positive emotion for fourteen of seventeen dogs (82%) in the owner group (Binomial $z=2.43$, $p=0.006$); ten of seventeen dogs (58%) in the no-object group (Binomial $z=0.49$, $p=0.31$) and six of nineteen dogs (31%) in the stranger group (Binomial $z=1.38$, $p=0.08$).

Choice phase

In the owner group one dog did not choose between the boxes and thirteen of the remaining sixteen dogs (81%) chose the box (i.e. touched it with their nose) that had elicited a positive emotion from the owner (Binomial $z=2.25$, $p=0.01$). We also analysed the number of dogs that after touching the first box/barrier went around to investigate the content of the box. A total of 9 dogs investigated the content of their first choice, 7 the positive and 2 the negative (Binomial $p=0.08$)

In the no-object group 6 dogs did not move from their owner's side. Of the remaining 11 dogs, 2 touched their nose to the ground in the positive location, 2 more passed through it without

stopping and 7 passed through the negative zone first (with none stopping nor sniffing the area). A binomial test was carried out excluding dogs that did not choose, to evaluate whether there was a preference for the positive location, no difference emerged (Binomial $z=0.6$, $p=0.27$). In the stranger group four dogs did not choose between the boxes and seven of fifteen dogs (46%) chose the box (i.e. touched it with their nose) that had elicited a positive emotion from the stranger (Binomial $z=0$, $p=0.5$) (Figure 5). We also analysed the number of dogs that after touching the first box/barrier went around to investigate the content of the box. A total of 8 dogs investigated the content of their first choice, 3 the positive and 5 the negative (Binomial $p=0.36$).

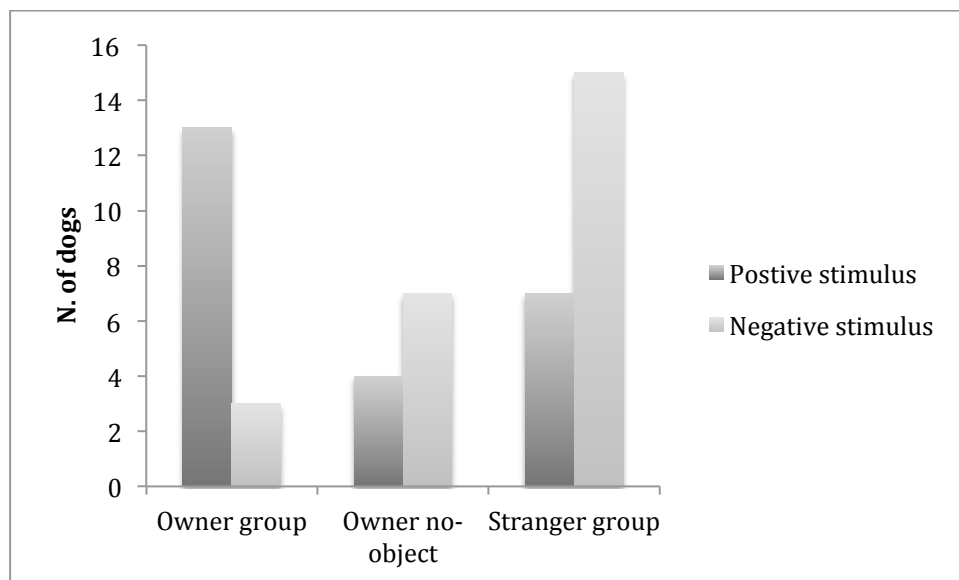


Figure 5. Number of dogs that chose the positive vs negative box in owner group, in the no object group and in the stranger group

The latency to reach the boxes/location was significantly different between the owner group and the no-object group ($z=3.53$, $p= 0.0004$). The number of dogs that reached the boxes/location was no different in the two groups 16/17 in the owner group and 11/17 in the no-object group ($X=4.5$, $p=0.34$), however only 2 dogs of the 11 dogs in the no-object group explored the zone of the boxes with their noses, the others just walked through it, hence using this criteria a

difference between groups did emerge, with a greater number of dogs in the owner group choosing approaching the boxes/locations (16/17 in the owner group and 2/17 in the control group $X=23.14$ $p=0.000$).

A greater proportion of dogs in the stranger group (4 dogs 21% in the stranger group vs. 1 dog 5% in the owner group) remained close to the owner and did not explore the boxes, but this difference between groups was not significant ($X=1.73$ $p=0.18$).

Quality and accuracy of the delivered messages

The duration of the positive vs. negative message delivered by the owner (vocal expression) was found not to differ in neither the owner nor the stranger group (owner: $z=1.49$, $p=0.13$; experimenter: $z=0.88$, $p=0.37$), while in the no-object group a significant difference was found with the owner talking for longer when delivering the positive vs. negative message ($z=2.74$, $p=0.006$).

The evaluation of the emotional messages carried out by the blind coder showed that in the no-object group 5 owners were evaluated as poor or very poor in their delivery. 3 owners in the owner group received such a low evaluation. In the stranger group, delivery to one dog was judged as being poor. To assess whether the poor delivery of the emotional messages by the owners could have affected results both in terms of the dogs' first choice of the box, and in terms of their behaviour modification during the demonstrations, statistical tests were re-run excluding these dogs but results did not change.

Discussion

In the current study we aimed to assess whether dogs would show an understanding that emotional messages delivered by people can refer to specific objects. We predicted that if dogs show a referential understanding of the emotional message, they would choose to explore the box eliciting a positive (rather than a fearful) message first.

Our prediction was partially confirmed, in that when the owner expressed a fearful message in relation to one box and an enthusiastic message towards the other, dogs approached the box eliciting a positive reaction first. In contrast, when no object was present, and the owner simply expressed the same two emotions in two separate locations, a third of subjects stayed next to the owner whereas the remaining dogs walked through the marked areas, but without a preference for either one or the other. Only two dogs, actually stopped in one of the locations and explored it, and in both cases this was where a positive message had been delivered.

The preference for the box eliciting the positive emotion in the owner-group cannot be explained by a greater attention being given to the owner when they expressed the positive message because there was in fact no difference between the time spent looking at the owner when s/he delivered the two emotional messages. However, there may be evidence that dogs were more emotional involved when observing the owner demonstration in this group than in the no-object control group. In fact, although no differences emerged in the dog's behaviour in terms of fearful signals, and general arousal (pulling at the leash), the blind coders, asked to look at each dog and note whether there were changes in their overall behaviour when watching the deliverance of the two messages, were able to successfully 'guess' which emotions were expressed by the owners when the boxes were presented but this was not the case in the no-object control group.

One possibility is that owners themselves were less clear in acting out the different emotions in the control group when no object was present, which reflected in a more shallow involvement by dogs during the demonstration, and hence a more varied behavioural response both in the observation and choice phase. However, the independent coder's evaluation of the owners emotions in the two groups were comparable hence this does not appear to explain the differences in results. The more subdued emotional involvement by dogs (reflected in the coders inability to detect a change in their behaviour and hence which message was being conveyed), may be due to the fact that, whereas when barriers were present, an element of the unknown may have kept the dogs' more interested and intrigued by the owners' reaction, here dogs could plainly

see that there was nothing to be afraid of or particularly happy about.

Taken together these results, show that dogs do in fact appreciate that an emotional message can relate to a specific object, and considering the non-specific behaviours exhibited by dogs (both in the choice and observation phase) in the no-object control group, it would even suggest that dogs' *expect* emotional messages to refer to specific objects. Interestingly, Repacholi (1998) differentiated between the infants' behaviour directed at the container (e.g. touching it) and behaviour directed at the object inside. The argument being that, if infants had a representation of the emoter's message as referring to a specific object inside the box and understood the emoter's referential cues as being directed towards it, they should seek this out, and not stop at touching the container. Similarly, in our study most dogs (70%) did not stop at touching the box, rather the majority of dogs went round the cardboard container and sniffed the toy placed within it.

Although results suggest that dogs have at least a basic understanding of the referentiality of the emotional message, a form of emotional contagion was also evident, suggesting that in fact these two processes are not necessarily in opposition. In fact, although an analyses of the behaviours carried out by the dogs (distress and arousal) did not appear to show differences in the dogs reactions to the different emotional expressions, the independent coder's assessment was able to correctly identify which emotions dogs were witnessing. The discrepancy of results between these two methods may be because in the latter case rather than observing specific behaviours, (tail movement or body posture), the observers focused on if and how the dogs behaviour overall changes when observing the owner next to the two different stimuli. Hence, observers were able to account for the individuality of the dogs' behavioural expression (e.g. one dog may have simply changed the rate of tail wagging, whereas another, who never wagged their tail, changed their body posture and ear movement, hence 'giving' away what emotions their owners were displaying).

The second aim was to evaluate if the relationship with the person (owner vs. stranger) could influence the dogs' understanding of the emotional message and consequent choice. Results

showed that when the stranger showed a fearful and happy reaction towards the content of the two boxes, dogs did not show a preference for the box eliciting a positive emotion. Looking at the dogs' behaviour during the demonstrations, we found no difference in arousal and fearful reaction elicited when watching the positive vs. negative message. Furthermore, the three blind coders were unable to correctly guess which emotions were being expressed by the stranger based solely on watching the dogs' behaviour. Based on these results it seems that the emotional involvement during the demonstration was not as strong when the stranger, rather than the owner conveyed a message of potential threat (fearful reaction) and excitement to the dogs.

The lack of a preference for the positive eliciting box in the stranger group could be explained in two different ways: one is that dogs are unable to recognize the emotions expressed by strangers but can only recognize the emotional communication of their owner; the second is that dogs can appreciate also a stranger's emotional message, but, at least in this context they are less inclined to act upon it.

The first interpretation receives some support from the absence of mood modification during the observational phase in this group. Furthermore, the relatively few studies yielding positive results on dogs' understanding of human emotions have been mostly with owners as emoters (Adachi et al. 2007; Merola et al. 2012a). Two studies however employed strangers as emoters. In a similar paradigm to the one adopted here Buttellmann and Tomasello (2012) found that dogs did show a slight preference for exploring the content of a box eliciting an interested rather than a disgusted reaction from the researcher himself. Whereas Merola et al. (2012a) found that dogs' behaviour was affected by the stranger exhibiting a fearful vs. enthusiastic reaction to a novel object in a social referencing paradigm. In the latter study, the stranger's fearful reaction resulted in dogs seeking out the owner, but, differently from when the owner was the emoter, the strangers' enthusiastic reaction to the object did not cause dogs to approach the it more. Taken together these studies suggest that dogs' did have some understanding of the stranger's emotional messages, but perhaps were are less inclined to act upon them.

Compared to Buttleman and Tomasello study, in the current study dogs may have been less motivated to explore behind the screens, since in the latter study dogs had prior knowledge of food being present, whereas in our own paradigm, no such prior information was available. However, although a greater proportion of dogs (4 dogs 21% in the stranger group vs. 1 dog 5% in the owner group) in this group remained close to the owner and did not explore the boxes, this difference between groups was not significant. Furthermore, most dogs that did leave the owners side, not only touched the front of the barrier but actually went around and looked inside (8 dogs 53% in the stranger group vs. 9 dog 56% in the owner group) ($X=0.03$ $p=0.87$). So it appears that just as with the owner dogs did perceive the emoter's behaviour as referring to an object. It remains however unclear whether dogs were unable to discern between the strangers' positive and negative emotions or whether they were simply less inclined to act upon them and further studies will be required to tease these alternatives apart.

Overall results from this first study seem to indicate, that when the owner is conveying the emotional message, dogs' are capable of discerning between a fearful and an enthusiastic expression, and have some basic understanding that the emotional message refers to a specific object. However, what is unclear from the current experiment, is whether dogs are choosing which apparatus to approach first based on attraction towards the box eliciting a positive reaction or an avoidance of the one eliciting a fearful expression. In our second experiment we sought to answer this question.

Experiment 2

A number of studies in the human infant literature show that there is an ontogenetic shift in the visual attention given to positive and negative emotional expressions. In fact, whereas very young infants preferentially look at smiling faces, after 7 months of age infants' attention is drawn significantly more towards negative expressions of emotion (Vaish et al. 2008). Interestingly, the

looking bias towards the negative emotion cannot be explained simply as a preference for a novel, less familiar expression. In social referencing paradigms, one year old infants have been shown to approach the object/situation more following delivery of a positive or a neutral message than after a emotionally negative one (Mumme et al. 1996, Hornik et al. 1978). Hence, from the latter study it would seem that infants are avoiding the stimuli when it elicits a negative emotion, rather than approaching it if it elicits a positive one.

Dogs have been shown to discriminate between happy and neutral faces and generalize this discrimination to unfamiliar faces (Nagasawa et al. 2011). However, Buttelmann and Tomasello (2012) found that whereas dogs would preferentially choose a box containing food eliciting a positive vs. negative response, there was no such preference between the positive and neutral eliciting stimuli. The latter study would therefore suggest that dogs recognize the expression of disgust more strongly and hence avoid the apparatus eliciting it, but show an inability to recognize between the positive and neutral expressions manifested by the experimenter.

From our first study, however it was not possible to tease apart whether dogs were avoiding the stimuli eliciting the negative-fearful emotion or choosing the one causing a positive-happy emotion in their owners. Hence, the aim of our second experiment was to evaluate whether dogs could in fact recognize both the fearful expression and the happy one when these were contrasted with a neutral expression. To answer this question a group of dogs was tested with the owner expressing a positive vs. neutral emotion in reference to the content of the two boxes, whereas a second group of dogs was tested with their owners expressing a negative vs. neutral emotion. We predicted that if dogs have an understanding of both the fearful and the positive emotions expressed by the owner, they would choose the positive eliciting stimuli in the first group and the neutral one (to avoid the fearful eliciting stimuli) in the second group.

Methods

Subjects

Forty dogs (13 males, 27 females; mean 5.45 years SD 2.69 range: 1-12; 21 pure breed, 19 mixed breed see Appendix) and their owners participated in the study. Dogs were semi-randomly allocated to one of two groups: 19 in the positive-neutral group (8 male and 11 female), 21 in the negative-neutral group (5 male and 16 female).

Procedure

Apparatus and testing room were the same as for Experiment 1. The procedure was the same as for Experiment 1, as were the instructions given to owners as regards the positive vs. fearful emotions. As for the neutral vocalizations owners were told to speak in a monotone voice, with minimal inflection and in a matter-of-fact fashion using the words “Oh, its useless”, and remaining quite still with their body and facial expression. Because the fear and happy vocalizations were exaggerated expressions of emotion, they were typically louder. (like in Mumme et al. 1966 study).

Data collection and Analyses

All data collection and statistical analyses were the same as for Experiment 1; except that the dog's arousal and fear responses during emotional displays were not coded. A second independent blind coder analysed 25% of the total data and Cronbach's Alfa were calculated for the main behavioural categories (Gaze Neutral: $\alpha=0.99$; Gaze Positive: $\alpha=1$). Inter-observer agreement on the dogs' first choice of the apparatus was 100%.

Results

Of the 40 dogs tested, six dogs (2 male and 4 females) were excluded from all analyses, because of procedural errors committed during testing. Of the remaining 34 dogs: 17 were in the positive-neutral group and 17 in the negative-neutral group.

Observational phase

No differences were found in the time spent by dogs looking toward the boxes when the owner was expressing the different emotions (positive-neutral group $z=0.17$, $p=0.86$; negative-neutral group $z=0.29$, $p=0.77$).

Based on watching only the dogs' behaviours, the blind observers identified the correct box in which the owner expressed the positive (vs. the neutral) emotion for ten of seventeen dogs (58%) (Binomial $z=0.49$, $p=0.31$). In the negative-neutral group observers correctly identified the emotion being expressed by the owner for eleven of fifteen dogs (73%) (Binomial $z=1.55$, $p=0.059$). Two owner/dogs from the latter group could not be evaluated due to an error in the angle video-recording which meant it was impossible to observe the dogs behaviour on video without at the same time observing the owners (hence not being blind).

Choice phase

In the positive-neutral group one dog did not choose between the boxes whereas twelve of sixteen dogs (75%) chose the positive box (Binomial $z=1.75$, $p=0.0038$). In the negative-neutral group one dog did not choose between the boxes whereas eight of sixteen dogs (50%) chose the neutral box (Binomial $z=0$, $p=0.059$). (Figure 6)

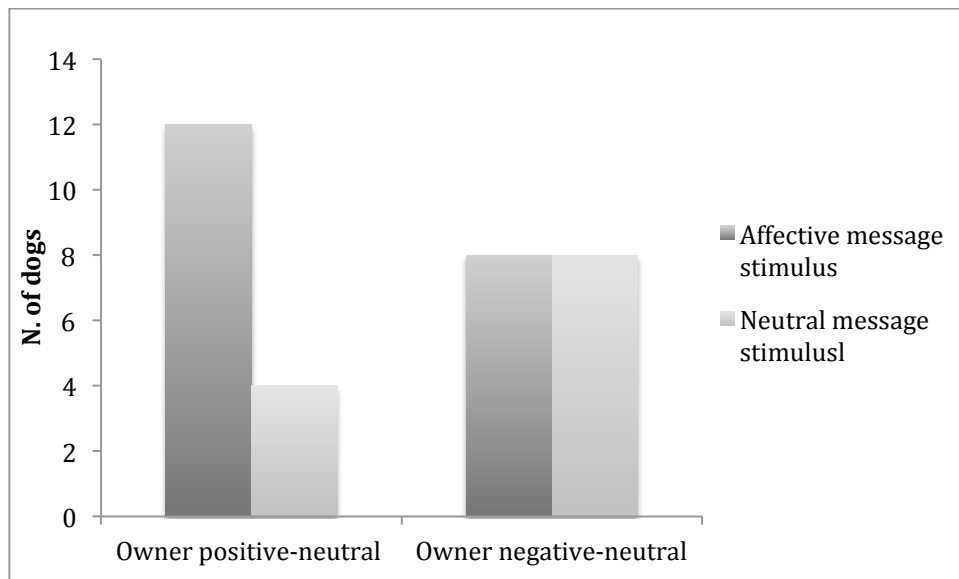


Figure 6. Number of dogs that chose the positive vs negative box in owner positive-neutral and owner-negative-neutral group

Quality and accuracy of the delivered messages

The duration of the message delivered by the owner in the positive-neutral and in the negative-neutral groups was analysed. In the positive-neutral group owners spent longer expressing the positive message ($z=2.91$, $p= 0.003$), while in the negative-neutral group owners spent longer expressing the negative message ($z=3.30$, $p= 0.000$).

The quality of the emotional message evaluated by a blind coder showed that two owners in the positive-neutral group were particularly poor in the emotional expression of the messages. No owner received a particularly bad rating in the negative-neutral group. Data for the positive-neutral group were re-analysed excluding the two dogs whose owners received low ratings, however results as regards the dog's first choice did not change.

Discussion

The aim of this second experiment was to evaluate whether dogs would be capable of recognizing the valence of both the positive and fearful emotions distinguishing them from a neutral expression. We predicted that if this were the case, dogs would preferentially choose to visit the box eliciting a positive emotion in the positive-neutral group, whereas they would preferentially approach the neutral eliciting stimuli in the negative-neutral group.

Our predictions were only partly met. Although dogs showed a preference for the positive eliciting stimuli in the positive-neutral group, they only showed a trend towards choosing the neutral over the negative eliciting stimuli in the negative-neutral group. Results cannot be explained by dogs giving more attention to one emotion compared to the other during demonstrations since their looking time towards their owners' emotional outputs did not differ. However, based solely on the dog's behaviour, the observers struggled to correctly identify which emotions they were witnessing, especially in the positive-neutral group. In the negative neutral group, the accuracy was higher (73%) although it did not reach statistical significance. Thus it seems that dogs showed a clearer emotional involvement when observing the owner express a negative vs. neutral emotion, yet when the choosing which box to approach they did not avoid the stimuli eliciting the owner's fearful reaction. Whereas, during the observational phase, the positive and neutral expression of emotions did not elicit in dogs a particularly clear change in their pattern of behaviours (hence the observers' difficulty in correctly identifying these), yet overall their choice as to which box to approach was clearly influenced by the owners' emotional reactions.

The dogs' preference for the positive eliciting stimuli in the positive-neutral group could have been affected by the longer time spent by owners delivering the positive message, in that through a process of stimulus enhancement, this particular object could have become more salient, simply due to the temporal association between it and the owner. However, if the length of time spent next to the box were the influencing factor, we should have found a preference for the

negative eliciting box in the negative-neutral group, since owners spent more time delivering the negative vs. neutral emotion in that group, but this was not the case, in fact the trend was in the opposite direction.

Overall results from the second experiment seem to indicate that dogs discriminated between the fearful and neutral reaction whilst it was being manifested (since observers correctly identified a majority- although not statistically significant, of the owner's emotional messages based solely on the dogs' behaviour), however they either did not give the appropriate valence to the emotion expressed (i.e. they did not perceive the owner's behaviour as fearful and hence a signal to a potential danger), or they chose to ignore it and hence explore the box containing the potential danger anyway. Based on the current results it is not possible to tease apart which of these is correct.

Dogs' discrimination between the positive and neutral emotional expression was not clearly evident during the demonstration, in fact based solely on the dogs' behaviour, the observers were unable to correctly identify which emotions had been expressed by the owners in relation to the two objects. However, considering that the majority of dogs then went on to choose the positive eliciting box, it would seem that in this situation dogs both discriminated between and appreciated the valence of the positive message delivered. The most likely explanation for such a preference is that dogs were familiar with expressions of enthusiasm and happiness of their owner, and have learned in the course of their lives that such displays are normally associated with positive objects or experiences. It is likely that dogs were far less familiar with their owner's expression of fear hence they may not have learned to associate such reactions with negative outcomes or potential threats from the environment.

Our results are somewhat in contrast with the only other study investigating these issues in dogs. Buttelmann and Tomasello (2012) found that dogs manifested a slight preference for the positive-eliciting box when compared with a box eliciting a reaction of disgust from the experimenter. However, no difference emerged in the dogs' choice between the positive and

neutral stimuli, suggesting that the negative emotion may have had the larger impact on the dogs' choice. Unfortunately, in their study they did not compare dogs observing a negative vs. neutral emotion hence it is not clear whether dogs' were really avoiding the disgust eliciting stimuli, or whether the difficulty lay in the discrimination between the positive and neutral expressions of emotions which may have been given the same valence. Of course the negative expressions were different in the two studies, disgust in Buttelmann and Tomasello and fear in our own, so one possible reason for the discrepancy in results is that dogs may be more capable of discriminating and using expressions of disgust than of fear to direct their actions. Possibly expressions of disgust are used more frequently in dog-human interaction than expressions of fear, allowing dogs the necessary familiarity with such expressions to allow for their use as referential cues to objects.

Conclusion

Infants can discriminate between different emotions (Nelson 1987; Field et al 1982), they can change their behaviour after perceiving this emotions (Feinman 1982; Klinnert et al 1983), and they can percept that that the referent's emotion is directed towards a specific target and it is the behaviour towards this target (Repacholi 1998; Buttelmann and Tomasello 2012).

Dogs have been shown to discriminate between smiling and neutral human faces (Nagasawa et al. 2011), reacting differently to actors performing a range of emotional facial expressions (anger and fear) compared to neutral ones, and to change their behaviour according to the emotional expression received by the humans (Merola et al. 2012, 2012a). The current study significantly adds to the growing literature on dogs' understanding of human emotions by showing that: a) like infant and some non-human primate, dogs can attribute another's emotion as being elicited by an object, i.e. they can have a referential understanding of human emotions. In fact, whereas dogs showed a clear preference for a positive eliciting stimuli vs. a negative one (with the owner as the emoter), no such preference occurred when the owners' emotions where expressed in

a particular location, with no object as referent.; b) dogs show a form of emotional contagion when observing their owner's express positive vs. negative emotions. In fact independent observers were able to correctly identify when dogs were witnessing positive vs. negative message (when the owner was the emoter). Furthermore, a trend emerged in the negative vs. neutral, suggesting that the dogs' response to the owner's negative emotions was probably stronger than to the positive one; c) dogs are particularly sensitive to their owner's positive emotional expressions, probably due to a greater everyday familiarity with this emotion. In fact, with the owner as the emoter dogs preferentially chose the positive eliciting stimuli both in the positive. Negative group and in the positive vs. neutral group, whereas there was only a trend against choosing the negative stimulus in the negative vs neutral group: d) dogs understanding of human emotions appears to strongly dependent on the identity of the person, in that dogs in the group with the stranger as the emoter showed neither a change in behaviour during the demonstrations, nor a preference for the positive eliciting stimuli. Whether this lack of results with a stranger is due to dogs' inability to recognize a stranger's emotional expression or a lower inclination to take the stranger's emotions into account when acting upon them, remains an open question for future research.

Appendix

Experiment 1

2 Akita inu, 1 Basenji, 1 Bichon Frise, 1 Border Collie, 1 Boxer, 2 Epagneul Breton , 1 Caudé de agua, 1 Cavalier King Charles , 1 Dobermann, 2 Flat coat retriever, 5 Golden Retriever , 1 Australian Kelpie , 4 Labrador Retriever , 1 Pastore Ted, 1 Pinscher, 1 Rhodesian Ridgeback , 2 Setter Irish , 1 Terranova.

Experiment 2

2 Barboncino, 2 Beagle, 1 Bolognese, 1 Border Collie, 1 Bracco, 1 Breton, 1 Cirneco dell'Etna, 3 Golden Retriever, 4 Jack Russel, 2 Labrador Retriever, 1 Pinscher, 1 Rottweiler, 1 Westhighland terrier

Chapter 9

General conclusions and future research

In the last 15 years a lot of studies have been carried out on dogs, showing that they are really skilled in communicating with human, and in understanding human communication signals (Hare et al 1998, McKinley and Sambrook 2000, Soproni et al. 2001, Miklosi et al. 2000, Virányi et al. 2006). However, so far, only a limited number of studies have focused on the emotional communication between this two species (Morisaki et al. 2009, Nagasawa et al. 2011, Fukusawa et al. 2005, Marshall-Pescini et al. 2011), and little is known as regards interspecific understanding of emotions despite the fact that dog-human communication is based on nonverbal information aimed also at conveying and sharing emotions.

The four studies reported in this thesis were aimed at evaluating some aspects of dog' understanding of human emotional expressions. To reach this goal in the first three studies we selected a Social referencing procedure, never used with dogs before, while in the last one we used a two object choice task after an emotional message was conveyed toward objects by human (owner vs. stranger).

In particular the first three studies (Chap. 5,6,7) were all carried out using a similar procedure based on a Social referencing paradigm, to evaluate the use of the referential looking and behavioural regulation by the dogs towards an ambiguous object (Chap. 5), dependent on the owner or a stranger emotional message towards it (Chap. 6), and dependent on the kind of training received by the dogs (Chap. 7).

The purpose of the first study was to (1) evaluate the presence of referential looking in dogs' communication with people in a context which did not involve requesting an object/food; (2)

investigate whether the human's voice and facial expressions alone can influence dogs' behaviour when confronted with an ambiguous stimulus (what is known in the infant literature as 'the behavioural regulation' element of social referencing).

Results from this study showed that dogs, like human infants, use referential looking towards a familiar person (i.e. their owner) in a situation of ambiguity. This could show that dogs can use gaze and gaze alternation not only to request something like food (as found in previous literature: Hare et al. 1998, Miklosi et al. 2000), but also to seek for information when faced with a strange situation. However, results so far were unable to exclude that dogs were looking towards the person as a comfort-seeking request.

Furthermore, what was not clear was the behavioural regulation of dogs after receiving an emotional message by the owner (the only difference was dogs in the negative group showed more Static behaviour, i.e. standing, sitting or lying, than dogs in the positive group). There were nonetheless two important differences between the current procedures and the infant studies, which may have affected the current results. In the infant studies, mothers immediately delivered the message as soon as their child looked at them; furthermore, the 'scary object' was switched off whilst the mother continued delivering her message (Walden and Ogan 1988; Mumme et al. 1966; Kim et al. 2010). In our own study, the first time dogs looked at the owner they received no overt response, which may have conveyed a mixed message about the value of the object. Furthermore, the scary object was switched off only at the end of the test, not allowing us to evaluate whether with a lower intensity of the scary stimulus dogs would have approached the object.

Thus, having ascertained in the first study that dogs do look at the owner when confronted with a strange object, the second study was carried out following more closely the infant procedure, to better evaluate the presence of behavioural regulation after receiving an emotional message by the owner. Furthermore, we tested as informant not only the familiar person, but also a stranger to evaluate the effect of the relationship in this paradigm.

Results in this study provided clear evidence that dogs use referential looking not only toward their owner but also towards a stranger acting as an informant. These results, with dogs looking both at a familiar and unfamiliar informant, indicate that referential looking should not be interpreted as a comfort-seeking request, as it can be directed also toward a stranger (i.e. not an attachment figure). However, in infants there is cleared evidence that referential looking in a social referencing paradigm is aimed at obtaining information, since infants look preferentially at the stranger informant than the caregiver present in the room, and they even choose to look more towards an ‘experienced’ than a naïve stranger informant. In dogs the picture is still not so clear, in fact, although dogs looked at both the stranger and the owner when they acted as an informant, when both the owner and the stranger-informant were in the room, the dogs looked equally towards both. Hence, it is still not clear, whether dogs’ looking behaviour can be considered a request for information.

In the second study we also found that dogs regulated their behaviour towards the object after receiving a positive or a negative emotional expression by the owner. In fact, dogs in the positive group (i.e. positive emotion) looked at him/her more often than those in the negative group (negative emotion), and also spent more time approaching the fan and in the Fan-zone. Conversely, dogs in the negative group took longer to reach the Fan-zone and to interact with the fan. These results were not found when the stranger was acting as the informant: in this case only dogs in the negative emotional expression group changed their behaviour: they spent more time in the area close to the door (i.e. close to the seated owner), exhibited more static behaviour and looked more often to the seated owner compared to dogs in the positive emotional expression one. Taken together these results suggest that probably dogs were sensitive to the emotional expression of the stranger (in line with Deputte and Doll 2011, Ruffman and Morris-Trainor 2011), but the way they changed their behaviour was dependant on their relationship with the informant.

To better evaluate the influence of the identity of the informant in social referencing paradigm we did the third study choosing a special group of trained dogs (water rescue) where the

main purpose of this type of training is to promote strong cooperation and synchronization between dog and owner that can persist in stressful and challenging situations, but even to focus the dogs' attention on unknown people who scream for help and wave their arms, simulating people in distress. We reasoned that considering their training experience these dogs may be more willing to take into account the message delivered by a stranger. Hence, we presented these dogs (and a group of sex and breed matched dogs) with a social referencing paradigm with a stranger acting as informant and giving a positive emotional message.

In the third study results partially replicated those in the second, but added an interesting, unexpected element. Firstly, as in study 2, dogs showed referential looking toward the stranger. However, differently from prediction water rescue dogs, did not change their behaviour towards the object following the strangers' positive message. Surprisingly, however the control (not trained) group did change their behaviour toward the ambiguous object, approaching it more than trained dogs, following positive emotional message given by the stranger. Considering in study 2 we had found no behavioural regulation with a stranger when testing untrained dogs, these results were unexpected. The only notable difference between studies was that in the current one, the untrained dogs were all retrievers. This suggests that breed may have an effect on the dogs behavioural regulation with a stranger as informant, and points to interesting future studies.

In sum these three studies showed how social referencing is a process present in dog-human communication: in particular referential looking occurs both toward the owner and a stranger, while behavioural regulation appears especially toward the owner (with whom dogs have a relationship). However, further studies need to be carried out to better understand the presence of this behaviour towards a stranger, and how this may be modulated by such factors as training and breed. In the human literature, in fact, babies are selective in social referencing and usually prefer the attachment figure (i.e. the mother): when a stranger acts as informant, they change their behaviour only if the mother is also present in the experimental room.

Future studies could be directed to further investigate how the relationship with the person that is expressing the emotions can influence the dogs' reactions: for example it could be interesting to evaluate different kinds of relationship with the stranger (i.e. a new stranger vs. a less novel stranger) or different expertise of the stranger in the situation (i.e. an expert stranger vs. a non expert one). The latter tests have been used with infants to better understand whether their referential looking towards the informant is in fact a request for information rather than comfort. A similar paradigm could be adapted to dogs to address the same issue. Furthermore, it could be interesting to compare different breeds of dogs since our preliminary results in Study 3 suggest that this variable may be important, particularly when it is a stranger giving a message. A better understanding of how breed may modulate the effects in a social referencing paradigm may help answer questions on how much the artificial human selection affected dogs communication. Furthermore, it would be interesting to evaluate the presence of this behaviour toward conspecifics to investigate the origin and evolution of this behaviour thus evaluating if social referencing is acquired during lifetime and as a consequence of interaction and communication with humans, or if this behaviour is specie-specific in dogs.

In the fourth study we adopted a different experimental paradigm, to better evaluate if dogs were really referencing the emotional message received toward a specific object. In fact, what has not clearly emerged from the three previous studies was whether the dogs' change in behaviour was intentionally directed specifically towards the target object hence with an understanding of the referential quality of the emotional message received (henceforth 'object referencing'), or whether it may in fact be caused by a process of mood modification or emotional contagion. In that, a positive message may simply increase the dog's arousal status causing it to move around the room more, which as a side effect would then coincide with an increased proximity to the target object. Whereas, through a process of emotional contagion a negative message may decrease the overall activity of the dogs and hence reduce the likelihood of them approaching the target object.

To better evaluate this point we used a paradigm where dogs could witness their owner or a stranger expressing two different types of emotions (positive-negative, positive-neutral, negative-neutral) towards two objects hidden in a box or in two locations (the procedure was the same of the other group but in this case there were no object). After witnessing the informant delivering the message the dogs were free to choose which object/location to approach. In this study we found a clear preference for the object eliciting a positive message, compared to the negative-eliciting object when the owner was the informant. On the contrary no preference emerged when the stranger was acting as informant. Thus, similarly to previous results we found that the relationship between the dog and the informant seems to significantly affect results. Furthermore, there was evidence that dogs didn't show a choice behaviour when the owner was expressing the emotion in a specific location without the boxes present. These results seem to indicate that dogs were referencing the emotional message towards a specific object and that they were not just modifying their mood in response to the owner's expression.

Taken together these results, show that dogs do in fact appreciate that an emotional message can relate to a specific object, and considering the non-specific behaviours exhibited by dogs (both in the choice and observation phase) in the no-object control group, it would even suggest that dogs *expect* emotional messages to refer to specific objects.

It would be interesting to set up further studies on this topic aimed at better understanding if dogs can choose and react differently if the emotional expression is directed towards, for example, a person and not just towards an object or food (as in previous Buttelmann and Tomasello 2012 study) Moreover, it would be interesting to clarify which aspect of the emotional expression is the most relevant for dogs in emotional communication (i.e. the voice or the facial expression). Furthermore, different kind of expressions (like angry, sadness, etc.) could be used in the same set up, to clarify dogs understanding of different human emotions.

In sum this thesis showed some important aspect of dog-human emotional understanding and communication, with dogs behaving toward the human in a similar way as do infants with their

mother, but also with important differences which need to be further explored to clarify whether the underlying mechanisms in both species are the same.

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