Supplemental Online Material

Study 1: Are dogs more skilled than primates in using human social cues?

Materials and Method

Eleven adult and juvenile chimpanzees were tested. The chimpanzees live in a spacious facility (4533m²) at the Wolfgang Primate Research Center in the Leipzig Zoo, Germany. Eleven adult and juvenile dogs (Table 1) were recruited from families in and around Leipzig, Germany.

Both species were tested with the same apparatus consisting of a table with a number of moving parts. Two small, yellow cups (8cm diameter x 7.5cm) were placed .55m apart on a wooden food platform attached to the table. The platform could slide (25cm) across the table (45cm tall with 84cm x 32cm table top) toward the waiting subject. Also, a plastic occluder (.5m x 1m) was attached to the front legs of the table using metal drawer pulls. Therefore, the occluder could be pulled up (.5m) to hide the cups and table from the view of the subjects and subsequently pushed back down again, revealing the table and cups. During testing the subjects sat across the table, facing the experimenter. The chimpanzees were able to reach through oval holes (10cm x 5cm) in either side of the plexi windows and touch one of the cups. For the dogs the testing table was placed in an empty room and the dogs were instructed to sit across the table. The dogs could chose a cup by walking to one side of the table and touching a cup. Finally, two wooden blocks

(11cm x 7.5cm x 3cm) were painted white with black spots and could be place on top of one or both of the cups.

After a brief introduction to the apparatus, a test session began with four warm-up trials where food was hidden twice in each cup as the subject watched. For the test the subject was seated in front of the testing table, the experimenter pulled the plastic occluder up hiding the table and cups from the subject's view. The subject was then shown a piece of food before it was hidden in one of the two cups behind the occluder. Therefore, the subjects knew that food was hidden, but did not know where. As soon as the food was hidden, the occluder was lowered and, as the subject watched, the experimenter placed one of the wooden markers on the baited cup while staring at it (eyes and head oriented toward baited container). Then the experimenter pushed the food platform toward the subject saying "ok" several times allowing them to chose one of the containers by touching it. If the subjects touched the baited container first, they were allowed to eat the hidden food treat. If the subjects touched the empty container first, they were shown that it was empty and then the location of the hidden food. The experimenter scored live which cup the subject chose first. All trials were videotaped.

Study 2: Are dogs more skillful than wolves in using human social cues to find hidden food?

Materials and Method

Seven wolves (mean 6.14 years) and seven dogs (mean 3.5 years) participated (Table 2). all the wolves lived together at the Wolf Hollow Sanctuary, Ipswich Massachusetts, USA in large outdoor enclosures (.6 hectare). As puppies, all of the wolves were adopted into a human family at 10 days old and only interacted with littermates and people until they were five weeks old. At five weeks they were placed in a holding pen with their mother so that they could continue to interact with people daily. At twelve weeks of age the wolves were reintroduced to the entire pack and interact with their caretakers on a daily basis. Because the wolves were socialized with humans as puppies, their human caretakers (including the 3rd author) can still safely enter the wolves enclosure when necessary for management purposes. The seven dogs were recruited from families living in the Boston, MA area.

The 3rd author is a caretaker (working at the sanctuary for the past nine years), helped raise all the wolf subjects, and typically interacts with them daily. The same author collected the majority of wolf data to help assure the wolves were comfortable with the testing situation. Testing did not interfere with the wolves' daily activity or feeding schedule. Water was available ad libitum.

Each wolf was tested individually in a familiar holding enclosure (40 m²). Each dog was tested individually in a familiar room. The test apparatus consisted of a plastic container (.6x.5x.4m) with a wooden board (1m long) placed on top which could be pushed forward with ease. Food was hidden underneath one of the two plastic bowls (10 cm diameter) placed at opposite ends of the board. Therefore, the experimenter could slide

the bowls towards the waiting subject. The subjects indicated their choice of bowls by approaching and touching a plastic doorstop protruding from each bowl 10 cm.

An experimental session began after the subject could reliably find food they saw hidden in one of the bowls. This typically took 6-10 warm-up trials. For each experimental trial the subject was positioned in front of the apparatus and food was hidden under one of the bowls, but the subject did not see where. After checking that the subject was equidistant between the two hiding locations, the experimenter would gain the attention of the subject (by calling their name or showing them food) and indicate the location of the hidden food by 1) Gaze+Point+Tap Cue (**GPT**): The experimenter looked toward the baited bowl while extending their cross-lateral arm and tapping on it for 3-5 seconds making a small noise. 2) Gaze+Point Cue (**GP**): identical to GPT except the tapping was replaced with pointing at the baited bowl (index finger 10-15 cm from the bowl). 3) Point Cue (**P**) identical to GP except no gaze cue given (the experimenter looked at the subject) 4) Control Cue (**C**)**:** the experimenter gave no cue (looked straight ahead). The experimenter then returned to their resting posture, and pushed the bowls forward to allow the subjects to choose. The subjects were only rewarded if they touched the correct bowl first.

All subjects received cues 1-4 in order. A subject received no more than 18 trials per session. Therefore subjects were tested on at least eight days, receiving 36 trials in each of the four conditions for a total of 144 trials per subject (108 experimental trials followed by 36 control trials). Half of the trials were videotaped. Learning within

sessions was assessed by comparing 1) the first and second half of trials and 2) the first 5 and last 5 trials for each species by cue using paired t tests (as it is in study 4).

Study 3: Are dogs better than wolves in all experimenter guided tasks?

Materials and Method

Five wolves (mean age: 4.6 years) and five dogs (mean age: 4 years) participated in this study (Table 3). One of the wolves had previously participated in the study comparing the ability of wolves and dogs in using human social cues (Study 1). As in Study 1, all the wolves lived together at the Wolf Hollow Sanctuary, Ipswich Massachusetts, USA in large outdoor enclosures (.6 hectare).

The general procedure was the same throughout this experiment. Food was hidden in one of two 35mm film canisters (6cm x 3 cm diameter). The canisters were presented to the subject (one in each of E's hands) before each trial. Once E presented the canisters, she moved her hands (each containing a film canister) apart (parrallel with the ground) stopping when her arms were extended (1.3m). Once her arms were extended, she noted which container the subject chose. If the subject chose the correct container, they were rewarded. If the subject chose incorrectly they were shown the location of the hidden food.

Subjects first completed a short warmup by chosing the hand holding the canister which they had seen baited. Subsequently, they were given a pretest in which: 1) after baiting

one of the canisters, both canisters were capped, placed in a bag and shaken to assure that the experimenter did not know which canister contained the food (until the subject made their choice) and 2) after canisters were presented to the subjects (the caps were removed), the experimenter covered the opening of canisters with her hands and extended her arms. Subjects passed the pretest after correctly chosing the food location on four of five consecutive trials. After meeting the pretest criterion, subjects were then given the memory task. This test was procedurally the same as the pretest except that the experimenter slowly spread her hands apart taking approximately 4-5 seconds to extend her arms before deciding which canister the subject chose. Finally, subjects were tested in a control session that differed from the experimental session in that the experimenter kept the openings of the film canisters covered with her hands during the entire trial. Each subject received 12 experimental and 12 control trials. E coded live the subjects first choice (indicated by pawing at or licking the experimenters hand) Each subject's performance was compared to chance using binomial probability (<.05).

Study 4: Is the skill of dogs in using human social cues associated with their amount of exposure to humans?

Materials and Method

In the fourth experiment, the same basic methodology was used as in Study 1 and 2 with a set of 32 dog puppies varying in age from 9 to 26 weeks (Table 4). 24 puppies lived with human families and were recruited from puppy classes in Boston, MA. 8 puppies lived their entire lives with littermates awaiting adoption at Pik a Pup Kennel Holliston,

MA. These puppies interacted with humans only briefly for a few minutes each day and only for husbandry purposes.

The only methodological changes from study 1 and 2 were that the bowls for hiding food were spread 1.5 m apart on the ground and a second experimenter held the subject until Experimenter 1 gave a cue while lying on the ground (to assure that even the smallest subjects could see the cue). In addition, Experimenter 1 continued giving the cue while Experimenter 2 released the subject to find the food. The puppies were tested with two cues: 1) Gaze + Point (GP): same as for adults in experiment 1 and 2) Gaze (G): The experimenter turned his head in the direction of and stared at the bowl where the food was hidden.

To test for the effect of rearing history 6 family reared puppies (adopted from birth to eight weeks and participating in training classes at the time of testing) and 6 litter-reared puppies received 18 trials with both cues. The remaining dogs were only included in the cross-sectional analysis of age and performance receiving 18 trials with one cue. All trials were videotaped. Learning was assessed as in Study 2.

	DOGS	
	BREED	Number of Subjects
1.	Mongrels	6
2.	Labradors	2
3.	Others	3

Table 1. Breed of dog subjects participating in Study 1.

	WOLVES		DOGS	
	NAME	SUBSPECIES	NAME	BREED
1.	Sultan	*C. l. lycaon*	Chelsea	Mongrel
2.	Luna	*C. l. lycaon*	Samson	Mongrel
3.	BC	*C. l. lycaon*	Rosie	Boxer
4.	Teebee	*C. l. lycaon*	AC	G. Retreiver
5.	Yorgo	*C. l. lycaon*	Ben	G. Retriever
6.	Alyki	*C. l. lycaon*	Phin	Irish Setter
7.	Denali	*C. l. lycaon*	Cypress	Mongrel

Table 2. Subspecies or breed of subjects in Study 2.

	WOLVES		DOGS	
	NAME	SUBSPECIES	NAME	BREED
1.	Misha	*C. l. lycaon*	Missy	Doberman
2.	Jelly	*C. l. lycaon*	Jakob	Mongrel
3.	Weeble	*C. l. lycaon*	Winnie	Mongrel
4.	BC	*C. l. lycaon*	Mora	Mongrel
5.	Geniek	*C. l. lycaon*	Conso	Labrador

Table 3. Subspecies or breed of subjects in Study 3.

	PUPPIES	
	BREED	Number of Subjects
1.	Mongrels	5
2.	Shephards	5
3.	Collies	2
4.	Labrador Retrievers	6
5.	Pointers	5
6.	Spaniels	3
7.	Terriers	2
8.	Others	4

Table 4. Breed of subjects participating in Study 4.