A Comparative Study of the Use of Visual Communicative Signals in Interactions Between Dogs (*Canis familiaris*) and Humans and Cats (*Felis catus*) and Humans

Ádam Miklósi, Péter Pongrácz, and
Gabriella Lakatos
Eötvös Loránd University

József Topál and Vilmos Csányi
Hungarian Academy of Sciences

Dogs' (*Canis familiaris*) and cats' (*Felis catus*) interspecific communicative behavior toward humans was investigated. In Experiment 1, the ability of dogs and cats to use human pointing gestures in an object-choice task was compared using 4 types of pointing cues differing in distance between the signaled object and the end of the fingertip and in visibility duration of the given signal. Using these gestures, both dogs and cats were able to find the hidden food; there was no significant difference in their performance. In Experiment 2, the hidden food was made inaccessible to the subjects to determine whether they could indicate the place of the hidden food to a naive owner. Cats lacked some components of attention-getting behavior compared with dogs. The results suggest that individual familiarization with pointing gestures ensures high-level performance in the presence of such gestures; however, species-specific differences could cause differences in signaling toward the human.

Both dogs and cats are referred to as being "domesticated" by humans—that is, we assume that genetic changes have made them adapt to the human environment. At present, most researchers agree that the origin of the dog is most likely linked to the ancient wolf (*Canis lupus*) or some extinct relative, a wolflike species (Clutton-Brock, 1984; Coppinger & Coppinger, 2001; Olsen, 1985); similarly, it has been assumed that the North African wildcat (*Felis silvestris lybica*) or some other relatives provided the genetic variation for the selection of the domestic cat (Bradshaw, Horsfield, Allen, & Robinson, 1999; Cameron-Beaumont, 2002). It has also emerged that dogs (approximately 15,000–30,000 years; Savolainen, Zhang, Luo, Lundeberg, & Leitner, 2002) as a species can be traced back to an earlier origin than can cats (approximately 8,000–10,000 years; Clutton-Brock, 1979; Davis, 1987), and many assume that the evolutionary scenario for the emergence of the two species might have been different, although clearly a major factor was that both species found food resources in connection with humans. Regarding the transition from the wild state to the domesticated one with respect to the genetic isolation from the wild (and feral) living populations, it is likely that cats represent an earlier state of domestication than do dogs (Bradshaw et al., 1999).

Dogs and cats differ in their social systems in general (Bradshaw & Brown, 1992; Bradshaw & Wickens, 1992; Fox, 1971). Whereas cats and their close relatives are mostly solitary hunters, dogs and their closest relatives are pack hunters with a tendency toward scavenging. Being members of the order Carnivora, both cats and dogs are flexible in their learning capacities and rely on visual, olfactory, and acoustic cues (for separate reviews on domestic cats and dogs, see Bradshaw, 1992; Serpell, 1995; Turner & Bateson, 1988).

As a result of domestication (Bradshaw et al., 1999), the living places of these species overlap to a considerable degree with the living places of humans (flats, houses, gardens, farms, etc.). Such individuals or groups of animals differ from their native counterparts because they are exposed to more intensive contact with humans. Often the human is the only source of food, and therefore the animals' possibilities of getting food are restricted. Although not necessarily, many cats and dogs living in human environments have less chance to socialize with members of their own species; in contrast, they predominantly interact with humans in various activities (play, feeding, etc.) from early puppyhood and kittenhood.

It is interesting to note that there are no studies directly comparing dog–human interactions with cat–human interactions; yet such investigations could provide valuable information toward understanding the contribution of species-specific traits and learning abilities in the development of interspecific communicative behavior. The comparison of the two species could reveal to what extent living in a similar social environment provided by humans has shaped the divergent communicative behavior of dogs and cats.

Given species-specific differences in the communicative system of the two species, the following possibilities should be considered. Even if we consider that cats and dogs have different predispositions for interspecific communication, we can hypothesize that both species are able to communicate effectively with humans in various situations. Thus, cats and dogs communicate with hu-

mans in a similar manner because they have the ability to adapt to the human social environment, and the engagement in a communicative relationship with humans will overshadow particular behavioral differences.

Alternatively, dogs and cats communicate differently with humans because, in addition to species-specific differences, humans will develop a qualitatively different type of relationship with these species. The only way to separate these possibilities is to compare individuals that live in a qualitatively similar relationship with humans (pets in the family) and are observed in a situation that is part of their natural everyday interaction with humans. Therefore, to test the ability of dogs and cats to communicate with humans by either reacting to gestural signals or emitting signals, we chose a type of interaction that is usually the same in the two species: feeding. We wanted to compare the behavior of dogs and cats in a feeding context involving communicative cueing on the part of either the human (Experiment 1) or the subjects (Experiment 2). Both experiments relied on paradigms that have been well established in the case of dogs. Various studies have found that dogs are able to find hidden food only on the basis of human pointing cues (Hare & Tomasello, 1999; McKinley & Sambrook, 2000; Miklósi, Polgárdi, Topál, & Csányi, 1998; Soproni, Miklósi, Topál, & Csányi, 2001). Other lines of investigations have established that dogs readily use various means of signaling behavior to direct the attention of humans to a problem situation they face. For example, when dogs cannot reach hidden food, they display elevated levels of both gazing and vocalizing behavior toward humans (Miklósi, Polgárdi, Topál, & Csányi, 2000). In comparison, cats also show various forms of communicative behaviors before a feeding interaction with their owners (Bradshaw & Cook, 1996), including gazing at the human.

There is a general belief that exclusive dog lovers have different personalities than exclusive cat lovers, so we thought it could affect the ways they interact with their animals. To control for the possible differences between dog and cat owners in their social interactions with their pets, apart from testing subjects living alone in human families, we also included human families that have both dogs and cats living together.

General Method

Subjects and Procedure

Initially, 26 cat owners and 21 dog owners (approximately half of the owners had both a cat and a dog; see below) agreed to participate in this study, which involved several visits to the home of the owners. Because we wanted to make the two species samples as similar as possible, selection criteria were applied (see below) for including any subject in the experiments. All dogs (*Canis familiaris*) and all but 2 cats (*Felis catus*) passed these initial tests. On some occasions, we discontinued the testing of the subject (see Experiment 1) if the subject left the place of the experiment at least three times on successive trials within the same session (which happened usually when it was allowed to make a choice after cueing) or if it could not be motivated any further with any type of food. For this reason, 7 cats dropped out, which resulted also in the exclusion of 5 dogs that were living with these cats. Finally, for technical reasons, 2 dogs and 3 cats participated only in either Experiment 1 or 2 (see below for details). Subjects were always tested first in Experiment 1, and this was then followed by participation in Experiment 2.

Criteria for Participation

Pilot observations have shown that the presence of an unfamiliar experimenter has a strong deteriorating effect on cats' behavior (see also Turner, Feaver, Mendl, & Bateson, 1986). Although such influence has not been observed in previous studies with dogs (e.g., Soproni et al., 2001), we introduced behavioral criteria for participation in the experiment to avoid aspecific effects on the communicative behavior of the cats in the study. Both dogs and cats were observed in the situations below, and only those that met the predetermined selection criteria participated:

Test 1: The experimenter called (any sound, verbal utterance, and/or the subject's name were used) the subject three times, leaving 5-min pauses between calls. The subject passed if it approached the experimenter within 1 min at least two times out of three.

Test 2: The experimenter sat down next to the subject and petted it for 1 min. The subject passed if it did not leave her during this time.

Test 3: The experimenter placed the test bowls in front of the subject and put a piece of food into either bowl. The subject passed if it took out the food within 1.5 min.

The subject participated in our experiments if it passed two tests out of three.

Experiment 1

Interspecific communicative behavior and the ability to understand human visual communicative signals have been investigated recently in a wide range of species (for a review, see Miklósi & Soproni, in press). Previous studies have indicted that dogs might be superior in relying on these gestures partly because of their history of domestication (Miklósi et al., 2003; Soproni, Miklósi, Topál, & Csányi, 2002) and exposure to human signaling. It has also been claimed that dogs are capable of higher levels of performance in two-choice situations based on pointing signals than are apes because of dogs' history of domestication (Hare, Brown, Williamson, & Tomasello, 2002). However, this simplified argument has been challenged by recent results presenting evidence that dolphins trained by humans can use pointing as directional signals (Herman et al., 1999; Tschudin, Call, Dunbar, Harris, & van der Elst, 2001) and that seals (Scheumann & Call, 2004; Shapiro, Janik, & Slater, 2003) and goats (Kaminski, Riedel, Call, & Tomasello, 2005) are able as well to base their choices on human pointing. It is interesting to note that at present there is no parallel data for domestic animals living in close human contact. This experiment compares the performance of dogs and cats in a two-choice situation in which various forms of the human pointing gesture indicate the place of the hidden food.

Method

Subjects

Four different groups of subjects were established according to the species and rearing conditions:

Cat alone: Cats living without a dog ($n = 7$: 4 neutered males, 1 spayed female, 1 unneutered male, and 1 unspayed female; mean age + SD = 3.56 + 3.27 years, range = 0.3–4.5 years).

Dog alone: Dogs living without a cat ($n = 7$: 5 unneutered males and 2 unspayed females; mean age + SD = 5.21 + 2.36 years, range = 2–9 years).

Cat with dog: Cats living with a dog (n = 7: 2 neutered males, 1 spayed female, and 4 unspayed females; mean age + SD = 4.67 + 3.37 years, range = 0.6–10 years).

Dog with cat: Dogs living with cats that were members of the third experimental group (n = 7: 3 unneutered males, 3 unspayed females, and 1 spayed female; mean age + SD = 6.0 + 3.97 years, range = 1.5–10 years).

Pretraining

Both the pretraining and the testing took place in one room of the owners' flats. The experimenter placed the two bowls (brown plastic flower pots: 14.5 cm in diameter, 11 cm in height) 1.3–1.6 m apart in front of herself. She put a piece of food into one of the bowls in the presence of the subject. Meanwhile the subject was held by the owner at a distance of 2–2.5 m from the experimenter. After the experimenter put the food into the bowl, the owner released the subject and it was allowed to eat the bait within 30 s. This procedure was repeated twice for each bowl to ensure that the subject knew that the bowls might contain food.

Testing

The position of the bowls was the same as above, but now the subject was prevented from observing the baiting. The experimenter picked up the bowls and turned away from the subject while she put a piece of food into both bowls. After the food was hidden, the owner made the subject sit, facing the experimenter, while the experimenter placed both bowls onto the floor at the same time in front of her. During the pointing, the experimenter was kneeling on the floor 0.5 m back from the middle line between the two bowls, facing the subject at a distance of 2–2.5 m. The owner was holding the subject gently until the experimenter gave the cue. The experimenter drew the subject's attention to her (any sounds, like clapping and/or the subject's name, could be used) and presented the visual cue when the subject was looking in her direction. She pointed with her hand in the direction of the correct location, with her index finger either 10–20 cm (proximal pointing) or 70–80 cm (distal pointing) from the bowl. The experimenter looked at the subject during the pointing. If the subject did not leave the owner at the first cue, the experimenter repeated the pointing gesture again. The subject was allowed to choose only one pot. If the subject chose the incorrect bowl, the experimenter moved forward quickly and picked up the bowls so that the subject was prevented from eating the hidden food. When the subject chose the correct bowl, the experimenter picked up the second bowl while the subject ate the food from the correct bowl.

Pointing was performed either in a dynamic manner (i.e., the subject could see the experimenter's arm movement in the direction of the correct bowl, and the arm was in pointing position until the subject made a choice) or in a momentary manner (i.e., the subject could also see the experimenter's arm movement in the direction of the correct bowl, but the arm was in pointing position for only a second, and the subject was released only after the arm had been lowered).

The first and second test sessions consisted of 10 trials of proximal dynamic pointing only. Next subjects were tested in 32 trials that were divided into three test sessions (10 + 10 + 12 = 32). We used four different types of pointing cues (proximal dynamic pointing; proximal momentary pointing; distal dynamic pointing; distal momentary pointing) in predetermined semirandom order, and each gesture was presented eight times (4 Gestures × 8 Trials = 32 Trials). At a particular session, one type of gesture was shown two or three times. For the statistical analysis of performance data (the number of correct choices), nonparametric procedures were used. Neither the same gesture nor the same place of the reward was applied more than two times in a row.

Results and Discussion

Pairwise comparisons (Mann–Whitney U tests) showed no significant difference in performance between the two cat groups and the two dog groups in response to any of the pointing gestures during the third session; therefore, these 2–2 groups have been pooled together. Next we performed separate Friedman analyses of variance (with Dunn's post hoc tests, $p < .05$) to look for variability among the effect of different gestures. In the case of both cats and dogs, we obtained a significant overall difference: cats, $\chi^2(3, N = 14) = 15.43$, $p = .01$; dog, $\chi^2(3, N = 14)$ 8.47, $p = .05$. However, the post hoc test revealed significant differences among the pointing gestures only in cats because they performed better with the proximal dynamic pointing than with both proximate and distal momentary pointing. No such differences were found in the case of the dogs.

Next we compared the results of the cats and the dogs directly, and no significant difference was found in any of the pointing gestures (proximal dynamic pointing: $U = 92.00$, $p = .80$; proximal momentary pointing: $U = 59.00$, $p = .07$; distal dynamic pointing: $U = 82.50$, $p = .48$; distal momentary pointing: $U = 82.50$, $p = .48$). However, we should mention that in the case of proximal momentary pointing, dogs tended to be more effective at finding the hidden food, although the difference does not reach significance. Therefore, we cannot exclude the possibility that with a larger sample size, one could find significant differences between cats' and dogs' performances, especially in response to the more difficult momentary pointing gestures.

Separate one-sample Wilcoxon signed-ranks tests (Motulsky & Searle, 1998) indicated that the performance of dogs and cats differed from the random choice level (50%) for each pointing signal (see Figure 1). Further, there was no significant difference between the results of the first 10 and the second 10 trials of the proximal dynamic pointing in either the dogs' or the cats' performances (Wilcoxon's matched pairs test): dogs, $T(-) = 12.0$, $p = .74$; cats, $T(-) = 20.0$, $p = .77$. Neither did we find significant differences in performance when comparing the results of the first two and the last two trials: dogs, $T(+) = 1.0$, $p = .32$; cats, $T(+) = 1.5$, $p = .99$. The lack of significant improvement suggests that no learning took place during the two introductory sessions with the less demanding version of the pointing gestures.

Similarly, there was no sign of learning during the third phase of the testing when the different types of gestures were varied. The comparison of the performance on the first two and the last two gestures for each type revealed no significant changes; cats: proximal dynamic pointing, $T(+) = 0.0$, $p = 1.00$; proximal momentary pointing, $T(-) = -35.0$, $p = .49$; distal dynamic pointing, $T(+) = 7.5$, $p = .37$; distal momentary pointing, $T(+) = 27.0$, $p = .65$; dogs: proximal dynamic pointing, $T(+) = 6.0$, $p = .08$; proximal momentary pointing, $T(+) = 3.0$, $p = .99$; distal dynamic pointing, $T(-) = -14.0$, $p = .56$; distal momentary pointing, $T(+) = 14.0$, $p = .99$.

It is important to note that the subjects gained a reward from the test bowls when choosing correctly (they were allowed to eat the hidden food), and therefore the position of the food could have affected subsequent choices. However, as we pointed at the right and left bowls in a semirandom order (see above), such an effect should have resulted in a chance performance. Our results proved that this was not the case. As a whole, the results did not show statistically significant species-specific differences in the use of
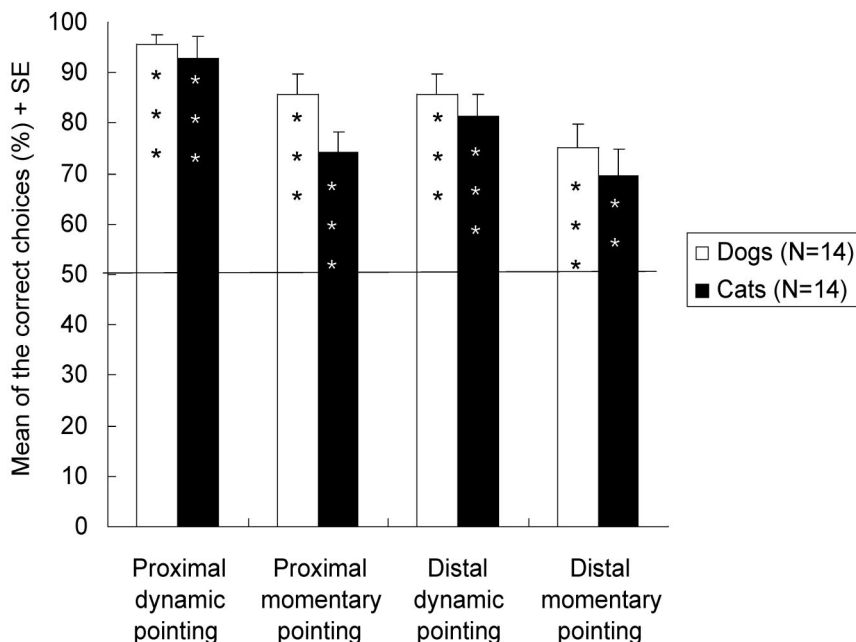
Figure 1. Choice performance of dogs and cats in the case of different pointing gestures. The solid line represents the chance level. The asterisks within the bars refer to the significant differences (one-sample Wilcoxon's test) from the chance level (**$p < .01$, ***$p < .001$). Proximal dynamic pointing: dogs, $T(+) = 105.0$, $p < .001$; cats, $T(+) = 105.0$, $p < .001$; proximal momentary pointing: dogs, $T(+) = 91.0$, $p < .001$; cats, $T(+) = 66.0$, $p < .001$; distal dynamic pointing: dogs, $T(+) = 91.0$, $p < .001$; cats $T(+) = 78.0$, $p < .001$; distal momentary pointing: dogs, $T(+) = 66.0$, $p < .001$; cats, $T(+) = 63.5$, $p < .01$.

human-based cueing in cats and dogs, although we should note that the gestures used were relatively simple and might have been familiar to all subjects.

Experiment 2

Two earlier studies have established that dogs show a tendency to gaze at the human's face when confronted with an unsolvable problem situation. Witnessing the hiding of food in an inaccessible place, dogs showed increased gazing toward the naive owner and other forms of attention-getting behaviors (e.g., vocalization) in comparison to the control situation when no food was hidden or the owner was not present (Miklósi et al., 2000). In another study, dogs and socialized wolves have been trained to pull out from a cage a rope with a piece of meat attached to its end (Miklósi et al., 2003). Dogs, in contrast to socialized wolves, increased their gazing time (and decreased their latency of looking) toward the human when they were prevented from pulling out the rope, which was fastened imperceptibly to the cage. In this and other cases, humans usually interpret the gazing behavior of the subjects as a communicative signal, and they act appropriately by providing help to solve the problem. The present experiment compares the behavior of dogs and cats in a similar problem situation to find out whether species-specific differences or environmental factors have a greater influence on the emergence of human-oriented communicative behavior, like gazing, in these domesticated species.

Method

Subjects

Four different groups of subjects were established according to the species and rearing conditions:

Cat alone: Cats living without a dog ($n = 7$: 3 neutered males, 2 spayed females, 1 unneutered male, and 1 unspayed female; mean age $+ SD = 3.70 + 3.21$ years, range $= 0.3–10$ years). Six of these cats also participated in Experiment 1.

Dog alone: Dogs living without a cat ($n = 7$: 4 unneutered males and 3 unspayed females; mean age $+ SD = 5.36 + 2.19$ years, range $= 2–9$ years). Six of these dogs also participated in Experiment 1.

Cat with dog: Cats living with a dog ($n = 7$: 3 neutered males, 1 spayed female, and 3 unspayed females; mean age $+ SD = 6.93 + 3.39$ years, range $= 4–13$ years). Five of these cats also participated in Experiment 1.

Dog with cat: Dogs living with cats that were members of the third experimental group ($n = 7$: 4 unneutered males, 2 unspayed females, and 1 spayed female; mean age $+ SD = 7.36 + 4.21$ years, range $= 2–13$ years). Six of these dogs also participated in Experiment 1.

Procedure

Solvable trials. The training and testing took place in one room of the owner's flat. For the cats, we placed three small stools (9.5 cm in height, 25.5 cm in length, 12.5 cm in width) at least 1 m apart, and we tied a commercial plastic butter pot (9.5 cm in diameter, 5.5 cm in height) to each stool with a 50-cm-long white thread (see Figure 2). The trial started when the experimenter placed a piece of food in either butter pot in the presence of the subject but in the absence of the owner and placed the butter pots in front of the stools. The subject was allowed to observe the baiting process, but it was prevented from eating the food. The experimenter took the subject from the room (she took out the cats in her arms, and she gently directed the dogs out of the room), and after a few seconds she called the subject and the owner back into the room. In the presence of the owner and the experimenter, the subject was allowed to move freely around until it
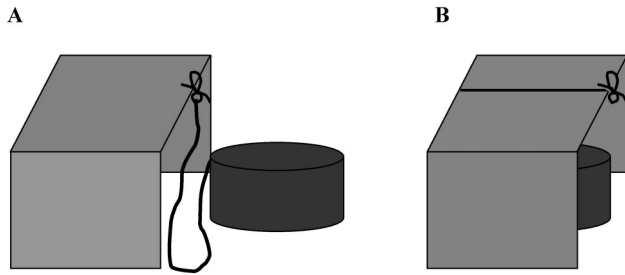
Figure 2. A: Arrangement of the stool used with cats in the problem-solving task in the solvable trials. B: Arrangement of the stool in the unsolvable trial.

obtained the food. The trial was terminated as soon as the subject took out the food from the butter pot. The same procedure was repeated three times in succession; there was approximately a 1-min pause between the trials, which lasted for a maximum of 25 s. For the dogs, three plastic dinner cans (16 cm in diameter, 8 cm in height) were used, which were placed in front of three different pieces of furniture in the solvable trials. The baiting procedure and letting the subjects eat the food from the cans were the same for the dogs as they were for the cats.

Unsolvable trial. In the final unsolvable trial, after hiding the food in the presence of the subject, the experimenter made a loop with the thread around the stool when the subject was outside the room. As a consequence, pulling at the butter pot did not result in the butter pot emerging from beneath the stool. After the stabilization of the butter pot, the subject and the owner were called in and the subject had 1 min to solve the problem situation in the presence of the owner and the experimenter. Cats and dogs were tested similarly; however, for the dogs, three plastic dinner cans (16 cm in diameter, 8 cm in height) were placed under the piece of furniture (9–13 cm away from the bottom edge of the piece of furniture) in this trial.

During the trials, both the owner and the experimenter were present and standing at the same distance (approximately 1 m) from the bowl. One of them was directed to stay on the left side of the subject opposite the other human on the right. This was done to facilitate the determination of the looking direction of the subjects. Both solvable and unsolvable trials were recorded on video and were analyzed later.

Observed behavioral variables

Poking (s): Time spent poking the pot containing the hidden food with leg or nose.

Near food (s): Time spent sitting or standing next to the pot containing the hidden food (in a distance of one body length) without trying to get the food.

Gazing at food (s): Time spent gazing at the pot containing the hidden food from any distance without trying to get the food.

Latency of gazing at the owner and the experimenter (s): The latency of the first gaze toward humans.

Gazing at the owner and the experimenter (s): Time spent gazing at the owner or the experimenter.

Gaze alternations: The number of gazes at the owner or the experimenter, followed directly by a gaze at the pot containing the food within 2 s, or vice versa.

All behavioral variables were found not to differ from normal distribution (Kolmogorov–Smirnov test); therefore, parametric analyses were used.

It should be noted that at the beginning of the experiment, we also considered recording other communicative behaviors in our subjects. In

similar situations, dogs have been observed to vocalize (e.g., Miklósi et al., 2000), or they are often reported to poke humans (by using their nose). There are also similar observations of cats using vocalization or body rubbing (Bradshaw & Cook, 1996). However, in our sample, only 2 cats (14%) used rubbing, 1 cat (7%) used meowing during the unsolvable trial, and only 3 dogs (21%) vocalized. Therefore, we decided to restrict our analysis of communicative behaviors to the visual mode.

Apart from the principal coder (G. L.), a naive observer coded the behavior of 2 dogs and 2 cats on the basis of the list of behavioral units described above by looking at the videotapes. The calculation of the kappa coefficient yielded the following values: for poking, the percentage agreement was 100% ($\kappa = 1$); for *near food,* the percentage agreement was 100% ($\kappa = 1$); for gazing at food, the percentage agreement was 100% ($\kappa = 1$); for gazing at owner, the percentage agreement was 97.9% ($\kappa = .95$); and for gazing at experimenter, the percentage agreement was 100% ($\kappa = 1$).

Results and Discussion

All animals were very successful in finding the food in the solvable trials. Most of them went more or less directly to the food dish, never looked at the owner or experimenter, and began eating. As a consequence, we restricted our behavioral analysis to the unsolvable trial only. We found that the family environment had no significant effect on the cats' and dogs' behavior; there was no significant difference between cats living alone or living with dogs; and similarly, such an effect was lacking in the case of dogs. Again, two groups with different living experiences were pooled together for further analysis. The comparison of the behavior displayed by cats and dogs in the unsolvable trial showed that there was no significant difference in the duration of time spent near the place of food or gazing at the location of food, but cats spent significantly more time poking than did dogs (see Figure 3 and Table 1).

In contrast, dogs were gazing earlier and for a longer duration at their owners when faced with an unsolvable situation in comparison to cats (see Figure 4 and Table 1). Further, we found significant differences in the number of gaze alternations: Cats displayed gaze alternation between the hidden food and the human at a lower frequency than did dogs (see Figure 5). In addition, we found that 12 dogs (85%) and only 6 cats (42%) displayed gaze alternation between the hidden food and the human. We found it interesting that dogs seemed also to gaze differently toward the humans present. Usually they oriented their first gaze toward the owner and
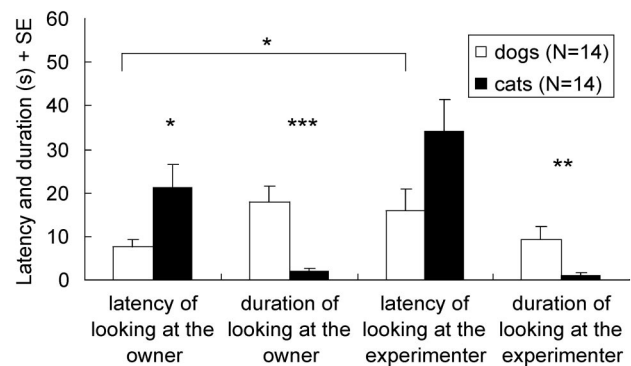
Figure 3. Latency and duration of gazing behavior in cats and dogs during the unsolvable trial in the problem-solving task ($M + SE$). $*p < .05.$ $**p < .01.$ $***p < .001.$

Table 1

Comparison of Behavioral Variables in Experiment 2 When Subjects Faced an Unsolvable Problem Situation

Variable	$F(1, 26)$	p	
Trying to get the hidden food	6.49	.05	cat > dog
Being next to the hidden food	0.09	.75	cat = dog
Gaze alternations	17.36	.01	cat < dog
Latency of looking at the owner	6.14	.05	cat > dog
Duration of looking at the owner	28.85	.01	cat < dog
Latency of looking at the experimenter	2.87	.10	cat = dog
Duration of looking at the experimenter	10.08	.01	cat < dog
Looking at the hidden food	1.81	.19	cat = dog

gazed only later at the experimenter; differences of gazing latencies to owner vs. experimenter, $t(13) = -2.04$, $p < .05$. No such difference could be found in the case of cats.

General Discussion

The present study found both similarities and differences in interspecific communication in the feeding context in dogs and cats. Although both species seem to show comparable performance ability to use human gestural cues as directional signals, there are differences in behaviors in a different context when the subject can freely display patterns of behavior in a social feeding situation. Whereas dogs tended to look at the human and back to the hidden food when they were unable to get the reward themselves, the cats did not give up as easily, trying to get the food themselves and seldom looking at the human's face.

We should note that we are aware that a limitation of this study was that the naturalistic setting prohibited us from excluding all environmental variables that might have influenced some differences between cats and dogs. Therefore, the approach used here should be viewed as a first approximation to the comparative behavioral analysis of dogs and cats. We think that our design of the experiments is comparable to those applied in ape–human comparisons when, for example, the behavior or performance of captive and more or less socialized chimpanzees are compared
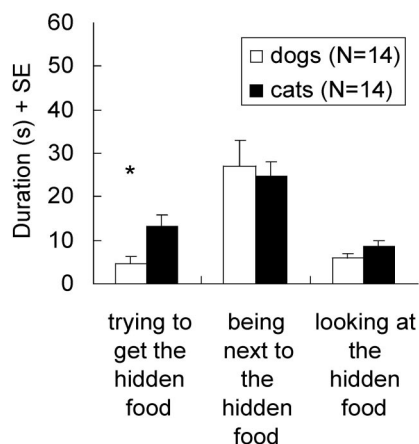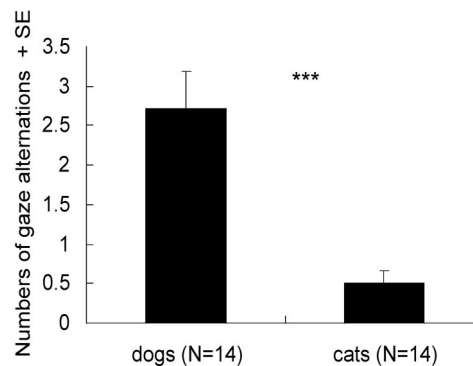

Figure 5. Number of gaze alternations in cats and dogs during the unsolvable trial in the problem-solving task ($M + SE$). ***$p < .001$.

with that of children (e.g., Povinelli, Reaux, Bierschwale, Allain, & Simon, 1997; but see Call & Tomasello, 1996, for a discussion).

Recent observations have shown that members of various species are able to rely on human cueing in directing their behavior in a choice situation. There is now evidence that seals (Scheumann & Call, 2004; Shapiro et al., 2003) and goats (Kaminski et al., 2005) with restricted human social contact and some training can also rely on this cue in the two-object choice test, and the basic ability seems to also be present in monkeys if they are raised in an appropriate social environment and receive formal training (Kumashiro, Ishibashi, Itakura, & Iriki, 2002). Therefore, the relative good performance of cats in this study presents no surprise. However, such species comparisons reveal only species abilities for learning but not whether these abilities are put to work in natural environments. In such comparisons, it is often implicitly assumed that, for example, learning such human cues provides evidence of the role of learning in a communicative context when the individual interacts with a member of its own species. Along these lines it could be said that when dogs and cats learn human cueing, they rely on a mechanism originally dedicated to learning communicative signals emitted by conspecifics. Alternatively, such performances could come about on the basis of a general learning ability associating observable events in the environment with rewarding outcomes.

The advantage of the present study and a previous one comparing performance of dogs with individually socialized wolves (Miklósi et al., 2003) was that all subjects were raised in comparable environments along with comparable social stimulation provided by humans. We have found that socialized wolves still perform at chance levels with the pointing gestures in comparison to dogs. To explain the differences in performance between individually socialized wolves and dogs in the light of positive results with seals (Tschudin et al., 2001) or dolphins (Herman et al., 1999), we must infer that the main difference lies not in cognitive differences in learning communicative cues but in other auxiliary behavioral mechanisms that enable or restrict such learning to take place but can be "overridden" in some cases by special forms of training. In the case of the wolf and dog, Miklósi et al. (2003) suggested that the inferior performance of wolves could be explained on the basis of their avoidance to gaze at humans in spontaneous situations. It is interesting to note that a monkey trained for extended eye contact with humans has been shown to subsequently perform much better when it has to rely on human pointing gestures as its

Figure 4. Behavior of cats and dogs during the unsolvable trial in the problem-solving task ($M + SE$). *$p < .05$.

cue (Kumashiro et al., 2002). The difference in eye-gazing patterns between dogs and cats could also be explained by a different history of domestication. One could also assume that cats have not been selected for preferring eye contact with humans to exploit this form of social interaction as a potential source of information, and they rather avoid gazing into the eyes of the humans, similar to wolves.

We should also note that dogs and cats could have been familiar with most forms of pointing gestures used in the present experiment. Other studies have collected data that show some animals can also use different, partly novel forms of the pointing gesture that suggest some ability for generalization on the part of the subjects. For example, in cross-body pointing the opposite arm is used for indication of the correct location, and therefore the appearance of the signal becomes different. It has been shown that dogs (Soproni et al., 2002), a seal (Shapiro et al., 2003), and dolphins (Herman et al., 1999) perform well with cross-body pointing, whereas at present we know of no such evidence in chimpanzees. In our case, the comparable performance of dogs and cats supports the hypothesis that if exposed to the human environment, members of both species are able to develop skills that enable them to react to human behavior in social contexts.

The performance of animals in the pointing comprehension task is often discussed in the framework of discrimination learning. It has been repeatedly claimed that successful performance is the result of rapid learning. We would not like to refute that learning plays a role in the emergence of this ability, but its influence is more complex than often assumed. First, in a study with socialized wolves, Miklósi et al. (2003) found that extensive human contact (with unlimited possibilities for experience and learning) in itself was insufficient for good performance in a task similar to that used here. Second, the trial order of the pointing experiment was designed to minimize the chances of learning, and we did not find evidence for learning over the trials and tests, which is actually in agreement with findings of others (goats: Kaminski et al., 2005; chimpanzees: Povinelli et al., 1997; seals: Scheumann & Call, 2004). If one or the other species showed rapid learning, then one would expect some improvement over the testing trials. Third, although a learning experiment was outside the scope of this study, such experiments with chimpanzees (Povinelli et al., 1997) could only achieve moderate increases in performance. Fourth, there is evidence that if nonsocial cues (e.g., red balls) are used for discrimination in similar settings, neither dogs (Agnetta, Hare, & Tomasello, 2001) nor chimpanzees (Jenkins, 1943) are able to learn the discrimination task.

In contrast to the similar ability of reading human signals in cats and dogs, we found important differences when their behavior was observed in a problem situation. We assume that such situations occur often in the life of these animals because of their restricted means of solving problems on their own in a complex human environment (e.g., opening a refrigerator, etc.). In this situation, one possibility for our subjects would be to try to manipulate the behavior of the humans by various behaviors directed at them— that is, they could learn that certain behaviors directed at humans have beneficial outcomes. This strategy could be useful because owners are very sensitive to the behavior of their pets.

It should be stressed that we tried to account for possible differences of diverse human influence on the two species. Such differences could come from two sources. First, cat and dog owners could differ psychologically—that is, they could be differ-

ent in some aspects of their personality. Cat owners often report that they like their pet because it has an independent personality, whereas dog owners often prefer dogs for showing unconditional love. To minimize such differences, we included families that had both cats and dogs living in their flats. It is interesting, however, that we did not find behavior differences between these animals and their conspecific mates living alone in a human family.

Second, humans can react differently to dogs and cats just because they perceive members of the two species differently. However, if true, this would suggest that even under similar circumstances, the two species would display different behavioral strategies that could be recognized by humans. We think that by using the feeding context for testing, we made the situation the most comparable for both species because feeding is a general daily activity, both cats and dogs have ample experience in this regard, and we could also assume that humans show relatively few behavioral differences on the basis of the species fed.

Our results showed that dogs gazed earlier and more frequently at the humans than did cats; nevertheless, cats did not avoid gazing at humans in general (see also Bradshaw & Crook, 1996). Further, there is also some evidence that cats tried to solve the problem for longer time periods. One could argue that cats are predisposed to more persistent problem solving—that is, they do not give up as easily. This could be explained either by referring to their solitary predatory behavior or by differential experience in the human household. However, Miklósi et al.'s (2003) results on socialized wolves contradict this explanation. Despite the fact that wolves are known social hunters and these individuals were raised in human families, their behavior in a similar situation was comparable to that of cats in the present study. Therefore, the lack of frequent and early glances at the humans can be a common sign of relative independence from humans in both socialized wolves and domesticated cats.

Another line of arguments relies on the suggestion that the difference lies in the way dogs and cats use gaze contact with humans. In their research on wolves, Miklósi et al. (2003) suggested that during the course of domestication, dogs have been selected for increased willingness to gaze at humans, capitalizing on the fact that gazing behavior also plays a crucial role in human-to-human communication, so dogs could use this communicative channel for interaction with humans. Alternatively, dogs that were better at finding out about human behavior (by monitoring human gazing; see also Topál, Miklósi, & Csányi, 1997; Virányi, Topál, Gácsi, Miklósi, & Csányi, 2004) were also at advantage in early human settlements for finding food and protection. One could assume that it has been more characteristic for dogs to obtain their food (leftovers, etc.) as a product of some human activity, (eating) whereas cats have habitually found their food independently by hunting.

Finally, our results may suggest that the difference for preference of eye contact with humans might contribute to the differences in trainability encountered in cats and dogs. Although both species show evidence of flexible learning, in general dogs seem to be much easier to train (Naderi, Miklósi, Dóka, & Csányi, 2001; Pongrácz et al., 2001). We would suggest that this difference is exaggerated by the species-specific difference in gazing behavior. Because training by humans usually involves many communicative signals (gazing, verbalization, etc.) and relies on a similar type of feedback from the individual being trained, dogs have a natural

advantage in this case by relying predominantly on the same visual signals by using frequent exchanges of gazing.

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