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Obey or Not Obey? Dogs (*Canis familiaris*) Behave Differently in Response to Attentional States of Their Owners

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Sixteen domestic dogs (*Canis familiaris*) were tested in a familiar context in a series of 1-min trials on how well they obeyed after being told by their owner to lie down. Food was used in 1/3 of all trials, and during the trial the owner engaged in 1 of 5 activities. The dogs behaved differently depending on the owner's attention to them. When being watched by the owner, the dogs stayed lying down most often and/or for the longest time compared with when the owner read a book, watched TV, turned his or her back on them, or left the room. These results indicate that the dogs sensed the attentional state of their owners by judging observable behavioral cues such as eye contact and eye, head, and body orientation.

Keywords: dog–human relationship, *Canis familiaris*, attention, social cognition, communication

Communication by visual signals is a crucial feature in the human–dog relationship. Working dogs such as hunting or shepherd dogs have probably been selected for their understanding of human communicative signals, including visual ones. It is yet undecided whether dogs' understanding of human communicative cues is a genetic trait or develops during ontogeny following close contact with humans. Studies have shown that dogs understand visual cues given by humans very well (Hare, Brown, Williamson, & Tomasello, 2002; Hare, Call, & Tomasello, 1998; McKinley & Sambrook, 2000; Miklósi, Polgárdi, Topál, & Csányi, 1998; Soproni, Miklósi, Topál, & Csányi, 2001, 2002) and are also able to recognize and use visual attention of humans (Hare et al., 1998; Hare & Tomasello, 1999; Miklósi, Polgárdi, Topál, & Csányi, 2000; Virány, Topál, Gácsi, Miklósi, & Csányi, 2004). For communication to fulfill the purpose of reliably transferring visual signals from a sender to a receiver, attention plays a crucial role. Either there is first attention contact between the individuals involved followed by the signal to be transmitted or the signal can be followed by looking toward the receiver to check whether he or she was attending (Miklósi et al., 2000). In either case, attention is necessary to actively and usefully transfer signals and is mainly described by two components.

The first component is the so-called shared attention mechanism (SAM), a neurocognitive mechanism for identifying if one person and another organism are both attending to the same object or event (Baron-Cohen & Swettenham, 1996), which is expressed either by following the gaze of others or by directing someone's attention to an object or event and is necessarily accompanied by observable behavioral cues. Following the gaze of others cannot occur without the model turning his or her eyes and often also the head or body to the object or event of interest, and directing someone's attention to something is often realized through gestures like showing or pointing; these are therefore main features of communication (Baron-Cohen & Swettenham, 1996).

Eye contact is a second essential feature of attention. It has been considered as an index of attention contact and is fundamental in communicative situations (Gómez, 1991). The general picture is that attentional states of communicative partners are characterized by overt signals (Scérif, Gómez, & Byrne, 2004), perceived from behavioral cues, like body posture, or from facial configuration, like head orientation and gaze direction (Baron-Cohen, 1991).

The use of human bodily cues has been found in object-choice tasks with a number of different species. Researchers have investigated an animal's understanding of communicative cues by actively directing the animal's attention to an object with gestures like touching, pointing (with arm, hand, and finger), gazing (turning head and eyes), and glancing (eyes only; Baron-Cohen & Swettenham, 1996). Horses (*Equus caballus*) show the ability to use touching and pointing gestures (McKinley & Sambrook, 2000), as do domestic goats (*Capra hircus*; Kaminski, Riedel, Call, & Tomasello, 2005) and one gray seal (*Halichoerus grypus*; Shapiro, Janik, & Slater, 2003), but they all failed to understand referential cues like gazing and glancing (if the latter was tested at all). Capuchin monkeys (*Cebus capella*) show similar abilities in comprehending human pointing gestures but fail to use head and eye direction (Anderson, Sallaberry, & Barbier, 1995; Itakura & Anderson, 1996). There is some ambiguity in studies of apes. Chimpanzees (*Pan troglodytes*) seem to need some training to understand pointing cues (Povinelli, Bierschwale, & Cech, 1999), whereas the ability to use gazing (Call, Hare, & Tomasello, 1998; Povinelli et al., 1999) or glancing as a referential cue in apes is debated (Call, Agnetta, & Tomasello, 2000).

In contrast, the majority of dogs effectively use many different visual cues given by humans in object-choice tasks (Hare et al., 2002). They understand gestures of pointing very well (Hare et al., 1998; McKinley & Sambrook, 2000; Miklósi et al., 1998; Soproni

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et al., 2002) and are also able to use gazing to find the hidden food (Hare et al., 1998; Soproni et al., 2001), whereas glancing seems to be the most difficult cue for dogs to understand (Hare et al., 1998; McKinley & Sambrook, 2000; Miklósi et al., 1998; Soproni et al., 2001).

But still, direct eye contact not only seems to be a crucial feature in communicative situations but also plays an important role in predator–prey relations. When disturbed, hognose snakes (*Heterodon platirhinos*) often puff, hiss, coil, and strike, followed by energetic writhing behavior that ends in a quiescent inverted posture with the mouth open, the tongue extruded, and no overt signs of breathing (Burghardt & Greene, 1988). Recovery time from this death-feigning behavior has been investigated with the presence of a human gazing at the snake and with the presence of a human with his eyes averted from the snake. Results showed that recovery times from the death feigning in the human-gazing condition were significantly higher than in a control condition and suggest that hognose snakes possess good visual acuity and can use this ability in a rather sophisticated way to adaptively modify their behavior (Burghardt, 1991). Furthermore, snakes might well be more sensitive to visual cues from a predator's eyes than just its presence (Burghardt & Greene, 1988).

Similar results concerning gazing humans in a predator–prey context were obtained from Burger and colleagues, who investigated fleeing responses to humans in black iguanas (*Ctenosaura similis*). Iguanas moved earlier, ran earlier, and ran further when the face of an approaching human was clearly visible than when an approaching human's face was hidden by hair (Burger & Gochfeld, 1993). Likewise the iguanas responded differently when a human approached directly or tangentially with direct or averted gaze: Their escape distances and distances the iguanas ran were greatest when the human looked and walked toward the iguana and were least when the human approached tangentially and looked away (Burger, Gochfeld, & Murray, 1992). The same results in escape behavior were found when the approaching human wore a mask with large eyes than when he wore a mask with small eyes (Burger, Gochfeld, & Murray, 1991). Burger et al. (1992) concluded that the iguanas' ability to perceive differences in predator behavior could be attributed to many factors, including body orientation and direction of gaze.

Furthermore, this differential sensitivity to external stimuli has been shown in chickens (*Gallus gallus*) in shock situations. They showed significantly differential tonic immobility (freezing) behavior with regard to the presence of conspecifics compared with the presence or absence of artificial eyes (Rodd, Rosellini, Stock, & Gallup, 1997). The latter are considered as a fear stimulus for chickens in the context of predation (Gallup, Nash, & Ellison, 1971).

In our study we investigated to what extent dogs are able to discriminate attentional states of humans expressed in different body postures and modify their behavior accordingly. The experimental design is similar to the one reported by Call and colleagues (Call, Bräuer, Kaminski, & Tomasello, 2003), in which the dog "competes" with a more or less attentive human over food. In that study, the experimenter placed a piece of dry dog food on the floor of an experimental room and the dogs were forbidden to take the food. Then the experimenter either sat in a chair watching the dog (control condition), sat in a chair facing the dog but with eyes closed, sat in a chair facing the dog but engaged in a distracting activity, or sat in a chair facing the wall with the back turned to the dog. In comparison with the eyes-open condition, dogs approached the food in a more direct or quicker way and retrieved more food in the test conditions (Call et al., 2003). These results provided first evidence that dogs are able to discriminate at least some attentional states of humans and respond appropriately.

Our study deviates from Call et al.'s (2003) study in some aspects that we consider important for finding the true abilities of dogs' understanding of attentional states shown by their human partner. Rather than testing the dogs' reaction to a completely unknown person, to whom the dog could not have established any closer relationship, we tested the dog's responses to its owner. We thought that familiarity would enable the dog to use experiences on how to interpret attention-dependent behavioral cues in its owner in a quite familiar situation. In contrast, in the "punishment avoidance" game used by Call et al. (2003), the dog could not know which consequences the verbal command of a strange person would have. This state of uncertainty was perhaps further strengthened by the fact that until the end of the first session and thereafter in four of five trials, the experimenter did not react contingently to the dog's behavior either during the trial or after the trial was concluded.

Our decision to exploit the dog–owner relationship for the dog's reaction to the different attentional states of humans rests on the assumption, shared with others (e.g., Topál, Miklósi, & Csányi, 1997), that dogs show their best cognitive performance and their strongest sensitivity to human attention cues in a highly familiar situation and with their most familiar human partner. As noted by Gácsi, Miklósi, Varga, Topál, & Csányi (2004, p. 152), "situations used for testing are often 'caricatures' of natural situations" and "frozen gestures are not the best candidates for tackling the existence of understanding of attention." Therefore, we created as much as possible natural testing conditions for the dogs. In contrast to Call et al. (2003), who tested the dogs in an unfamiliar, quiet, and sterile testing room, we tested them in their owner's living room. And in contrast to Call et al. (2003) seeking to tempt the dogs by presenting all subjects the same piece of dry dog food, which is unlikely to be very attractive for all the dogs, we used the dogs' favorite food.

Additionally, dogs were only given the command to lie down without any explicit prohibition of eating the presented food. This allowed a comparison between food and no-food conditions, with the latter aimed at testing dogs without any additional stimulus (food), a situation they often encounter in their everyday lives. To test for the effects of behavioral cues reflecting the degree of attention toward the dogs, we asked owners to engage in everyday activities like reading or watching TV.

Dogs in our study were told to lie down on the floor while their owner looked at them, read a book, watched TV, turned his or her back on them, or left the room. We predicted that the dogs would stand up (or stand up and eat the food in those trials in which food was used) more often or more quickly the less the owner was attentive to them. If the dog would discriminate between all of the different attentional states of the owner, the dog's responses should be related to the above sequence of situations in a stepwise function.

Method

Subjects

Because the response of the dog in the experiment is likely dependent on the dogs' preexperimental obedience-training history, the preexperiences made in similar situations, their personality (bold vs. shy), and possibly many more factors, we selected dogs that showed an intermediate level of obedience in a preexperimental test. To fit the purpose of the experiment, they should have already learned to obey commands but must not be too strictly trained, too lazy, or too anxious in the test situation. Therefore, we selected the experimental subjects from a big sample depending on their behavior in the first session that we used as a preexperimental test. Only those dogs that fulfilled two criteria were used in the main experiment: (a) They obeyed their owner's command to lie down on the floor and kept lying there for 1 min in more than half of the trials without food, and (b) they moved within 1 min and took the food that was placed in front of them when left alone in the room. In this first session there were four trials conducted without food (Conditions 1, 2, 3, and 4) and two trials with food (Conditions 1 and 5) with one of them representing Condition 5 when the owner left the room and the dog was left alone with the food. Of 41 dogs tested, 5 dogs were excluded because they failed to meet the first criterion and 13 dogs because they failed to meet the second criterion. Three other dogs could not be used any further because their owners did not follow the instruction not to talk to or feed the dogs during or in between those selection trials. Thus there were 20 dogs selected to participate in the main experiment. After finishing the experiment, the first criterion was tested again to make sure that all dogs were in fact well enough trained to obey their owner's commands. Four dogs did not meet the first criterion to obey the command in more than half of the trials without food and were subsequently excluded as experimental subjects.

The experimental subjects included in the video and statistical analyses were 16 domestic dogs (*Canis familiaris*; 8 female, 8 male; mean age = 4.25 years; range = 1.25–8 years). Seven dogs were mongrels, and 9 dogs were members of seven different breeds. Nine dogs lived together with their owner since they were puppies, and the others spent most of their lives with their owners. The age of the 14 female owners and the 1 male owner (2 dogs had the same owner) ranged from 25 to 64 years. We ascertained that the owners were the most familiar persons to their dogs, and both dogs and owners were recruited from dog training schools in Vienna, Austria. Owners were asked not to feed their dog 2 hr prior to testing.

Procedure

The experiment was conducted in the living room of the owners' house or apartment, where the dog was usually not fed but allowed to take food. Food that was used in the trials was always the favorite food of each dog. So it differed between dogs but stayed the same throughout the sessions for each dog. Each dog was tested by its owner without the experimenter being present in the room during the experimental tests. We used a video camera with a wide-angle lens to record the behavior of the dog and its owner simultaneously. The camera was directed at the face of the dog, with the food and the owner in line with it. Dogs were allowed to inspect the video camera and tripod prior to every session to habituate them to the technical equipment. The experiment was carried out from November 2002 to February 2003.

The procedure for the experimental tests was as follows. Prior to every session, which always consisted of six trials, the owner was instructed what to do or not do using a written instruction. Owners were not allowed to move, speak, give signs, or react in any other way to the dog's action during the trial. They were told to sit on the chair in a relaxed manner and keep engaged in their activity (reading, watching TV, etc.) no matter what the dog did. Before the trials started, the owner gave the dog the one and only verbal command to lie down on the floor. As soon as the dog reliably obeyed the command, the owner took his or her position and behaved in the predetermined manner depending on the experimental condition. In those trials in which food was used, the owner placed the favorite food item at a distance of 1.5 m from the dog after it obeyed the command. Then the owner took his or her predetermined position again at a distance of 1.5 m from the dog. So the distance between dog and owner and dog and food was always 1.5 m, and it was 3 m between owner and food. While the owner placed the food on the floor, he or she looked at the dog and took care that the dog was always attentive and looked in his or her direction. As soon as the owner had taken his or her position, the trial started. Between trials there was a short break of 2 min in which the owner was encouraged to talk to the dog and get the dog up again. If in a food trial the dog did not eat the food item, the owner removed it in the intertrial interval.

Conditions were chosen to reflect everyday situations, with which the dog is assumed to be familiar, and with the assumption that attention in humans is behaviorally expressed especially through three bodily cues: eye gaze direction, head direction, and body posture. Thus differences in these three cues should express different and (in the following order) decreasing degrees of attention (see Table 1).

Condition 1 (look at dog). The owner sat straight on a chair and looked at the dog without moving his or her body. Eyes, head, and body of the owner were turned to the dog. The owner watched the dog during the whole trial and tracked the dog with his or her head and gaze if the dog moved, thereby signaling high attention. This condition resembles the eyes-open condition of Call et al. (2003).

Condition 2 (read book). The owner sat on a chair with his or her head and body turned toward the dog, but the eyes were focusing downward because he or she was reading a book. The owner read the book during the whole trial and did not look at the dog at all. This condition resembles the distracted condition of Call et al. (2003), except that in their experiment the experimenter was playing a handheld computer game.

Condition 3 (watch TV). The owner sat on a chair and his or her body was turned toward the dog. Head and eyes were turned away from the dog in a 90° angle toward a TV monitor. The owner watched TV during the whole trial and did not look at the dog at all. There was no similar condition in Call et al. (2003).

Condition 4 (back turned). The owner sat on a chair, and head and body were facing away from the dog with the back turned to the dog and the food. The owner kept reading a book during the whole trial and did not look at the dog at all. This condition resembles the back-turned condition of Call et al. (2003).

Condition 5 (leave room). The owner left the room immediately without saying anything, closed the door behind him or her, and was out of sight during the whole trial. This condition resembles the out-forbid condition of Call et al. (2003).

The order of presentation of conditions was counterbalanced across sessions. One condition per session was conducted twice, once with and once without food. Dogs received five sessions to complete the experiment. Four trials per session were carried out without food and 2 trials per session were carried out with food, which were conducted on the third and sixth position in every session. Each trial lasted for 1 min. Thus every dog received 10 trials with and 20 trials without food. Intervals between sessions were 2 to 3 weeks to reduce the probability of learning effects.

Table 1
Summary of the Relationship Between Condition and Owner's Body Cues

Condition	Presence of owner	Body	Head	Eyes
1	+	+	+	+
2	+	+	+	
3	+	+		
4	+			
5				

Note. Crosses indicate that the owner was present in a certain condition and that his or her body, head, or eyes were turned to the dog.

Data Analysis

One of us (Christine Schwab) coded the behavior of the dogs from the videotapes in seconds for further analysis. Scoring of whether dogs stood up and took the food did not demand more than one observer because it could be determined without ambiguity. Analysis of latencies started as soon as the owner had taken his or her predetermined position and referred to lying-down behavior of the dogs because this was the only command they got and were expected to obey. Data were not normally distributed, and thus we used nonparametric tests (Friedman, Wilcoxon's, or Mann–Whitney U tests) to compare conditions. All statistical tests were two-tailed.

A comparison of food trials presented in the third trial with those presented in the sixth trial in each session shows no significant difference in the latencies of standing up (Wilcoxon's test, $n = 16$, $Z = -1.758$, $p = .079$). It implies that there was no effect of learning throughout the session, thus we collapsed the data for further analysis. Furthermore, there were no learning effects throughout the sessions concerning trials without food. Comparisons of sessions with regard to different conditions did not reveal any significant differences (Friedman test): Condition 1, $\chi^2(3, N = 16) = 6.077$, $p = .108$; Condition 2, $\chi^2(3, N = 16) = 0.259$, $p = .968$; Condition 3, $\chi^2(3, N = 16) = 0.682$, $p = .877$; Condition 4, $\chi^2(3, N = 16) = 2.607$, $p = .456$; and Condition 5, $\chi^2(3, N = 16) = 6.314$, $p = .097$.

Results

Figure 1 shows the proportion of trials in which the dogs obeyed the command for the whole 60 s of the trials. In trials in which no food was presented (Figure 1a), the proportion of trials in which the dogs obeyed the command to lie down decreases from Condition 1 to 5. However, these differences were not significant across conditions (Friedman test), $\chi^2(4, N = 16) = 7.021$, $p = .135$.

In trials with food (Figure 1b), there was a significant difference across conditions (Friedman test), $\chi^2(4, N = 16) = 19.652$, $p = .001$, which was based on Condition 5 that differed significantly from Condition 1 ($n = 9$, $Z = -2.373$, $p = .018$) insofar as when the owner left the room the dogs stood up more often than when being watched.

With regard to latencies, comparisons across conditions showed significant differences in both conditions: trials without food, $\chi^2(4, N = 16) = 9.832$, $p = .043$; trials with food, $\chi^2(4, N = 16) = 15.529$, $p = .004$. In trials without food (see Figure 2a), dogs stood up significantly quicker when the owner left the room than when it was being watched (see Table 2). But when the owner turned his or her back on them, the dogs also stood up significantly quicker than in Condition 1 when the owner looked at them and signaled highest attention (Table 2). As in trials without food, in trials with food (Figure 2b), the latency for disobeying the lying-down command was significantly shorter in Condition 5 than in Condition 1 (Table 2).

In trials with food, the motivation of dogs to stand up (and then take the food) was overall much higher than in trials without food. They stood up (and then took the food, respectively) both more often (with the exception of Condition 2) and more quickly in trials in which food was used than when it was not (see Table 3).

It is worth noting that despite being strongly motivated by their favorite food, the dogs obeyed the command to lie down in 41.25% of all food trials, and they remained lying down the whole 60 s of the trial. Therefore, to achieve a more sensitive comparison between conditions, we reanalyzed the data by considering only those trials in which the dog disobeyed the command and ate the food (see Figure 3; consumption trials). With this restriction, dogs stood up significantly quicker when the owner read a book or watched TV than when the owner looked at the dog (see Table 2). There was no significant difference in performance between the sexes in any of the conditions.

Discussion

Taken together, the results corroborate those of Call et al. (2003) by providing additional and to some extent complementary evidence that dogs are able to discriminate attentional states in humans. Our results are comparable because in both studies dogs

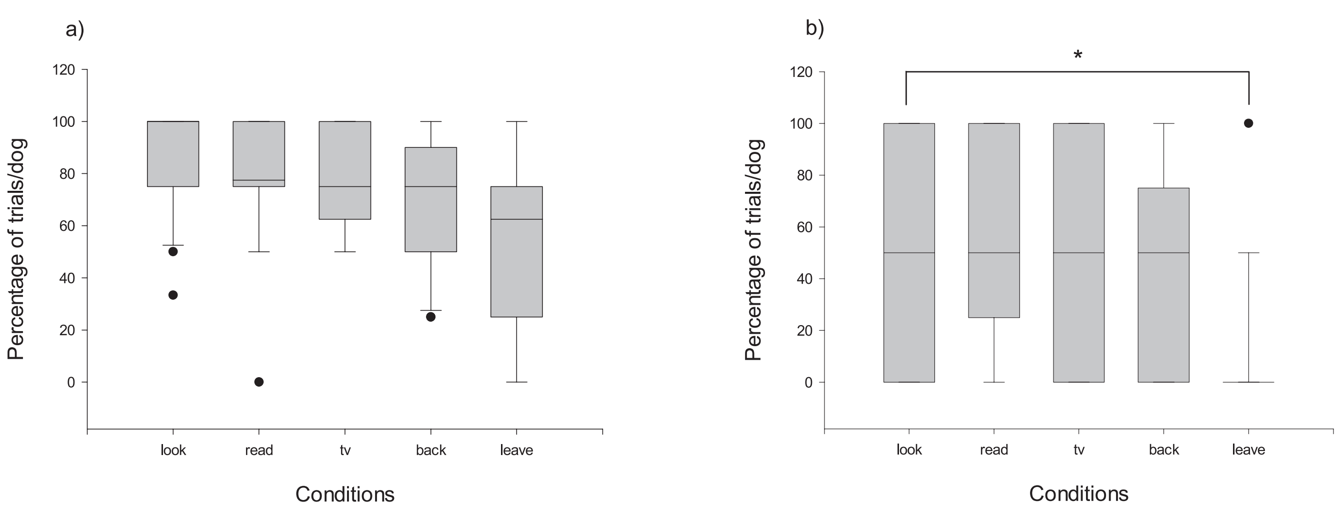

Figure 1. Proportion of trials (a) without and (b) with food in which the dogs obeyed the command. The figure shows percentage of trials in which they stayed lying down for the whole 60 s of the trial. The box represents the interquartile range, which contains 50% of the values, and the bold lines indicate the median. The error bars extend from the box to the highest and lowest values, excluding outliers, which are indicated by black dots. *$p < .05$.

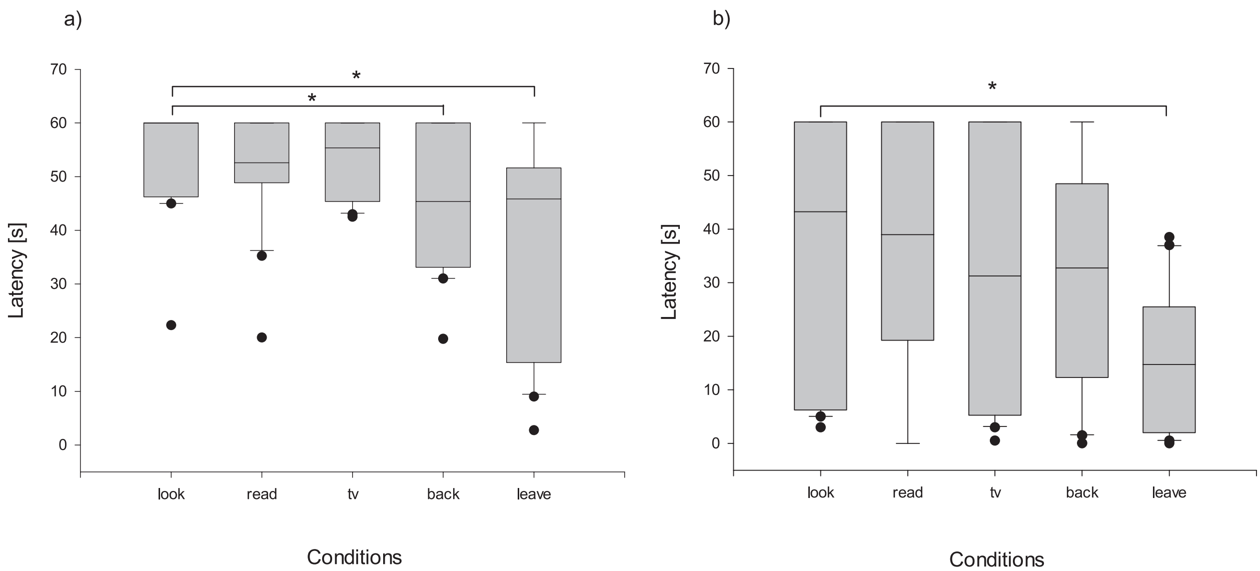

Figure 2. Time (in seconds) until standing up in trials (a) without and (b) with food. The figure shows mean duration of time dogs obeyed the command to lie down. The box represents the interquartile range, which contains 50% of the values, and the bold lines indicate the median. The error bars extend from the box to the highest and lowest values, excluding outliers, which are indicated by black dots. *$p < .05$.

showed they were sensitive to the attentional states of humans when required to obey a command given by them. In both studies the dogs disobeyed the human's command more readily when the human left the room than when he or she sat on a chair watching them. In our study, this was the case in two types of trials, in those with and those without food, because the dogs stood up more often or more quickly when their owner left the room than when they were watched. But also in trials without food of the back-turned condition (Condition 4), which has no equivalent in Call et al.'s (2003) study because they conducted their study with food, the dogs stood up more quickly than when being watched. In addition, with the temptation of their favorite food in front of them and in cases when the dogs stood up and ate it, they did it more quickly when the owner read a book or watched TV than when being watched. This indicates that the dogs in our study responded according to the different attentional states of their owners, corroborating similar results of other dog studies, which we discuss in the following.

Leaving the room seems to have a different quality than just giving the least quantitative level of attention. Hare et al. (1998) showed that being physically present is the first prerequisite for communication. In their study dogs had to draw the attention of a human to a location where food was hidden that the dogs themselves could not reach. One of the dogs' behaviors were vocalizations they only produced if a human was present (Hare et al., 1998). Discriminating front and back of humans was tested by a human throwing a ball the dog should fetch, with the restriction that the ball will only be thrown again if the dog placed it inside the visual field of the human (Hare et al., 1998). If the humans turned their back on the returning dogs, the latter walked around and dropped the ball or, in very few trials, stayed in front of the humans' back side but then started to bark to get the humans' attention (Hare et al., 1998). This suggests that dogs realize the asymmetry of humans' front and back side and understand the meaning of a human's back as showing low attention by the human.

Table 2
Summary of Results Concerning Comparisons of Latencies Between Condition 1 and All Other Conditions

	Without food			With food			Consumption		
Condition	*n*	*Z*	*p*	*n*	*Z*	*p*	*n*	*Z*	*p*
2	10	−0.868	.386	10	−0.051	.959	**9**	**−2.134**	**.033**
3	10	−0.357	.721	12	−1.059	.289	**7**	**−2.366**	**.018**
4	**11**	**−2.179**	**.029**	12	−1.138	.255	10	−1.173	.241
5	**13**	**−2.271**	**.023**	**16**	**−3.051**	**.002**	10	−1.172	.241

Note. Results are given for trials without and with food and for consumption trials in which the dogs stood up before the 60 s of the trials elapsed. All given results are from Wilcoxon's tests and are two-tailed. Bold results indicate significant differences between the given condition and Condition 1.

Table 3
Comparison of Conditions With and Without Food Concerning Proportion of Trials in Which the Dogs Obeyed the Command (Frequency) and Time Until Standing Up (Latency)

	Frequency			Latency		
Condition	*n*	*Z*	*p*	*n*	*Z*	*p*
1	12	−2.565	**.01**	12	−2.353	**.019**
2	11	−1.841	.066	12	−2.589	**.01**
3	13	−2.229	**.026**	14	−2.542	**.011**
4	14	−2.127	**.033**	14	−2.103	**.035**
5	13	−2.727	**.006**	16	−2.999	**.003**

Note. All given results are from Wilcoxon tests and are two-tailed. Bold results indicate significant differences.

Significant results of facing versus back turning to returning dogs were also found by Gácsi et al. (2004), indicating that the ability to discriminate these two bodily orientations of humans can serve as a basis to recognize attention. Our results from the back-turned condition provide additional support for the dog's ability to judge a human's back as showing low attention by the human.

When the owner was reading a book or watching TV, thereby turning the body toward the dog but only head or eyes away, we assumed a stronger temptation for the dogs to disobey the command than when it was being watched. In fact, when they stood up facing their favorite food, they showed shorter latencies in these two conditions than in the looking condition (see Figure 3).

Giving, processing, understanding, and using cues are probably context dependent. This, we believe, could explain some of the differences found between the study by Call et al. (2003) and the present one. In both studies the special feature of eye contact resulted in dogs obeying the given command most often or for the longest time. However, concerning the results of the food trials, there are interesting deviations from Call et al.'s (2003) study. In their study the dogs took more food pieces in all experimental conditions than when being watched, but they took them more quickly only in the eyes-closed condition, which has no equivalent in the present study, but not when the experimenter played a handheld computer or turned her back to the dog. In contrast, the dogs in our study did not show significantly different numbers in the frequencies of taking the food, except when the owner left the room, but the dogs took the food more quickly in the read book and watch TV conditions, with the former being equivalent to the distracted condition in Call et al.'s (2003) study. These differences might be explained by the experimental context. In the present study every dog got its favorite food and had to lie down on the floor. They were tested in the owners' apartment, and during the experiment the only human present was their owner and most familiar person. All relationships between humans and dogs in this study were determined by friendliness and familiarity, so it can be assumed that the dogs were not afraid of their owners. They have probably learned throughout their ontogeny that obeying a command is desired by their owners but that disobedience will not be punished severely. In contrast, the dogs of Call et al.'s (2003) study could not know the reaction of a stranger if they failed to obey. Probably those dogs did not dare to take the food as often as in the present study, especially in Condition 1 (or in the forbid or eyes-open condition in Call et al.'s, 2003, study). So influences on these results might have arisen from the unfamiliar versus familiar experimental setting and the use of the same dry dog food versus the favorite food of each dog contributing to the less frequent taking of food in Call et al.'s (2003) study.

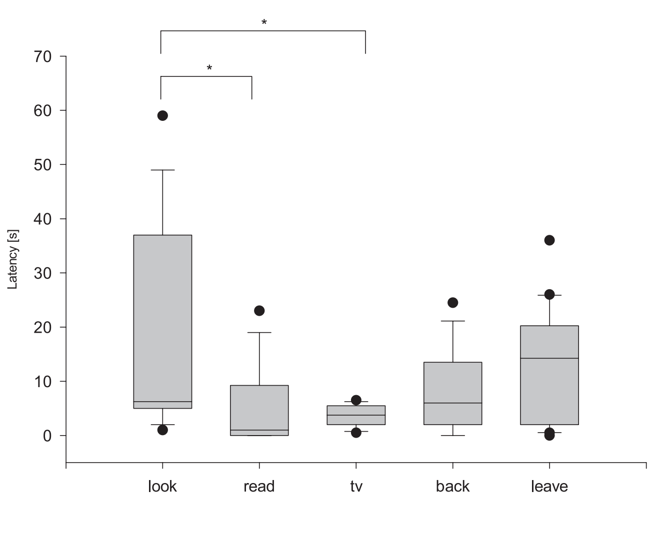

Figure 3. Time (in seconds) until standing up in consumption trials. Only those trials with food were considered in which the dogs stood up before 60 s of the trials elapsed. The figure shows mean duration of time dogs obeyed the command to lie down. The box represents the interquartile range, which contains 50% of the values, and the bold lines indicate the median. The error bars extend from the box to the highest and lowest values, excluding outliers, which are indicated by black dots. $*p < .05$.

For both studies it also seems plausible that dogs used experiences they have made throughout their lives to judge the attentional state of the humans involved. If one takes into account that for an understanding of attention, an individual "may learn many additional things about the relation of their group mates' visual access to objects in the environment and its implications for their (their group mates') subsequent behavior" (Hare, Call, Agnetta, & Tomasello, 2000, p. 784), also learning experiences are likely to play an important role in making a connection between visual access and behavior of others in different social contexts. Dogs have probably experienced situations with humans turning away their head or eyes or turning their back on the dogs, and the dogs could have learned that in those situations the human hardly noticed an undesirable behavior of the dog. In other words, they could have learned that with this constellation of observable characteristics there are less consequences if they do not obey a command. Naturally, these experiences could be increased through context.

The ongoing discussion of attributing mental states to others mainly deals with the question of whether organisms that seem to show this ability do or do not refer to observable behavioral cues. This conflicting debate does not seem to be decisive for judging attentional states of others because if attention is understood as turning the mind to something, this often involves turning the body, head, and especially the eyes to something (Gómez, 1991). And because even the most complex attributional processes are necessarily supported by objective cues (Povinelli, Nelson, & Boysen, 1990), mental states like attention are characterized by overt signals (Scérif et al., 2004) and are directly perceivable in behavioral cues (Baron-Cohen, 1991). Dogs have been shown to be sensitive to attentional states of their owners by using such signals provided by absence, front and back side, head orientation, and eye orientation of their owners and by adapting their behavior accordingly.

References

Anderson, J. R., Sallaberry, P., & Barbier, H. (1995). Use of experimenter-given cues during object-choice tasks by capuchin monkeys. *Animal Behaviour, 49,* 201–208.

Baron-Cohen, S. (1991). Precursors to a theory of mind: Understanding attention in others. In A. Whiten (Eds.), *Natural theories of mind: Evolution, development and simulation of everyday mindreading* (pp. 233–251). Oxford, England: Blackwell.

Baron-Cohen, S., & Swettenham, J. (1996). The relationship between SAM and ToMM: Two hypotheses. In P. Carruthers & P. K. Smith (Eds.), *Theories of theories of mind* (pp. 158–168). Cambridge, England: Cambridge University Press.

Burger, J., & Gochfeld, M. (1993). The importance of the human face in risk perception by black iguanas, *Ctenosaura similis. Journal of Herpetology, 27,* 426–430.

Burger, J., Gochfeld, M., & Murray, B. G. (1991). Role of a predator's eye size in risk perception by basking black iguanas, *Ctenosaura similis. Animal Behaviour, 42,* 471–476.

Burger, J., Gochfeld, M., & Murray, B. G. (1992). Risk discrimination of eye contact and directness of approach in black iguanas (*Ctenosaura similis*). *Journal of Comparative Psychology, 106,* 97–101.

Burghardt, G. M. (1991). Cognitive ethology and critical anthropomorphism: A snake with two heads and hog-nose snakes that play dead. In C. A. Ristau (Eds.), *Cognitive ethology: The minds of other animals* (pp. 53–90). Hillsdale, NJ: Erlbaum.

Burghardt, G. M., & Greene, H. W. (1988). Predator simulation and duration of death feigning in neonate hognose snakes. *Animal Behaviour, 36,* 1842–1843.

Call, J., Agnetta, B., & Tomasello, M. (2000). Cues that chimpanzees do and do not use to find hidden objects. *Animal Cognition, 3,* 23–34.

Call, J., Bräuer, J., Kaminski, J., & Tomasello, M. (2003). Domestic dogs (*Canis familiaris*) are sensitive to the attentional state of humans. *Journal of Comparative Psychology, 117,* 257–263.

Call, J., Hare, B. A., & Tomasello, M. (1998). Chimpanzee gaze following in an object-choice task. *Animal Cognition, 1,* 89–99.

Gácsi, M., Miklósi, Á., Varga, O., Topál, J. & Csányi, V. (2004). Are readers of our face readers of our minds? Dogs (*Canis familiaris*) show situation-dependent recognition of human's attention. *Animal Cognition, 7,* 144–153.

Gallup, G. G., Nash, R. F., & Ellison, A. L. (1971). Tonic immobility as a reaction to predation: Artificial eyes as a fear stimulus for chickens. *Psychonomic Science, 23,* 79–80.

Gómez, J.-C. (1991). Visual behaviour as a window for reading the mind of others in primates. In A. Whiten (Eds.), *Natural theories of mind: Evolution, development and simulation of everyday mindreading* (pp. 195–207). Oxford, England: Blackwell.

Hare, B., Brown, M., Williamson, C., & Tomasello, M. (2002). The domestication of social cognition in dogs. *Science, 298,* 1634–1636.

Hare, B., Call, J., Agnetta, B., & Tomasello, M. (2000). Chimpanzees know what conspecifics do and do not see. *Animal Behaviour, 59,* 771–785.

Hare, B., Call, J., & Tomasello, M. (1998). Communication of food location between human and dog (*Canis familiaris*). *Evolution of Communication, 2,* 137–159.

Hare, B., & Tomasello, M. (1999). Domestic dogs (*Canis familiaris*) use human and conspecific social cues to locate hidden food. *Journal of Comparative Psychology, 113,* 173–177.

Itakura, S., & Anderson, J. R. (1996). Learning to use experimenter-given cues during an object-choice task by a capuchin monkey. *Current Psychological Cognition, 15,* 103–112.

Kaminski, J., Riedel, J., Call, J., & Tomasello, M. (2005). Domestic goats, *Capra hircus,* follow gaze direction and use social cues in an object choice task. *Animal Behaviour, 69,* 11–18.

McKinley, J., & Sambrook, T. D. (2000). Use of human-given cues by domestic dogs (*Canis familiaris*) and horses (*Equus caballus*). *Animal Cognition, 3,* 13–22.

Miklósi, Á., Polgárdi, R., Topál, J., & Csányi, V. (1998). Use of experimenter-given cues in dogs. *Animal Cognition, 1,* 113–121.

Miklósi, Á., Polgárdi, R., Topál, J., & Csányi, V. (2000). Intentional behaviour in dog–human communication: An experimental analysis of "showing" behaviour in the dog. *Animal Cognition, 3,* 159–166.

Povinelli, D. J., Bierschwale, D. T., & Cech, C. G. (1999). Comprehension of seeing as a referential act in young children, but not juvenile chimpanzees. *British Journal of Developmental Psychology, 17,* 37–60.

Povinelli, D. J., Nelson, K. E., & Boysen, S. T. (1990). Inferences about guessing and knowing by chimpanzees. *Journal of Comparative Psychology, 104,* 203–210.

Rodd, Z. A., Rosellini, R. A., Stock, H. S., & Gallup, G. G. (1997). Learned helplessness in chickens (*Gallus gallus*): Evidence for attentional bias. *Learning and Motivation, 28,* 43–55.

Scérif, G., Gómez, J. -C., & Byrne, R. W. (2004). What do Diana monkeys know about the focus of attention of a conspecific? *Animal Behaviour, 68,* 1239–1247.

Shapiro, A. D., Janik, V. M., & Slater, P. J. B. (2003). A gray seal's (*Halichoerus grypus*) responses to experimenter-given pointing and directional cues. *Journal of Comparative Psychology, 117,* 355–362.

Soproni, K., Miklósi, Á., Topál, J., & Csányi, V. (2001). Comprehension of human communicative signs in pet dogs (*Canis familiaris*). *Journal of Comparative Psychology, 115,* 122–126.

Soproni, K., Miklósi, Á., Topál, J., & Csányi, V. (2002). Dogs' (*Canis familiaris*) responsiveness to human pointing gestures. *Journal of Comparative Psychology, 116,* 1–8.

Topál, J., Miklósi, Á. & Csányi, V. (1997). Dog–human relationship affects problem solving behavior in the dog. *Anthrozoös, 10,* 214–224.

Virány, Z., Topál, J., Gácsi, M., Miklósi, Á. & Csányi, V. (2004). Dogs respond appropriately to cues of humans' attentional focus. *Behavioural Processes, 66,* 161–172.

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