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Intentional behaviour in dog-human communication: an experimental analysis of "showing" behaviour in the dog

Abstract Despite earlier scepticism there is now evidence for simple forms of intentional and functionally referential communication in many animal species. Here we investigate whether dogs engage in functional referential communication with their owners. "Showing" is defined as a communicative action consisting of both a directional component related to an external target and an attention-getting component that directs the attention of the perceiver to the informer or sender. In our experimental situation dogs witness the hiding of a piece of food (or a favourite toy) which they cannot get access to. We asked whether dogs would engage in "showing" in the presence of their owner. To control for the motivational effects of both the owner and the food on the dogs' behaviour, control observations were also staged where only the food (or the toy) or the owner was present. Dogs' gazing frequency at both the food (toy) and the owner was greater when only one of these was present. In other words, dogs looked more frequently at their owner when the food (toy) was present, and they looked more at the location of the food (toy) when the owner was present. When both the food (toy) and the owner were present a new behaviour, "gaze alternation", emerged which was defined as changing the direction of the gaze from the location of the food (toy) to looking at the owner (or vice versa) within 2 s. Vocalisations that occurred in this phase were always associated with gazing at the owner or the location of the food. This behaviour, which was specific to this situation, has also been described in chimpanzees, a gorilla and humans, and has often been interpreted as a form of functionally referential communication. Based on our observations we argue that dogs might be able to engage in functionally referential communication with their owner, and their behaviour could be described as a form of "showing". The contribution of domestication and individual learning to the well-developed communicative skills in dogs is discussed and will be the subject of further studies.

Key words Intentional communication · Dog-human interaction · Gaze alternation · Directional signals · Dogs

Introduction

One of the most intriguing problems of animal communication is the question of communication about external events. One may start off with the null hypothesis that since animals are generally exposed to the same environmental information, there is no need for individuals to obtain information about external events from others. However, early observations and experiments have clearly shown that this is not the case. For example, the famous experiments by von Frisch (1967) on the communication system in bees showed that worker bees in the hive rely on the information about the food source presented to them by the foragers ("bee dance").

To date we know that in many species across a variety of genera individuals are able to communicate about external events to their conspecifics. For instance, in many social species individuals are able to inform group members about a predator by giving alarm calls. Vervet monkeys (*Cercopithecus aethiops*) use distinctive calls to signal the approach of different categories of predators, such as eagles, leopards or snakes (Struhsaker 1967; Cheney and Seyfarth 1990). Gallinaceous birds have been reported to give a distinctive type of call ("food call") upon discovery of food. The function of this call is to provide food for the young and also, in the case of calling males, to attract females. In a series of experiments Evans and Marler (1994) showed that these latter calls are not simple courtship signals, and they refer to the food discovered.

Marler et al. (1992) suggested that most communicative signals consist of both motivational and referential components (see also Hauser 1996), and they assume that functionally referential signals relate to a special category

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of external events and are relatively independent from the motivational state of the signaller.

It has only been recently recognized (see Evans 1997; Macedonia and Evans 1993) that there are many possibilities for categorizing external events. Such a category might refer to particular objects (e.g. predators), or actions to be taken (e.g. "run to the burrow"). But a signal can also be regarded as referential if it refers to a category of objects that occupy in particular place in space, i.e. directional signals. In this sense the bee dance contains referential information about the objects (flowers) that can be found at the place indicated by the dancer.

One might note however that in many cases informants are passive producers of the signals in the sense that they do not seem to take into account whether the signals have been perceived by the bystanders once they have been emitted by the signaller. In the case of acoustic signals no such "care" might be necessary; however, in other situations (e.g. visual signals) it would be in the signaller's interest to ensure that its signals are received. In descriptive terms "active" information transfer by the informant could be defined in short as an example of "showing". An individual engaged in showing displays directional signal(s) related to the external event of importance in concordance with signal(s) that direct the attention of the receiver(s) upon that individual.

At present there is only a limited amount of information on whether animals are able to show complex behaviours such as showing. Based on the experiments of Köhler (1926), Gómez (1990) developed a test where an animal is faced with a problem-solving situation, but here the subject is offered the possibility of soliciting the assistance of a human who is also present. In his experiments Gómez observed how a young gorilla (*Gorilla gorilla*) manipulated the human to achieve her goal. Over the course of observations the gorilla changed behaviour strategies to accomplish her aims. At 9–12 months the gorilla tried physically to manipulate the body of the person; later (at 12–15 months) it gently led the human to the goal, and finally (at 18–21 months) it incorporated an additional strategy of gaze alternation, presumably to direct the attention of the person to the goal. Gaze alternation can be also interpreted as the gorilla trying to ensure that the human is attending to it, and by doing this, the person has a greater chance to perceive the signal of the sender. In humans gaze alternation seems to fulfil the requirement of active information transfer (showing) since looking at the other (or in a more dynamic way: trying to establish eye contact) increases the chances of attention contact occurring (Bates 1976; Gómez 1996b), which is subsequently followed by the signal to be transmitted, i.e. looking towards the target. Similarly, looking towards the target can be followed by looking towards the observer to check whether he was attending to the informant during signal production. [This discussion assumes that the observer has the ability to understand the meaning of the signal, and in the present case, it must be able to follow the line of sight (or the line of pointing) of the informant]. In humans such abilities are well-developed, and emerge even in infants (e.g. Butterworth and Jarrett 1991; Tomasello 1994; but see also Butterworth and Itakura 2000); however the exact nature of similar abilities in non-human animals is still a matter of debate (e.g. Povinelli and Eddy 1996; Povinelli et al. 1997). For example, it has been suggested that in monkeys gaze alternation between an attacker and an ally might communicate the identity of the attacker to the ally, but alternatively this behaviour might simply suggest that the subject is tracking the positions of both group mates (Noe 1992; Gouzoules et al. 1984).

This study was designed to extend our understanding of showing behaviour in animals by studying this phenomenon in the domestic dog (*Canis familiaris*). This study is part of an extended research effort to investigate cognitive abilities of dogs, a species that has been associated with humans for the last 50–100,000 years (Vila et al. 1997). It has been supposed that domestication might have led to behavioural analogies between humans and dogs (e.g. Topál et al. 1998).

Recently, in an experimental study Hare et al. (1998, Study 3) investigated whether a dog is able to inform a naive human about the location of hidden food. They found that on most sessions (81.5%) the dog successfully led a person to the food. Although the naive person was able to find the location of food by observing the bodily orientation of the dog only, the dog's frequent barking during the experimental sessions was interpreted as kind of attention-getting signal, suggesting that in certain situations dogs might display showing behaviour.

The main aim of this study was to investigate under what conditions showing behaviour emerges in dogs. In contrast to earlier experimental designs (e.g. Gómez 1996b), the dogs were observed under different experimental conditions where the presence of the human and/or the hidden food was manipulated systematically. This was because we wanted to distinguish possible motivational and referential components of the signal(s) (see also Marler et al. 1992). Signalling behaviour could be elicited purely on motivational bases by the presence of the food. In contrast, if the dog displays showing and attention-getting behaviours, their emergence should correlate with the presence of the human. Moreover, in the case of showing behaviour, functionally referential signalling and attention-getting behaviours should occur closely associated in time to be able to elicit the desired actions on the part of the observer.

Methods

Subjects

Four male and six female dogs (two Hungarian vizslas, and one poodle, one Kerry blue terrier, one West Highland terrier, one Hovawart, one Tervueren, and a mongrel) took part in this study, on the basis of their availability and their owner's willingness to cooperate in the experiment. The ages of the dogs ranged from 2–7 years. All owners were females aged between 19 and 37 years. Dogs were recruited among the participants of our Family Dog Research Program, provided that the dog was keen on food (or on playing with a small toy), and it was allowed to receive and consume food anywhere in the owner's flat.

Procedure

All observations took place in one room of the owner's flat. Owners were provided with three small, identical feeding bowls (brown, 12 cm in diameter). For 3 days prior to the observations dogs had been fed food from these bowls to familiarize them with this new object (or their toy was placed into one of these bowls before being retrieved for play). Three persons were involved: the owner of the dog, a familiar person (the hider, usually a member of the family) and the experimenter (R.P.). According to the protocol, the owner and the hider had to enter and leave the room at given times; the experimenter, however, did not enter the room during the recordings. Her job was to supervise the movements and actions of the human participants by signalling and controlling their entries and exits.

The experiment consisted of three conditions (indicated by capital letters, A, B, C) and each condition was divided into three sessions (indicated by arabic numbers). A detailed description of the conditions was given to the owners and it was thoroughly discussed with them to avoid any misunderstandings. The observations were conducted on two consecutive days, and the order of the conditions was chosen at random for each pair. Before the start of the conditions the three bowls were placed at approx. 1.5 m or higher somewhere in the room (e.g. on bookshelves) with the limitation that they had to be within the visual angle of the video camera. The experimenter also checked visually that the dog could not see the contents of the bowl, and before the start of the observations she hid a small piece of food behind each bowl to avoid confounding effects of odours. Each condition started when the experimenter began the video-recording and left the room, leaving behind the dog and the owner.

A. "Petting" condition. This condition controls for the general effects of the presence of the owner, and also provides a "baseline" measure for any signalling activity in the absence of a desired object (food or toy).

   1. Dog and owner are in the room. The owner sits and reads for 1 min, then leaves the room.
   2. Hider enters and gently pets the dog for 30 s and then leaves the room.
   3. Owner enters, sits down and reads for 1 min before leaving again (Here and in all other sessions the owners were specifically instructed to ignore the dog since we tried to avoid any unintentional human influence on the emergence of signalling, see also discussion).

B. "Dog-alone" condition. Here we control for the effects of presence of the hidden food. Signalling behaviour that emerges when the dog is left alone should be attributable to the motivational effects of food on behaviour.

   1. Dog and owner are in the room. The owner sits and reads for 1 min, and then leaves the room.
   2. Hider enters with food (or a toy), and shows it to the dog (it is allowed to have a "sniff" at the food). After that, the hider takes one bowl (the experimenter had told the hider which one to choose just before she entered the room), shows it to the dog, puts the food (toy) in the bowl, and places it back in its original position. Finally, she leaves the room.
   3. The dog is alone in the room for 1 min. The owner and the hider enter the room, and the hider gives the contents of the bowl to the dog.

C. "Hiding" condition. This condition allows investigation of the dog's signalling behaviour in the presence of both the desired object (food or toy) and the owner.

   1. Dog and owner are in the room. The owner sits and reads for 1 min, then leaves the room.
   2. Hider enters with food (or a toy) and shows it to the dog (it is allowed to have a sniff). Then she takes one bowl (the experimenter told the hider which one to choose just before she entered the room, so the owner was never aware of where the food had been hidden), shows it to the dog, puts the food (toy) in the bowl, and places it back in its original place. Finally, she leaves the room.
   3. Owner enters the room, sits down and reads for 1 min. At the end of this session the owner stands up and gives the food to the dog provided she has found out where the food was hidden.

Behavioural observations

The behaviour of the dog was analysed in sessions 1 and 3 for all conditions by defining both non-overlapping (mutually exclusive) and overlapping behaviour units:

1. Non-overlapping behaviour units (the type of measurement used is indicated in parentheses):
   A. "Passive behaviour". The dog either stands or lies anywhere in the room (relative duration).
   B. "Walking". The dog moves around in the room (relative duration).
   C. "Standing at the door". The dog stands or lays within one body length to the exit (door) of the room (relative duration).

2. Overlapping behaviour units:
   A. "Mouth licking". The dog sticks out its lips and/or licks its mouth (frequency).
   B. "Vocalisation". Any vocalisations (e.g. barking, whining) given by the dog (frequency). Vocalisations directed at the owner, door or location of food were noted separately.
   C. "Bowl-sniffing". Sniffing in the direction of the bowl where the food was to be hidden (petting condition, see below) or was actually hidden (dog-alone condition; hiding condition) (relative duration). Sniffing was recognized as the dog audibly inhaled air through its nose that was associated with a characteristic body posture.
   D. "Tail-wagging". Any form and frequency of tail-wagging (frequency of tail-wagging bouts).

Furthermore, the direction of gazing was recorded on the basis of the head orientation of the dog. The frequency of gazing toward five distinctive locations in the room was observed: (1) gazing at the owner (or at the owner's location in the dog-alone condition); (2) gazing at the door; (3) gazing into the camera (to control for "baseline gazing" at an arbitrary point in space); (4) gazing at the location of the food (or a randomly chosen bowl in the petting condition; and (5) gazing at the location of an empty bowl (to control for baseline gazing at any bowl).

For all conditions gazes in session 3 were also subjected to a sequential analysis. By our definition a gazing sequence (gaze alternation) consisting of two gazing units occurred if gazing at the owner was followed directly by a gaze at the bowl containing the food within 2 seconds or vice versa (see also Russell at al. 1997).

The behavioural observations were done by R. P., but for the analysis of the gazing sequences, an observer who was naive with regard to the aims of the experiment repeated the coding. She was presented only with the recordings of sessions 3, and thus she was also unaware of the location(s) where the food (or the toy) had been hidden. Their inter-observer agreement yield a kappa value of 0.78, therefore the observations of R. P. were used for further analysis.

Statistical analysis

Despite all our efforts, the duration of the experimental sessions varied, so raw data were converted into relative durations and frequencies. Within a condition the change in behaviour was analysed by comparing the behaviour of dogs in sessions 1 and 3 (Wilcoxon signed-rank test), between condition analysis was based on Mann-Whitney U-test. We also compared the number of dogs displaying any (yes or no) sniffing, mouth licking and vocalisation in sessions 1 and 3 (McNemar's test). The evaluation of sequential data of gazing was based on calculating Yule's Q (Bakeman and Quera 1986), and subsequently the probability of positive values being higher than expected by chance was assessed by sign test (for a similar approach see Russell et al. 1997).
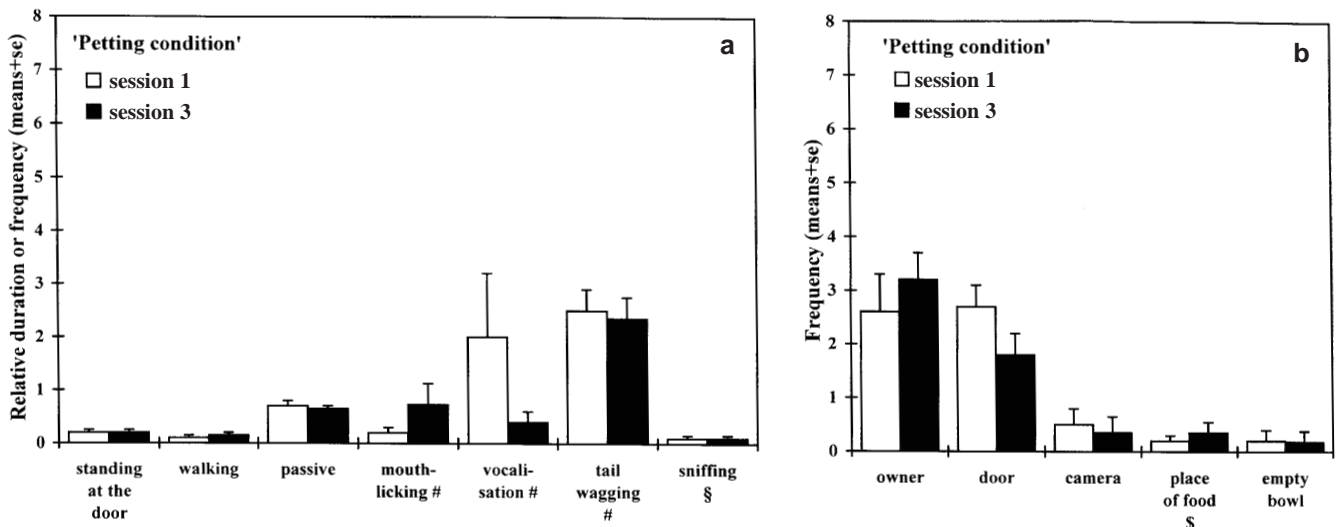
Fig. 1 The behavioural profile of the dogs in the "petting" condition (A), before (*session 1*) and after (*session 3*) the petting interaction with a familiar person. **a** Non-overlapping and overlapping behaviour units (relative durations or frequencies). **b** Frequencies of gazing (# frequency measures were used, § the actual values for sniffing were multiplied by 10, $ there was no food in the bowl)

Results

Within-condition analyses

The comparison of sessions 1 and 3 within conditions is intended to detect the effects of the manipulations during session 2, and whether the conditions in session 3 promote change in the behaviour of the dogs.

Fig. 2 The behavioural profile of the dogs in the "dog-alone" condition (B), before (*session 1*) and after (*session 3*) the petting interaction with a familiar person. **a** Non-overlapping and overlapping behaviour units (relative durations or frequencies). **b** Frequencies of gazing (# frequency measures were used, § the actual values for sniffing were multiplied by 10, $ the owner was not in the room during session 3). *Significant difference between sessions 1 and 3 (Wilcoxon test, $P < 0.05$)

In the petting condition (A) the only difference between sessions 1 and 3 was that the later was preceded by the dog's interaction (petting) with a familiar person. This condition was staged to control for any effects of the involvement of the familiar person on the dog's behaviour in session 3. The results show that there was no change in the behaviour of the dogs (Fig. 1). No significant increase or decrease was detected in any of the non-overlapping behaviour units (walking, passive behaviour, standing at the door) and the overlapping behaviour units (mouth licking, vocalisation, tail-wagging, sniffing, all gazing). In the case of mouth licking there appears to be a difference, but this was not significant and was due to only three dogs that showed an elevated frequency of mouth licking. In summary, the petting of the dog and the presence of a familiar person in session 2 did not have any effect on subsequent behaviour of the dog.
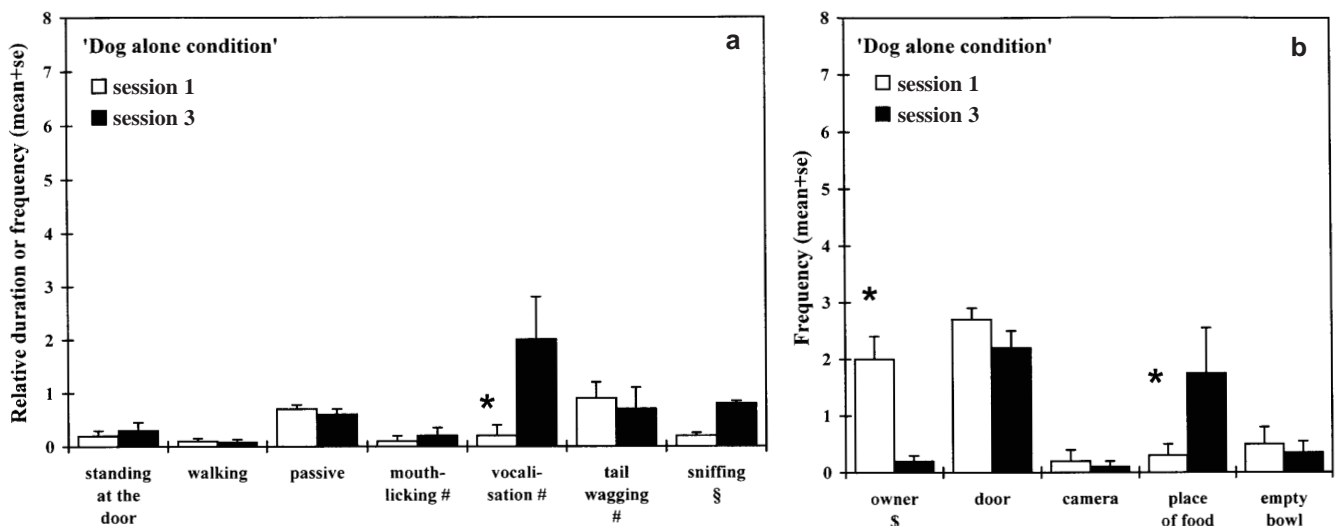
In the dog-alone condition (B) the familiar person hid a food item in the presence of the dog, however, in session 3 the dog was left alone in the room. The comparison of sessions 1 and 3 was aimed to show whether the presence of food alters the dog's behaviour (Fig. 2). We found that there was a significant increase in the frequency of vocalisations
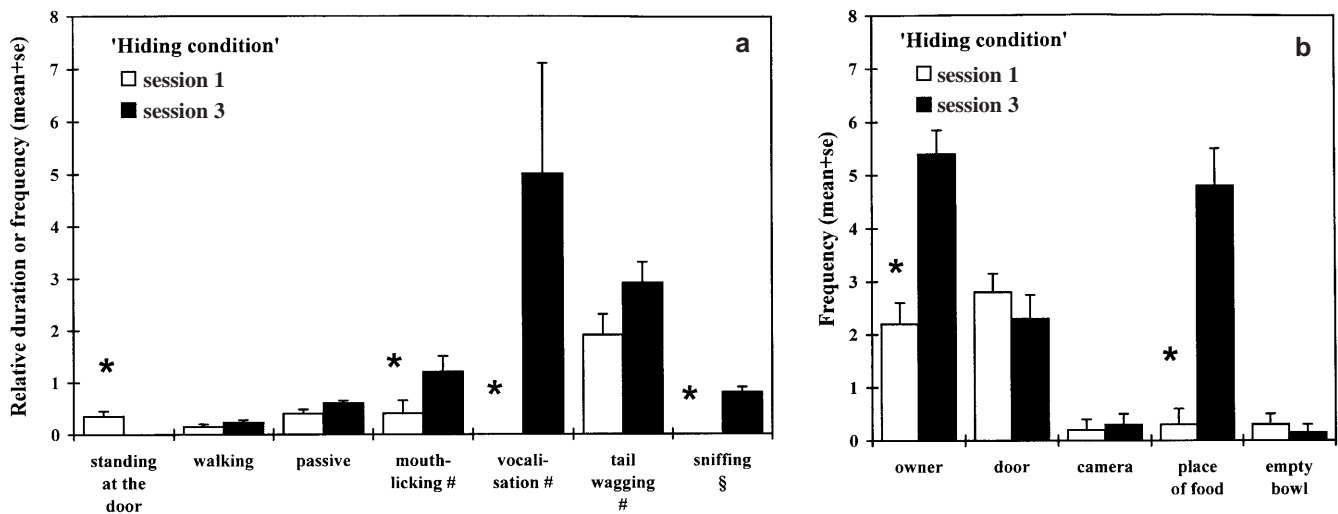
Fig. 3 The behavioural profile of the dogs in the "hiding" condition (C), before (*session 1*) and after (*session 3*) the petting interaction with a familiar person. **a** Non-overlapping and overlapping behaviour units (relative durations or frequencies). **b** Frequencies of gazing (# frequency measures were used, § the actual values for sniffing were multiplied by 10). *Significant difference between sessions 1 and 3 (Wilcoxon test, $P < 0.05$)

($n = 7$, $T = 2$, $P = 0.0425$), and all vocalisations were directed at the door. Dogs looked more in the direction of the bowl containing the hidden food ($n = 7$, $T = 2$, $P = 0.0425$). The frequency of looking towards where the owner had been declined significantly (the owner was not present: $n = 10$, $T = 0$, $P = 0.0051$). No other significant differences were found.

In hiding condition (C) we investigated whether the presence of both the owner and the food changed the behaviour of the dogs (Fig. 3). Comparison of sessions 1 and 3 showed that there was a significant decrease in relative duration of standing at the door ($n = 6$, $T = 0$, $P = 0.027$). However, dogs increased their gazing frequency significantly, both in the direction of their owner ($n = 10$, $T = 3$, $P = 0.0125$) and the bowl containing the hidden food ($n = 10$, $T = 0$, $P = 0.0051$). The relative duration of sniffing also increased significantly ($n = 6$, $T = 0$, $P = 0.027$), along with the frequency of mouth-licking ($n = 6$, $T = 0$, $P = 0.04$). More dogs sniffed and licked their mouth in session 3 than in session 1 (McNemar's test: $\chi^2 = 5$, $P = 0.05$; $\chi^2 = 6.25$, $P = 0.05$, respectively).

In the hiding condition half of the dogs vocalised in session 3, which was a significant change in comparison to session 1 since there all dogs remained silent ($\chi^2 = 7.2$, $P = 0.01$). All vocalisations in this phase occurred when the dogs were looking at the location of the hidden food, or at the owner. In other words vocalisations co-occurred with the gazings.

Between-condition analyses

The comparison of session 3 in the case of the petting condition and the hiding condition (the owner was present in both conditions) revealed that in the latter dogs gazed significantly more at the owner ($U = 19.5$, $n_1 = 10$, $n_2 = 10$, $P = 0.031$). Furthermore, dogs gazed more at the location of the food (toy) ($U = 16$, $n_1 = 10$, $n_2 = 10$, $P = 0.008$) if the owner is present in the hiding condition (session 3) than when they are alone (dog-alone condition, session 3). These comparisons suggest that instead of competition between the gazing directions, the presence of both targets increases the frequency of gazing toward both the owner and the food (toy).

The analysis of gaze alternation revealed that these sequences occurred only during the hiding condition when both the hidden food and the owner were present in the room. The mean length of gaze alternation sequences was 2.7 units (SE = 0.42), and on average, dogs initiated 3.0 (SE = 0.53) sequences of gaze alternation during the 1 min of session 3. Yule's Q-test was used to investigate whether the alternation between looks at the owner and at the bowl with food was greater than expected by chance given the total number of looks at the bowl and the owner. Separate analyses were conducted for looks at the owner followed by looks at the bowl and for looks at the bowl followed by looks at the owner. In the case of looks to the bowl followed by looks at the owner, Yule's Q was positive for eight out of ten dogs (sign test: $P = 0.055$), and for the opposite sequence it was positive for nine out of ten dogs (sign test: $P = 0.011$). Interestingly, in eight out of ten dogs gaze alternation started with looking first at the owner followed by a look to the bowl. These gazes were usually directed towards the entering owner, and were followed within 2 s by looks towards the location of the food. The analysis of latencies of gazing at the owner confirmed this observation. The comparison of latencies of looking at the owner in session 3 in the petting and hiding conditions (both conditions start with the owner entering) showed a significant decrease when there was food hidden in the room since dogs were faster to orient their head towards the owner ($U = 11$, $n_1 = 10$, $n_2 = 10$, $P = 0.012$).

Finally, it should be noted that at the end of the "hiding" episode all owners (ten out of ten, binomial test, $P = 0.001$) were able to localize correctly the location of the food.

Discussion

Our results show that dogs are able to communicate the location of hidden food to their owners, and this corroborates earlier similar findings by Hare et al. (1998). Thus purely from a functional point of view, this communicative behaviour leads the owner to the location of the food. For successful information transfer to occur dogs should be able to give the appropriate signals and owners should be able to "read" this message. Owners, perhaps not surprisingly, are very good at reading the communicative signals of their dog, therefore our main concern was to evaluate the behavioural strategies used by the dog in communicating. It should be noted that this study was not designed to test the dogs' ability to understand human attention but to examine their inclination to produce both attention-getting and directional signals.

Condition 1 confirmed that the mere interaction between the familiar person and the dog had no effect on the dog's subsequent behaviour. In both sessions dogs seemed to be interested in looking at the owner and the door, but they did not look at the bowls often.

In condition 2 we found that the presence of hidden food had only a small effect on the behaviour of the dog when it was left alone in the room. The increased vocalisations (directed at the door) indicated probably that dogs wanted to leave the room (see also Topál et al. 1998); the number of dogs that vocalized doubled in session 3 but this change was not significant. They looked less often at the location of the owner, which can be explained by the fact that the owner was not there. The presence of the hidden food increased their gazing at the bowl containing the food.

Most changes occurred in condition 3 when, in session 3, the food was hidden and the owner was present. Generally, dogs decreased the relative duration of staying at the door, suggesting that the presence of both food and owner in the room decreased their motivation to leave. More interestingly, both mouth licking and sniffing increased significantly in session 3. Since no such change was observed in condition 2 where the dog was left alone with food present, one could assume that emergence of these behaviours can be attributed to the joint presence of the owner and food. This might also indicate increased levels of motivation because they associate the arrival of the human with the retrieval of food.

Half of the dogs started to vocalize in session 3 which was also unique to this situation. In this session the gazing pattern of the dogs changed as well. They looked more frequently at both the owner and the baited bowl compared to session 1 (no food present). The increase in gazing at the food bowl can be explained more readily, since a similar increase was also observed when the dog was alone with the hidden food in the room in condition 2. However, an interesting question to answer is why the presence of the food should increase the frequency of looking at the owner. Moreover, not only the frequency of looking, but also its pattern of distribution in time changed in session 3 of condition 3. This was the only condition where we observed gaze alternation which was defined by the alternate looking from the baited bowl to the owner or vice versa. Finally, in many dogs we observed that vocalisation became an integral part of gazing behaviour, since sound production always co-occurred with gazing at the owner or the location of hidden food.

Before turning to the interpretation of showing behaviour three important issues should be dealt with. First, comparative research that borrows concepts from human psychology often faces difficulties when comparing the behaviour of different species where species-specific behavioural repertoire limits the possible behavioural actions. In our case dogs might use different behaviour actions in showing from apes or humans (e.g. in dogs gaze alternation and pointing behaviour are not independent of each other since dogs point by orienting their head and body). It should be also noted that our definition of showing differs in many respects from that introduced by Gómez (1996a, 1996b). This difference can be attributed to the fact that Gómez's explanation of showing and ostension relies heavily on concepts of human communication, and involves mental concepts whose role is still debatable with regard to animal communication, and further, it involves species specific behaviours observed mainly in humans, and partly in apes (e.g. pointing gesture). Second, we would like to stress that the owners were asked to behave passively since we wanted to see what kind of behavioural actions emerged in the dog. Therefore the situation was to some extent unnatural from the point of view of the dog, but this was necessary, since over-attentive owners could have prevented the unfolding of communicative signalling on the part of the dog. Third, it should be recognized that each owner-dog dyad might have developed a communication system consisting of unique and individualized signals. This process, also described as ontogenetic ritualization (see e.g. Tomasello et al. 1994; Tomasello and Call 1996), might play a very important part here, since it could mask general behaviour pattern(s) involved. For example, some owners discourage dogs from barking in the flat. In summary, in any dyad the actual communicative behavioural exchange described as "showing" could be a result of ontogenetic ritualization processes.

The first question is whether the behaviour of the dogs just described, amounts to a form of showing as defined above. We think that dogs use both attention-getting signals and directional signals. Both vocalizing and gazing at the owner could be used as attention-getting signals. Barking and whining (the types of vocalizations recorded most often) had been described as signals used for getting attention (Fox 1971; Bekoff 1974; Bradshaw and Nott 1995). It is also striking that the dogs looked at the owner much sooner if food was present in the room. Gazing at the baited bowl can be regarded as directional signal. Four pieces of evidence suggest that looking at the bowl was not a simple response to the mere presence of hidden food but was a communicative signal aimed at the owner. First, dogs looked more frequently at the baited location if the owner was present (compared to the situation when dogs were alone but the food was hidden). Second, looks at the

baited bowl were either preceded or followed by looks at the owner more often than in any other conditions. This gaze alternation was in most respects very similar to respective behaviours described by others in humans (Bates et al. 1975), chimpanzees (Russell et al. 1997; Tomasello et al. 1985) and a gorilla (Gómez 1996a). Third, dogs can easily learn that similar behaviour displayed by humans (gaze alternation between the dog and the location of hidden food) signals the location of hidden food (Miklósi et al. 1998; Hare and Tomasello 1998), i.e. dogs are able to react appropriately if showing behaviour is performed by the owner or other humans. Fourth, vocalising dogs (half of the dogs tested) always synchronized this attention-getting signal with their patterns of gazing, i.e. they vocalized only when looking either toward the owner or the location of hidden food.

In recent years researchers have developed a three-level model with increasing complexity for the interpretation of gaze alternation as a form of showing. First, "proto-imperative pointing" is defined as getting someone else to do something (Bates et al. 1975; Povinelli et al. 1997). It is supposed that the signaller is not about to influence the mental state of the receiver but only wants to produce instrumentally a change in the physical world (obtain the desired object). Second, gaze alternation may indicate an understanding of attention without the understanding of an accompanying internal mental state (Povinelli et al. 1997). Third, Gómez (1994) supposes that looking at the eyes of a person (or a conspecific) is a sign of attending to the receiver's attention, which could lead (not necessarily) to the representations of the mental state of the other. In contrast to earlier findings (Povinelli and Eddy 1996) recent experiments have demonstrated that chimpanzees might know what conspecifics do or do not see (Hare et al. 2000).

Gómez and his coworkers (reported in Gómez 1996b) showed that chimpanzees seem to understand something about the attention of the perceiver, since they called the attention of the humans in situations when he was inattentive. Our study was not designed to test for these possibilities, but Hare et al. (1998) found that two dogs seemed to take the position (forward- or backward-turning) of the owner into account when retrieving an object. In summary, dogs might show a similar level of understanding attention to that of the chimpanzee but further experiments are clearly necessary.

We have to stress that one should distinguish the description of a phenomenon at the behavioural level from the processes that lead to the manifestation of this behaviour. Accordingly, the interpretation of the dog's behaviour as showing does not exclude the involvement of associative processes in the establishment of this behaviour. For example, one could assume that since dogs spend most of their life in human families, there are many opportunities for learning such signals as operants. As we noted earlier most owners are keen to find out about their pet's "desires", which would provide good conditions for operant conditioning to take place. For example, upon smelling or observing inaccessible food a dog starts to sniff at it or lick its mouth, and the owner, realizing the change in the

dogs behaviour, supposes that it might be hungry, and "rewards" this behaviour by providing food. In this way dogs could be conditioned to display such behaviours upon encountering inaccessible food in the presence of human. In similar fashion one could argue that the owners tend to respond to directional gazing by dogs and that this causes dogs to conventionalize their gazing as a communicative exchange aimed at desired objects (Povinelli et al. 1997).

At present we have no direct evidence to refute the participation of such processes in the emergence of showing behaviour, but there are some circumstantial observations that make this explanation less likely. If dogs had been conditioned then we should have witnessed only the emergence of one or more communicative signals, but this would not explain the increase in looking at the owner or the relatively complex organisation of alternative gazing sequences and vocalisations in many dogs. Moreover, the passive behaviour of the owners should have also inhibited the unfolding of the signalling on the part of the dog. Interestingly, autistic children have problems of developing gaze alternation in similar situations (Mundy et al. 1986; Phillips et al. 1995), suggesting that showing behaviour is more complex than simply a behaviour sequence that has been rewarded in the past.

Furthermore, one could assume that increasing gazing time at the owner and the food is simply the result of the anticipation of the owners action or is the result of divided attention. One could also suggest that dogs gaze at the location of the hidden food, and then look at the human to monitor his/her activities. The problem with these interpretations is that in themselves neither of them would predict the observed organized pattern of gaze alternation and vocalisation that emerges when both the owner and the hidden food are present.

As a last point it may be worth considering the adaptive value of showing from a functional perspective. Gaze following can be explained by the needs of the individual to update its information about the activities of group mates (Tomasello et al. 1998). For the emergence of gaze alternation as a form of showing, however, more special circumstances should apply. Interestingly, most experimental setups for demonstration of showing in animals involved food that was inaccessible and "had to be shown". The question is whether animals encounter such situations in nature. Cooperative hunting represents such a possibility where individuals of a group have to decide in which direction to hunt or during a hunt in which direction the prey moves. Since both chimpanzees (Boesch and Boesch 1989) and wolves (Mech 1970) have been reported to hunt in such a manner, it might be interesting to observe whether such communication actually takes place under natural conditions among fellow members of a hunting group.

A more likely alternative explanation is that dogs have been selected specifically for enhanced communicative abilities in the course of their domestication. There is some evidence that even on shorter timescales such changes are possible, since McKinley and Sambrook (2000) have shown that pet gundogs are better in reading human communicative signals than other pet non-gundog breeds. So

it might have been the case that dogs that were better at exchanging information with humans gained a selective advantage.

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