

SHARED INTENTIONALITY BETWEEN HUMANS AND CANINES

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Abstract

It is argued by some that humans are set apart from all other species by their social abilities, most notably their ability to exhibit shared intentionality, which refers to the shared psychological states of two (or more) individuals working together toward a common goal, achieved through a joint effort and coordinated roles. By age 2, human toddlers outperform non-human primates on sociocognitive tasks, despite performing similarly on tasks involving physical reasoning. Previous studies have suggested that domestic dogs, *Canis familiaris*, could potentially have the ability to also exhibit shared intentionality with humans, as they have similar underlying social cognitive abilities (MacLean, Herrmann, Suchindran, & Hare, 2017). We tested 25 dogs in a newly developed canine shared intentionality test to examine if individual dogs would preferentially reengage a cooperating human over a non-cooperating human, when presented with an unsolvable task. We found no evidence in this study to indicate that dogs exhibit shared intentionality with humans by preferentially reengaging a cooperative human over a non-cooperative human in a triadic food acquisition task. Other recent studies, however, indicate that dogs will gaze at humans when presented with insoluble tasks, and outperform socialized wolves when following human cues (Miklosi, Kubinyi, Topal, Gasci, Virani, Csanyi, 2003). Future studies are needed to determine if the similar underlying social cognitive structures between humans and domestic dogs allow for shared intentionality between the two species.

Introduction

It has been argued that humans are easily set apart from all other animals by their complex social structures and cognitive skills. There are many different hypotheses regarding human cognitive uniqueness, with substantial evidence supporting the “Cultural Intelligence Hypothesis”. This hypothesis emphasizes a species-specific set of social-cognitive skills that arise early in life, allowing humans to reason about and participate in the social world around them (Herrmann, Call, Hernandez-Lloreda, Hare, & Tomasello, 2007). While the cultural intelligence hypothesis aims to explain what it is that makes humans different, it still leaves open the question of *why* humans are different from other animals, and more specifically why humans are potentially able to cooperate on an entirely different level. Research on this has centered on two main concepts: 1) reciprocal altruism, and 2) the collaboration of multiple individuals working together as a group toward a common and mutually beneficial goal (Tomasello, 2009). In other words, it has been argued that humans’ ability to work together, see other members of the species as more than just competitors, and even altruistically help others is what caused them to develop skills that enable them to understand the goals and intentions of others. With humans so closely related to other primate species, one might think that non-human primates share the same – or at least close to the same – complex mechanisms for cooperation, but studies have shown this is not the case. Evidence shows that while great apes perform at a similar levels to human toddlers on tests of reasoning about the physical world, by age 2 humans toddlers already surpass other apes in tests of social cognition, and that gap further increases by the time human children reach 4 years of age (Hare, Herrmann, Tomasello, Wrangham, & Wobber, 2014). One important element of human social cognition is the concept of shared intentionality, sometimes called “we” intentionality, which refers to the shared psychological states of two (or more) individuals working together toward a common goal, which is achieved through a joint effort and coordinated roles (Gilbert, 1989; Raimo, 1995; Searle, 1995; Tomasello, Carpenter, Call, Behne, & Moll, 2005; Tomasello & Carpenter, 2007)

Humans begin to display sensitivity to others’ intentional states early in ontogeny, following the gaze of adults to nearby objects at around 6 months of age, and to more distal objects around 12 months (Butterworth & Jarrett, 1991; D’Entremont, Hains, & Muir, 1997). While this alone does not indicate understanding of the adult’s psychological states, further behavior such as sensitivity to whether an adult’s eyes are open or closed, whether or not the adult is wearing a blindfold, whether or not the adult’s gaze is occluded by a barrier, as well as the fact that infants will locomote to achieve the same perspective as the adult if necessary, indicates they do have an understanding of the adult’s perception. Around this age, infants also will follow the gaze of an adult to an object behind themselves, but will not follow the gaze if the adult’s line of sight is occluded by a barrier (Brooks & Meltzoff, 2002; Caron, Butler, & Brooks, 2002). Infants at this age also show evidence of selective attention, by contextually inferring which specific object an adult is indirectly referencing out of a choice of multiple different objects (Tomasello & Haberl, 2003). At around 9-12 months of age, human infants begin to engage in triadic social interactions between themselves, an adult, and an object of mutual importance. Among others, these activities include passing a ball back and forth,

building a block tower together, and cleaning up toys together. Not only are infants engaging with others of their species in these interactions, but at around this age they will also attempt to reengage a recalcitrant adult in joint activities when the adult stops participating (Hay, 1979; Hay & Murray, 1982; Ratner & Bruner, 1978; Ross & Lollis, 1987; Verba, 1994). Once infants become slightly older at around 12-15 months of age, their triadic interaction behaviors expand so that they not only engage in these activities, but also understand that each person has his or her own individual role in completing the joint goal. In an attempt to reengage recalcitrant adults, infants may now switch roles and begin performing the adult's task instead (Bakeman & Adamson, 1984; Ross & Lollis, 1987).

When human infants and nonhuman primates (NHPs) both complete the same tasks to test social cognition, results show that human infants are able to easily pass the tests by working together with an experimenter to accomplish joint tasks or receive help from them, but that NHPs do not display these same behaviors. One experiment by Hare and Tomasello (2005) with chimpanzees, however, challenged the notion that NHPs are completely unable to understand the intentions of others. In one condition, the experimenter pointed towards the location of hidden food, but the chimpanzees were not successful in finding the food or understanding that the experimenter was trying to help them. However, when the experimenter first established a competitive relationship with the ape, and then attempted to (unsuccessfully) reach for the hidden reward, the chimps suddenly became successful at understanding there was a reward hidden in the location that the experimenter was reaching for, and then subsequently at finding the food (Tomasello & Carpenter, 2007). These results suggest that chimpanzees do have the ability to understand the intentions of another individual, but do so most flexibly in contexts involving competition. When the experimenter is altruistically pointing towards the bucket to alert the chimp of the hidden food, the chimp can follow the experimenter's point and see that it is toward the bucket, but it is not able to understand the human's (cooperative) motivation for pointing toward it. Human toddlers demonstrate that they do understand the adult's altruistic intentions by easily completing the task from around 14 months of age (Hare & Tomasello, 2005).

Although nonhuman primates do not share these social cognitive abilities with humans, increased research is challenging the concept that shared intentionality is unique to humans. Domestic dogs (*Canis familiaris*) are being increasingly studied as good models for cooperative social cognitive skills because they evolved from wolves (which participate in cooperative behaviors), they have been selected for cooperative roles in human activities (herding, companionship), and they live closely with humans (which may facilitate the development of these social skills) (Cooper et al., 2003). In the previously mentioned Hare and Tomasello (2004) experiment, chimpanzees were able to follow the pointing direction of the experimenter toward an overturned bucket with hidden food inside, but they were not able to understand that the experimenter was trying to communicate that the bucket – or rather what was underneath the bucket – was of interest to the chimpanzee. When this same experiment was conducted on dogs, however, not only were the dogs very adept at following human cues and could infer target locations from many different behaviors (pointing, gazing, bowing or nodding, and

even placing arbitrary communicative markers in front of target location), but they were also able to infer that the human was attempting to communicate something to them, and could successfully locate the hidden food (Call, Hare, & Tomasello, 1998; Hare & Tomasello, 1999; McKinley & Sambrook, 2000; Miklosi, Polgardi, Topal, & Csanyi, 1998). There is also other evidence indicating that dogs are not just following behavioral cues, but also can understand what humans can see in other contexts. If a human turns its back on a dog during a fetch game, most dogs will bring the toy around to the front of the person so that they may drop it in front of the human's face (Call et al., 1998). Dogs will also beg for food from a non-blindfolded person versus a blindfolded person when given the choice, and will approach forbidden food more often when a human cannot see the dog (i.e. when a human has his or her eyes closed or gaze averted, or when a barrier is in the way) than when they can (Call, Brauer, Kaminski, & Tomasello, 2003; Eddy & Povinelli, 1996; Gacsi, Miklosi, Varga, Topal, & Csanyi, 2004; Kaminski, Call, & Tomasello, 2004; Virányi, Topál, Gácsi, Miklósi, & Csányi, 2004). Another unique behavior that one border collie has shown is the ability to learn new words via a process called inferential reasoning. In this case, the pet's owner would ask him to retrieve a novel object that he has not yet learned the word for. The pet would then search the room, surveying the objects he already knew the names of and eliminating them as possibilities. By using this form of inferential reasoning, the dog was able to zero in on the object the owner wanted him to retrieve, and also learn the word for that object at the same time. This type of social language inference has only previously been demonstrated in humans (Call, Kaminski, & Fischer, 2004).

Previous studies have shown not just that dogs are adept at working with humans and understanding their social cues, but that the basic framework of canine social skills in dogs is indeed very similar to that of humans. Findings from experiments by MacLean et al (2017) showed dog-human similarity in skills for understanding cooperative communication, but research has not been done to test whether dogs are also similar to human children with respect to traits that have been suggested as indicative of shared intentionality (MacLean, Herrmann, Suchindran, & Hare, 2017). Therefore, a canine shared intentionality test (CSIT) – similar to that used with human and non human apes – is needed to collect data on how dogs cooperate with humans in triadic tasks, if at all. To research this question, we tested 23 dogs using a newly developed CSIT with a human non-cooperator and a human cooperator, and assessed if dogs preferentially reengaged a cooperative social partner, in a manner similar to human children.

Methods

The canine shared intentionality test (CSIT) was conducted with pet dogs of different breeds, and administered in administered over ~30-60 minutes per dog. Most dogs were tested only once, but some were tested a second time if they seemed too nervous to participate the first time. The test consisted of one task shared between a human experimenter and a dog, designed to assess the dog's understanding of working towards a common goal with a human partner.

Subjects

All dogs included in the CSIT were pets volunteered by owners, although three of the pets also classified as therapy dogs, and one as a service dog for his owner. The population included dogs of various breed, size, age, and sex. All dogs were tested in the same room at the Arizona Canine Cognition Center. Owners did not participate in testing and remained in separate room until completion of testing in majority of cases, although one dog required the owner to be in room during testing due to separation anxiety, but at no point during the test trials did the dog gaze at or attempt to interact with the owner. All testing was strictly voluntary, and dogs were free to stop participating at any time. Subjects participated for food rewards, were not deprived of food or water prior to or during the study. Water was available *ad libitum* during testing. All dog-testing procedures were approved by the Institutional Animal Care and Use Committee of University of Arizona.

Apparatus

All dogs were tested in an indoor room at the University of Arizona Canine Cognition Center, marked with starting locations for the experimenters (E1, E2, E3), the subject, and the experimental box. White noise was played from overhead speakers at all times during experimentation, to limit any outside noise. The experimental box consisted of a wooden rectangular box (46cm x 24cm x 32cm), constructed and fashioned onto a wooden base (60cm x 60cm x 2cm). The front face of the box was not wooden, and instead consisted of a clear Plexiglas door (P1)(46cm x 32cm), built onto a rolling track and with a wooden handle on one side of it, such that a dog could push it open using a muzzle or paw. Built onto the base and extending up vertically 84cm were two metal tracks set 60cm apart, such that a second Plexiglas door (P2) (60cm x 45.5cm) could slide vertically up and down in front of the box, physically blocking entrance to the box in the down position but not in the up position, and also being able to be removed completely from the tracks by a human. Black adhesive strips were placed diagonally across the face of P2 in order to make the door visible to subjects, but did not occlude viewing the inside of the box. Inside of the box was a Plexiglas dish (15.5cm x 2.5 cm) attached to the base using hook-and-loop fasteners so that it was secure, but still removable for ease of cleaning. Directly above the dish, a round hole 3cm in diameter was cut into the top of the box such that a food reward could be dropped into the dish by an experimenter.

The experimental box was placed on the floor, set flush against a wall in the testing room, equidistant from the other two adjacent walls. Two rectangle areas (89cm x 111cm) were marked on the floor on either side of the box for E2 and E3 to sit in. The position of E2 and E3 rotated between each subject. E1 sat at the “start point” marked with tape, 168cm away from the front of the box. The experimental set up is shown in Figure 1.

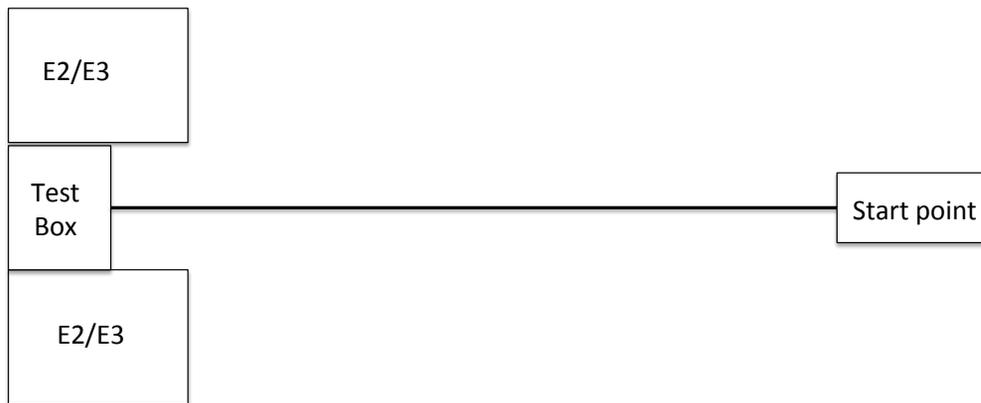
Figure 1

Figure 1: Diagram of the experimental set up for the CSIT, to scale. E2 and E3 rotated between the rectangles labeled “E2/E3” located on either side of the test box switching for each new experiment. E1 always started with the dog at “start point” for each trial.

All trials were audio recorded from ceiling mounted microphones in the testing room, as well as visually recorded from ceiling mounted cameras on the East and West sides of the testing room. E2 and E3 each wore a pair of eye glasses with a camera built in to the frame between the lenses, and tracked the dogs during test trials to record eye contact.

The subject reward for this study was a small piece of food (approximately 1cm x 1 cm) dropped into the Plexiglas dish in to motivate the dog to attempt to solve the box so that it can retrieve the reward. Food rewards included Jerky Treats and/or Zuke’s Mini Naturals. For dogs not interested in these treats, alternative food rewards brought from home by owner were used.

Procedure

Each of the dogs followed the same experimental procedure, which consisted of one single experiment (retrieving a food reward from the box). Dogs were first allowed time to explore the testing room and waiting area (where owners remained during the experiment) with both owners and experimenters, until comfortable enough with the testing environment to proceed with experiment, away from owner. Treats were sometimes used to motivate dog to enter and explore testing room. Once the experiment began, each dog went through a series of warm-ups and familiarization trials, until the subject understood the concept of opening P1 to retrieve food reward from box. After familiarization was complete, four trials were conducted and coded both live, and from video/audio recordings.

Familiarization and warm ups

After dogs were given some time to freely explore the experimental room and become comfortable with it, dogs were then familiarized to the testing box with warm up trials. With E2 and E3 in their respective positions (could reference a top-down diagram here),

E1 took the subject to the start point, and restrained the dog there until ready. Treats were kept directly behind the box, out of sight of the dog. First, E2 took the dish out of the box and placed it onto the floor in front of the box, called the dog's attention (name, "treat", whistle, etc), and dropped a treat into the dish. E1 then released the dog, saying "okay," allowing the dog to approach the dish and take the food reward. After the dog succeeded in retrieving food from the dish, E2 moved the dish back inside the box and repeated the same procedure as before, this time dropping the treat through the hole in the top of the box, with both P1 and P2 removed so nothing was obstructing the dog's ability to retrieve the treat. After the dogs were comfortable retrieving food from inside the box, the same procedure would continue, but E2 would close P1 in incrementally larger amounts between each reward, but increasing the amount only a small amount each time so as not to confuse or discourage the dog before it fully understood the task. Once the dog was able to retrieve the reward in 4 out of a sliding window of 5 trials with P1 closed, P2 was added. The same procedures were followed, but when E1 would release the subject, E1 would start a timer. After 5 seconds, E2 lifted P2, allowing the dog access to P1 so it could retrieve the food reward. If the dog did not understand at first, prompting and encouragement was directed at the dog from E1, E2, and E3. Once the dog was able to successfully retrieve the food reward in 4 out of a sliding window of 5 trials in these conditions without encouragement, familiarization was complete and test trials began.

Test Trials

In test trials, the dog started in the same starting position with E1. E3, rather than E2 called the dog's attention and drops the food reward into the box. E2 and E3 wore camera-mounted eyeglasses, and held stopwatches behind their backs. After E1 released the dog, s/he timed 30 seconds, announcing "time" when time was up. During this time, E2 and E3 tracked the dog with the camera-mounted glasses, as well as recorded the total amount of time the dog made eye contact with them, using the handheld stopwatches. Once E1 announced "time," E2 then lifted P2 so that the dog could retrieve the food reward. Four trials were completed, and eye contact time was recorded live on a sheet of paper inside the testing room.

Coding

Using the recorded videos of the experiment, we coded for the following behaviors: eye contact, orientation, time spent in front of the cooperator/non-cooperator, active touching, vocalizations and persistence. These behaviors were operationalized as follows:

Eye Contact

Total time spent making eye contact with either E2 or E3 in each trial.

Orientation

Total time spent looking at any part of either E2 or E3's body (including eye contact) in each trial.

Position

Total time spent with both front paws inside the box drawn around E2 and E3 in each trial. Instances in which the dog's paws were on the lines that compose the box were included in this measure.

Active touching

A count of instances of the dog touching or nudging either E2 or E3 with his/her paws or snout (intended as a measure of intentional attention-getting contact) in each trial.

Vocalizations

A count measure of the presence or absence of any vocalizations made by the dog during each trial, broken down by the orientation of the dog while making the vocalization (directed at E2, E3, or neither). Here, orientation was defined as which way the dog was looking, not necessarily the position of the dog's body.

Persistence

Total time spent physically trying to open the box, defined as pawing or otherwise contacting the front face of the box. Instances in which the dog brushed the side of the box while searching for treats behind the box were not included in this measure. Pawing at the box was coded as one continuous event as long as the dog did not lose contact with the box for over two seconds.

Analysis

After each variable was objectively coded, means and standard deviations were calculated for each measure. Two tailed paired-samples *t*-tests were run on orientation, position, and look time, to compare differences between the extent of these behaviors directed toward the non-cooperator and cooperator.

Results

Of the 25 dogs tested in this sample, 12 were able to complete the task. Experiments were aborted on the remaining 13 dogs for various reasons, including lack of motivation, inability to learn to open the box, or anxiety caused by being in a new environment and away from owner. We ran two tailed paired-samples *t*-tests to compare the difference in time the dogs spent oriented toward, looking at, or positioned in front of the non-cooperator and the cooperator. There was no significant difference in the scores for orientation for non-cooperator ($M=2.59$, $SD=1.91$) and cooperator ($M=2.58$, $SD=2.08$); $t(11)=0.006$, $p=0.99$. There was also not a significant difference in the scores for looking time at the non-cooperator ($M=1.78$, $SD=1.89$) and cooperator ($M=1.92$, $SD=1.89$); $t(11)=2.98$, $p=0.85$. These results do not provide any evidence to suggest that the dogs preferentially attempted to reengage either the non-cooperator or the cooperator over the other. There was a significant difference in the scores for position, with dogs tending to position themselves in front of the non-cooperator ($M=8.95$, $SD=3.84$) more than the cooperator ($M=3.96$, $SD=3.68$); $t(11)=2.98$, $p=0.01$.) This result, however, does not suggest that the dogs attempt to preferentially engage the person who baits the box, as they did not orient or look at the non-cooperator more than the cooperator. The results for

mean orientation, looking time, and position of the dog relative to both E2 (cooperator) and E3 (non-cooperator) are shown in Table 1, and in Figures 1. Time spent for orientation, position, and look time toward cooperator were also plotted for each subject and trial (Figure 2), but plots showed no trends across trials. Results for vocalizations, persistence, and touch are shown in Table 2. These results were not analyzed, however, as they did not show much evidence behaviors, so there was not enough data to run statistics on.

Table 1

Variable	Experimenter	Mean (s)	Standard Deviation
Orientation	Non-cooperator	2.59	1.91
	Cooperator	2.58	2.08
Look Time	Non-cooperator	1.78	1.89
	Cooperator	1.92	2.05
Position	Non-cooperator	8.95	3.84
	Cooperator	3.96	3.68

Table 1: Mean times and standard deviations for orientation, look time, and position, relative to cooperator and non-cooperator.

Figure 2

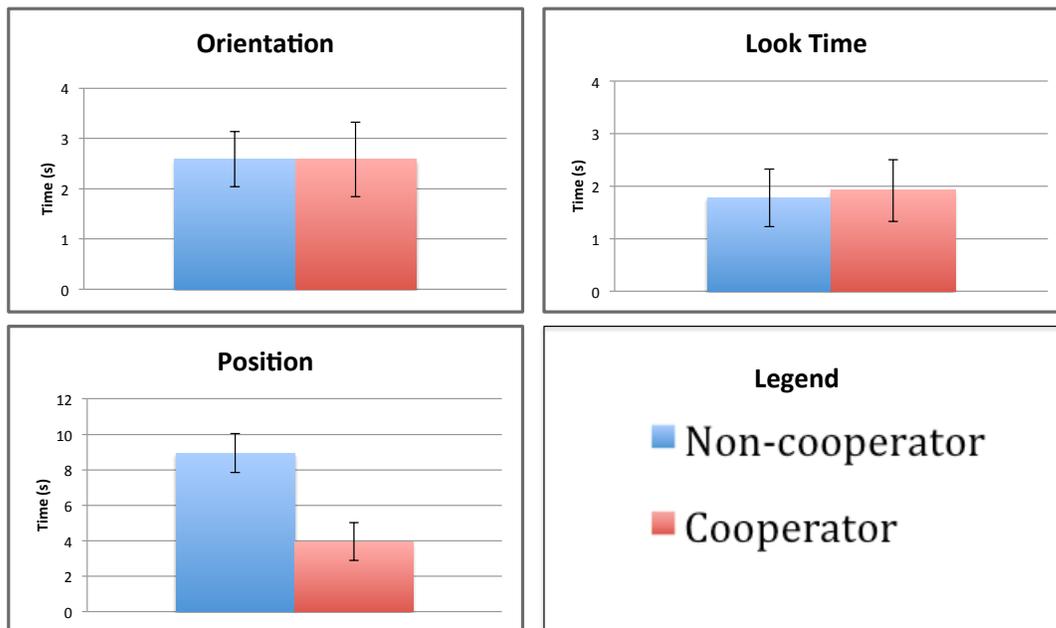


Figure 2: Orientation, look time, and position in seconds, relative to both non-cooperator and cooperator, with standard error bars.

Figure 3

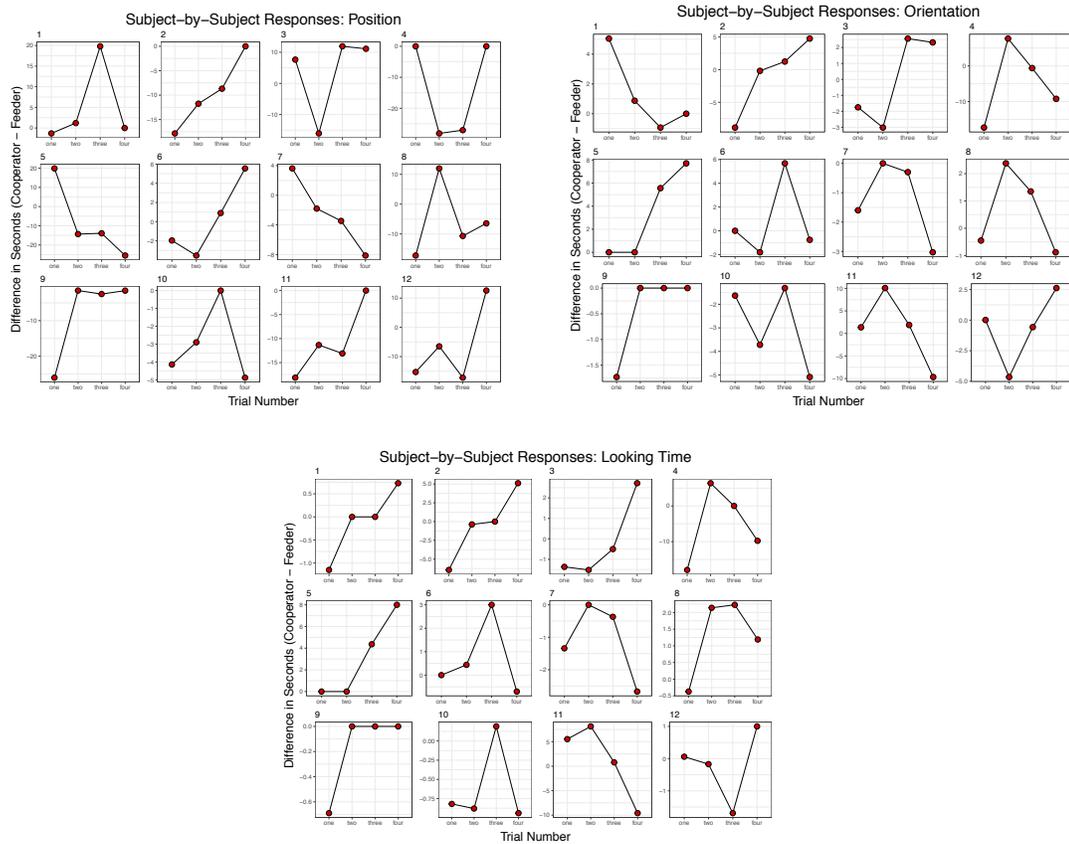


Figure 3: Plots across the four test trials per individual subject for position, orientation, and look time toward cooperator.

Table 2

Trial	Vocalization Non-cooperator	Vocalization Cooperator	Vocalization Neither	Touch Non-cooperator	Touch Cooperator	Persistence
1	M=.083 SD=0	M=.083 SD=0	M=.25 SD=0	M=.58 SD=0	M=.42 SD=0	M=2.78 SD=.97
2	M=.083 SD=0	M=.17 SD=0	M=.083 SD=0	M=.42 SD=0	M=.25 SD=0	M=1.72 SD=1.32
3	M=0 SD=0	M=0 SD=0	M=.083 SD=0	M=.58 SD=	M=.083 SD=0	M=2.78 SD=3.15
4	M=.17 SD=0	M=.083 SD=0	M=.33 SD=0	M=.33 SD=0	M=.083 SD=0	M=2.70 SD=2.10

Table 2: Mean results and standard deviations for vocalization toward non-cooperator, cooperator, or neither, touch toward non-cooperator and cooperator, and persistence. Vocalizations and touch were binary measures and were a value of either 1 (presence of behavior) or 0 (absence of behavior), and persistence was measured in seconds.

Discussion

The main findings of our CSIT were that dogs learned to manipulate the apparatus, and to do so cooperatively with the human when the task required each individual to play a role. However, when the cooperator stopped participating, dogs showed little indication of trying to preferentially reengage the cooperator (vs another individual) for help with the task. Evidence of soliciting help from the cooperator could have involved gazing at, orienting toward, or standing in front of them, behaviors commonly reported in other studies of dog social cognition (Call et. al 1998; Call, Brauer, Kaminski, & Tomasello, 2003; Eddy & Povinelli, 1996; Gacsi, Miklosi, Varga, Topal, & Csanyi, 2004; Kaminski, Call, & Tomasello, 2004; Maclean et. al 2017; Virányi, Topál, Gácsi, Miklósi, & Csányi, 2004). . In this study, dogs showed no preference in any of these behaviors toward the cooperator over the non-cooperator, and in fact stood in front of the non-cooperator more.

Our analyses of orientation and look time between the non-cooperator and cooperator did not yield any statistically significant results, and thus offer no evidence that dogs attempt to preferentially re-engage the cooperator in this task. Results for persistence, vocalization, and touch were not analyzed, as a larger sample is needed to yield enough data to analyze these (rare) behaviors. Plotting values for orientation, look time, and position, respectively, for individual dogs showed no trends in increased preference across the four trials for either the non-cooperator or cooperator. Mean orientation and look time for all dogs was almost equal between the non-cooperator and cooperator, showing the dogs did not try to preferentially attempt to re-engage either experimenter over the other.

One interesting finding is that analysis of position did show a significant preference ($p = .01$) of the dogs to stand in front of the non-cooperator (who baits the box) rather than the cooperator (who opens the box). One possible interpretation of this finding is that the dogs may not have formed a joint goal with the cooperator. The higher amount of time spent in front of non-cooperator without an increase in orientation and/or look time toward the non-cooperator suggests that position in front of non-cooperator may be due to other factors, and is unlikely to be an attempt to reengage the non-cooperator in the cooperative activity. One possible explanation is that after baiting the box, the non-cooperator's hand smells like the treat they were just holding. In many instances, the dogs sniffed and/or licked the non-cooperator's hand that held the treat. This would incidentally lead to an increase in time spent in front of non-cooperator.

The main limitation of this study is that the sample size was very small, allowing for large margins of error, leading to less conclusive results. A larger sample would be needed to decrease the margin of error and increase the confidence levels with which results can be reported. Another limitation is that the sample included only pet dogs, and did not include any type of non-owned dogs, such as shelter dogs, or lab-reared dogs. Theoretically, expanding the study to include shelter dogs should not affect results because the underlying cooperation mechanisms are hypothesized to be the result of thousands of years of evolution, rather than the environment the dog was brought up in.

However, to test this hypothesis, shelter and pet dogs would need to be tested independently, and the results compared to confirm consistent. Therefore, leaving out shelter dogs is a limitation of this study, as it is not necessarily representative of the domesticated dog population as a whole.

Lastly, the experimental design presented a few limitations in this study, which could have contributed to dogs' preferences to stand in front of the control rather than the cooperative experimenter. The way the test box apparatus was built, it was possible for dogs to get behind the box to where treats were kept. This posed two problems: (1) it made human intervention necessary at times to prevent the dogs from reaching the treats, and (2) some dogs may have spent time trying to figure out how to reach the treats behind the box rather than trying to solve the box to retrieve the treat from inside the box. Altering the set up and/or apparatus to make it impossible for the dogs could eliminate this problem. Another limitation of the experimental design is the order in which the cooperator and non-cooperator bait the box. In all of the familiarization trials leading up to the test trials, the cooperator is always the one to bait the box, and cooperatively open P2 to allow the dogs to reach the treat. It's possible that the dogs may learn during this time that the person who baits the box also lifts P2, and then transfer that "knowledge" to the test trials. However, in the test trials the non-cooperator only baits the box, but the cooperator remains the one lifting P2. If the dog believes that the person who baits the box and the person who cooperates are one in the same, then standing in front of the non-cooperator during the test trials could possibly be an attempt to indeed reengage the person they now expect to be a cooperator. Future studies could address this problem by randomizing or alternating between the cooperator and non-cooperator baiting the box between all trials, or by having a mechanical object bait the box, but keep the human aspect of having one cooperator who lifts P2, and one non-cooperator who is present but does nothing. Another possible explanation of why the dogs spent an increased amount of time in front of the non-cooperator is that the non-cooperator's hand may have smelled like the treat immediately after baiting the box. Many of the dogs licked and/or sniffed the non-cooperator's hand during the test trials, which is something they did not do to the cooperator. Perhaps they were looking for more treats in the non-cooperator's hand, or smelling the scent left behind from the treat the non-cooperator had just been holding. Baiting the box mechanically could help with this problem as well, although it is possible that dogs may begin to look towards the mechanical device for more treats in that situation.

Ultimately, we find no evidence that dogs exhibit shared intentionality with humans by preferentially reengaging a cooperative human over a non-cooperative human in a triadic food acquisition task. However, dogs were still able to manipulate the apparatus and cooperate with their human counterpart to solve the box and retrieve the food reward. It is interesting that dogs did not solicit more help from either human in this studies, because previous studies have found that when presented with an impossible task, dogs will attempt to reengage humans. One example of this is in a 2003 experiment that compared socialized wolves to domestic dogs in two different studies. The first study found that while wolves were able to locate hidden food based on cues from humans, but they were still outperformed by dogs. In the second study when the wolves and dogs were presented

with an insoluble version of a simple food acquisition task, it was found that dogs would gaze at humans when they could not solve it, whereas wolves did not (Miklosi, Kubinyi, Topal, Gasci, Virani, Csanyi, 2003). Given this, along with the evidence from the MacLean (2017) experiment demonstrating how similar human toddlers and dogs perform on some sociocognitive tasks, further research is needed to substantiate the extent to which dogs are able to perform cooperatively with humans.

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