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Use of experimenter-given cues in dogs

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Abstract Since the observations of O. Pfungst the use of human-provided cues by animals has been well-known in the behavioural sciences (“Clever Hans effect”). It has recently been shown that rhesus monkeys (*Macaca mulatta*) are unable to use the direction of gazing by the experimenter as a cue for finding food, although after some training they learned to respond to pointing by hand. Direction of gaze is used by chimpanzees, however. Dogs (*Canis familiaris*) are believed to be sensitive to human gestural communication but their ability has never been formally tested. In three experiments we examined whether dogs can respond to cues given by humans. We found that dogs are able to utilize pointing, bowing, nodding, head-turning and glancing gestures of humans as cues for finding hidden food. Dogs were also able to generalize from one person (owner) to another familiar person (experimenter) in using the same gestures as cues. Baseline trials were run to test the possibility that odour cues alone could be responsible for the dogs’ performance. During training individual performance showed limited variability, probably because some dogs already “knew” some of the cues from their earlier experiences with humans. We suggest that the phenomenon of dogs responding to cues given by humans is better analysed as a case of interspecific communication than in terms of discrimination learning.

Key words Dogs · Inter-specific communication · Visual cues · Attention · Human gestures

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Introduction

Since the famous story of the horse Clever Hans, experimenters have consciously tried to avoid giving cues to animals under observation in learning tasks. The case of Clever Hans demonstrated the extent to which an animal is able to observe and to respond to subtle human gestures (Pfungst 1911). This finding was generalized to experiments on other animals in laboratory settings, and to avoid providing animals with such cues, special equipment and procedures were developed (e.g. Wisconsin General Test Apparatus; Harlow 1951).

However, until recently, it has never been formally tested whether different animal species are able to use human gestures as cues. A different approach to the Clever Hans effect would suggest that it reflects the ability to acquire information by observing others’ behaviour, which in turn might reflect either or both the presence of well-developed cognitive capabilities or social skills selected for in domesticated species (see also Candland 1993). This kind of cue learning might be expected both in species with sophisticated sociocognitive abilities (e.g. primates) and in domesticated animals (e.g. horses, dogs).

Originally interested in the understanding of “attentional states” in animals, Anderson et al. (1995) tested whether three capuchin monkeys (*Cebus apella*) would be able to use human gestures as discriminative cues for choosing an object. The results showed that capuchin monkeys learned to discriminate between two objects on the basis of human pointing, but their performance was at chance level if the cue was the experimenter’s gaze direction. A further experiment with rhesus monkeys had similar results (Anderson et al. 1996). To explain these “negative” findings two general hypotheses were put forward. The “learning hypothesis” suggested that the cause of the weak performance was the lack of spatial contingency between the cue and the reward. Monkeys are known to show weak performance under these conditions (Murphy and Miller 1955), and in the experiment of Anderson et al. (1996) there was a considerable distance between the

physical localation of the cue in space (e.g. the position of the experimenter's head or index finger) and the object that covered the reward. In contrast, the "mental state attribution hypothesis" would explain the results on the basis of the monkey's limited ability to rely on visual coordination or engage in perspective taking (see also Povinelli et al. 1990, 1991). Recently, Itakura and Anderson (1996) showed that when gestures were introduced sequentially (from the "easiest" to the "most difficult": pointing, head-turning, and so on) during the training, one capuchin monkey was able to learn to use the direction of head-turning as a cue for choice. More recently, Itakura and Tanaka (1998) have shown that chimpanzees (*Pan paniscus*), an orangutan (*Pongo pygmaeus*) and human infants readily learn and use the directionality of even slight human gestures, like glancing, to localize food rewards under conditions similar to those used to test monkeys (Itakura and Anderson 1996).

It has also been realized that before claiming the ability of mental attribution for species other than humans (e.g. chimpanzees, see Povinelli et al. 1990) it is important to show experimentally that these animals can understand the significance of gaze direction in conspecifics (or heterospecifics) since this knowledge is a prerequisite for representing mental states of others. In a series of experiments Povinelli and Eddy (1996, 1997, in press) investigated the extent to which chimpanzees understand the mental state of attention of humans. These experiments indicated that chimpanzees do not necessarily have the same sophisticated ability to perceive visual attention of the other as humans, but nevertheless they are able to use the position of the body, head and to some extent the eyes to discriminate between attentive and inattentive states. These authors argued that differences in species-specific attention behaviour might account for the discrepancies between humans and apes. The latest results of Povinelli and Eddy (1996), and earlier observations on human development of joint visual attention (e.g. Butterworth and Jarrett 1991), lead to a simplified approach to the broadly presented "mental state attribution hypothesis" in animals. One main question today is whether different species of animals are able to perceive the attentional state of a conspecific (or heterospecific) companion and use this information in shaping their behaviour (Povinelli and Eddy 1996).

Dogs may have lived in human communities for tens of thousands of years (Vilá et al. 1997). It is widely believed that the success of dogs in becoming "man's best friend" was due to their ability to adapt to several aspects of human behaviour and social organization (Scott and Fuller 1965; Kretchmer and Fox 1975; Cox 1993; Serpell 1995; Topál et al. 1998). Since humans continuously and unconsciously use gestures in their communicative interactions with both conspecifics and heterospecifics, dogs might be highly responsive to these cues. With regard to the learning hypothesis, Frank (1980) suggested that domestication of the dog resulted in the ability to respond to a broad range of stimuli that might be arbitrarily selected as being signals. Interestingly, apart from a few anecdotes

in the literature on dog behaviour there are no studies examining the ability of dogs to respond to cues given by humans.

Here we present experiments that were carried out under slightly different conditions, although with the same goal in mind. Our aim was to investigate whether dogs are able to use human gestures as cues under similar conditions to those used to test monkeys and apes. We also investigated the sensitivity of dogs to human cuing by testing several different gestures, especially gestures that are signs of directional attention in humans (e.g. pointing, head-turning, glancing).

General methods

The method used in the following experiments is based mainly on the experiments originally described in Anderson et al. (1995, 1996), but the procedure is closer to that of Itakura and Anderson (1996), modified to suit the species under investigation and the particular circumstances. In this section the general procedure is described. Particular modifications of the general procedure for particular experiments are described in the appropriate sections.

Baiting and choice

Baiting

Two bowls (brown plastic flower-pots; 20–35 cm in diameter, 20–40 cm height) were used to hide the bait. Both pots were lined with a piece of cloth to prevent any noise occurring during the baiting. Both cloths were kept for 2 days with some food pellets to absorb the odour of the food. Their presence kept both pots equally scented during the experiments and hindered the use of odours as cues.

Trials took place between 1000 and 1800 hours. Each trial started with baiting. First, the dog was led by an assistant behind a folding screen or object situated in the same room which prevented the dog from observing the process of baiting. The experimenter took a small food pellet in each hand and put one in each pot, but one was immediately removed and put back in the food container. This process ensured that both of the experimenter's hands and both pots became equally scented, and the noises that might be associated with the presence of food in the pots were also similar. Different brands of commercial dog food that were part of the dogs' normal diet were used as rewards. There were no restrictions on feeding of the dogs; however, they generally had not been fed for at least 1 h prior to the training session. (For some dogs a favourite toy was hidden, in a similar manner as described for food.) The order of baiting was previously determined by tosses of a coin with the restriction that one side could not be baited more than twice in a row.

Cuing and choice

During the trials the experimenter stood 0.5 m back from the middle line between the two pots which were 1.5 m apart. He/she took up a relaxed standing posture facing the dog. The dog stood at a distance of 2.5–3 m from the experimenter. The experimenter tried to make eye contact with the dog. If the dog did not pay attention within 10 s he/she called it by its name. While the dog was looking the experimenter performed the predetermined gesture. If the dog changed its line of view during the presentation, the cue was repeated no more than twice. After giving the cue the experimenter returned to the relaxed standing position and the dog was allowed to make a choice. The dog could therefore use the direction of pointing (or other cue) to decide whether to go to the left or right pot. It is important to note that the cue was not visible while the dog was approaching the pots. If the dog chose the correct container it received its reward, but there was no restriction on looking into the other container. Dogs were also praised verbally. If the dog visited the empty pot first, it did not receive a reward, but the position of the food was shown to it.

Cues given by the experimenter

All gestures lasted about 1–2 s, after which the resting position was taken up again. The following gestures were used:

1. Pointing. The common human pointing gesture was used. The experimenter pointed briefly toward the correct container after which his/her arm returned to the resting position at the thigh. During the pointing gesture the experimenter faced the dog.
2. Bowing. The bow was presented by bending the upper torso approximately 30° from the vertical in the direction of the correct container, during which the experimenter looked towards the correct pot. Both arms were held tightly at the side of the body.
3. Nodding. The experimenter turned his/her head in the direction of the baited pot and nodded once, looking towards the baited pot.
4. Head-turning. The experimenter turned his/her head in the direction of the baited pot.
5. Glancing. During this gesture the experimenter was kneeling. The experimenter's head remained still, in a horizontal position facing the dog, and only the eyes were moved in the direction of the baited container.

Baseline trials with no cuing

To ensure that only the deliberate cues influenced the behaviour of the dogs, and that the asymmetrical presence of the food in one of the pots had no effect, both before and after the experimental trials baseline trials (“controls”) were staged during which the experimenter was instructed

not to make any movements and to watch the ceiling above the dog. The experimenter waited in this relaxed posture for a similar period to that used in cued trials, after which the dog was allowed to choose as described above.

Procedure

Pretraining

The dog was allowed into the room where the experiment would take place. The experimenter showed a piece of food to the dog and put it into one of the pots which earlier had been placed in their appropriate position. This procedure was repeated twice for each pot to ensure that the dog knew that the pots might contain food. (For some dogs this procedure was done with a toy.)

Baseline trials 1

The dog was instructed or gently forced to a location which prevented it from watching the baiting. After the food (or toy) was hidden, dogs that reliably obeyed the “sit” command were made to sit down facing the experimenter at 2–3 m distance; others were gently restrained by an assistant who stayed with the dog until the end of the cuing. For dogs sitting alone a neutral releasing command was given (e.g. “Come!”, or they were called by their names); “restrained” dogs were simply released by the assistant. In the baseline trials the experimenter remained still for 2 s before he/she allowed the dog to choose. Ten such trials were performed.

Cuing trials

These trials had a similar general structure to the baseline trials, with the exception of gesturing. The order of cuing gestures was previously determined (pointing, bowing, nodding, head-turning, glancing). In the first session only pointing was used. At the same time the number of trials per session and per gesture was also determined for each individual dog. Trials per gesture ranged from 8 to 10, and the number of trials per session varied between 20 and 30. In pilot experiments we found that dogs' interest in participating in the training was highly variable, and therefore variation of conditions between individuals (in discussion with the owner) seemed inevitable. However, after the first session the number of trials per gesture was kept constant. If the dog reached the learning criterion with one gesture the next one was introduced. For any given gesture the learning criterion was set as at least 80% correct choice in two subsequent sessions. Glancing was only introduced after the dog had reached the criterion for all the other gestures.

Baseline trials 2

After the experiment, ten baseline trials were carried out to check that dogs did not respond to any subtle movements of the experimenter that might have developed during the training. Furthermore, this control observation could also test whether dogs had learned to use the odour of the food pellet as a discriminative cue.

Data analysis

Group performance in control and cued trials was analysed with one-sample *t*-tests testing for significant departure from the baseline. Individual learning performance was evaluated by comparing the number of correct choices in the first 15 and last 15 trials for any given cue, to the baseline performance with the chi-square goodness of fit test. Performance in response to different gestures was compared by the Wilcoxon test. In experiment 2b the number of trials was low so the binomial test was used to test individual performance.

Experiment 1

The observations were carried out during Spring 1997 (March–May) at the training centre for assistant dogs (Verein zur Förderung der Partnerhunde für Behinderte) in Salzburg, Austria.

Subjects

Two male golden retrievers (Sam and Spike), and two females (Mandy and Delta) and one male (Campo) of a golden retriever × labrador cross, took part in the experiment. Campo, Mandy and Delta came from the same litter. All dogs were 1.5 years old and had been raised in foster families until their training as assistant dogs started at the training centre, where the dogs were kept in a large garden together with other dogs and were in continuous contact with humans. When these experiments started the dogs had already been in training for 6 weeks.

Methods

The procedure followed that outlined under General methods, but with no need for an assistant, since the dogs went into the holding box that prevented them from watching the baiting on command. After the food had been hidden the experimenter (J.T.) went to the holding box, let the dog out, and made it sit 3 m away from the baited pots. The experimenter then stood between the pots and made the gesture, after which the dog could choose freely between the pots. One training session consisted of ten trials per gesture of two different gestures. Two or three sessions were staged in a week. This group of dogs was also shown a head-turning gesture that was performed by the experimenter while kneeling.

Results and discussion

The results are summarized in Table 1. In the baseline trials both before and after the training the performance of the dogs did not differ from chance ($t_4 = -0.9$, $P > 0.05$ and $t_4 = -1.6$, $P > 0.05$ respectively). Although all dogs were treated in the same way and the order of learning was also fixed it is useful to present an analysis for both groups and individuals (for individual significance levels see Table 1). We assume that if the performance for the first 15 trials did not differ from the baseline the dog had to learn the given cue. However, if performance was significantly better than baseline during the first 15 trials, this could be because: (1) the dog had already learnt the signal during its interactions with humans, or (2) the dog generalized from its previous experiences (or learning during the experiment).

It is clear that all dogs but one were familiar with pointing, since their performance was over the baseline in the first 15 trials. This was also confirmed at group level for both the first and last 15 trials (two-tailed $t_4 = 8.82$, $P < 0.01$; $t_4 = 9.39$, $P < 0.01$). Most dogs responded above baseline level to the bowing cue both in the first and the last trials ($t_4 = 7.7$, $P < 0.01$; $t_4 = 11.9$, $P < 0.01$), but there were individual differences since three out of five dogs probably learnt this gesture during the training. Nodding was the first gesture for which the performance of dogs (at

Table 1 The performance of assistant dogs in the cuing task with a familiar experimenter. The first 15 and last 15 trials of the training are compared. For control 1 and control 2 the percentage of “correct” choices is given (*tot n* the total number of trials completed by a dog

with the gesture in question). Note that since the performance of individual dogs is compared with their own baseline their significance level might differ even if the actual percentile performance is at the same level (* $P < 0.05$, chi-squared test)

	Control 1 Pointing <i>n</i> = 10				Bowling				Nodding				Head-turning				Glancing				Control 2 <i>n</i> = 10
	Tot	<i>n</i>	1st 15	2nd 15	Tot	<i>n</i>	1st 15	2nd 15	Tot	<i>n</i>	1st 15	2nd 15	Tot	<i>n</i>	1st 15	2nd 15	Tot	<i>n</i>	1st 15	2nd 15	
Campo	70	30	93*	100*	30	80	93	30	60	87	60	60	80	50	53	87	60				
Spicky	30	30	100*	80*	50	60	80*	30	67*	87*	70	73*	73*	–	–	–	30				
Sam	40	30	70*	80*	80	67*	80*	80	47	93*	60	40	60	–	–	–	30				
Mandy	40	30	100*	100*	30	73*	100*	30	80*	87*	40	33	93*	60	67*	87*	30				
Delta	40	30	90*	80*	50	80*	93*	50	100*	90*	50	73*	87*	–	–	–	50				

the group level) did not differ from the baseline during the first 15 trials ($t_4 = 2.7$, $P > 0.05$); however, the group performed well above the baseline at the end of training ($t_4 = 39.0$, $P < 0.01$). Three out of five dogs had to learn to find the reward that was indicated by the direction of nodding. Again, this gesture was not difficult for most of the dogs to learn. More interestingly, initially all dogs performed near to baseline when head-turning was used as a directional cue ($t_4 = 1.66$, $P > 0.05$) but this improved in the course of training ($t_4 = 6.38$, $P < 0.01$). Nevertheless only three out of five dogs reliably learnt the significance of this gesture. Only three dogs were trained to respond correctly to head-turning with the experimenter kneeling, and only one of them showed a performance significantly different from chance at the end of the training. However, Mandy subsequently learnt to find the reward on the basis of directional glancing. In sum, these results show that dogs can use most of the gestures that were presented to monkeys (Anderson et al. 1995; Itakura and Anderson 1996), apes and humans (Itakura and Tanaka 1998) as directional cues. However their performance in this task was more similar to that of the apes (and humans) than to that of monkeys. Their performance in baseline trials also showed that dogs did not utilize odour cues during training.

Experiment 2a

This experiment was designed to extend the results of the previous experiment to adult pet dogs which had lived for a long time in human families (Budapest, Hungary) and had not previously received explicit training. This series of experiments originally started with ten dogs. However, for various reasons (mainly because the owner could not cooperate any longer), four dogs could not be trained on all gestures. Here we report only the results of the six dogs that completed the training.

Subjects

A male Kerry blue terrier (Figura, aged 5 years), a female labrador retriever (Becky, aged 3 years), a male West Highland white terrier (Franky, aged 1.5 years), a female English setter (Tracy, aged 5.5 years), a female Belgian shepherd (Astor, aged 7.5 years) and a female Hovawart (Cleo, aged 4.5 years) participated in this study. They all lived in human families, and had been obtained as puppies at the age of 2 months with exception of Becky who joined the family at the age of 1.5 years. The owners of the dogs were young or middle-aged women (aged between 22 and 39 years).

Procedure

Two people (the experimenter and the owner) were present during the trials, which took place in the living room

of the owner's home. The experimenter met each dog before the start of the experiments and was considered to be familiar to the subjects. The furniture in the room was rearranged to provide a space sufficiently large to conduct the trials and provide a place to keep the dog so that baiting was hidden from it.

In both baseline and training trials the owner showed the cues to her own dog. The experimenter explained and demonstrated to the owner the cues to be presented. The owner practised the gestures prior to the experiment and her actions were corrected if necessary. The order of both cues and baiting as well as the owner's general behaviour were always directed by the experimenter. Training sessions were videotaped for later evaluation. If necessary, the dog was handled by the experimenter. He/she led the dog behind folding screens (or other obstacle) during baiting and if necessary restrained it while the owner presented the cue. Otherwise the procedure was the same as described earlier.

Results and discussion

In the baseline trials that preceded and followed training the dogs performed at chance level (two-tailed $t_5 = 1.58$, $P > 0.05$; $t_5 = -0.5$, $P > 0.05$, respectively). The analysis of the group data showed that in the first 15 trials dogs responded to pointing ($t_5 = 10.28$, $P < 0.01$), bowing ($t_5 = 16.66$, $P < 0.01$), nodding ($t_5 = 7.32$, $P < 0.01$) and head-turning ($t_5 = 7.32$, $P < 0.01$) significantly above baseline. In contrast, the dogs' performance in response to glancing did not differ from the baseline in the first 15 trials ($t_5 = 0.38$, $P > 0.05$) but improved to significantly above baseline in the course of the training ($t_5 = 4.6$, $P < 0.01$).

The individual analysis however offers a more detailed perspective. With only a few exceptions (Cleo: pointing, first 15 trials; Franky: nodding, first 15 trials) the performance of all dogs was significantly above chance for pointing, bowing and nodding in both the first and the last 15 trials (Table 2). This uniform result suggests that these gestures are often used in human families and dogs might have known their significance.

Three of the six dogs performed at around baseline level when the head-turning cue was introduced. A comparison of the first 15 trials of nodding with the first 15 trials of head-turning revealed that as a group the dogs' performance was significantly weaker in the case of the latter (Wilcoxon test: $z = -2.2$, $P = 0.03$). Interestingly, a similar pattern was observed in experiment 1. However, all dogs improved their performance significantly during the trials, and eventually reached the criterion level, when head-turning was the cue.

At least four out of six dogs performed significantly over their baseline at the end of the training in the case of glancing, but the results also show that all dogs but one were also learning this cue during the experiment. Franky was the only dog that did not reach the criterion with this cue and his training on glancing was terminated after 140 trials.

Table 2 The performance of family dogs in the cuing task with the owner. The first 15 and last 15 trials are compared. For control 1 and control 2 the percentage of “correct” choices are given (tot *n* the total number of trials completed by the a dog with the gesture

in question). Note that since the performance of individual dogs is compared with their own baseline the significance level might differ even if the actual percentile performance is at the same level (**P* < 0.05, chi-squared test)

	Control 1 Pointing <i>n</i> = 10				Bowling				Nodding				Head-turning				Glancing				Control 2 <i>n</i> = 10	
	Tot <i>n</i>	1st 15	2nd 15		Tot <i>n</i>	1st 15	2nd 15		Tot <i>n</i>	1st 15	2nd 15		Tot <i>n</i>	1st 15	2nd 15		Tot <i>n</i>	1st 15	2nd 15			
Astor	70	30	80*	93*	30	100*	73*	30	80*	80*	42	73*	87*	90	87*	73*	20					
Becky	60	40	100*	100*	30	100*	100*	30	90*	80	60	73	100*	70	67	87	60					
Cleo	50	32	80	83*	32	87*	93*	32	100*	100*	64	53	93*	72	47	87*	60					
Figura	60	30	100*	100*	30	100*	100*	30	100*	80*	30	80*	80*	80	33	80*	40					
Franky	40	30	100*	90*	40	87*	87*	40	67	80*	140	60	80*	140	60	50	60					
Tracy	60	30	100*	100*	30	100*	100*	40	93*	93*	40	87*	100*	60	27	87*	40					

Table 3 The performance of family dogs in response to cues presented by a familiar experimenter (number of trials = 10, **P* < 0.05, binomial test)

	Pointing	Bowling	Nodding	Head-turning	Glancing
Astor	100*	90*	80*	–	80*
Becky	100*	100*	100*	100*	70
Cleo	100*	100*	90*	90*	80*
Figura	100*	100*	100*	80*	80*
Franky	80*	90*	80*	70	–
Tracy	100*	100*	90*	80*	80*

In sum, these results supported the previous observation that dogs can learn to use human-given cues to locate hidden rewards and that their performance is not based on locating odour cues. Some of these gestures are apparently used by humans in the everyday life often enough that dogs learn to attend to them as they grow up. Head-turning and glancing, however, had to be learned by most the dogs during the experiment.

Experiment 2b

Even if the dogs showed high performance, it is still possible that they were responding to cues from their respective owners that were not our pre-specified cues. However, if the dog responds correctly only to the cues of the familiar experimenter then the chance that it is responding to a cue other than the one that was originally presented is minimal. Therefore, after experiment 2a the roles of the owner and experimenter were swapped, so that the experimenter presented the gestures to the dog.

Procedure

The procedure was similar to those used in experiment 2a. Ten trials per gesture (pointing, bowling, nodding, head-turning, glancing) were presented by the experimenter in the same order as previously. This experiment was completed in two visits to the owner’s home. (For technical reasons trials with head-turning gestures are missing for Astor. Since Franky had not learnt glancing as a cue, no trials with this gesture had been staged for him.)

Results and discussion

At group level dogs responded to all gestures of the experimenter significantly above chance (pointing: $t_5 = 14.0$, $P < 0.01$; bowling: $t_5 = 22.14$, $P < 0.01$; nodding: $t_5 = 10.95$, $P < 0.01$; head-turning $t_4 = 6.6$, $P < 0.01$; glancing: $t_4 = 14.0$, $P < 0.01$). Because of the small number of trials the results for individual dogs were analysed with the binomial test (Table 3). The results indicate clearly that most dogs performed at a similar level in response to the cues delivered by the experimenter and those given by their owner. This suggests that during training they had learnt to respond to the gesture that we defined previously.

General discussion

In three experiments we have shown that the domestic dog is able to use various directional gestures of humans to find hidden reward. The baseline trials of experiments 1 and 2a also established that dogs did not use odours from the baited container as a discriminative stimulus since their performance never differed from chance if there was no gesture shown.

Apart from obvious breed differences, several explanations can be put forward to deal with the small discrepancy between assistant dogs and family dogs. Family dogs were generally older than assistant dogs, and it is interesting to note that the only family dog that did not learn the significance of glancing (Franky) was also the youngest. Age might be an important factor if any kind of attention is needed on the part of the dog. Moreover, while family dogs were cued by their owner, assistant dogs were faced

with the gestures of a familiar person with whom they had only limited experience. However the change in the person giving the cues had only a limited effect on the performance of the family dogs.

The main question is whether this cuing procedure, used by us and other investigators, should be regarded as an asocial discriminative learning situation where the subject forms an association between a cue and the place of reward, or whether this is a communicatory situation where subjects might learn about the meaning of the cue. In the latter case this particular learning performance would be supported by extensive experience gained through earlier communicatory interactions with companions.

The first possibility was considered by Anderson et al. (1995; but see also Itakura and Anderson 1996), who pointed out that the failure of rhesus monkeys to learn some of the cues could be attributed to the relatively large distance between the cue and the reward. Carefully designed learning experiments revealed that rhesus monkeys and chimpanzees show slower learning rates if the cue is separated from the site of reward by 15–20 cm (Jenkins 1943; Murphy and Miller 1955; Miller and Murphy 1964). However, for example, chimpanzees readily learn to attend to human pointing when the distance between the tip of the finger and the “reward” is usually over 20 cm (e.g. Povinelli et al. 1990). In the present experiments the tip of the index finger was at least 50–60 cm away from the pot during pointing, and in the case of the other gestures this distance was even greater. Moreover, in our case, in contrast to all other previous studies, the cue was no longer being presented when the dog began its approach to one of the baited containers, and therefore the gestural cue could not be used as a discriminative stimulus during approach.

It is more likely, however, that the dogs perceived the cues as communicatory signals emitted by the human, and that learning of some of the new signals was based on their species-specific abilities to perceive and send signals, as well as on their previous experience of interactions with companions. In this regard it is important to note that we did not present the gesture until eye contact occurred. Under natural conditions eye contact is a frequently used communicatory signal between dogs and humans (owners). Therefore we would like to argue that the experimental situation is more similar to a special case of visual communication aimed at showing someone the location of for instance, food (see also Gomez 1996).

For effective communication to occur there is a need for accurate collaboration between sender and receiver. Particularly in the case of communication via visual signals, it is important that the sender is somehow aware of the presence or attention of the receiver. In our experiments, similarly to those described by Itakura and Anderson (1996) and Itakura and Tanaka (1998), the owner or experimenter always waited for eye contact to occur before presenting a gesture. Similarly, the receiver must also be in a position to pick up the signal. Gestural signals usually have a very short duration, putting the re-

ceivers under pressure to show good observational abilities. Monkeys, apes (e.g. Andrew 1962; van Hooff 1962; Weigel 1979; Maestripietri 1996), dogs (Bolwig 1964; Fox 1970) and wolves (*Canis lupus*; Schenkel 1947) are reported to show several facial gestures to which conspecifics respond. In the case of the wolf it is suggested that during dyadic confrontation companions monitor each others' head gestures carefully, and the typically yellow eye is a communicatory adaptation for determination of the affective state of the other (Ginsburg 1976). Despite the different facial musculature of dogs and monkeys both Bolwig (1964) and Fox (1970) pointed to parallels in facial gestures of canids and primates. Furthermore, Fox (1970) suggested that highly social species of both orders should display a sophisticated level of gestural communication. One might hypothesize that under appropriate conditions these species would also gain an evolutionary advantage from perceiving and learning interspecific gestural signals.

From the results of these experiments it is very clear that most dogs had already learnt the meaning of the pointing gesture. Although there are no experimental data, in a preliminary study we also found that most pet dogs know the significance of human pointing. This ability develops in human infants by approximately 9 months (Lempers 1976; cited in Leung and Rheingold 1981), and apes with extensive human contact seem to learn to attend to this gesture spontaneously (Itakura and Tanaka 1998). There are no reports on whether monkeys spontaneously respond to human pointing, but after formal training in pointing (“reaching” their arm), they can learn the meaning of this gesture (Blaschke and Ettlinger 1987; Povinelli et al. 1991).

There is also some evidence that the comprehension and the production of pointing might be coupled together at some cognitive level. Only after having mastered pointing were monkeys able to comprehend this gesture when it was used by the experimenter (Blaschke and Ettlinger 1987). However, with regard to the natural behaviour of the species, pointing seems to be specific to humans. It is suggested that in apes (Menzel 1973) and monkeys (Sigg and Stolba 1981) interest in a particular spatial direction is signalled by the orientation of the whole body. Similar behaviour has also been observed in wolves by Mech (1970, p. 197), and possibly the pointing behaviour in some breeds of gun dogs relates to the orientation behaviour of the wolf ancestor. Although the exact level of comprehension of human pointing needs to be further investigated in dogs, it is a possibility that the natural tendency towards pointing behaviour in wolves and their relatives has enhanced their ability to utilize this human signal.

The seemingly superior performance of dogs compared to monkeys could be explained by differences in interspecific relations (human-monkey versus human-dog) or in learning abilities. Many observations suggest that monkeys reared under standard laboratory conditions are unsuitable for testing interspecific communication (with humans). Monkeys do not typically look into the faces of humans, partly because direct gazing is a threatening signal for them (Redican 1975), which they avoid by looking

away. (Similarly, wolves avoid direct eye contact with conspecifics: Fox 1970.) Compared to chimpanzees, monkeys [e.g. capuchin monkey, squirrel monkey (*Saimiri sciureus*), rhesus monkey, tonkean macaque (*Macaca tonkeana*)] are also less interested in interacting with a human experimenter if they have a choice (Itakura 1996). Only rhesus monkeys reared from birth isolated from conspecifics (during the first month of life) preferred humans to monkeys at the age of 2–3 years (Sackett et al. 1965). Furthermore, Emery et al. (1997) showed that rhesus monkeys display gaze-following if the “animal” to be observed is a video image of a conspecific. All this could mean that if monkeys and apes are tested in an interspecific context the inferior performance of the former should not necessarily be attributed to their limited cognitive abilities. In contrast, many dogs spend most of their lives in or around human families and therefore humans are part of their natural environment (Messent and Serpell 1981; Barker and Barker 1988). During their development they form strong attachments to humans that are apparently less influenced by their contact with other conspecifics than it is the case in the rhesus monkey (see above). (Freedman et al. 1961; Niebuhr et al. 1980; Scott 1992).

A second possibility is that the better performance of dogs is related to their superior ability to attend arbitrary cuing. As mentioned earlier Frank (1980) suggested that domestication of dogs has favoured sensitivity to a wide range of stimuli. The ability of dogs to respond to a broad range of both visual and acoustic human communicative signals is widely utilized in working dogs (e.g. McConell and Baylis 1975). This could be contrasted with the ability of monkeys reared (“tamed”) in the laboratory which might be more constrained in selecting arbitrary cues from their environment during learning. In sum, probably better results will be obtained from testing the cognitive and communicative abilities of dogs in an interspecific context than from testing monkeys.

It is also clear that, in contrast to pointing, bowing and nodding, most dogs learnt to use head-turning and glancing as cues during the experiment. This might be because humans use the former gestures more often in their interactions with dogs. Moreover, whilst pointing, bowing and nodding gestures displayed an overt attention of the human to the correct pot, the experimenter did not pay attention to the pot during head-turning and glancing; he/she only indicated the direction horizontally. This distinction suggests that the recognition of the direction of human attention might have helped the dogs in directing their choice. The attention of the trainer was found to be an important aspect of vocal learning in parrots (Pepperberg and McLaughlin 1996) and a similar argument could hold for interactions between dogs and humans.

With one exception, none of the dogs could use glancing as a cue for finding the reward at the beginning of the learning trials. However, in contrast to rhesus monkeys (Anderson et al. 1996), capuchins (Anderson et al. 1995; Itakura and Anderson 1996), and similarly to apes and humans (Itakura and Tanaka 1998), dogs were able to learn the significance of glancing. It should also be pointed out

that social species evolve specific mechanisms which tend to make them look where companions are looking, using gaze and/or body pointing as cue (see also Povinelli and Eddy, in press). The next step would be to show whether in dogs this ability is coupled with some understanding of the attention and/or mental states of others.

In sum, with the exception of the apes, only the dog has so far been found to be able to comprehend subtle movements of the human eye as a communicatory signals. At present, we do not know how some dogs might come to learn the significance of eye movements under natural conditions. Certainly, this ability is necessary for understanding some aspects of human attention (or in other cases the attention of conspecifics), but whether dogs are able to comprehend the attention of others has yet to be shown experimentally.

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