

THESIS OF DOCTORAL DISSERTATION

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**Analysis of visual communication
between human and dog**

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Introduction

The pointing gesture is a human-specific signal, which is referential in its nature. For different theoretical reasons many different species have been tested for pointing comprehension. Apes generally perform poorly with human visual signals (Itakura et al., 1999). Capuchin monkeys (*Cebus apella*) performed well with proximal dynamic pointing (Anderson et al., 1995; Vick and Anderson, 2000) but three Rhesus macaques were less successful in a similar task (Anderson et al., 1996). Recent comparative experiments however have shown that seals (Scheumann and Call, 2004), and dogs (Miklósi et al., 2005) are very skillful in trials with proximal dynamic pointing gestures in contrast to chimpanzees (Tomasello et al., 1997). Dolphins (Tschudin et al., 2001) have only been tested with the distal dynamic gesture, in which case their performance was above the chance level similarly to one seal (Shapiro et al., 2003).

Recent comparative studies have shown that living in human social environment has a strong effect on communicational abilities of different animal species considering the comprehension of human visual signals (Call and Tomasello, 1996). This explains the controversial results with chimpanzees in experiments examining the comprehension of the human pointing gesture. Povinell et al. (1999) found that chimpanzees (*Pan troglodytes*) are not able to comprehend the pointing gesture without previous training, while Itakura and Tanaka (1998) found that enculturated chimpanzees and an enculturated orangutan (*Pongo pygmeus*) showed high performance in similar tasks even without previous training.

Recent experimental results provided evidence that some domesticated species show high performance in comprehension of human gestural signals in contrast to apes. The “domestication” hypothesis assumes that the superior performance of dogs in comparison to apes can be explained by domestication (Hare et al., 2002; Miklósi et al., 1998, 2000; Soproni et al., 2001, 2002). It has been suggested that dogs had been selected for enhanced socio-cognitive and communicational abilities for living in human social environment. A recent finding that domesticated goats with relatively little human contact are also able to comprehend human pointing gestures (Kaminski et al., 2005) also supports the domestication hypothesis. Dogs have been reported to be very skilful in comprehending a variety of human pointing gestures in many independent studies (Hare et al., 1998; Hare & Tomasello, 1999; McKinley & Sambrook, 2000; Miklósi et al., 1998; Soproni et al., 2001). Pongrácz et al. (2003) have found that dogs with previous experience of an experimenter's pointing gestures

chose successfully relying also on the signals of a life-sized projected image of the same experimenter. In addition, the result of a test series of Soproni et al. (2002) suggested that dogs are able to rely on relatively novel gestural forms of the human communicative pointing gesture but still many questions remained open regarding those features of this communicative signal, which help the dogs to choose correctly.

There are some indications that dogs have a strong propensity to initialize communicative interactions with humans by using visual and sometimes also acoustic signals functionally similar to the ones used by humans (Miklósi et al., 2000).

Interestingly, in contrast to the many investigations of pointing in dogs there are only a few experimental studies on pointing and gazing comprehension in human children. Most of our knowledge is based on longitudinal investigations (Morissette et al., 1995) revealing that human infants are able to look in the general direction indicated by the mothers' gaze at 12 months of age, and they are able to look at the indicated target at 15 months of age if the targets are close and at 18 months of age if the targets are distant (see Morissette et al., 1995). But when gazing is accompanied by a pointing gesture children look at the indicated distant target at 15 months of age. According to Butterworth and Grover (1998) the comprehension of manual pointing develops by 12 months of age, and the exhibition of pointing for others is observed in most children at about 14 months of age (Leung and Rheingold, 1981). More recently Behne et al. (2005) found that 14 months old children are able to choose an object in an object-choice task on the basis of two different types of cues when the cues are given in a communicative way but they show very poor performance if the same cues are given in a non-communicative way.

The most important critic of the comparative studies on pointing comprehension of the different species is that the experimental procedure used with the different animals shows a great variance. There are variations not only in the way the pointing gestures are presented but also in the experimental environment. There are differences also in the distance between the subjects and the bowls, and in the degree of familiarity with the testing environment and the experimenter. The presentation of the pointing gesture also varies in a certain degree, which is very important as it can have a strong effect on the performance.

Aims and questions

The goal of the present dissertation was to investigate dogs' communicational abilities through controlled and direct comparative studies and to reveal further details of visual communication between humans and dogs in order to find out more about the mechanisms behind dogs' ability to comprehend human gestural signs.

Study I. The aim of the present study was to reveal to what extent living in a similar human social environment has shaped the divergent communicative behaviour of dogs and cats through a comparison of the two species. We aimed to compare directly dogs' and cats' communicative abilities towards the humans in both directions.

Questions of the study:

1. Are the communicational abilities of dogs and cats similar considering the comprehension of human pointing gestures?
2. Are the communicational abilities of dogs and cats similar considering their behaviour in a problem situation (do they show "requesting" behaviour towards humans)?

Study II. The social environment of human infants is often shared by pet dogs in the family. Although for many this does not come a surprise other debate that there is a similarity between the social stimulation received by either species. Thus the first goal of the second study was to find a period of human development in which children and dogs display similar levels of performance. Given the stable performance of dogs beyond their first year in Experiment 1 we compared adult dogs to 2 and 3 years old infants. The second aim of this investigation was to gather comparative evidence on the ability to generalize to unfamiliar gestures in both species.

Questions of the study:

1. To what extent are dogs and children in different ages able to generalize toward a topographically similar gesture that is executed with a different bodypart based on the assumption that subjects have been rarely (if at all) exposed to such body movements in a communicative context?
2. Do dogs and children at some age gain the capacity to recognize the significance of the pointing finger in the communicative context?

Study III. On the basis of the results of this previous study in the third study we wanted to see whether there are alternatives or additions to the comprehension that is based on

protruding bodyparts and we aimed to examine the importance of certain aspects of the visual signal in more details.

Questions of the study:

1. What are the key-features of the human pointing signal for the dogs aside from the protruding bodypart?

2. Are dogs able to use the human pointing gesture as a cue if the experimenter and so the pointing signal is projected on a screen in the life-size of the experimenter and in different smaller sizes?

Study IV. In the fourth investigation we aimed to examine the two-way visual communication between dogs and humans in both directions in relatively complex situations through three different experiments. Dogs experience different communicational events in various situations in the everyday life when interacting with humans. Nevertheless, their communicational abilities have been investigated previously only through simpler situations, using direct association between the communicational signal and the signalled object.

Hereby in the present study the following specific questions were examined:

1. Are dogs able to comprehend indirect signals and use this indirect information in locating a hidden reward in a relatively complex situation?

2. Are dogs able to choose on the basis of the momentary distal pointing gesture in a four-way object-choice task?

3. Are dogs able to understand indirect information about the place of a hidden object and pass this information to the owner?

Methods

In Study I. we examined dogs' and cats' behaviour in two different test situations. In the first experiment we compared the communicational abilities of the two species in a two-way object choice task, in which the experimenter signalled the location of the hidden food in one of four types of the pointing signal. The pointing signals differed in the staticness of the gesture and in the distance between the tip of the index finger and the signalled object. In the second experiment we approached the dog-human, cat-human communication from the other side. This time we analysed the subjects' "requesting behaviour" in a problem situation, in which the experimenter hid a piece of food into one of three possible hiding locations (from

where the subject could not get it out by itself). We observed the dogs' and cats' behaviour with their owners for one minute.

In the second comparative study (Study II) we also used a two-way object choice task, in which we investigated dogs' and children's comprehension of novel pointing gestures. In the first experiment we utilized different kind of pointing gestures by arm, while in the second experiment we used novel gestures by leg.

In Study III we analysed in further details dogs' communicational abilities toward humans in two-way object choice tasks. In the first part of the study we examined the importance of the visual salience of the pointing gesture, so in this experiment we utilized the "Cross-forward pointing", which is known to be difficult for the dogs to comprehend. The gesture was presented by the experimenter in different clothes making it more or less salient (white arm – nude hand – black body, black arm – nude hand – black body, black arm – black gloves – black body, everyday clothes). In the second half of this study we applied the two-way object choice task using a projector, so that the two dimensional image of the experimenter was projected on a screen (in an interactive situation). The size of the projected image of the experimenter was varied (life size, half of the life size, tierce of the life size).

In Study IV we examined dog-human communication in relatively complex situations. In the first experiment we increased the number of the possible hiding locations to four in the object choice task. We used a four-way object choice task also in the second experiment, but this time the situation was even more complex by having a two-step signalling system. Two experimenters were pointing to one of two-two possible hiding locations, but only one of them indicated the correct bowl. The owner's pointing signal indicated the experimenter providing the correct information. In the third experiment of the study we investigated dog-human interactions from the other side. In this test we used three possible hiding locations at a height where the dogs could not reach them. The experimenter did the hiding at the absence of both the dog and the owner then with one of four gestures signalled the location for the dog. After this the dog had one minute to pass this indirectly received information to the not knowledgeable owner by its behaviour.

Results and discussion

Study I. As a whole, in the first experiment our results did not show statistically significant species-specific differences in the use of human based cueing in cats and dogs,

although we should note that the gestures used were relatively simple and might have been familiar to all subjects. In contrast, in our second experiment we have found that there are differences in dogs' and cats' behaviour in a different context when the subject can freely display behaviour patterns in an unsolvable situation. While dogs tended to use gaze-alternations (to look at the human and back to the hidden food) when they were unable to get the reward themselves, the cats were trying to get the food themselves and looked very rarely at the owner or at the experimenter (Miklósi és mtsai., 2005).

Study II. The results of our first experiment suggested that dogs chose on the basis of a body part that protruded from the signalling person's silhouette, and it seems that the directionality of the index finger plays little role in influencing the choice. Their performance was below the chance level when the experimenter's elbow was protruding in the wrong direction, while their performance was on the chance level when there was no protruding body part. Further it seemed that there was little difference in the performance of 2-year-old children and dogs, while 3-year-old children's performance was already high in all cases. The results also suggested that to some extent all subjects were able to generalize from their previous experience to a relatively novel directional gesture.

Study III. Considering our findings in the first half of this study one can assume that dogs utilize the forward cross pointing gesture, which does not protrudes the body torso, only if it is visibly (and asymmetrically) emphasized by the pointing hand. Our results showed that making the gesture visually more salient can have an enhancing effect on dogs' performance. In the second half of this study we examined dogs' performance in an object choice task using a projector. As it was found earlier in the previous studies of Pongrácz et al. (2003), dogs did not seem to be disturbed by the change in the procedure. The present results showed that dogs that could use the pointing gesture in the presence of the experimenter performed the task subsequently with similar success when the same experimenter was displayed via video projector even when the image of the experimenter was smaller than the life-size. However, in the individual level only few of the dogs could use the projected signal.

Study IV. Taken together the findings of the three experiments we can conclude that dogs have the ability to comprehend indirect signals and to deal with relatively complex situations. In addition the results of the second experiment provide further support for the previous assumption, namely that the comprehension of pointing is unlikely to depend on extrapolating precise linear vectors along the pointing arm in dogs as it has been shown already also in humans (Butterworth and Itakura, 2000). Results of the third experiment

showed that dogs' were able to recognize the place of a hidden food not only on the basis of direct but also on the basis of indirect signals and to transmit this to their owner.

Summary of the most important results

Across the dissertation we have investigated the mechanisms behind the utilization of the pointing gestures in dogs from different aspects through four different studies.

The results of our studies suggested that dogs do not grasp the meaning of the pointing index finger, instead they rely on a common simple rule: follow the direction indicated by the protruding body part. According to our findings the protrusion of a body part of the silhouette provides the key feature of the signal for the dogs. By this relatively simple rule dogs are able to reach a flexible comprehension of human visual signals (also in relatively complex situations). This flexibility in their understanding was supported also by the results that dogs showed some evidence of generalization in the presence of unfamiliar gestures although their ability to generalize seemed to be limited compared to that of 3-year-old children. The importance of these results is given by the assumption that the ability of generalization from familiar gestures to novel ones provides some evidence for comprehension of the referential nature of the pointing gesture (Povinelli et al., 1997, Herman et al., 1999).

Further investigations have shown that making the gesture visually more conspicuous can have an enhancing effect also in cases when the gesture does not stick out from the silhouette. These studies demonstrated that the most informative cue for the dogs is a clearly visible patch, which appears conspicuously at one side of the body torso. Our results suggest that the most important feature of the pointing gesture for the dogs is the visual asymmetry represented by the signal which guides their attention to the appropriate direction. These observations also pointed to the importance of taking into account the visual abilities of the species in comparative work, apart from the possible differences or similarities of the underlying cognitive architecture.

The results of our studies led us to the conclusion that dogs are not able to localize precisely the target of the pointing gesture and hereby the comprehension of the human pointing gesture is unlikely to depend on extrapolating precise linear vectors along the pointing arm in dogs.

Summarizing, the results of our studies provide further knowledge that helps the researchers to get closer to the understanding of the mechanisms behind the dog-human visual communication.

Publications in the topic

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