

Domestic Dogs (*Canis familiaris*) Are Sensitive to the Attentional State of Humans

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Twelve domestic dogs (*Canis familiaris*) were given a series of trials in which they were forbidden to take a piece of visible food. In some trials, the human continued to look at the dog throughout the trial (control condition), whereas in others, the human (a) left the room, (b) turned her back, (c) engaged in a distracting activity, or (d) closed her eyes. Dogs behaved in clearly different ways in most of the conditions in which the human did not watch them compared with the control condition, in which she did. In particular, when the human looked at them, dogs retrieved less food, approached it in a more indirect way, and sat (as opposed to laid down) more often than in the other conditions. Results are discussed in terms of domestic dogs' social-cognitive skills and their unique evolutionary and ontogenetic histories.

Domestic dogs are in many ways a unique animal species. According to recent genetic analyses, they have been under human domestication for something on the order of 100,000 years—longer by several orders of magnitude than any other domestic species (Vilà et al., 1997). The artificial selection regimes used with dogs are many and various, but most of them contain relatively intense social interaction with humans in one form or another. It is conceivable that dogs may have evolved some special predisposition for interacting with and communicating with humans (Lorenz, 1964; Miklósi, Polgárdi, Topál, & Csányi, 1998; Mitchell & Thompson, 1986).

Recent research on dogs' communication with humans has indeed revealed some complex social-cognitive skills. Miklósi et al. (1998); Hare, Call, and Tomasello (1998); and Agnetta, Hare, and Tomasello (2000) each set up situations in which a human hid food in one of several distinct locations and then gave a cue to the dog to indicate where the food was hidden, with several different kinds of control procedures used to ensure that subjects could not locate the food without such a cue (e.g., by smell). Across the three studies, the majority of dogs were able to use several different cues to locate the hidden food at above chance levels: (a) a human pointing to the target location, (b) a human gazing to the target location (head and eyes oriented to target, either dynamically or statically), (c) a human bowing or nodding to the target location, and (d) a human placing a marker in front of the target location. Although glancing (without head direction) was the hardest cue for dogs to follow, some dogs spontaneously (McKinley & Sambrook, 2000) or after some training (Miklósi et al., 1998) were capable of using this cue.

Agnetta et al. (2000) found that puppies under 6 months of age with little experience with humans were as skillful as adults in this basic object-choice task (see also Hare & Tomasello, 1999) and that arctic wolves do not seem to show similar skills in interacting with humans. Miklósi, Gácsi, Kubinyi, Virányi, and Csányi (2002) have also shown that dog and wolf pups raised by humans under comparable conditions differ in their ability to follow human signals. Dogs, unlike wolves, follow human signals such as pointing. Therefore, dogs (raised with and without human interaction) follow human cues from an early age, whereas wolves (raised with and without human interaction) do not follow human cues. Non-human primates are also not nearly as good as dogs in this task. Although many primates follow conspecific gaze direction to outside targets (Tomasello, Call, & Hare, 1998), and at least chimpanzees seem to know what conspecifics can and cannot see (Hare, Call, Agnetta, & Tomasello, 2000), several primate species, including chimpanzees, fail to use human cues effectively in the object-choice task (or require large amounts of training to do so; see Call & Tomasello, in press, for a review). Together, these results suggest that dogs' skills in communicating with humans may reflect a predisposition that arose relatively recently after, and perhaps as a result of, domestication and contact with humans.

The psychological mechanisms underlying dogs' skills in the object-choice task are far from evident. In particular, understanding precisely what the human is seeing as he or she gestures or looks toward the target location is not necessary to follow his or her directions in this "cued foraging" situation. Thus, despite their successful performance, it is unclear whether dogs in this task are demonstrating an understanding of the visual experiences of others. Most dogs are not skillful when the only cue given is eye direction in the absence of any accompanying head or body orientation, which lends credence to this interpretative possibility. It is also relevant that no dog in the study by Agnetta et al. (2000) reliably followed human gaze direction into empty space the way that nonhuman primates and human children do routinely, suggesting that dogs are not interested in (or perhaps are unable to comprehend) what humans are seeing outside of the cued foraging game—in which they know ahead of time that desirable food resides in one of a few possible hiding locations. Finally, it must

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be noted that dogs have been specifically selected for their predisposition to attend and follow human vocal or gestural cues to specific locations (herding dogs, hunting dogs, retrieving dogs, etc.), without necessarily requiring any knowledge of the human's visual experience. Consequently, to answer the question of whether dogs are sensitive to the attentional states of humans in a particular situation, researchers need to develop a different experimental paradigm (i.e., other than the object-choice task).

In the current study, therefore, we attempted to assess directly whether dogs were sensitive to the attentional states of humans, particularly regarding the role of the eyes and body orientation during social interactions. Twelve domestic dogs of various breeds were given a task modeled after Call and Tomasello (1994). In that study, 2 orangutans gesturally indicated for a human which one of two containers they wished to have the contents of. Sometimes the human was facing them attentively, sometimes he or she had his or her back turned, sometimes he or she had his or her eyes closed, and sometimes he or she was out of the room completely. Both orangutans gestured more often when the human was facing them compared with when the human had his or her back turned or was out of the room. One of the orangutans—that had been raised from infancy by humans and so had much more communicative experience with them—gestured more often when the human was facing him with eyes open than with eyes closed; the other did not. In a similar but somewhat different series of studies, Povinelli and Eddy (1996) found that chimpanzees did not discriminate between a human with eyes open and eyes closed.

The method of the current study was extremely simple. In a small room, a human placed food on the floor and forbade the dog subject from taking it (all dogs had had some form of prohibition training from their owners previously). She then left the room, stayed in the room facing the dog with eyes open, stayed in the room and sat in a chair facing the wall (back turned to the dog), sat in the chair facing the dog but with eyes closed, or sat in the chair facing the dog but engaged in a distracting activity. If the dogs were sensitive to the human's attentional state in this situation (given that they wanted the food but did not want to be punished), they should have behaved differently when the human was facing them with eyes open than when she was out of the room, facing the wall, distracted, or had her eyes closed.

Method

Subjects

Twelve dogs (*Canis familiaris*; 8 females and 4 males) of various breeds and ages (range = 1–9 years old) participated in the study (see Table 1). Dogs were recruited through personal contacts. All subjects had been living as pets with their owners all of their lives, except Dona, who had been abandoned and lived in an animal home for about 3 months. None of the dogs had ever received special training beyond the normal obedience training typical for domestic dogs. They all obeyed the experimenter when she forbade them to take food and also readily took food pieces when allowed to do so. Subjects were not food deprived during the experiment, but they were always interested in food treats offered by the experimenter. Four dog owners (those for Jule, Mora, Eva, and Luna) were informed about the purpose and methods of the study when they requested this information and were asked not to train their dogs on the experimental tasks while the study was in progress.

Table 1
Subjects Included in the Study

Subject	Breed	Gender	Age (years)
Ben	Mongrel (briard and mongrel mix)	Male ^a	2.5
Butch	Mongrel (German shepherd and rottweiler mix)	Male	1.0
Dona	Mongrel (Doberman and mongrel mix)	Female	5.0
Jule	Labrador retriever	Female	1.0
Linda	Mongrel	Female	9.0
Mora	Mongrel (German shepherd and mongrel mix)	Female	3.0
Sissi	German shepherd	Female	2.0
Salim	Mongrel (giant schnauzer and dalmatian mix)	Male	2.0
Eva	German wire haired pointer	Female	6.0
Luna	German shepherd	Female	3.0
Spencer	Mongrel (German shepherd and mongrel mix)	Male ^a	5.0
Linda2	Mongrel	Female	2.0

^a Castrated.

Materials

Testing took place in one of three quiet rooms (2.9 m × 4.7 m or 2.3 m × 4.9 m) in which there was a video camera positioned opposite to the door. There was also a chair to the right of the door, with its back to the wall and facing into the room. Throughout testing, dogs interacted with the same experimenter whom they had met shortly before testing began. Small pieces of dry dog food were used as rewards.

Procedure

Dogs were tested individually between April 2000 and June 2001 and received two experiments administered in counterbalanced order to assess the potential carryover effects across experiments. Three of the dogs (Ben, Jule, and Mora) received Experiment 1 first, and three of them (Butch, Dona, and Linda) received Experiment 2 first. The other dogs (Luna, Eva, Sissi, Salim, Spencer, and Linda2) just received Experiment 2. Experiment 1 tested whether dogs behaved differently when the experimenter either stayed in or left the room (and whether they responded to verbal commands that either forbade or allowed them to take the food). Experiment 2 tested whether dogs behaved differently depending on the experimenter's attentional state—in this experiment, the experimenter always stayed in the room. The experimenter's body orientation (facing dog or back to the dog), whether her eyes were open or closed, and whether she was engaged in another task (i.e., distracted) were varied across trials.

The procedure for Experiment 1 was as follows. The experimenter brought the dog inside the experimental room and placed a piece of food on the floor. She then looked at the dog, said "Aus!" (which in this context means "Don't take it!"), called the dog's name, and said "Aus!" again. The dog was always attentive and looked at the person or the food. Then the experimenter behaved differently depending on the experimental condition.

Out forbid condition. The experimenter left the room immediately without saying anything.

In forbid (control) condition. The experimenter sat straight on the chair and looked at the dog without moving her body. If the dog moved, she very slowly tracked the dog with her head and gaze.

Out take condition. The experimenter said either "Geh ab" or "Da nimm's" (which in this context means "You can take it") and left the room. The use of either "Geh ab" or "Da nimm's" depended on which term was more familiar to each of the dogs.

In take condition. The experimenter sat straight on the chair, said either “Geh ab” or “Da nimm’s” (“You can take it”), and looked at the dog without moving her body. As before, if the dog moved, she very slowly tracked the dog with her head and gaze.

The trial was concluded after the dog took the food in the in forbid or in take conditions or after 180 s elapsed in the other conditions. The experimenter reentered the room (if she was outside), retrieved the food from the floor (if it was still there), and led the dog outside of the experimental room. At no point during the trial or after the trial was concluded did the experimenter react to the dog’s actions. That is, she refrained from praising the dog for not taking the food or punishing the dog for taking it.

The procedure for Experiment 2 was similar to that of Experiment 1 (see Figure 1). The experimenter brought the dog inside the experimental room and placed a piece of food on the floor while she looked at the dog and said “Aus!, [the dog’s name], Aus!” Then the experimenter sat on the chair and engaged in one of the four following conditions.

Eyes open condition. The experimenter sat facing the food with her eyes fully opened and looked at the dog. If the dog moved, she followed the dog with the eyes. This condition was identical to the in forbid condition from Experiment 1.

Distraacted condition. The experimenter sat facing the food while playing a handheld computer game that produced a soft audible melody to which dogs did not respond in any appreciable way. The experimenter played this game during the whole trial and did not look at the dog at all.

Eyes closed condition. The experimenter sat facing the food with her eyes closed. Her head orientation and posture were identical to those in the eyes open condition.

Back turned condition. The experimenter sat facing away from the food with her back turned to the food. The chair remained in the same orientation as in the other trials.

The trial ended after 180 s when the experimenter got up and took the food if it was still there and led the dog outside of the experimental room. At no point during the trial or after the trial was concluded did the experimenter react to the dog’s actions. That is, she neither praised the dog for not taking the food nor punished the dog for taking it.

Dogs received eight trials per condition in each of the two experiments. Each condition occurred only once per day, and the order of presentation of the conditions was counterbalanced across sessions. Thus, eight sessions were needed to complete each experiment. The dogs were tested not more than four times a week. All trials were videotaped from a location opposite to the room’s door.

As previously indicated, the experimenter did not react contingently to the dog’s behavior either during the trial or after the trial was concluded. To avoid the situation that dogs would learn to take the food regardless of whether this was forbidden (because there was no punishment during the

test), we implemented one training trial at the end of each day of testing. The training consisted of a single 120-s trial in which the experimenter placed a piece of food on the floor and forbade the dog to take it (“Aus!”). If the dog attempted to take the food during the trial, the experimenter punished it verbally and prevented it from taking it. After the 120 s had elapsed, the dog was verbally encouraged to take the food. This training trial always took place after completing the four experimental trials in a session. Therefore, overall each dog received four experimental trials and one training trial per session.

Scoring

The following variables were scored for each trial: (a) whether the subject took the food, (b) the approach route to the food, (c) the latency to take the food (Experiment 2 only), and (d) the dog’s posture (Experiment 2 only). The determination of whether dogs took the food (and its associated latency) was completely unambiguous. To find out whether dogs used different approach routes to the food, we distinguished two categories: direct and indirect (see Figure 2). If dogs took the shortest path to the food from their current location, it was coded as a direct approach; otherwise, it was coded as an indirect approach. Finally, we used continuous recording to assess the duration of each of the following four postures: lay (the dog’s legs laid flat on the ground while the head could rest on the ground, legs, or remain off the ground), sit (the dog’s forelegs were extended and perpendicular to the ground while the hind legs were flexed with the tarsus resting flat on the ground), stand (all legs were extended and perpendicular to the ground), and move (the dog displaced its body from one location to another by alternately moving its legs more than two steps). Moreover, when the dog was not visible, we scored it as out of camera. A posture was scored only if it lasted 2 s or more. For each trial in Experiment 2, we calculated the percentage of time spent in each posture out of the total time available in each trial.

One of the authors (Juliane Bräuer) scored all trials from the videotapes. Another of the authors (Juliane Kaminski) and a third naive observer who did not know the purpose of the study scored a randomly selected sample of trials (26%) to assess interobserver reliability for the type of approach route and the dog’s posture during the trial. Reliability between the two authors (approach route, Cohen’s $\kappa = .73$; posture, mean Spearman $r = .97$) and between the author (Juliane Bräuer) and the naive observer (approach route, Cohen’s $\kappa = .67$; posture, mean Spearman $r = .90$) was good. We did not calculate reliability for whether dogs took the food because it could be determined without ambiguity. Throughout the article, we use two nonparametric statistical tests (i.e., Friedman and Wilcoxon tests) to compare across conditions. All statistical analyses concerning the amount of food taken were one-tailed because it was predicted that dogs



Figure 1. Procedure for Experiment 2 in the back turned condition. The experimenter placed food on the ground and forbade the dog to take it (A) and then sat on a chair with her back turned to the dog (B), and the dog took the food (C).

A



B



Figure 2. Two sequences showing a direct (A) and an indirect (B) approach to the food.

would take more food in those conditions in which the experimenter was not attending compared with the control condition (in forbid, Experiment 1; eyes open, Experiment 2). All other statistical analyses, including those on approach route, latency, and posture, were two-tailed because there were no a priori predictions.

Results

Experiment 1

Table 2 presents the number of food pieces taken in the different conditions of Experiment 1. There were significant differences across conditions, Friedman test, $\chi^2(3, N = 6) = 16.85, p = .001$. Subjects took significantly less food pieces in the in forbid (con-

trol) condition compared with all other conditions, $T(N = 6) = 21, p = .016$, in all cases. Moreover, there were no significant differences among the three experimental conditions ($N < 2, ns$, in all cases).

Figure 3 presents the percentage of indirect approaches to the food. Although there was a greater percentage of indirect approaches in the in forbid condition than in the other conditions, this difference was not statistically significant ($N = 2, ns$, in all cases). There were very few trials in which subjects took the food while the experimenter was inside the room.

Table 2
Number of Food Pieces Taken (Out of 8 Possible) in Each Condition of Experiment 1

Subject	Condition			
	In forbid (control) ^a	In take ^b	Out forbid ^c	Out take ^d
Ben	1	8	7	8
Butch	0	8	8	8
Dona	2	8	8	8
Jule	1	8	8	8
Linda	2	8	8	8
Mora	2	8	8	8

^a $M = 1.3, SE = 0.3$. ^b $M = 8, SE = 0, p < .001$. ^c $M = 7.8, SE = 0.2, p < .001$. ^d $M = 8, SE = 0, p < .001$.

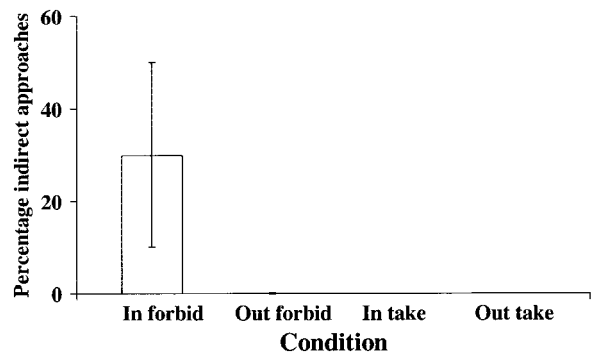


Figure 3. Mean percentage of indirect approaches in Experiment 1. Error bars represent standard errors.

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Experiment 2

Table 3 shows the number of food pieces taken by the subjects in the different conditions in Experiment 2. There were significant differences across conditions, $\chi^2(3, N = 12) = 11.09, p = .011$. Subjects took significantly less food in the eyes open (control) condition than in the distracted, $T(N = 8) = 34, p = .012$; eyes closed, $T(N = 10) = 52, p = .005$; and back turned conditions, $T(N = 10) = 52, p = .005$. Moreover, there were no significant differences in the number of food pieces taken across the three experimental conditions, $\chi^2(2, N = 12) = 1.17, p = .56$.

To assess the effect of learning over trials on the amount of food retrieved, we compared the amount of food taken in the first and the last four-trial block for each of the four experimental conditions. There were no significant differences between blocks for any of the four conditions: eyes open, $T(N = 9) = 27, p = .33$; distracted, $T(N = 11) = 39, p = .32$; eyes closed, $T(N = 10) = 38, p = .16$; back turned, $T(N = 9) = 33, p = .13$; all one-tailed.

We analyzed two additional variables for those trials in which dogs took the food. First, we analyzed the percentage of indirect approaches to the food in the different conditions (see Figure 4). There were significant differences across conditions, $\chi^2(3, N = 12) = 10.09, p = .018$. Subjects used an indirect approach significantly more often in the eyes open (control) condition than in the back turned, $T(N = 7) = 28, p = .016$, and eyes closed conditions, $T(N = 7) = 27, p = .031$. In contrast, there was no significant difference between the eyes open condition and the distracted condition, $T(N = 6) = 20, p = .063$.

Second, we analyzed the latencies to take the food in the different conditions (see Figure 5). There were significant differences across conditions, $\chi^2(3, N = 12) = 9.61, p = .022$. Although the latency in the eyes open condition was the largest of the four conditions, only the eyes closed condition was significantly different from the eyes open condition, $T(N = 11) = 56, p = .042$. There were no significant differences between the eyes open and the distracted, $T(N = 11) = 47, p = .24$, or back turned conditions, $T(N = 11) = 49, p = .17$.

Finally, there were 5 dogs (Ben, Linda, Salim, Eva, and Luna) that took as much food in the eyes open condition as in at least one

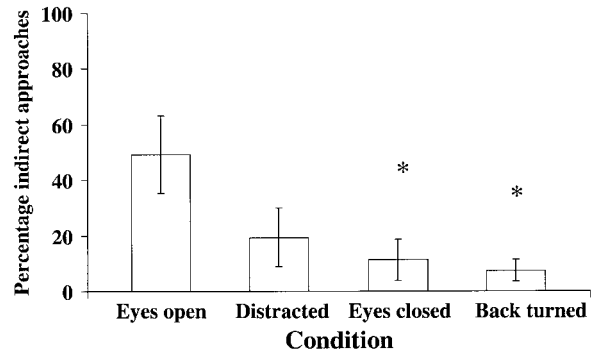


Figure 4. Mean percentage of indirect approaches in Experiment 2. Error bars represent standard errors. * $p < .05$.

of the other conditions. An additional dog (Sissi) took more food in the eyes open condition than in at least one of the other conditions. Therefore, we decided to investigate whether the dogs' postural behavior would indicate whether they perceived the experimenter's attentional state in the different conditions. There were significant differences across conditions in the percentage of time that these dogs spent sitting, $\chi^2(3, N = 6) = 11.80, p = .008$. In particular, dogs sat significantly more often when the experimenter was looking at them (eyes open condition) compared with the distracted, $T(N = 6) = 0, p = .031$, and back turned conditions, $T(N = 6) = 0, p = .031$. There were no significant differences between the eyes open and the eyes closed conditions, $T(N = 6) = 2, p = .094$.

Taken together, the current results show that dogs were highly sensitive to the experimenter's attentional state. In particular, either dogs retrieved less food when the experimenter was watching than when she was not, or if they retrieved the food, they used an indirect approach route. Moreover, those dogs who did not take less food when the experimenter was watching compared with other conditions nevertheless spent more time in an attentive posture (i.e., sit) and less time in a nonattentive posture (i.e., lay) when they were being watched.

Discussion

The results of the current study are clear. Dogs were sensitive to the attentional states of humans as they approached forbidden

Table 3
Number of Food Pieces Taken (Out of 8 Possible) in Each Condition of Experiment 2

Subject	Condition			
	Eyes open (control) ^a	Distracted ^b	Eyes closed ^c	Back turned ^d
Ben	1	1	2	3
Butch	2	4	3	4
Dona	1	3	4	2
Jule	0	1	3	1
Linda	1	1	1	2
Mora	4	6	7	8
Sissi	2	1	1	1
Salim	3	3	5	4
Eva	1	1	1	1
Luna	3	5	4	3
Spencer	3	4	6	5
Linda2	1	4	2	2

^a $M = 1.8, SE = 0.3$. ^b $M = 2.8, SE = 0.5, p < .01$. ^c $M = 3.3, SE = 0.6, p < .01$. ^d $M = 3.0, SE = 0.6, p < .01$.

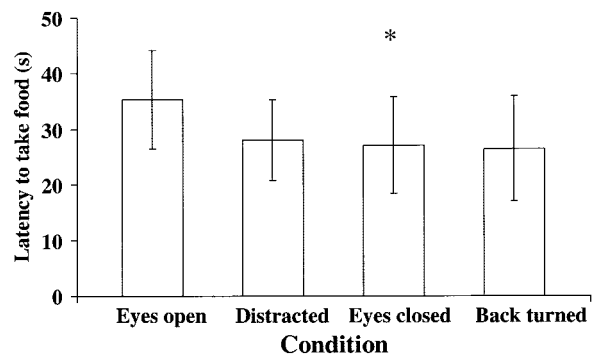


Figure 5. Mean latency (in seconds) to take the food in Experiment 2. Error bars represent standard errors. * $p < .05$.

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food. When the human looked at them, dogs retrieved less food, approached it in a more indirect way, and sat more often than in those conditions in which the human did not have visual access to the food. In contrast, there was no difference in the latency to take the food across conditions. Thus, it appeared as though dogs knew that the human could see them if she was looking at them and that she could not see them if she was out of the room, if her back was turned, if her eyes were closed, or if she was distracted by something. The implication of the eyes open versus eyes closed comparison, in particular, suggests that the dogs perceived the eyes as an important component in determining the attentional states of humans. Although one can argue that dogs might have used some other inadvertent cue by the experimenter (Clever Hans effect) rather than the state of the eyes to decide whether to approach the food, we think that this possibility is unlikely. First, we could not detect any cues provided by the experimenter. Second, several studies have documented the importance of the eyes in object-choice situations. In particular, dogs can use eye direction to successfully choose between two or more containers but, more importantly, fail to do so in control tests when the eyes are closed or not directed at the object (McKinley & Sambrook, 2000; Miklósi et al., 1998).

The mechanism responsible for the dogs' behavior is unclear. One possibility is that dogs merely respond to the presence of specific cues (e.g., open eyes directed at them). For instance, over the course of their experiences with humans, dogs have learned that punishment follows in certain situations (e.g., taking food after the human has said "Aus!") when the eyes of the human are open. In other words, the state of the eyes is a discriminative cue that informs dogs when it is safe to engage in certain behaviors in particular situations. This explanation is weakened to some extent by the results of the distracted condition in which the experimenter's eyes were open but dogs still behaved as if the experimenter could not see them, although head direction down toward the handheld computer may have helped dogs make this distinction.

A second possibility is that dogs do more than merely learn specific cues in specific situations. Instead, dogs may be able to use their past experiences to derive some knowledge about what humans are capable of seeing or not seeing. Lempers, Flavell, and Flavell (1977) used this argument to explain the performance of 2-year-old children in a battery of 24 showing and hiding tasks. Among other things, they found that children who were asked to show an object to an experimenter with his or her eyes covered by his or her hands placed the object between the eyes and the hands or removed the hands from the eyes before showing the object. When confronted with an experimenter with his or her eyes closed, most 2-year-old children placed the object closer to the observer's closed eyes, whereas most 2.5-year-old children opened the observer's eyes and then showed the object. These findings led these authors to conclude that children at this age have some knowledge about visual perception. Our current study presented dogs with far fewer situations than those used by Lempers et al. (1977), and therefore, it would be premature to conclude that dogs have some knowledge about visual perception in others. Nevertheless, the positive findings of this and other studies on object choice (Agnetta et al., 2000; Miklósi et al., 1998) and in free-play situations (Hare et al., 1998) lend some credence to this interpretation. Of particular interest, in the study by Hare et al. (1998), 2 dogs that ran to retrieve balls almost always returned them in front of the

human thrower—even when his or her back was turned to them when they returned, so that they had to circle his or her body to drop the ball where the human could see it. Future studies using additional novel problems should explore the precise mechanisms underlying dogs' behavior.

Although dogs took less food when the human was looking at them compared with other conditions, all dogs took the food at least in one trial while the human stared at them. It can be argued that this shows that the dogs did not really understand that the human was looking at them, otherwise they would have never taken the food in this situation. However, in the current experimental arrangement, the dog's options were extremely limited. Namely, the human was facing the dog across an empty room, with the food in the open and nowhere to hide. Despite these severe constraints, dogs approached the food in ways that further indicated their sensitivity to the human's attentional states: When dogs took the food, they followed indirect routes more often when the human was staring at them compared with the other conditions (see Figure 4). There are various hypotheses to explain the use of indirect routes. The repulse–dominance hypothesis states that dogs were simply avoiding the proximity of the human in the eyes open condition because she constituted an aversive stimulus. Thus, the indirect approaches and the crawling behavior observed in some dogs may be interpreted as signs of subordination. Although this hypothesis is supported by some trials in which dogs would circle around the food while moving away from the human (and the food), there were other trials in which the dog circled around the food but actually approached the human while moving away from the food.

A related hypothesis is that dogs were not avoiding proximity with the human but simply eye contact. Thus, when humans disappeared from view, dogs were more likely to engage in forbidden behaviors. This hypothesis is supported by the fact that some of the detours would take dogs to a position facing away from the human, thus making the human "invisible" when they took the food. However, it is also true that some dogs actually looked more (and in general were more attentive as measured by their posture) to the experimenter in the eyes open condition. Another hypothesis is that dogs used their gradual approach path to test whether humans would react to them closing on the food. It is conceivable that dogs were approaching the food gradually to gauge whether the human showed any reaction to their approach. Finally, there is the blocking hypothesis. In this case, the dog may have moved its body to a position facing away from the human and in front of the reward to block the human's visual access to the reward, thus occluding the reward collection with its own body. Currently, we cannot decide among these alternatives, and future experiments should be devoted to teasing them apart. Regardless of which of these four alternatives is correct, it is still the case that dogs adjusted their approaches and posture appropriately depending on the human's attentional state.

Comparison with the behavior of nonhuman primates is instructive. Nonhuman primates are not skillful in the object-choice task, perhaps because cooperative communication with others about monopolizable food resources is rare and therefore odd. In other studies, however, chimpanzees have shown good skills in determining what a conspecific can and cannot see as they compete with one another for food—which is a much more frequent and typical social interaction for members of this species (Hare et al.,

2000; Hare, Call, & Tomasello, 2001). By comparison, dogs are very skillful in the object-choice task, perhaps because such communication with humans is frequent and normal for them. Thus, it was possible that dogs would show the opposite pattern from chimpanzees across the two types of tasks.

The current study thus contributes to a growing body of research that a variety of animal species beyond nonhuman primates possess flexible social-cognitive skills, perhaps especially those concerning the understanding of the visual behavior of others. Recent studies have found that several different bird species are sensitive to the visual orientation of conspecifics (Heinrich & Pepper, 1998), and our own unpublished data (Kaminski, Riedel, Call, & Tomasello, 2003) suggest that domestic goats follow the visual gaze direction of conspecifics as well. Confining attributions of social intelligence to nonhuman primates is thus clearly incorrect (see Rowell & Rowell, 1993). There are still many unanswered questions, and future research on animal social cognition should thus be explicitly comparative and should attempt to establish the full range of social-cognitive skills for a wide range of animal species. It also remains to be determined what role individuals' social experiences (including with humans, when appropriate) play in the development of sensitivity to the attentional states of others and in social-cognitive development in general.

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New Editor Appointed for *Contemporary Psychology: APA Review of Books*, 2005–2010

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