

The Truth about Cats and Dogs:
Studying Pointing in Domestic Cats (*Felis catus*)
and Domestic Dogs (*Canis familiaris*)

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Abstract

Domestic cats and dogs were tested in a pointing task to determine whether they could follow a human's body orientation to find a reward. Of those cats (n=11) and dogs (n=10) that participated, all of the subjects performed significantly above chance levels in the pointing task. Catch trials were added to test whether the subjects were using olfactory cues from the food rewards. Performance during the catch trials remained extremely high, indicating that the subjects were not using olfactory cues. No significant difference was found between cats or dogs, nor between visible displacement and pointing tasks. Results suggest that both cats and dogs can follow body orientation cues to find a reward.

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Humans are able to imagine a number of mental events that help us to gather information about the world. One such ability is to follow the gaze of another. The ability to follow the gaze of another occurs in human infants at two months of age (Scaife & Bruner, 1975). This ability develops extensively, along with the ability to follow pointing, between 9 and 15 months of age. It is thought that these early abilities help humans to share attention and later to learn language (Carpenter, Nagell, & Tomasello, 1998). Since the ability to follow gaze and to understand gestures develops so early, one wonders whether humans have a biologically innate predisposition to share attention socially.

Another mental event that appears early in children is object permanence, or the recognition that objects continue to exist when they are hidden (Sternberg, 1999). By the time they are eight months old, human infants are acutely aware that things do not cease to exist simply because they are out of sight and will deliberately search for objects when they are hidden (Gleitman, Fridlund, & Reisberg, 1999).

Piaget separated this capacity, called object permanence, into six sub-stages of development. For the purpose of this study, the relevant stages are four through six. According to Piaget, stage four is depicted by searching for a completely hidden object. The cognitions involved are limited, though, because if this object is moved in plain view of the subject, he or she will still search at its original hidden location. Children reach this stage at 8-12 months of age. At around ages 12-18 months, children will reach stage five

of object permanence and start searching for an object after seeing it hidden, which is known as visible displacement. By age two, children can search for an object that they did not watch being hidden, (known as invisible displacement), and will continue to search for that object until it is found or until interest wanes because the child is fully certain that the object still exists (Cole & Cole, 2001).

As a species, humans have an incredible ability to mentally represent objects and to collect information via the orientation of others. However, our understanding of our perception and of how we imagine the world is incomplete if we do not consider how other animals think about the world as well. For example, you could suppose that object permanence and visual co-attending helped humans develop a symbolic language, and that is why these abilities emerge so early in human development. On the other hand, if animals that do not use a symbolic language (other primates or mammals) have the same cognitive abilities, then the evolutionary purpose of object permanence and visual co-attention is not for developing symbolic language. After all, humans are mammals in the same way as apes, monkeys, and even cats and dogs are – we share common ancestors and common evolutionary beginnings. In order for our understanding of how we think about the world to be complete, we must study how non-human primates and other mammals think (or do not think) about the world.

One way to look into this topic is to see if other animals have the ability to learn to follow gaze and to understand pointing. Part of testing gaze following or pointing in animals involves hiding objects, usually without the animal watching. Thus, the animal that succeeds in this must at least maintain object permanence. This experiment tests whether other animals spontaneously follow a gesture (e.g. eye gaze, pointing), to find a

hidden object. In order to propose such an experiment, however, findings among primates and other mammals must first be reviewed to determine what is known about the evolution of this process.

Review of Perspective-Taking in Mammals

Tomasello and Call argue that since humans learn to follow gestures (specifically, eye gazes and pointing) from a very young age, that the ability is innate. There has been some systematic study of gaze following in primates, and four notable studies exist on the subject. Povinelli & Eddy (1996) found that chimpanzees can use head direction and eye gaze or just eye gaze alone as a cue. The task was to select a cup with treats hidden inside. For the control condition, the experimenter stared directly at the subject and avoided looking at any of the cups. The experimenters used a variety of combinations of eye gaze, head orientation, and gestures to see which cues the subjects would follow. The chimpanzees looked where the experimenters were looking regardless of whether the entire head or just the eyes moved. The subjects were even able to follow the experimenter's gaze to a location behind where they were standing. This ability develops in human children by age 18 months (Povinelli & Eddy, 1996).

A study by Itakura & Tanaka (1998) showed that chimpanzees and an orangutan could also follow cues from an experimenter to choose one of two cups. There were five conditions in this study: tapping the correct location, head and eye orientation, close and far gaze (involving head and eyes), and glance (eyes only). All of the subjects were able to use all of the cues within three sessions, and glance was the most difficult condition to master. The experimenters compared these results to a study of children aged 18-27 months using the same cues and found similar results.

Anderson, Sallaberry, & Barbier (1995) studied a group of capuchin monkeys, (*Cebus apella*), in a series of five tests, all involving the initial secret baiting of food in one of two buckets. For the control condition, the experimenter would stare in-between the two buckets. For the experimental conditions, the experimenters used a series of cues to test which cues or combination of cues would aid the subject in choosing the correct bucket. They found that head direction alone or eye gaze alone was not sufficient for any of the subjects to direct them to the correct hiding location. Touching one of the buckets, as well as a combination of head direction and eye gaze, however, were effective cues.

Neiworth, Burman, Basile, & Lickteig (2002) conducted two experiments to test co-orienting skills and the ability to follow cues with cotton-top tamarin monkeys (*Saguinus oedipus*). In the first experiment, two different objects, (novel photos selected to be bright, detailed, and engaging), were set up on opposite sides of the subject's cage and the experimenter directed his or her attention towards one of the objects. The experimenter did this in several ways by either pointing at the object, gazing at the object with just his or her head, or gazing at the object while orienting his or her entire body towards the object. These three trial types were repeated with the experimenter close to the object and far away from the object, plus a catch trial which aimed to determine how the subjects would react to the experimenter moving towards an object without drawing attention to it. Results indicated that, in general, pairs that lived together showed significant high positive correlated co-orienting with each other but only co-oriented with the human experimenter on an average of 27%. They determined that while cotton-top tamarins do not generally visually co-orient with cues given by humans, they do co-orient

with each other. Further, the rate of visual co-orientation was significantly increased by hand-pointing cues and look cues, more than any other cue given.

The second study involved hiding a treat under one of two cups. The experimenter baited one of the cups without the subject seeing the baiting and then indicated the correct cup by several different types of indicator cues: 1) pointing and tapping the correct cup; 2) just pointing; 3) body, head, and eyes oriented towards the cup; or 4) glancing with just the eyes. The experimenter also used two catch trials connected to the body/head cue to test the subjects without reinforcement. In one trial the experimenter oriented body, head, and eyes to one cup, but neither was baited. In the other, the experimenter oriented to the wrong cup, (the one that was not baited). Results indicated that look cues (head + eyes) generated the highest percentage of correct scores, which was particularly significant because a percentage of those cues did not actually offer any reinforcement (the catch trials). In this experiment the subjects did, in fact, use experimenter cues to find a reward without being trained to do so (each subject only experienced 30 trials). Ultimately it appears that, in cotton-top tamarins, their understanding of attention relies heavily on a spatial relationship between an interesting object and another being's body orientation to that object.

Though primates can all follow gazes and directional cues, different species do so in different ways. Human children develop the ability to follow directional orientation cues from others at approximately a year old. While adult chimpanzees and orangutans can follow even the slightest eye gaze in any direction, (including behind them), New World monkeys like capuchins, (*Cebus paella*), require eye gaze combined with head direction in order to follow such cues, and cotton-top tamarins (*Saguinus oedipus*)

depend heavily on spatial relationships when following look cues. Even though primates have shown different means and requirements for following gaze cues, they all succeed to some extent. The next logical question, then, is whether other mammals like dogs and cats also share these abilities.

In fact, there have been several studies on the performance of dogs in such tasks. Miklósi, Polgárdi, Topál, & Csányi, (2000) used dog orientation to determine whether dogs can “show” their owners what they want. The researchers define showing as “a communicative action consisting of both a directional component related to an external target and an attention component that directs attention of perceiver to the informer or sender” (Miklósi, Polgárdi, Topál, J., & Csányi, 2000, p. 159). Ten dogs participated in this study in their owner’s home and there were three conditions: food/toy present, owner present, and owner and food/toy present. They found that when a food or toy was presented, subjects would look where their owner had gone. When the subjects’ owner was present, the subjects looked at the location where the food or toy was hiding. When both the owner and the food or toy was present, the dogs looked alternately between the location of the food/toy and the owner’s location within two seconds. Based on these observations, the researchers concluded that it is possible that dogs engaged in “showing” behavior for their owners and that the different look rates in the different conditions indicated that the dogs were trying to indicate to their owners using body orientation where the food or toy was hidden.

Fourteen dogs participated in an experiment by Soproni, Miklósi, Topál, & Csányi, (2001), which aimed to study the spontaneous interpretation of human gestures by dogs. The experimenters used two bowls in this experiment to hide the bait. During a

pre-training phase, the experimenter showed the dog the food and placed it in one of the bowls while the dog was watching (a simple visible displacement task). The dog was then required to choose one of the bowls, and this was repeated four times. Then, a pointing phase was done to test the subjects' ability to follow a pointing cue combined with a look cue. The subjects had to reach a learning criteria of 90% or better in order to continue. In the testing phase, three types of novel trial were introduced with pointing trials embedded into the mix as well. In the "at target" trials, the experimenter's head and eyes were oriented towards the correct bowl. In the "above target" trials, the experimenter's head was oriented towards the correct bowl, but her eyes glanced well above the correct bowl to the corner of the room. During the "eyes only" trials, the experimenter only used a glance towards the correct bowl.

All of the dogs reached learning criteria (90% or higher) for the pointing trials. Overall the dogs performed significantly above chance for the "at target" trials ($t(13) = 5.3, p < .01$), but were at chance level for the "above target" and "eyes only" trials. No learning effects existed for the "at target" and "above target" trials. However, a learning effect was found for the "eyes only" trials ($T(N = 10) = 3, p < .01$), but it was not an odd effect: the dogs performed significantly below chance during the first few "eyes only" trials, and by the last few they performed slightly above chance (Soproni, Miklósi, Topál, & Csányi, 2001). It would have been interesting to further study the "eyes only" type of trial to see whether the dogs would eventually learn to follow only an eye gaze. Even if the dogs did eventually learn to use this type of cue, however, it does not necessarily mean that the dogs learned to think about it in the same way as humans, especially if the response requires extensive training.

McKinley & Sambrook (2000) found that dogs who were of breeds specifically bred for hunting and who had specialized training for pointing used pointing more successfully than other types of dogs. They hypothesized that cognitive ability may be the result of domestication and socialization with humans over time. Further, regardless of whether this ability develops naturally in dogs, the ability can nevertheless be trained.

Unfortunately there have not yet been many studies testing cats for their ability to follow human gestures (for example, pointing). However, many well known aspects of cat behavior offer evidence that cats may be able to pick up some information from human gestures. Cats seem acutely aware of body orientation; for example, cats who want to avoid conflict will avoid approaching another cat with their body oriented forward, and will instead approach sideways or diagonally. Slow, deliberate blinking is also a non-aggressive act. Feral domestic cats do in fact form loosely based social groups. Domestic cats who are members of multi-cat households also form social hierarchal groups that, for the most part, remain rigid throughout the lives of the cats; for example, the dominant cat in the home tends to remain the dominant cat throughout its lifetime, regardless of how many new cats are later introduced (personal observations).

Object Permanence in Mammals

Tasks commonly used to test gaze often require subjects to have some level of object permanence. If an animal does not know that objects it cannot physically experience (either by sight, scent, sound, touch, or taste) continue to exist, the animal has no reason to search for hidden objects or to pay attention to the body orientation of others to find something. The first question to ask, then, is whether non-human primates do object permanence.

In fact, studies have shown that several different species of non-human primates can perform object permanence tasks. Neiwirth, Steinmark, Basile, Wonders, Steely, & DeHart (2003) studied visible displacement in eight cotton-top tamarin monkeys (*Saguinus oedipus*), and invisible displacement with seven. The study involved hiding one treat in one of three cups and the subjects had to tip over the cup in order to receive the food reward. They found that all of the subjects performed significantly above chance for both visible displacement, when they had to track the object to a hiding place, and invisible displacement, when they had to imagine the movement of a concealed object. Similar methods have shown similar results for chimpanzees (Hallock & Worobey, 1984), gibbons (Snyder, Birchette, & Achenback, 1978), a gorilla (Visalberghi, 1986), squirrel monkeys (Vaughter, Smotherman & Ordy, 1972), capuchin monkeys (Dumas & Brunet, 1994), and Japanese macaques (Antinucci, Spinozzi, Visalberghi, & Volterra, 1982). Tomasello & Call (1997) state that it is likely that all primates, apes, Old World Monkeys, and New World Monkeys, have full object permanence, including the ability to solve/track invisible displacement. Given that studies of so many different species of primates have shown object permanence, it is likely that this is indeed the case.

If primates can represent objects that they can no longer experience in a sensory way, perhaps this ability extends to other mammals. Dogs and cats, for example, are both predator species that may need to track moving objects to hiding places in order to survive. In a study by Gagnon & Doré (1992), dogs not only succeeded in invisible displacement tasks, but also did so without the use of olfactory cues. This study involved two phases, and in the first phase thirty dogs were tested for their ability to perform visible and invisible displacement tasks. The subject was restrained while he or she

watched a rubber toy being hidden, and then was released to go find the toy. During this experiment, the subjects were tested in single visible and multiple single displacements, and then in single and multiple invisible displacement. Objects were hidden behind opaque screens and the subjects were then required to seek out the object and touch it with either their face or their paw. Reinforcement involved social praise and the chance to play with the toy. A Group x Test repeated measures ANOVA found a significant effect of test, $F(7,126) = 19.32$, $p > .0001$, and further testing revealed that while all tasks were performed significantly above chance levels, single visible displacement and sequential visible displacement tasks were performed at higher rates of success than the invisible displacement tasks. This part of the study showed that dogs could perform visible and invisible displacements, and that invisible displacement was more difficult than visible displacement. Dogs did make more errors with the invisible displacement trials, usually when the initial hiding location was novel. The order in which each test was administered also had an effect. It is clear from the data that the dogs were becoming familiar with the task at hand: dogs who received visible displacement tasks first did better when they were given the invisible displacement tasks than the dogs who received the invisible displacement tasks first.

In the second phase to this study, ten dogs were exposed to an odor-masking procedure to test whether the dogs were using olfactory cues to find the toy. Replicas of the toy were placed behind all screens so that each toy served as the target for some trials and a smelly decoy for other trials. The ten dogs completed both invisible and visible displacement and the results did not show a significant difference between performances

in the first phase as opposed to the second phase. This suggests that dogs were not using smell to find the toy, and can indeed do visible and invisible displacement.

In another test of object permanence, Gagnon & Doré (1994) studied 70 puppies aged four weeks through nine months of age and found that puppies as young as five weeks old were able to show signs of understanding a visible displacement task, which developed rapidly through the age of eight weeks (Gagnon & Doré 1994). This study suggests that, like humans, dogs show object permanence at a very young age. It is likely, then, that dogs can reach at least stage 5 of object permanence, if not also stage 6. Since dogs also show object permanence, perhaps the ability is general to mammals? To explore this question further another species of non-primate mammal – cats – were tested.

Cruber, Girgus, & Banuazizi (1971) found that young cats can perform visible displacement tasks within an experimental situation, but tend to fail at invisible displacement tasks. The study included four kittens aged 10-12 weeks (group 1), four cats aged 24-26 weeks (group 2), and four cats aged 108-110 weeks (group 3). These three groups of kittens were lab-raised. Group four consisted of seven house-reared kittens aged 10-13. The experimenters also collected data from three house-reared kittens aged 6 days – 10 weeks and from another four house-reared kittens aged 13-30 weeks to obtain some longitudinal data on the development of object permanence in cats (collectively group 5).

The first test of object permanence involved covering a toy while the kitten/cat was distracted and the target behavior was either pawing at the cloth or pawing at the cloth and uncovering the object. None of the animals in groups 1-4 initially performed either behavior at first. However, the house-reared subjects were able to perform the

behavior by age 10.5 weeks. In a second test, the experimenters uncovered the object while the kitten was playing with it and the target behavior was the same as in the first test. All of the lab-reared kittens in the older groups succeeded and all of the younger lab-reared kittens failed. Two kittens in group 4 pawed at the cloth and one kitten from that group actually succeeded in uncovering the object. The first appearance of searching in the longitudinal kittens was at 10.5 weeks and 16 weeks, respectively.

The experimenters had high expectations for the subjects in these two tests – expectations that may be unfair. For example, grasping and removing a cloth is not necessarily a natural behavior for a young kitten. Even so, by 24 weeks of age all of the kittens could vigorously paw at the cloth to uncover the object. This shows a progression of development in much the same way as we see in humans and also in puppies. Also interesting to note is that in the first test of object permanence, none of the cats in group 1-4, which were mostly lab reared, were able to perform the task at the ages they were initially tested at, whereas the house-reared kittens were able to do so at a young age.

In a study by Dumas (1992), cats easily mastered a single invisible displacement task. Nineteen house-reared cats, aged 4-84 months were studied in their owner's homes. The target was a small ball made of foil. The subjects were allowed to watch the target fall into a hidden position while standing behind a transparent screen. When the target was released, the subjects were allowed to run behind the screen to search for the foil ball. These methods require more anticipation on the cat's part of where the object will end up than most standard invisible displacement tasks. Movement is also an important factor in these methods because the cats are able to track the direction of the target briefly before it is obscured by the screens. Results showed that the cats easily mastered this

single invisible displacement task. The mean number of successful trials was 8.57 out of 10 trials. The significance of these results ($t(18) = 14.12, p > .005$) was well above chance level. If it is indeed the case that a cat's sense of object permanence is related to movement and tracking (or residual sensory experiences), then the results of this experiment would tend to go along with that hypothesis.

The cats in this study also showed flexible search, meaning that the subjects often took the opposite route than taken by the object when it disappeared to find it. Such behavior is common in cats, often manifesting itself in chase games between two cats where one cat chases another toward a couch (or other large object) and watches as the cat disappears behind it. Rather than follow the cat behind the couch, the cat instead anticipates the final location and runs to the opposite end of the couch. Such behavior is vital for predators trying to catch prey.

More recently, Dumas (2000) found that cats could do invisible displacement, but again only when the initial tracking of movement was involved. Fifteen house-reared cats participated in this experiment in their owners' homes. Cats were first trained to paw at a foil ball; this training took an average of 111 trials ($M = 111.0, SD = 63.0$) over an average of 5 sessions ($M = 5.5, SD = 3.8$) of 20 trials each. In the experimental phase, the subjects received two 20-trial sessions spaced out over several days ($M = 9$ days, $SD = 4.7$). The materials for both sessions were exactly the same, so that the first session was tagged a novel situation, while the second was tagged a familiar situation. Each session included two types of trials: Type 1 trials required the subjects to initiate search behavior before the object disappeared behind the opaque screen, but the foil ball was always hidden before the subjects reached the target screen. In Type 2 trials the object

disappeared behind the target screen before search behavior was initiated. In both trials, the cats had an opportunity to initially track the foil ball before it became hidden, but because the cats could never see its final hidden location, success would still require the cats to imagine the hidden foil ball and where it might have moved without seeing it. The total rate of success for both trials combined was 93.2%. This means that the cats in this study were able to perform invisible displacement and that it did not matter whether the cat was released before or after the foil ball escaped behind the opaque screen.

Since the ability to follow pointing has been well documented in many primate species as well as dogs, it follows that cats, being mammals, may also be able to follow pointing. Cats already share many of the same cognitive abilities with dogs and primates. They develop at least to stage 5 of object permanence, are social animals, and have been domesticated by humans for thousands of years. Additionally, their keen eye sight and observant nature make them a good species of mammal to study. With so many similarities between cats and other mammals (primates, dogs), there is a good possibility that cats can also follow pointing to receive a food reward. Can cats think about an object in the same way as a dog? A non-human primate? A human? Or is their ability to find hidden objects more closely linked with an extension of a movement sensation tied to prey capture as suggested by the 1992 Dumas study? The following study aims to examine how a cat can think about an object when it is being hidden, and whether cats can follow a human gesture to find a food reward. The study will use a simple visual displacement task and a pointing task to determine how cats perform in these conditions as compared to dogs.

Methods

Subjects

A total of 22 cats and 12 dogs, all pets not involved in prior psychology experiments, participated in the experiment. All cats were between 6 months and 13 years old. All dogs were between 2 and 12 years old. The cats were mostly mixed breeds, though some were purebred according to their owner. The dogs were mostly purebred, according to the owner. See Tables 1 and 2 for a complete list of subjects, their ages, and their training histories.

Apparatus

The testing apparatus was modified slightly for cats and dogs. For cats, three small lunch-sized brown paper bags (13 cm x 8 cm x 12 cm) placed 35 cm apart were set approximately 40 cm away from the experimenter. The bags were turned upside-down and the cats were unable to see the contents of any of the bags.

For dogs, three large, opaque stainless steel bowls (15 cm in diameter x 4.5 cm high) placed 35 cm apart were set approximately 40 cm away from the experimenter. The bowls were turned upside-down and the dogs were unable to see the contents of any of the bowls.

For all but one of the subjects (Missy the cat), the target was a highly desirable food item. The experimenter could not find a food item that Missy would eat, so a ball toy was used instead; otherwise, the methods were the same. Owners were asked not to feed their pet for 3 hours prior to the start of the experiment. Water was always available.

Procedure

Pre-training. All testing was performed in a quiet room in the owner's home. First, a pre-training phase was conducted in order to make sure that the target was a desirable item (or a desirable toy) that the subjects would choose. At the beginning of each trial in pre-training, the experimenter called the subject's name several times to get his or her attention and placed the target in front of the testing apparatus (the paper bags for the cats, and the bowls for the dogs) while the owner restrained the subject 2 m away. After a 5-second delay, (during which time the experimenter continued to call the pet's name) the experimenter said, "Go", and the subject was released and had 60 seconds to obtain the reward. The delay was based on prior research testing delays that produced good memory for searching in cats (Goulet, Doré, and Lehotkay, 1996). The pre-training phase trials were repeated until the subject approached and ate the target once within 60 seconds at each of the three locations consecutively. Trials were separated by a 5-second intertrial interval (ITI). If the subject did not respond for 7 consecutive 60-second trials, the experiment was ended and the subject was not tested. A large number of cats did not continue in the study by failing to respond at this level.

Visible Displacement. In visible displacement, the target was shown to the subjects and then placed under one of the paper bags (cats) or under one of the bowls (dogs) by lifting up the bag/bowl and slowly placing it under the bag/bowl. For both cats and dogs, the subject had to track the item from the time he or she first saw it in the experimenter's hand to the time he or she saw it leave the experimenter's hand and enter the testing apparatus. To make certain that the subjects were tracking the target, their attention was constantly being engaged by calling their names. Hiding locations were counterbalanced across 3 locations (see Table 2 for a progression of the trials). After a 5-

second delay, (during which time the subject's attention was engaged), the experimenter said, "Go", called the subject's name again, and the subject was released and had 60 seconds to make a choice. A choice was defined as touching one of the testing apparatus with part of the face (includes whiskers) or front paw. A choice was correct if it was the first choice the subject made and if it was directed at the location containing the target. If the choice was correct, the experimenter removed the target from the container and immediately gave it to the subject while also giving verbal praise. If the first response was incorrect, the experimenter said, "No," removed the incorrect container, and coded the trial as incorrect. Then, a correction procedure was initiated. The subject was then allowed a second attempt with just two bags/bowls. If the subject made another incorrect first choice, the experimenter would again say "No", remove the incorrect container, and allow the subject one last attempt at making the correct response. None of the responses during the correction procedure contributed to a calculation of correct performance. Each subject had to make the correct choice to move on. The experiment ended if the subject was unable to make five consecutive correct choices within the session. If the subject did not make a choice within the 60-second trial, it was considered an aborted trial and the trial was repeated. Five consecutive abort trials ended the experiment, and indicated the subject was unwilling to participate. This number was reduced from the previous phase because it was inferred that if the subject did not respond for five trials that it had likely lost interest and that subsequent trials would be unnecessary. The ITI remained at 5 seconds.

Pointing. This is the test phase in which tracking human gestures was tested. For each trial in the pointing condition, the owner first restrained his or her pet 2 m away

from the testing apparatus while the experimenter called the subject's name and showed him the target. Next, the owner oriented the subject's body and head away from the experimenter. The experimenter had 5 seconds to hide the target in one of the three containers while the subject's view was blocked. The experimenter always touched the other two containers to obscure any auditory cues to the location of the target. After 5 seconds, the subject's name was called and the owner reoriented the subject back so he or she was facing the experimenter. Then the experimenter oriented her entire body and head towards the correct choice while looking at the correct choice, and pointed directly towards it so that the finger was within 5 cm of the correct choice. The experimenter then said the subject's name again and then did not move for 60 seconds while the subject made a choice (see Table 3 for a depiction). If the choice was correct, the experimenter removed the target from where it was hidden and immediately gave it to the subject while also giving verbal praise, marking the response as correct. If the subject was incorrect, the experimenter would say "No" and remove the target, marking the response as incorrect. No correction procedures were given during the test. There were a total of 9 trials in this condition, separated by ITIs of 5 seconds, with each location used three times in pseudorandom order such that no single location was baited more than two times in a row (see Table 3 for trial progression).

Pointing Catch Trials. The final test condition was performed with methods similar to the first Pointing condition. The purpose of these trials was to test whether subjects used smell cues to find the target. Three different types of trials were presented three times each for a total of 9 trials. In the first type of trial, called REWARD-all, all containers were baited. In the second type of trial, called STANDARD-test, only the

container being pointed to was baited. In the final type of trial, called REWARD-nothing, none of the containers were baited. The order of the trials and containers being pointed at was randomized and counterbalanced across the three locations, with the constraint that a single location was not repeated more than twice (see Table 3). The subject received the standard reward (target + verbal praise) for choosing the container that the experimenter was pointing to. However, if the subject chose incorrectly, the experimenter said “No”, and no reward was given. There was no correction procedure during this test condition. There were a total of 9 trials separated by intertrial intervals of 5 seconds.

Results

Of the 12 dog subjects whose owners volunteered, 10 dogs met criteria, passed visible displacement, and were tested. Of the 22 cat subjects who were volunteered, 11 cat subjects met criteria, passed visible displacement, and were tested. In both species, non-participants (2 dogs and 11 cats) did not make clear choices during pre-training and/or were unwilling to participate.

A Mixed Model ANOVA was conducted with species (cat vs. dog) as the fixed factor and the test condition (visible displacement vs. pointing) as the repeated measure. The dependent variable was accuracy across the total number of trials in these conditions. The species main effect (dogs vs. cats) was not significant, $F(1,19) = 0.20, p = .66$. The condition main effect (visible displacement vs. pointing) was also not significant, $F(1,19) = 0.32, p = 0.58$. Finally, the interaction effect (species x condition) was not significant, $F(1,19) = 0.10, p = 0.75$. This means that the accuracy across conditions was not different, nor was it different across species. Figure 1 shows the means scores for each species for each condition; all of the subjects performed very well.

In addition, each species was analyzed separately to determine if there were differences in accuracies across the various tests. A paired samples t-test comparing the dogs' accuracy between visible displacement and pointing showed no significant difference, $t(9) = 0.171, p = .87$. The same test was repeated to test the cats' accuracy between the two conditions and also showed no significant difference, $t(10) = .635, p = .54$. The means indicated that the dogs do equally well in both conditions (visible displacement $\bar{x} = 98.3, s.d. = 5.38$; pointing $\bar{x} = 97.8, s.d. = 6.96$). The same was true for cats (visible displacement $\bar{x} = 98.18, s.d. = 6.03$; pointing $\bar{x} = 96.35, s.d. = 6.4$).

A one sample t-test against a hypothetical mean of chance performance (33%) revealed that in both conditions, dogs performed significantly above chance (for visible displacement, $t(9) = 38.41, p < .001$; for pointing, $t(9) = 29.45, p < .001$). The test was repeated for cats and also showed performance significantly above chance (for visible displacement, $t(10) = 35.85, p < .001$; for pointing, $t(10) = 32.84, p < .001$).

A final test compared the three catch trials to determine if the subjects continued to perform well without baiting or with all bowls baited. This test was statistically impossible to perform with the dog data because all of the subjects consistently performed 100% correct in all three conditions, and thus there was no variance. However, this test was statistically possible for the cat data, and showed that the cats did indeed continue to perform well throughout the catch trials ($F(2,16) = 0, p = 1.00$). The mean accuracy for each condition was 96.2, $s.d. = 11.10$.

Discussion

This study confirms previous research suggesting that dogs can follow pointing to a specific location to obtain a reward. It also shows that cats share this ability. In this

study there were very few trials and thus little opportunity for much learning. The fact that all of the subjects who passed the pre-training phase were able to follow pointing by humans suggests that they actually understood something about the gesture and were not simply doing as they were trained to do. The sustained good performance during the catch trials for both species indicated that both were indeed following the point and were not using scent cues to find the hidden object. There was also no significant difference between the visible displacement and pointing tasks, indicating that they did equally well in both conditions.

While no significant difference was found between the two species in their performance during these tasks, the fact that half of the cats who entered this study failed to perform the pre-training phase, while only two out of the twelve dogs failed, suggests that there is some difference between the two species that was uncovered by the methods. Part of this difference may be attentional, as shown by two cats that succeeded in visible displacement and pointing phases but then stopped responding during the catch trials. Very few errors were made even among those subjects who did not complete pre-training, but there were a lot of aborted trials especially among the cats. Those that willingly participated made clear responses, however, and did extremely well. Interesting to note is that when a subject did choose the wrong bowl/bag, it was always the location where the food was hidden in the previous trial. In addition to an attentional component, this shows a possible memory component to the task and also a problem with inhibiting prior responses. Some of the subjects were extremely excited with the game and occasionally had trouble paying attention. Others occasionally became distracted by other family members or from outside noises.

The important question here is still, what exactly do the cats and dogs attend to? It seems to be particularly important, especially to the cats, that they track objects to their final hiding place before the object disappears. Even though none of the subjects ever saw the experimenter hide the target during the pointing and catch trials of this experiment, the movement of the experimenter's body as it oriented to the correct location could have been a tracking cue. Dogs typically perform object permanence tasks with or without the opportunity to track objects. Thus, while the performance of cats and dogs in this experiment was not significantly different, it is possible that the two species were thinking about the task in slightly different ways. For cats, the ability to follow the body orientation of a human may be a manifestation of a movement-driven cue, rather than a cognitive or social cue.

Further research into what exactly the dogs and cats are attending to in such pointing tasks would be valuable to further explore this ability to follow pointing in both species. The pointing cue in this study was a very obvious one and included body orientation, head direction, eye gaze, hand gesture, and also very close proximity to the correct location. This extensive cue should be broken down in further studies to determine what parts of that whole cue are truly important for the cats and for the dogs. Soproni, Miklósi, Topál, & Csányi, (2001) did some preliminary work with different types of cues with dogs, but a better breakdown of experimenter-given cues can be found in Itakura & Tanaka, (1998) with primates. Until such research is done, it is impossible to determine for certain what exactly the cats and dogs were attending to during the trials of this experiment.

The important result of this experiment, however, is that both dogs and cats can follow experimenter-given cues that are not explicitly trained to find a reward; thus, this cognitive ability extends beyond primates and may also be found in other mammal species besides dogs and cats. Further study into what exactly the dogs and cats were attending to will give a clearer idea of what the dogs and cats can think about, thus giving a more complete understanding of this cognitive ability in non-primate mammals. Studies with other mammals will further explore the extent to which this cognitive ability is found in non-primate mammals. Furthermore, it is likely that the critical cues of visual co-orienting and following body postures to get information was not part of a developing human language system, but rather part of a system of social awareness across the order of mammals.

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Table Captions

Table 1. A list of dog participants.

Table 2. A list of cat participants.

Table 3. A pictorial summary of the methods.

Name	Breed	Age	Obedience Training	Hunting Training
Abbie	German Shorthair	5yr	Yes	Yes
Babe	Springer Spaniel	3yr	Yes	Yes
Griffin	Lab/Weimaraner Mix	5yr	Yes	No
JD	Springer Spaniel	12yr	Yes	Yes
Kerby	Bichon	2yr	No	No
Maggie	Springer Spaniel	5yr	Yes	Yes
Molli	Shih Tzu	3yr	No	No
Rico	Lab	8yr	Yes	No
Riggs	Poodle	2yr	No	No
Sadie	Cocker Spaniel	3yr	Yes	No
Sammi	Cocker Spaniel	11yr	No	No
Torii	King Charles Spaniel	3yr	Yes	No

Name	Breed	Age	Obedience Training
Athena	Bengal	2yr	Yes, minimal
Aurora	Bengal	1 yr	Yes, minimal
Bart	Mixed	8yr	No
Binx	Mixed	1yr	No
Cali	Mixed	1yr	No
Canna	Mixed	2yr	No
Cayenne	Bengal	10m	No
Daisy	Mixed	8yr	No
Flower	Mixed	7yr	No
Gaia	Bengal mix	2yr	No
Ivy	Mixed	2yr	No
Jonesy	Bengal	6m	No
Journey	Bengal	3yr	No
Mia	Bengal	2yr	No
Missy	Bengal (F1)	2yr	No
Mitsy	Mixed	1yr	No
Pansy	Mixed	13yr	No
Scout	Mixed	7yr	No
Shimmer	Bengal	9m	No
Snicker	Mixed	7yr	No
Sydney	Mixed	13yr	No
Tigar	Mixed	7yr	No

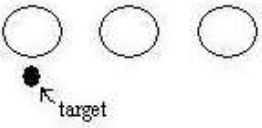
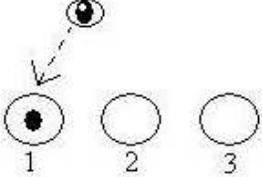

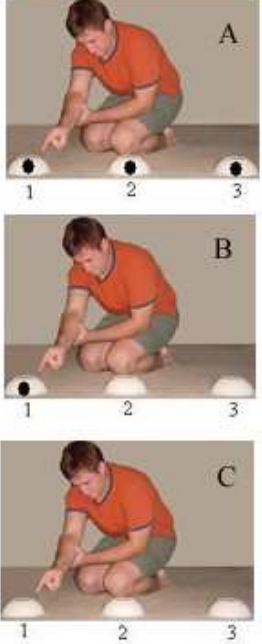
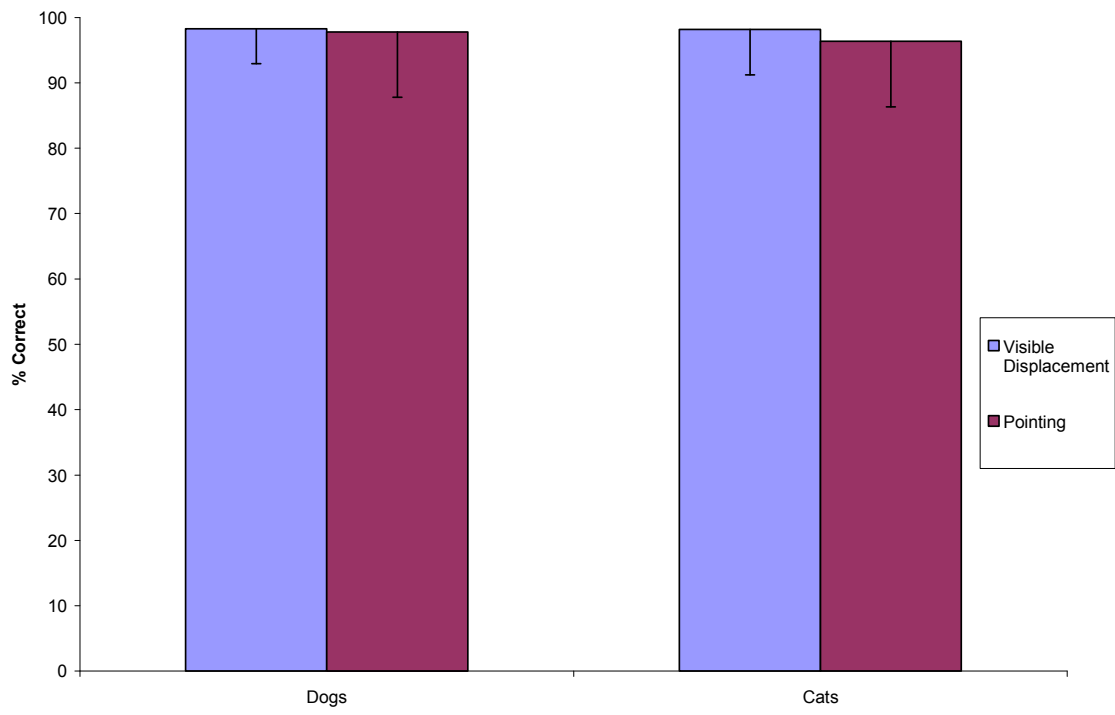
Type	Sequence	Photo	Criteria
Pre-Training	3, 1, 2, 3, 3, 3, 1, 2, 1, 3, 2, 1, 2, 2, 3, 2, 1, 1		1x each from each of 3 locations
Visible Displacement	1, 1, 2, 3, 2, 2, 1, 2, 3, 1, 2, 1, 3, 2, 3, 3, 1, 3		5 consecutively correct responses
Pointing	3, 1, 3, 2, 2, 1, 2, 3, 1		must complete majority of trials to count; 5 consecutive abort trials ends the experiment
Reward-ALL (A) Standard Pointing (B) Reward-NONE (C)	A1, C3, C2, B1, A2, B2, A3, C1, B3		must complete majority of trials to count; 5 consecutive abort trials ends the experiment

Figure Captions

Figure 1. Percent correct score for visible displacement and pointing in cats and dogs.

Visible Displacement and Pointing in Cats and Dogs



Appendix A

Permission Form

Data Sheet

PERMISSION FORM

The pet experiment has been explained to me by Mel Branco, senior psychology major at Carleton College, and I agree here to help assist her in studying my dog/cat, _____, in her psychology experiment. I understand that I can withdraw my pet at any time from the study, and if the pet does not respond well within a certain amount of time, he/she may have to be withdrawn. I understand that my pet will receive food treats as agreed upon by me and the researcher during the study, and that we will receive a pet toy at the end of the study regardless of how my pet performs (or does not perform). It is okay with me that the study be conducted in a room in my house. I also agree to gently restrain my pet at the beginning of each trial and orient him/her either towards or away from the experimenter as I am directed to do so. I also understand that I will receive, if I wish, the results of this experiment.

Signature of Pet Owner,

Date

___ check if you would like a single page result summary sent later.
___ initial that we received the pet toy.

Pointing Study

Date: _____ Time: _____ Age: _____

Pet Name: _____ Pet Type: _____

Obedience Training: _____ Hunting Training: _____

Trial Length: 60s ITI Length: 15s

Pre-training	Location 1		Location 2		Location 3		Order	#
	Treat /		Treat /		Treat /			
	Response		Response		Response			
Trial 1					x		3	
Trial 2	x						1	
Trial 3			x				2	
Trial 4					x		3	
Trial 5					x		3	
Trial 6					x		3	
Trial 7	x						1	
Trial 8			x				2	
Trial 9	x						1	
Trial 10					x		3	
Trial 11			x				2	
Trial 12	x						1	
Trial 13			x				2	
Trial 14			x				2	
Trial 15					x		3	
Trial 16			x				2	
Trial 17	x						1	
Trial 18	x						1	

Observation space:

Visible Displacement	Location 1		Location 2		Location 3		Order	#
	Treat / Response		Treat / Response		Treat / Response			
Trial 1	x						1	
Trial 2	x						1	
Trial 3			x				2	
Trial 4					x		3	
Trial 5			x				2	
Trial 6			x				2	
Trial 7	x						1	
Trial 8			x				2	
Trial 9					x		3	
Trial 10	x						1	
Trial 11					x		3	
Trial 12	x						1	
Trial 13					x		3	
Trial 14			x				2	
Trial 15					x		3	
Trial 16			x				2	
Trial 17	x						1	
Trial 18					x		3	

Pointing	Location 1		Location 2		Location 3		Order	#
	Treat / Response		Treat / Response		Treat / Response			
Trial 1					x		3	
Trial 2	x						1	
Trial 3					x		3	
Trial 4			x				2	
Trial 5			x				2	
Trial 6	x						1	
Trial 7			x				2	
Trial 8					x		3	
Trial 9	x						1	

Test Pointing	Location 1	Location 2	Location 3	Condition	#
	Treat / Response / Point	Treat / Response / Point	Treat / Response / Point		
Trial 1	x x	x	x	RWD-all	
Trial 2			x	RWD-none	
Trial 3		x		RWD-none	
Trial 4	x x			standard	
Trial 5	x	x x	x	RWD-all	
Trial 6		x x		standard	
Trial 7	x	x	x x	RWD-all	
Trial 8	x			RWD-none	
Trial 9			x x	standard	