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Domesticated dogs (*Canis familiaris*) tend to follow repeated deceptive human cues even when food is visible

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Abstract
There is abundant evidence that domestic dogs (*Canis familiaris*) readily follow pointing and other cues given by humans. But there has been much less research into the question of whether dogs can learn to discriminate between different humans giving repeated honest or dishonest cues as to food location, by ignoring the information imparted by the deceiver. Prior research has demonstrated that even after repeated exposures to deceptive cues with respect to food location, dogs failed to learn to ignore those cues completely. Kundey, De Los Reyes, Arbuthnot, Coshun, Molina, and Royer (2010) found the same outcome in a similar experiment. The purpose of the current experiment was to determine if dogs could learn to discriminate between an honest and a deceptive human by ignoring the deceiver's cues even when it was obvious that the container being pointed at was not baited by using two transparent containers. Eight dogs were tested. On 20 cooperator trials, the experimenter stood behind the baited container and cued the dog, located midway between the containers and 3 m away, to approach it. On 20 deceiver trials, a different experimenter stood behind the empty container and cued the dog to approach that container. Results replicated prior research in that, even though the containers were transparent, the dogs failed to learn to distrust the deceiver completely and went to the empty and indicated container on more than half of the deceiver trials.

Keywords Domestic dogs · Human cuing · Deception · Transparent food containers

Introduction

There has been an exponential growth in research into canine cognition over the last 20 years (Bensky, 2013). Many of these studies have demonstrated that domestic dogs (*Canis familiaris*) respond to cues from humans, especially when those cues are predicators of where food can be found (Agnetta, Hare, & Tomasello, 2000; Brauer, Kaminski, Riedel, Call, & Tomasello, 2006; Elgier, Jakovcevic, Mustaca, & Bentosela, 2009; Hare & Tomasello, 2005; Kundey et al., 2010; Miklosi, Polgardi, Topal, & Csanyi, 1998; Miklosi, Pongracz, Lakatos, Topal, & Csanyi, 2005; Miklosi & Soprani, 2006; Petter, Musolino, Roberts, & Cole, 2009; Soprani, Miklosi, Topal, & Csanyi, 2001, 2002; Udell, Giglio, & Wynne, 2008). Fewer studies have been designed to examine the question of whether dogs can learn to respond to human deception in locating food (Elgier et al., 2009; Kundey, Delise, De Los Reyes, Ford, Starnes, & Dennen, 2014; Kundey et al., 2010; Kundey, German, De Los Reyes, Monier, Swift, Delise, & Tomlin, 2012; Petter et al., 2009; Scheider, Kaminski, Call, & Tomasello, 2013; Szetei, Miklósi, Topál, & Csányi, 2003).

In only two of these studies, however, has the question of whether dogs can learn to ignore dishonest information given by one human while continuing to follow the information provided by an honest human been examined. Petter et al. (2009) carried out an experiment using domestic dogs that was based on an earlier experiment by Woodruff and Premack (1979) that had used chimpanzees. One of two opaque buckets was always baited with a piece of wiener, and the other was sham baited to control for odor cues. On each of 100 cooperator trials, a human pointed at the baited bucket and said: "Look (dog's name)" after which the dog was released and allowed to choose one of the two buckets. On each of 100 deceiver trials intermixed with the cooperator trials, a different human pointed at the empty bucket and said: "Look (dog's name)," after which the dog was released and

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allowed to choose one of the buckets. Even after 100 trials of each type, the dogs almost always went to the bucket pointed at by the cooperator but never learned to completely distrust the cues given by the deceiver. Choice of the indicated-and-empty bucket declined somewhat, but never fell below 5 out of 10 trials in any block of 20 trials. The fact that the dogs trusted the cooperator from the outset, and never really learned to distrust the deceiver, suggested to the authors that the dogs entered the experiment with a strong predisposition to trust the signals provided by humans. Kundey et al. (2010) gave dogs 12 trials in which a human correctly indicated the location of a dog treat in one of two opaque containers, and 12 trials in which a different human incorrectly indicated the location of the food, in both cases by pointing at one container. They found that the dogs failed to learn to ignore the incorrect points, almost always approaching the empty container pointed to by the deceiver. Thus, the dogs failed, as in the Petter et al. experiment, to discriminate between the two humans.

The remaining studies that looked at deception were focused more on the question of what types of deceptive information are attended to, and how the effect of deception can be augmented or reduced. Elgier et al. (2009) trained dogs to go to the baited of two opaque containers by following the advice of a human (owner or stranger) who always indicated the baited container by pointing at it. This was followed by extinction trials in which both containers were empty and one of them was pointed to on each trial, more training trials in which the human pointed at the baited container, and finally reversal trials in which the human pointed at the empty instead of the baited container. The dogs required more trials to reach the extinction criterion by not approaching the container pointed to on four successive trials, and later the reversal criterion by not approaching the container pointed to four times in a row, when tested by the owner rather than by a stranger. Kundey et al. (2012, 2014) used a deceiver and a cooperator, both offering information about which of two transparent or opaque containers was baited, or not baited, and varying the number of people in each role, and what sorts of points they used; but there was only one trial for each dog and hence no opportunity to examine the question of learned distrust. Scheider et al. (2013) exposed dogs to deceptive points, or to no points at all, by a human, when the dog had seen, or had not seen, which of two opaque cups was baited. They found a main effect of points, with dogs going more often to the empty cup when it was pointed to, regardless of knowledge, and a main effect of knowledge of food location, with the dogs going less often to the empty cup when they had seen which one was baited, regardless of points. There was, however, no interaction between points and knowledge, so it cannot be determined from these data if the knowledge or the points was the more salient cue. Szetei et al. (2003) attempted to determine if odor and knowledge of where the food was located could overshadow deceptive points. The first of two experiments was conducted outdoors using two opaque containers, one of which was baited with food, and the other not. In one condition, the empty container was pointed at. The dogs chose it more often than predicted by chance, thus demonstrating that points overshadowed olfactory cues. In a second condition, the dogs were allowed to observe one container being baited and the empty one was subsequently pointed at. This reduced the tendency of the dogs to follow the false points, but about half of the dogs still chose the empty pointed-at bowl. Thus, the presence of both olfactory cues and knowledge of the location of food were able to reduce the power of the deceptive points, but not completely. The second experiment was conducted indoors to accentuate the saliency of the olfactory cues, and the results were the same.

The present research was designed to further explore under what circumstances dogs might learn to discriminate between a serial cooperator and a serial deceiver. This is an interesting question because being able to learn to discriminate between an honest and a dishonest human should have considerable survival value for dogs. We employed the same general paradigm that was used by Petter et al. (2009), but used transparent containers to make it even more obvious that the non-baited container really was not baited. We were encouraged in this by the work done by Szetei et al. (2003), who had had some success in using odor cues to reduce the tendency of dogs to follow deceptive cues. Even more pertinent to our decision to use transparent containers was research by Kundy et al. (2010), who showed, using deceptive trials only, that attendance to the deceptive cues decreased when the food containers were transparent.

Method

Subjects

Eight adult domestic dogs (*Canis familiaris*) (four males and four females) of various breeds and ages were tested. Details on ages, weights, and breeds are presented in Table 1.

All the dogs were purebred, domesticated house pets. To the authors' and dog owners' knowledge, none of the dogs had received formal obedience training, but all had received informal training by the owners. Notably, the Saint Bernard and the male Boston terrier were rescue dogs that had been with their current owners for 2 years. Only one dog, Harley, was owned by an experimenter. None of the dogs had any prior experience in behavioral experimentation. All the dogs were deemed to be in good health based on their most recent veterinary appointment, and the owners reported no recent health problems for the dogs. All dogs were tested in the afternoon, at least 4 h after their morning meal. Additionally, all owners were instructed prior to testing that the dogs were to refrain from treats or human food on testing days; that is, the

Table 1 Name, sex, age, weight and breed of the dogs in the study

Name	Sex	Age (years)	Weight (kg)*	Breed
Harley	F	1.6	38	Labrador Retriever
Daisy	F	3.3	11	Boston Terrier
Binkey	M	7.0**	16	Boston Terrier
Rupert	M	10.0**	68	Saint Bernard
Mattie	F	12.1	28	English Bulldog
Pudge	M	7.5	26	English Bulldog
Lawslo	M	1.9	23	Vizsla
Roxy	F	4.3	52	Great Dane

*Weights were all estimated by owners based on the most recent veterinary appointment

**Ages estimated by a veterinarian because the dogs were rescue dogs

dogs only ate their regular morning meal. The owners also were instructed to refrain from giving the dogs human food in between the testing sessions.

Apparatus and setting

The experiment was conducted at each of the dogs' respective homes located in Toronto, Ontario, Canada. Sixteen rectangular transparent "containers" (31.8 cm long × 19.8 cm wide × 10 cm high) and manufactured by Iris USA, Inc. were used. Two new containers were used for each dog to control for any scent left by other dogs. These containers were set on the floor of the testing area separated by 1.5 m. Zabiha Halal Chicken Wieners, manufactured by Maple Lodge Farms, Brampton, Ontario, Canada served as the bait. The wieners were each 13 cm long and 2 cm in diameter. The six dogs that weighed more than 20 kg each could receive a quarter of the wiener on each trial, and the two dogs weighing less than 20 kg were each able to receive an eighth of the wiener. Finally, a small piece of masking tape was used to mark the floor 0.6 m from the front edge of the containers and 2.4 m from the point at which the dogs were located at the start of each trial. Four of the dogs were tested while attached to their leash because, during pre-training, these dogs seemed less controllable and did not reliably respond to basic human commands. In the cases of the leashed dogs, the leash was only held by the experimenter not performing the trial while the container was being baited. The other four dogs were not leashed and simply remained by the experimenter not performing the trial.

Procedure

Design The experiment was a within-subjects design. Each dog had one female and one male experimenter. For half of the dogs the female experimenter served as the cooperator and the male experimenter served as the deceiver. For the other half, the experimenter and cooperator roles were reversed. These roles were initially chosen at random and then were kept consistent for each dog for the duration of both testing sessions. It should be noted that the Labrador Retriever's owner was the female experimenter, and in the randomization process she was assigned to the cooperator trials. Thus, the deception trials were consistently performed by an experimenter relatively unknown to the dog. Forty trials were conducted over two sessions, 20 trials in each session. The two sessions were conducted 24 h apart. During the first session, alternating blocks of five cooperator and five deceiver trials were conducted. During the second session, the order of the cooperator and deceiver trials was randomized, but with 10 cooperator and 10 deceiver trials. Although we believed that whether a dog chose the indicated container or the non-indicated container was relatively unambiguous, we nevertheless videotaped the deceiver trials on Day 2. Lack of sufficient personnel made additional videotaping impossible.

Preliminary training Each dog had some familiarity with the experimenters, as the dogs, except for the Labrador Retriever, belonged to family and friends. Regardless, at the beginning of the first testing session, each dog was briefly introduced to the experimenters until all appeared comfortable and acquainted with one another, and the dogs seemed settled. The dogs were familiarized with the transparent containers and the reward outside of the testing area, before the containers were formally set up for the first trial. The dogs were allowed to eat two-quarters of a wiener from each of the two containers set on the floor. All the dogs willingly ate from both containers. Following this preliminary training, the owner, unless an experimenter, remained in a room separate from the testing area for the duration of the testing session.

Experimental conditions All the dogs were tested in their primary residence in a quiet location, either a hallway or a foyer. Any people in the home other than the experimenters remained out of the testing area for the duration of the testing session. Figure 1 illustrates the general arrangement of the testing environment during testing trials. The containers were placed on the floor 1.5 m apart and the dog was positioned 3.0 m from the imaginary line connecting the containers, and midway between them. The dog was controlled by the experimenter not performing the trial. Initially, the dog was turned to face away from the containers. On each trial, the container on the left or right was chosen at random and was baited with the wiener and the empty container was rubbed with a piece of wiener to ensure the container gave off wiener odor, thereby controlling for scent. Successive trials were separated by a 2-min intertrial interval.

Cooperator trials During cooperator trials, the experimenter, randomly selected to play that role, stood behind the container with the wiener in it. Once behind the container, the

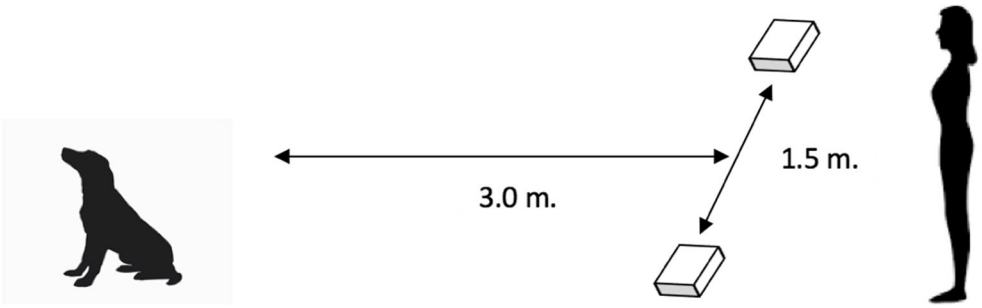

Fig. 1 Diagram of the testing set up

experimenter indicated to the other tester that the trial could begin by saying, "okay" and the dog was turned to face the containers. The experimenter, looking directly at the dog, then cued the dog to the container he or she was behind by extending his or her right arm downwards with the index finger extended and verbally enticed the dog by saying: "Look (dog's name)." The other experimenter then dropped the leash, or let go of the dog if it was not on a leash. A choice was considered to have been made when the dog was less than 0.6 m from one of the two containers. No dog was ever observed to stop approaching a container after crossing the tape located 0.6 m in front of the container. If the choice was for the baited container, the dog was allowed to eat the bait. If the choice was to the empty container, however, the experimenter quickly retrieved the bait from the baited container before the dog could get to it. Unless it was the final trial of a session, the dog was returned to the starting location while the experimenter prepared for the next trial.

Deceiver trials The procedure for the deceiver trials was identical to the cooperation trials, except that on deceiver trials the experimenter stood behind the empty container and when the dog had been released looked at the dog and pointed to the empty container and said: "Look (dog's name)." If the dog approached this empty container, the experimenter retrieved the bait from the baited container before the dog could get to it. If the dog went to the non-indicated container with food in it, the dog was allowed to consume the wiener. As on cooperator trials, a choice was considered to have been made when the dog was less than 0.6 m from one of the containers and once again no dog was ever observed to stop approaching a container after crossing the tape located 0.6 m in front of the container.

Results

The dependent variable in the experiment was the proportion of choices made by each dog to the indicated container during successive blocks of five trials. The first author, who was one of the experimenters, and the second author, who was not involved in the actual testing of the dogs, independently reviewed the videotapes from all 80 deceiver trials on Day 2. This resulted in agreement on 77 of the 80 trials. A third reviewer resolved the three disagreements. These data are shown in Fig. 2. It appears from the data that, throughout the experiment, the dogs first approached the indicated container more often during cooperator trials than during deceiver trials. There also appears to have been a slight increase in choices of the indicated container over blocks of trials on cooperator trials, and a slight decrease in choices of the indicated container over blocks of trials on deceiver trials, at least until the last block.

These data were subjected to a 2 (cooperator vs. deceiver) × 4 (blocks of five trials) analysis of variance. The analysis revealed a robust main effect of cue type [F (1,7) = 29.43, p = .001 , partial eta squared = .81] but no main effect of trial blocks [F (3,21) = 0.55, p =.657, partial eta squared = .07] and no Cue Type × Blocks of Trials interaction [F (3, 21) = 2.14, p = .124, partial eta squared = .23]. The main effect of trial type was interpreted to mean that the dogs more often made their first choice to the indicated container on cooperator than on deceiver trials. The lack of a main effect of trial blocks was interpreted to mean that, collapsed over trial type, there was little change in performance over the course of the experiment. Finally, the lack of a statistically significant interaction between trial type and blocks of trials was interpreted to mean that there was no change over trial blocks in the proportion of choices of the indicated container in either the cooperator or deceiver data. Given that one dog, Harley, was owned by the first author, we thought it prudent to re-run this ANOVA without Harley's data. This did not change the results. The main effect of cues remained significant [F(1,6) = 27.16, p = .002, partial eta squared = .82], and the main effect of trial blocks also remained not statistically significant [F (3,18) = 0.81, p = .506, partial eta squared = .12] as did the interaction between cue type and blocks of trials [F (3, 18) = 2.37, p = .104, partial eta squared = .28]. Given this, the remaining analyses were conducted using data from all eight dogs.

Given that there was a substantial difference between performance on the cooperator trials and the deceiver trials, even during the first block of five trials, we were interested to see if there was a significant difference between the proportion of choices of the indicated container on the very first cooperator

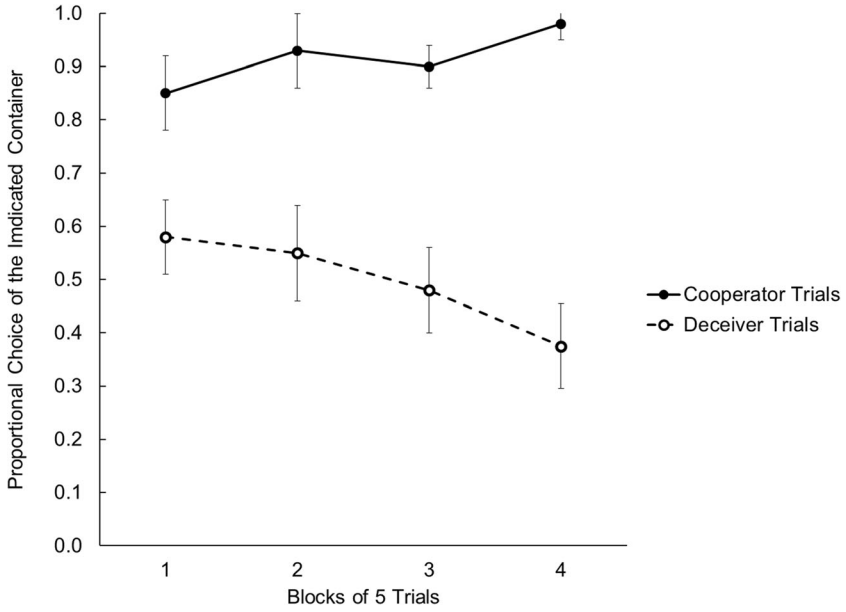

Fig. 2 Proportion of choices of the indicated container over four blocks of five trials. Error bars represent standard errors of the mean

trial and the very first deceiver trial. A chi-square test revealed that the proportion of dogs choosing the indicated container on these two initial trials was not significantly different [X^2 (1) = 1.16, p = .281] with Yates correction applied, due to the small N.

Single sample t-tests revealed that the dogs chose the indicated container significantly more often than chance on all four blocks of cooperator trials [t (7) ≥ 19.00, p < .05]. Similar single-sample t-tests also showed that the dogs failed to choose the indicated container significantly more, or less often, than chance, on all four blocks of cooperator trials [t (7) ≤ 1.30, p > .05].

Even in the absence of a cue type by trial blocks interaction, given the apparent downward trend in the data during the four blocks of deceiver trials, a one-way ANOVA was conducted on those data. This resulted in a non-significant main effect [F (3,21) = 1.68, p = .201, partial eta squared = .19].

Discussion

The results of the current experiment are consistent with those reported by Petter et al. (2009) in spite of the fact that transparent containers, which should have made it more obvious that one container was empty, were used in the current experiment. As in the Petter et al. experiment, the dogs showed a great willingness to follow the guidance of the cooperator, and a diminished willingness to follow the guidance of the deceiver, choosing the empty container on about 50% of the trials. Of course, on cooperator trials, responding to the discriminative stimulus of the point and the verbal cues was always reinforced by food, whereas on the deceiver trials, responding to the discriminative stimulus provided by the point and the verbal cues was never reinforced. What is surprising in this context is that, despite never being reinforced, the choice of the empty container on the deceiver trials remains at close to 50% over 20 deceiver trials, albeit declining slightly, but non-significantly, over the blocks of trials. This conclusion was reinforced by the finding that the proportion of choices to the non-baited container on deceiver trials never fell below chance in any of the four blocks of trials. In short, the dogs showed no evidence of learning to completely distrust the deceiver. Whereas it is true that we used only 40 trials, instead of the 200 trials used by Petter et al., there is little indication in the data that additional trials would have changed the outcome. Although the choices of indicated container appeared to be increasing slightly over the four blocks of cooperator trials, there was no main effect of blocks of trials during the deceiver trials, and the lack of a significant Cooperator versus Deceiver × Blocks of Trials interaction suggests that even the apparent upward trend in the cooperator data is best explained as sampling error. Aside from the number of trials, and the use of transparent, instead of opaque, containers, we attempted to keep our procedure similar to that employed by Petter et al. The cooperator (deceiver) stood behind the baited (non-baited container), pointed at it, and looking at the dog said: "Look (dog's name)." The non-baited container was sham-baited to control for odor cues. The testers, randomly assigned to be either cooperator or deceiver, included one female and one male. The bait in both experiments was a piece of wiener, albeit a larger piece in the current experiment. But, using larger bait should have encouraged the dogs more, and not less, to distrust the deceiver and approach the non-indicated and baited container. Admittedly, however, there were some

differences: (1) the Petter et al. experiment was conducted outdoors and ours was conducted indoors; (2) the owners were not inside the room handling the dogs as had been the case in Petter et al.; (3) the distances between the containers and between the dog's starting point and the containers were smaller; (4) the dogs only had to approach one container within 0.6. m unlike in the Petter et al. experiment in which they had to actually make contact with the bucket to have it count as a choice; and (5) one of the dogs in our study was owned by one of the experimenters. We do not believe, however, that these differences had a significant impact on the outcome, especially given the similarity between our results and those found by Petter et al. With specific reference to the criterion for determining when a choice had been made, on only three occasions during the videotaped Day 2 deceiver trials was a dog observed to approach closer than 0.6 m to one container and then to choose the other container. With respect to the fact that one of the dogs was owned by one of the experimenters, we re-ran the ANOVA without the data from that dog and it did not change the outcome.

Kundey et al. (2010) are the only other researchers we are aware of who used a successive discrimination procedure in which different humans provided either honest cues or dishonest cues as to the location of food in one of two opaque containers by means of pointing. Over 12 honest and 12 dishonest trials the dogs almost always chose the baited container on honest trials (about 95% of the time) and almost always chose the empty container on dishonest trials (about 95% of the time). It is not clear why the dogs in that experiment showed almost complete compliance with the deceptive cues from the outset. During the first 10 deceiver trials in our experiment, compliance with the deceptive cues was only about 55%.

Although not a successive discrimination procedure involving different humans as deceiver and cooperator, Elgier et al. (2009), using opaque containers, reported that their dogs did come to distrust a human who initially correctly pointed to the location of food until the dogs almost always chose that container. The human later deceived them by pointing at one of two empty containers (extinction), then again pointed correctly at the baited of two containers until the dogs again reliably chose the baited container, before once again deceiving them by pointing at the empty of two containers, one of which was baited (reversal). Despite considerable differences between their paradigm and ours, there was evidence that their dogs found it difficult to resist deceptive information. Over both the extinction and the reversal phases, the mean number of trials to criterion, which was four refusals in a row to follow the deceptive point by the experimenter, was 23.5. That suggests considerable resistance to extinction (reversal), which translates into a considerable tendency to follow deceptive information given by a human. The results do not, however, speak to the question: Can dogs learn to discriminate between an honest human and a dishonest human?

No researchers that we are aware of have used transparent containers in a successive discrimination paradigm. In a second experiment, Kundey et al. (2010) used two transparent containers or two opaque containers, only one of which was baited, and only deceiver trials in which a human, standing midway between the containers, gave no indication of the location of the food, made a static point at the empty container, made a momentary point at the empty container, or just stood behind the empty container. Collapsed over these four between-subjects conditions, the dogs followed the deceptive cues less often when the containers were transparent than when they were opaque, and, collapsed over container type, dogs followed the deceptive cues more often in the static point condition. Notably, in the static point group, the dogs followed the deceptive advice on 60% of the trials even when the container was transparent. Finally, in a third experiment, Kundey et al. extended the number of deceptive trials using transparent containers, and only static points, from six to 24, and found decreasing selection of the empty container over blocks of trials, choosing it less often than chance predicts on the last two blocks of six trials. These two experiments provided some evidence that dogs can learn to ignore deceptive cues when there are only deceiver trials but provide little insight into the question of whether dogs can learn to discriminate between honest and deceptive humans.

Kundey et al. (2012) carried out additional research using transparent containers but the design in that research was even further removed from ours, which makes comparisons difficult. In one experiment, two humans, each using one hand, pointed at the empty container, while one human, using one hand, pointed at the baited container. On a single test trial, the dogs all chose the empty container. In a second experiment, when one human pointed at the baited container with two hands, and the other human pointed at the empty container with one hand, the dogs tended to go to the baited container on a single test trial. Kundey et al. (2014) used the same paradigm with a mannikin arm located behind the empty container but pointing at it, and a mannikin arm located behind the baited container but pointing up, rather than at it. Again, the dogs again tended to follow the deceptive pointing cue on a single test trial. While very interesting, the use of only a single test trial in these experiments does not permit these results to speak to the question we were interested in: Can dogs *learn* to discriminate between a truthful human and a deceptive human?

Providing additional information beyond human cues to dogs about food location was looked at by Scheider et al. (2013) and by Szetei et al. (2003). Scheider et al. allowed dogs to either see or not to see which of two opaque containers was baited, and Szetei et al. added odor cues while allowing dogs to see or not to see which container was baited. Scheider et al. found some evidence that knowledge of the location of food was associated with a reduced tendency to go to an empty

container, but the failure of that main effect of knowledge to interact with whether a pointing cue was present or absent makes it impossible to conclude from these results that knowledge of food location reduces susceptibility to false points. Szetei et al. compared choice of an empty container when it was pointed to and the dogs could smell the food with a condition in which, in addition to odor cues, the dog also had knowledge of food location based on observation of which container had been baited. They found that the dogs tended to select the empty and pointed-to container when the dogs could smell the food in the baited container, but that they were merely indifferent to the containers when they could both smell the food and had knowledge about its location. Again, however, these results do not speak to the question we were most interested in: Can dogs learn to discriminate between an honest and a dishonest human?

It would be interesting to replicate the discrimination paradigm without controlling for odor by not wiping the empty container with a piece of wiener. If the dogs continued to follow the cues offered by the deceiver, despite being able to see that the empty container was actually empty and also to smell that the empty container was devoid of food, it would add further weight to the general conclusion reached in the present experiment and by Petter et al. (2009) and Kundey (2010).

We remain convinced that when an obviously non-baited container is repeatedly cued by a human, dogs have great difficulty learning to completely distrust that person, still selecting the cued and empty container on about half of the trials. Dogs have been bred for thousands of years with attention directed to cues given by humans likely being a trait selected for in this breeding (Erdohegyi, Topal, Viranyi, & Miklosi, 2007; Miklosi et al., 2005; Perrson, Wright, Roth, Batakis, & Jensen, 2016). The survival value of such devotion to humans is, however, questionable.

Author note Candice Dwyer now at Stanford University. Portions of this research were presented at the Meetings of the Canadian Society for Brain, Behavior, and Cognitive Sciences in Toronto, Ontario, June, 2014.

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