IT'S MAGIC! VIOLATION OF EXPECTATION IN DOGS (*CANIS FAMILIARIS*)

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Abstract

In this two-part study, canines and their ability to create expectations were tested using a Violation of Expectation (VoE) paradigm, with the use of sleight of hand. A dog's ability to problem solve with and without a human was also tested. Experiment 1 had 23 subjects. After habituation trials, where dogs received a reward following a demonstration, a "magic" trial followed, in which where the reward would "disappear". In Study 1, there was an increase in frustration related behaviours during the VoE trial compared to the habituation trials, but dogs did not search for the reward longer during these trials. Experiment 2 involved the surreptitious swapping of a positive reward for a reward of lesser value, with 18 subjects. During the "magic" trial, canines searched longer than during habituation trials, suggesting they noticed the change in reward. There were also significantly more frustration behaviours displayed during the magic trials. The major difference between the studies was the presence of the human experimenter in Study 1, while during Study 2 all humans were removed from the experiment. These results suggest canines can create expectations, but further research is needed to understand how and why dogs have this ability. Canines also persevere longer to find the reward when a human is not involved.

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Introduction

In June 2018, the "what the fluff" challenge was broadcast over social media, becoming a worldwide trend (Gutierrez, n.d.). This challenge involved dogs watching owners hide behind a blanket, multiple times, until the owner finally tossed the blanket up and dashed behind a doorway. The blanket then fell to the ground and, from the dog's perspective, the owner had disappeared. Canine responses varied from confusion to curiosity, but what is clear is the dog's expectation, that the owner will be found behind the blanket, had been violated, as evidenced by some dogs searching for their owners. Although these videos offer a comical glimpse into the canine's reaction to the unexpected, what was actually being illustrated was a window into a dogs view of the world. In order for this trick to fool a dog into believing the human has disappeared, the animal must have cognitive processes that result in an expectation of the outcome, which were then violated by this sleight of hand.

For an animal to experience violation of expectation, they must first have some level of object permanence. Object permanence can be defined as the knowledge that an object continues to exist even when it can no longer be perceived (Piaget, 1954; Piaget & Cook, 1952; Baillargeon, 1987), which is an important skill for both humans and animals (Baillargeon & Devos, 1991; Barth & Call, 2006). For animals, object permanence can be important for foraging, as well as tracking objects that may be occluded or disappear, such as when prey is chased by a predator. In conjunction with spatial memory, possessing object permanence allows an animal to remember where they have hidden caches of food and the locations they have already searched and exploited for resources (Barth & Call, 2006).

For human adults, when an object is occluded, three assumptions are made. First, we recognize that the object continues to exist behind the occluder. Secondly, we understand that the hidden object will retain the same physical and special properties as it had before having been occluded. Finally, that the object will continue to be subjected to physical laws and not change in an unpredictable way (Baillargeon & Devos, 1991). These assumptions are not present at birth in children and must be learned (Baillargeon & Devos, 1991).

Object Permanence in Children

During the first year of life, infants gain the ability to make sense of the physical world (Hespos & Baillargeon, 2008). Piaget was instrumental in the study of object permanence in children. Through his studies, he concluded that prior to 9 months of age, infants are unable to understand that objects continue to exist when hidden (Piaget, 1954; Piaget & Cook, 1952). Rather, he believed infants thought of objects as non-permanent entities, which ceased to exist when they were not visible and began to exist anew when they reappeared (Piaget, 1954; Piaget & Cook, 1952). His belief stemmed from the fact that prior to 9 months, infants were unable to search for hidden objects (Piaget, 1954; Piaget & Cook, 1952). More recent research has shown children acquire object permanence between 4 to 7 months in order to facilitate attachment (Bower, 1974; Baillargeon & DeVos, 1991).

Before 9 months' of age, infants are unable to perform coordinated actions (Baillargeon, 1987). With this in mind, Baillargeon (1987, 2004a/b, 1991) created a violation of expectation (VoE) paradigm to test object permanence without requiring the infant to search for hidden objects. In this paradigm, a box was covered by an occluder in a drawbridge style, where a rectangular occluder hinges at one end which allows the form to lift and hide an object. In the "possible" condition, infants' saw the occluder stop once it hit the box. In the "impossible" condition, the occluder passed through the box, covering the object completely. Unbeknown to the child, as the occluder began to move the object was lowered into a hidden platform (Baillargeon, 1987). Infants as young as 3.5 months looked significantly longer at the impossible condition, which suggested that they had a representation of solidity and continuity through expectation that was violated in the impossible condition. Infants as young as 2.5 months have been shown to be able to detect some violations in occlusion, containment, and covering of an object (Baillargeon, 2004a). This includes continuity, that an object continues to exist in space and time, and solidity, that two objects cannot exist continuously at the same time in the same space. Baillargeon believed that the principles of continuity and solidity may be innate to infants (Baillargeon, 2004a). Even very young infants have expectations about physical events and, as mentioned before, these expectations significantly develop during the first year of life in children (Baillargeon, 2004b). She also found that infants do not generalize what they have learnt from one event to another. Rather, they learn separately about occlusion, containment, and covering events (Baillargeon, 2004a). Another study found that both 6 and 9 month old infants often look to caregivers when faced with an unexpected event in a VoE paradigm (Walden, Kim, Mccoy, & Karrass, 2007). These findings suggest that infants may use social strategies to help them understand the world, since social referencing has been attributed to information seeking (Walden, Kim, Mccoy, & Karrass, 2007).

Although Baillargeon believed that she identified VoE in young infants, there is some concern that the paradigm may not be testing what it is intended for. Schilling (2000) found that the length and time of habituation trials prior to test trials had a strong effect on infant looking behaviours during VoE experiments. Furthermore, he suggests Baillargeon may not have controlled for familiarity preferences (Schilling, 2000). Infants have been found to attend longer to a familiar stimulus even after a relatively short habituation trial (Schilling, 2000). Novelty preferences only appear after long exposures and depend on the age of the child and the complexity of the stimulus (Schilling, 2000). Schilling (2000) suggests that in Baillargeon's studies infants may have looked longer at the impossible event, not because their expectation was violated, but rather because they were showing a familiarity to the stimulus they were shown during habituation trials. However, contrary to this, Rivera, Wakely & Langer (1999) found that even without habituation trials, infants looked longer at the impossible 180° rotation, compared to a 112° rotation, due to the difference in movement, suggesting a perceptual preference. These findings were replicated both in the traditional drawbridge experiment, with an object being occluded, and also when there was no object occlusion and only drawbridge movement. If Baillargeon's experiments were accurately testing VoE, the lack of object occlusion in Rivera et al.'s (1999) experiment should have resulted in a different outcome. If infants were responding to a violation of expectation, when there was no object being occluded they should have looked equally as long at the 180° and 112° rotation. Rather, because of the potential perceptual preference for more motion, infants showed longer looking times at all 180° rotation events (Rivera, Wakely & Langer, 1999).

Object Permanence in Animals

Similar studies have been conducted on animals in an effort to further understand how different species interpret the world. The majority of these studies have been conducted on great apes (which include chimpanzees, gorillas, and orangutans) and have compared the results to human children (Collier-Baker et al. 2005). Many studies which compare great apes to children involve an invisible displacement task. Traditionally, invisible displacement tasks are seen as a critical test of Stage 6 object permanence (Piaget, 1954; Piaget & Cook, 1952). In these tests, subjects are shown an object being hidden in a container (Container A) at the first location (Location 1). Container A is then moved to a secondary hiding location (Location 2), where, unknown to the subject, the desired object remains in the second container (Container B) at this location (Location 2). The subjects are then shown that the original hiding container (Container A) is now empty and they are allowed to search for the desired object. According to Collier-Baker et al. (2005), if a great ape is able to perform above chance in an invisible displacement task, their object permanence capacity is comparable to that exhibited by an 18-24-month old human child.

However, there are methodological issues when testing animals in displacement tasks. Natale (1986) highlighted these issues in their study of gorillas and Japanese macaques in an invisible displacement task. Solving an invisible displacement task implies that an organism has a mental representation of an object. Piaget believed mental representation was an essential prerequisite for further symbolic functions but warned that solving the task did not necessarily mean that the subject was using or capable of mental representation (Natale et al., 1986; Piaget, 1954; Piaget & Cook, 1952). The test of gorillas and macaques underscores this warning. Five tests were administered with the use of an apparatus. The apparatus consisted of a wooden board, along with “small” empty plastic blocks and “large” blocks of different sizes and colours. Three blocks were used for each test, one small and two large. They were aligned along the wooden board an equal distance apart. In full view of the subject, a reward was placed under the small block. The adjacent large block was then lifted, allowing the small block to slide underneath the large block. The reward was left under the large block, and the now-empty small block was slid back into place. In the first test, the direction of the small block movement was altered, left to right or right to left. Test two was an extension of test one, except that, for each trial, the blocks were changed. The previous blocks were swapped out for different sized and coloured testing blocks. In test three "false trials" were introduced. In these trials the small block was not moved and the reward remained under the originally placed block. The large block was then lifted similar to previous tests. This test helped to identify if subjects were using associative rules, such as "go to the last block lifted", in order to find the reward. During this version of the test, macaques chose the large block 50% of the time, whereas gorillas chose the small block every time (Natale et al., 1986). Natale believed this was evidence that gorillas were solving the problem through mental representation of the reward and its movement since they were able to find the reward 100% of the time. The macaque results highlighted the ability to solve the task through practical associative rules and, as a result, only found the reward half the time (Natale et al., 1986). Natale then questioned if the macaques relied on these practical strategies because they did not have the ability to mentally represent the reward during the trials or that is was simply the easier option. Test four was administered solely to the macaques to test this question. In these trials macaques were taught the correct response for test three. Teaching of the response disrupted the macaques use of practical strategies, which forced them to pay attention to the displacement of the reward. Once this happened, the macaques responses were similar to the gorillas. The final test altered the final placement of the small block. Rather than ending directly beside the rewarded large block, a second large block was placed between the reward and the small block. In this version, the majority of gorillas chose the small block, then when they realized it was empty, skipped the adjacent block and chose the large block that the small block had passed under. On the other hand, the macaques, after uncovering the small block, frequently chose the large adjacent block (Natale et al., 1986). During these tests, macaques seemed to develop an *ad hoc* rule based on task specific cues (Natale et al., 1986). Gorillas, on the other hand, showed systematic searching patterns, which in test five gave them the ability to trace the object back through the task, further supporting the idea that they are able to mentally represent objects (Natale et al., 1986). These associative rules used by macaques have been seen in other animals, such as some apes and monkeys, and dogs. It is therefore important to implement controls as a task may be solved through repetition of a successful action happened upon by chance (Collier-Baker et al., 2005).

When studying animals there are two main challenges when using object displacement tasks. First, the subject must understand object permanence, that the object continues to exist when not visible. Secondly, they have to keep the objects hidden location in their working memory, until they are given the chance to search (Barth & Call, 2006). The use of delayed response prior to the ability to searching can serve as a baseline to determine if an animal understands the basic principles of the task. If it is found that the animal does understand the tenets of object permanence, then any errors can be broken down into an inhibition problem or a memory deficit (Call, 2001). In the case of an inhibition problem, the animal is aware of where the object is hidden, but has trouble restraining their response to one choice. Whereas with a memory deficit, subjects simply are unable to remember locations visited by the experimenter (Call, 2001).

Barth and Call (2006) tested chimpanzees, bonobos, gorillas, and orangutans in a variety of displacement tasks with modifications, including delayed response, rotation, and transposition. When given a 30 s delay, all subjects made fewer correct choices than when there was no delay involved (Barth & Call, 2006). Subjects were also tested in transposition tasks, where the location of the target container was moved while the food reward was enclosed. This test was easier for the animals than the invisible displacement task (Barth & Call, 2006). Barth and Call found rotation tasks to be the most difficult for subjects, along with non-adjacent trials. In non-adjacent trials subjects showed trouble in choosing a container from a line of containers. In particular, they had trouble inhibiting themselves from choosing the container closest to them (Barth & Call, 2006).

Call (2001) further explored the relationship between memory deficit and lack of inhibition with the use of adjacent and non-adjacent trials. In a three choice displacement task, a selection pattern was identified in chimpanzees and orangutans. They tended to have a left side response bias and, in non-adjacent trials, chose the centre container afterwards even though the experimenter never visited this container (Call, 2001). For this reason, Call believed the memory deficit theory was not supported. Rather, he believed that container proximity is a more important influence on the subject's choice, which explains why non-adjacent trials are considered one of the more difficult tasks (Call, 2001). When two of the three containers were baited in both adjacent and non-adjacent trials, chimpanzees and orangutans performed above chance in adjacent but not non-adjacent trials. If a memory deficit was responsible, subjects should have performed equally as well on both tasks (Call, 2001).

A unique way to test object permanence and violation of expectation in primates is through the tunnel task. In one study, rhesus macaques watched a lemon roll down a ramp and behind an occluder. Rather than a lemon emerging from the first occluder, a kiwi continued to roll down the ramp until hidden by another occluder (Flombaum, Kundey, Santos, & Scholl, 2004). If the kiwi rolled out from behind the first occluder at the same speed as the lemon, macaques would search behind the second occluder, perceiving the lemon as having transformed (Flombaum, Kundey, Santos, & Scholl, 2004). However, if the speed was interrupted, subjects would search behind both occluders (Flombaum, Kundey, Santos, & Scholl, 2004). Although this study was focused more on the spatio-temporal effects, specifically dynamic object individuation, the subjects' search behaviour suggests their expectations were violated when a motion disruption was manipulated. By searching behind both occluders, macaques saw a change they did not expect. This is an important study to consider when testing VoE in animals other than primates. While Baillargeon may have shown object permanence in young infants, it is clear, both from contradictory studies and animal studies, that improvements and adaptations to the methodology need to be considered. The tunnel effect is one such adaptation that can be used to test VoE in non-primate subjects.

Object Permanence in Canines

Object permanence in primates has been extensively explored and well documented. Both humans and great apes have been shown to possess the highest level of object permanence (Piaget, 1954; Piaget & Cook, 1952; Collier-Baker et al., 2005; Natale et al., 1986). While it is clear many great apes reach the highest level of understanding of object permanence, there has been some argument over the abilities of other species, such as canines. Gagnon and Doré (1993) found that canines could complete visible and invisible displacement tasks at levels above chance. However, subsequent studies have not been able to replicate these findings. Because dogs have coevolved with humans (Pongrácz, et al., 2001), canines are incredibly sensitive to human social cues (Collier-Baker, Davis, & Suddendorf, 2004; Pongrácz, et al., 2001; Miklósi, Topál, & Csányi, 2004; Hare, Brown, Williamson, & Tomasello, 2002). This sensitivity may explain Gagnon and Doré findings. Without intentionally doing so, experimenters may have been giving cues to their canine subjects, helping them to solve the task (Collier-Baker, Davis, & Suddendorf, 2004). Collier et al. (2004) studied visible and invisible displacement in dogs using Natale et al.'s (1986) paradigm. They found that dogs based their searching on associative rules, such as “go to the first box visited by the displacement device”, rather than creating a mental representation of the movement of the object being moved. When human cues are removed, canine performance drops to chance (Collier-Baker, Davis, & Suddendorf, 2004).

There is experimental evidence to support the idea that domestication may have altered the brain of canines. When comparing the brains of domesticated canines and wolves, canine hippocampi are 42% smaller (Kruska, 2005). Previous studies have also suggested that wolf puppies are more successful at spatial problem solving compared to canine puppies (Fiset & Plourde, 2013). Finally, the skill of cooperative hunting, which wolves, rather than canines, gradually learn, requires the ability to mentally represent prey. With these ideas in mind, Fiset & Plourde (2013) compared canines and grey wolves on invisible displacement tasks. With olfactory cues controlled by rubbing each of the containers with food, both species had a similar understanding of invisible displacement. Canines and grey wolves passed visible displacement tasks but could not solve invisible displacement tasks. Fiset and Plourde (2013) also compared canines and grey wolves with the transposition task. In this procedure, an object was hidden in a container, which was then moved to another location. Rather than leave the original hiding location empty, experimenters placed an identical container in this space to reduce visual cues. When the empty space was not filled with an identical container, subjects were able to identify the target container by selecting the first adjacent container that they had seen moved. Fiset and Plourde believed it was the movement itself that aided the dogs and wolves in finding the reward. But when this space was filled with an identical container, both dogs and wolves failed the task, searching mainly where they saw the object disappear. Fiset and Plourde’s (2013) results suggest that both dogs and wolves have limited knowledge of how objects move and disappear in their environment. Furthermore, although cooperative hunting may involve a mental representation of prey, it does not seem to provide any cognitive advantages (Fiset & Plourde, 2013).

Compared to canines, apes have been shown to fully understand transposition tasks. Apes are unfazed by containers crossing each other or if the original location is filled with another object. They are able to track the reward with great success (Rooijakkers, Kaminski, & Call, 2009). Dogs experience major difficulties when containers cross or are substituted. If these manipulations were excluded, canines were successful in finding food. While it is impossible to conclude that canines are incapable of mentally representing an object, apes may just be more flexible with their representations (Rooijakkers, Kaminski, & Call, 2009). Studies have suggested that canine understanding of displacement is similar to that of a 1 to 2-year-old child. Both do well on visible displacement tasks, but have challenges with invisible displacement (Miller, Pattison, Rayburnreeves, & Zentall, 2010). Dogs also perform well above chance in visible displacement tasks when a short delay is applied before searching (Fiset, Beaulieu, & Landry, 2002). Their memory of the hidden object tends to decline between 10 to 60 seconds, but remains stable up to 240 seconds, allowing them to find the food reward above chance (Fiset, Beaulieu, & Landry, 2002).

Although dogs may not understand invisible displacement, this does not exclude them from the ability to create expectations. Pattison, Laude & Zentall (2013) used a VoE task in which a bone was placed behind an occluder, which was then replaced with a bone of a different size or colour. Dogs looked significantly longer at the changed bone than in the control trial, which suggests that dogs saw that there was a change in the bone's properties that they were not expecting. Pattison, Miller, Rayburn-Reeves, & Zentall (2010) replicated Baillargeon's (1987) drawbridge study, using a bone instead of a box. In the "expected" condition the draw bridge stopped when it neared the bone, whereas in the "unexpected" condition, the draw bridge continued to pass through the bone. Similar to the children, canines looked longer in the unexpected condition, suggesting they remembered physical details about the bone such as its size and that it was solid (Pattison, Miller, Rayburn-Reeves, & Zentall, 2010).

In one "magic cup" study comparing apes and canines, Bräuer and Call (2011) showed subjects a preferred or less preferred food entering a cup. The experimenter placed a lid over a cup, which when removed revealed a second hidden container. This second container held a less or more preferred food type. When subjects were able to explore the cup, apes looked longer and begged more when the preferred food was substituted for a less preferred food, whereas dogs smelled in and around the container more. Both apes and canines reacted to positive and negative surprises, but tended to react more strongly to negative surprises, when preferred food was replaced with the less preferred food. Both species were able to discriminate the food placed in the cup according to their physical properties and remembered which food they expected to see when the lid was removed. Brauer and Call's (2011) findings suggests that even though there may be differences in understanding invisible displacement, there is no difference between species in their ability to discriminate objects. Bräuer and Call predicted subjects would hesitate or reject the undesirable food when they became frustrated after a negative surprise. They also believed subjects would eat the desirable food more quickly after encountering a positive surprise. Rather, neither of these behaviours happened, possibly because of the limited trials run (Bräuer & Call, 2011). The increase in looking and begging in apes and smelling by dogs suggests that these animals had the expectation that the desired food was still hidden and that they would receive it if they begged or continued to investigate the objects.

Rationale

The purpose of the current study was to further explore canine expectation and the changes in behaviour when these expectations were violated, in two conditions. The first experiment involved humans in close proximity, whereas the second experiment removed humans from the testing arena. The first experiment used a “magic cup” similar to Brauer and Call (2011), where a reward was unexpectedly hidden from subjects and their behaviour recorded. This study included five conditions, two habituation trials, a VoE trial or “magic” trial, a control trial, and finally a reinstatement trial. No counter balancing was done since the desired effect of creating an expectation needed repeated trials. It is important to note that during this study canines were in direct contact with the experimenter, who held the “magic cup” while the dog explored. In Study 1, I predicted that dogs would search (sniff, look in surrounding area, etc.) when the reward was unexpectedly hidden, compared to their behavior on other trials. I also predicted that subjects would look for assistance from surrounding humans, since previous research has shown canines seek help from their owners when faced with a task they seemingly cannot solve (Miklósi & Kubinyi, 2016).

In the second experiment, I used a “magic box”, a tightly sealed food container which held both desired and less desired rewards in attainable and unattainable compartments. In this experiment canines were left alone with the apparatus and allowed to freely interact without human interference. Three types of food rewards were used: an appealing reward, a less appealing reward, and an undesirable food item. A range of rewards were used to determine if a slight change or a more drastic change in reward would affect the dog’s behaviour. During habituation trials, dogs received the appealing reward. On the VoE trial, the appealing reward was swapped for either the less appealing or undesirable food item. On the control trial, dogs only received the less appealing or undesirable food item. I predicted that dogs would search longer for the reward during the VoE trial than on the habituation trials, since they would have no humans to ask for assistance.

Method

Participants

All subjects were recruited from Good as Gold K9 School. Although there were multiple breeds, majority of the dogs were Golden Retrievers, Border Collies, and Mixed breeds.

Study 1.

A total of 23 subjects completed this study, 17 females, 6 males, with an average age of ~6. The breeds and ages of the subjects have been displayed in Table 1.

Study 2a.

A total of 9 subjects completed this study, 7 females, 2 males, with an average age of ~5. The breeds and ages of the subjects have been displayed in Table 2.

Study 2b.

A total of 9 subjects completed this study, 4 females, 5 males, with an average age of ~3 years. The breeds and ages of the subjects have been displayed in Table 3.

All subjects were tested in a familiar environment to ensure that they were comfortable and focused on the tasks. Although the average ages of each group is slightly different, it should not affect the outcome as object permanence has been identified in puppies by the age of nine months (Gagnon & Doré, 1994).

Apparatus

Study 1: The Magic Cup.

In Study 1, a Styrofoam cup was used as the reward container. Dehydrated beef liver was used as the positive reward, since a majority of canines are given this treat by owners. Prior to trials, a piece of dehydrated liver was shaken in the cups to control for scent. In the control trial, a clean cup was used.

Study 2: The Magic Box.

In Study 2, a plastic container (Figure 1) with a lid was used as the apparatus. The container was segmented into 3 compartments. In the largest compartment, the lid was cut open. This allowed the subjects to investigate the reward which was placed in this section. In one of the smaller sections, a piece of liver was placed as a scent control. In this area the lid was punctured multiple times to allow the subjects to smell the liver. The lid was tightly affixed to the container, which kept the subject from opening the scented compartment. Finally, the sides of the container were covered with black duct tape. This made it impossible for the subjects to see which reward was placed into the container.

Procedure

The experimental setup is shown in Figure 2. In each study, individual dogs were held by one researcher (the Handler) while the demonstration trial was run. Once the demonstration was completed, the dog was released and allowed to search for the item. A second researcher (the Demonstrator) hid the object and presented the cup to the dogs. A third researcher (the Camera person) videotaped each trial. Each subject experienced a familiarization trial, multiple habituation trials, the magic trial, a control trial, and finally a reinstatement trial. These trials were short and in its entirety the testing took approximately 10 min, varying by the amount of searching the dog conducted.

Study 1.

Preference Test.

Prior to testing, the eating habits of each dog was discussed with the owners. After preferred and less preferred foods were identified, dogs were given samples of treats provided by the experimenter in a relaxed setting to confirm the recommendations of the owner. Dehydrated liver (Celebrity dog treats, approximately 3g) was given as the preferred reward for all subjects.

Familiarization.

The purpose of these trials was to habituate the dogs to the experimental setting, and to establish the Demonstrator as a reliable source of preferred food. Dogs were brought individually into the testing area by the Handler, while the Demonstrator sat in a chair approximately 2.5m away. The dog was brought to a mark and, either sitting or standing, was asked to wait. The Demonstrator called the dog's name to get their attention, then placed a piece of dehydrated liver in their outstretched palm. Subjects were then released with a simple "Okay" command and allowed to move freely between the two experimenters. Dogs were able to approach the Demonstrator and consume the reward. Once the reward was eaten, the trial was complete.

Habituation Trials.

A total of two habituation trials was run for this study. Individual dogs were brought to their mark by the Handler and asked to wait. The Demonstrator sat in the chair and called the subjects name to get their attention. Subjects were then shown a piece of liver which was then placed into a Styrofoam cup (Figure 3a). The Demonstrator placed their hand over the mouth of the cup and shook the cup with the hidden treat inside, giving the dogs an auditory cue. After a few seconds of shaking, the Demonstrator turned the mouth of the cup towards the dog, allowing them to see the treat inside. The cup was then held by the Demonstrator at an attainable height, which allowed the subjects to search for the reward. Subjects were released and allowed to search. The trial was completed when the subjects had consumed the treat and walked away from the Demonstrator, signaling the cessation of searching behaviour.

Magic Trial.

Individual dogs were brought to their mark by the Handler and asked to wait. The Demonstrator sat in a chair and called the subject's name to get their attention. Subjects were then shown a piece of liver, which was then placed into a Styrofoam cup (Figure 3b). The Demonstrator placed their hand over the mouth of the cup and shook the cup with the hidden treat inside, giving the dogs an auditory cue. During the shaking, the Demonstrator surreptitiously palmed the treat, removing it from the cup. The Demonstrator then turned the mouth of the cup towards the dog and placed the treat in their pocket. Although the subjects may have been able to smell the treat in the Demonstrator's pocket, their hands and the Styrofoam cup would have also had the scent of the reward. Subjects were released and allowed to search for the "vanished" treat. The trial was completed when the subject walked away from the Demonstrator or other researchers.

Control Trial.

Individual dogs were brought to their mark by the Handler and asked to wait. The Demonstrator sat in a chair and called the subjects name to get their attention. Subjects were not shown a treat (Figure 3c). The Demonstrator then placed their hand over the mouth of the cup and shook the cup. Since there was no treat inside, there were no auditory cues. The cup was then turned towards the subjects and they were allowed to search.

Reinstatement Trial.

In order to end on a positive note, a final habituation trial was conducted. This ensured that subjects were rewarded at the end of the session. Once the trial was completed, each dog was given more rewards, both food and praise, in a more relaxed setting.

Study 2.

Similar to Study 1, dehydrated liver was used as the preferred reward. In Study 2, a less appealing reward was identified through preference testing. The majority of dogs found celery (Study 2a) to be an unappealing food item and broccoli (Study 2b) to be appealing, but less so than liver. From here on, celery will be identified as the least preferred food item (LPR), while broccoli will signify a moderately appealing reward (MPR).

In Study 2, rather than a food reward disappearing, it was swapped for something less desirable. Also, the interaction with the experimenter was removed because the plastic container allowed the subjects to interact with the apparatus without any human influence.

Familiarization.

The purpose of these trials was to habituate the dogs to the experimental setting, and to establish the Demonstrator as a reliable source of preferred food. Dogs were brought individually into the testing area by the Handler, while the Demonstrator was standing approximately 2.5m away. The dog was brought to a mark and, either sitting or standing, was asked to wait. The Demonstrator called the dog's name to get their attention, then placed a piece of dehydrated liver in their outstretched palm. Subjects were then released with a simple "Okay" command, and allowed the dog to move freely between the two experimenters. Dogs were able to approach the Demonstrator and consume the liver. Once the liver was eaten, the trial was complete.

Habituation Trials.

A total of two habituation trials for each food type, liver, celery (LPR), and broccoli (MPR), was run for this study (Figure 4a). Individual dogs were brought to their mark by the Handler and asked to wait. The Demonstrator stood and called the subject's name to get their attention. Subjects were then shown the reward, which was then placed into the plastic container. The Demonstrator placed the container on the floor, released the subject, and exited the testing area. Subjects were then allowed to search. The trial was completed when the subjects consumed the treat and walked away from the apparatus signaling the cessation of searching behaviour.

Magic Trial.

Individual dogs were brought to their mark by the Handler and asked to wait. The Demonstrator called the subject's name to get their attention. Subjects were then shown a piece of liver, which was then placed in a compartment (Figure 4b). This compartment was unattainable to the subjects but allowed for the liver scent to permeate. Prior to the experiment, a less appealing reward, either the LPR or MPR, had been placed in the attainable compartment of the apparatus. The Demonstrator then placed the apparatus on the floor, released the subject, and left the testing area. Subjects were then allowed to explore the container. The trial ended when the subjects walked away or when they tried to break open the unattainable compartment.

Control Trial.

Individual dogs were brought to their mark by the Handler and asked to wait. The Demonstrator called the subject's name to get their attention. Subjects were given either the LPR or MPR (Figure 4c). There was no liver in the unattainable compartment to control for olfaction. The Demonstrator placed the less desirable reward in the attainable compartment, put the apparatus on the floor, released the subject, and left the testing area. Subjects were then allowed to search. The trial ended when the subjects had consumed the treat and walked away from the apparatus, signaling the cessation of searching behaviour.

Reinstatement Trial.

In order to end on a positive note, a final habituation trial was conducted. This ensured that subjects were rewarded at the end of the session. Once the trial was completed, each dog was given additional rewards, both food and praise, in a more relaxed setting.

Results

For all the studies conducted, the observed behaviours were grouped for statistical analysis, for ease of analysis. Behaviours were grouped into four categories (human focused, frustration, looking and eating), as shown in Table 4.

Study 1

The purpose of Study 1 was to investigate if dogs could create an expectation and be fooled into believing they would receive a reward with the aid of a Styrofoam cup and some sleight of hand. This study directly involved humans and therefore was also a measure of how persistent a dog was to receive a reward when a human was present. I predicted that frustration behaviours would be performed by dogs more often in the magic trial compared to the other conditions, and that the dogs would look for assistance from surrounding humans, displayed through human focused and looking behaviours, during the magic trial.

A 4x3 ANOVA (condition x behaviour) was completed with the data collected. There was a significant interaction when comparing the conditions to the behaviours displayed by the subjects, $F(8, 5) = 21.91$, $p < .05$, and a significant difference within the individual variables of condition, $F(4, 5) = 13.71$, $p < .05$, and behaviour, $F(2, 5) = 49.23$, $p < .05$.

There were more behaviours displayed in the magic trial rather than the control ($F(1, 3) = 10.6$, $p < .05$) and reinstatement trials ($F(1, 5) = 12.2$, $p < .05$), which supports the hypothesis that something unexpected happened during the VoE trial. Overall, there were significantly more human focused behaviours compared to looking behaviours ($F(1, 1) = 12.4$, $p < .05$) and frustration behaviours compared to looking behaviours ($F(1, 1) = 8.6$, $p < .05$).

Looking at behaviours, we believed there would be more there would be more human focused behaviours during the magic trial compared to the previous habituation trial. We did not find this. There was no significant increase in human focused behaviours during the magic trial (M = 2.26, SD = 1.32) compared to the final habituation trial (M = 0.869, SD = 1.18), $t_{(22)} = 1.43$, $p > 0.05$. Rather, we found there was an increase in frustration behaviours when comparing the final habituation (M = 2.39, SD = 1.19) with the magic trial (M = 3.08, SD = 1.56), $t_{(22)} = 2.8$, $p < 0.05$. Finally, as predicted, search times were not significantly different when comparing habituation trials to the VoE trial.

Study 2

In Study 2 dogs were left with the apparatus in an enclosed area to control for the effects of inadvertent human cues. Since canines can pick up on subtle social cues, it was believed that removing the human from the experiment would allow the dog to behaviour in a more natural way, rather than rely on human cues for the answer. It was expected that subjects would search longer for the reward during the magic trials, since they would have no humans to ask for assistance and that they would perform increased searching behaviours compared to other trials.

During the least preferred reward (LPR) trials, there were significantly more frustration behaviours compared to human focused behaviours, $F(1, 6) = 11$, $p < .05$. Although human focused behaviours were controlled for as much as possible, some dogs were able to approach the camera person. The majority of the dogs did focus on the box since there were also significantly more frustration behaviours compared to looking, $F(1, 6) = 11$, $p < .05$, and eating behaviours, $F(1, 6) = 11$, $p < .05$. Again, this is in line with the hypothesis, since dogs tended to focus on obtaining the treat from the box. Many dogs chose not to eat the celery during the trials, which was expected since celery was considered the undesirable food item. As predicted, searching times during the magic trial (M = 25.88, SD = 12.73) compared to habituation trial (M = 13.22, SD = 9.86) were significantly longer, $t_{(8)} = 1.7$, $p < 0.05$, suggesting that subjects noticed the change in reward.

Looking at the moderate preferred reward (MPR) trial behaviours, there were significantly more human focused $F(1, 14) = 9.8$, $p < .05$, frustration, $F(1,14) = 9.8$, $p < .05$, and eating behaviours, $F(1, 14) = 9.8$, $p < .05$, compared to looking behaviours. Similar to the LPR trials, some canines did approach the camera person when unsure what was being asked of them, which would account for the human focused behaviours. We expected to see more frustration behaviours and slightly more eating behaviours since broccoli was considered the moderately appealing reward, which is represented through the statistics. Similar to the LPR trials, there was also a significance in time spent searching when comparing the habituation trial (M = 12.88, SD = 9.53) and magic trial (M = 24.66, SD = 7.48), $t_{(8)} = 0.3$, $p < 0.05$.

Similar to Study 1, we believed that certain behaviours would increase during the magic trial compared to the habituation trial. Since the human presence was removed from this experiment, we believed there would be an increase in frustration behaviours. We found this to be true in the LPR trials, but not the MPR trials. When comparing the celery habituation trial (M = 4.33, SD = 2.06) and magic trial (M = 6.88, SD = 4.04) there was a significant increase in frustration behaviours, $t_{(8)} = 2.8$, $p < 0.05$. This result is not all together surprising since celery was a less preferred reward compared to broccoli. Some dogs found the broccoli appealing which may have affected the behaviours that were displayed. Rather than being frustrated about the change in reward, some dogs may have been more willing to eat the broccoli, whereas no dog was willing to eat the celery.

Discussion

In Study 1, I predicted there would be an increase in frustration behaviours during the VoE or "magic" trial. The results support this prediction. I suspected that dogs would look for more assistance from humans during the magic trial. Contrary to this assumption, dogs performed fewer human focused behaviours during the magic trial. Dogs also did not search significantly longer during the magic trial compared to the habituation trial.

Similar results were found in Study 2. I predicted that search times would be longer during the VoE compared to habituation trials. This was found to be true in both LPR and MPR trials. As seen in Study 1, there were more frustration behaviours displayed during the VoE trial than the habituation trial, but this was only found when the reward was celery rather than broccoli. Since some dogs enjoyed eating broccoli, frustration behaviours were not as widely exhibited. Rather celery was not enjoyed by any subject, which explains the more extreme reaction in behaviour.

Previous research has shown that dogs seek assistance from nearby humans when faced with “unsolvable” tasks (Miklósi, Kubinyi, Topál, Gácsi, Virányi, & Csányi, 2003). Miklósi et al. (2003) questioned how dogs and wolves would behave when given an “unsolvable task” or when a food reward could not be obtained through individual effort. They found wolves were more persistent with the task, whereas dogs gave up quickly and began to gaze at a nearby human. Udell (2015) suggested that these results may have been affected by an experimental flaw where the “correct response” is the social response. If this is the case, these studies may mask evidence of social reliance or a failure to persist in the face of a challenge (Udell, 2015). Udell (2015) ran a similar study, where 10 pet dogs, shelter dogs, and human-socialized wolves were tested with a “solvable” task. A food reward was sealed inside a plastic container. The lid of the container was punctured, allowing a rope to pass through. The subjects were able to pull on the rope, while holding the container in place, releasing the lid and allowing them to eat the reward. Udell (2015) found dogs spent a significantly longer time gazing at humans and failed to persist more than the wolves. These results call into question whether Miklósi’s (2003) “unsolveable task” was a deterrent for dogs or if they gave up prematurely possibly due to hypersensitivity or dependence on human social cues (Udell, 2015). Similar to pet dogs, shelter dogs also refrained from interacting with the apparatus for long periods of time. Although shelter dogs may have less human interaction, this may be an effect of domestication as wolves continued to persist compared to the domesticated dogs, whether shelter animal or pet.

Another condition in Udell’s study (2015) looked at how the dog reacted when there was a human present to encourage them to interact with the apparatus. Wolves behaved the same whether there was a human present or not, but pet dogs and shelter dogs showed an increase in persistence when encouraged. To further understand this behaviour, Udell (2015) allowed an 8-week-old puppy to interact with the apparatus. The puppy was able to solve the task without the need for encouragement. This suggests that dog's inhibition to problem solving may be something that develops with age or is a learned behaviour to rely on social cues (Udell, 2015). The lives of pet and shelter dogs are very different than captive wolves kept in local zoos. Pet and shelter dogs' lives are tightly controlled by humans compared to wolves. This may give wolves the opportunity to practice independent problem-solving skills, whereas the pet and shelter dog's environment may condition them to be more dependent on humans. Dogs may also show inhibition of problem-solving behaviours when faced with a novel task. Most often humans teach dogs to refrain from interacting with foreign items, particularly containers holding food. This inhibition may result in a greater long-term success in cohabitation from dogs living in a human home. When given encouragement from people, dogs are given the confidence to interact with something novel (Udell, 2015). This idea is further supported by research which shows the presence of a human increases a dog's interest in a commercial dog toy and can decrease their interactions with a "forbidden" item (Horn, Huber, & Range, 2013).

Our results were somewhat different. Dogs were not encouraged by experimenters to persist in looking for the missing treat, but also did not express an increase in human focused behaviours. Rather, more frustration behaviours, such as biting the cup, were seen in both tasks, except during the broccoli trials. A factor which may be affecting this behaviour could be the truthfulness or deceptive qualities of the experimenter.

Dogs have co-evolved with humans for thousands of years, and this partnership has changed how dogs interact with humans (Petter, Musolino, Roberts, & Cole, 2009). In particular, through selective breeding, humans have been able to shape dog behaviour to allow them to read subtle social cues, such as pointing and gazing (Petter, Musolino, Roberts, & Cole, 2009). It has been argued that this trait has been learned by associating human pointing and limbs with the delivery of food. During critical periods of canine development, humans are associated as social companions. This may be linked to the location of food, either hidden or given by the human (Udell, Dorey, & Wynne, 2008; Wynne, Udell, & Lord, 2008). This association may create an expectation that humans are truthful reward dispensers.

Research into canine understanding of deception demonstrates that dogs can learn to associate a person with deceptive motives, but they still find it difficult to completely ignore the social cues of a deceptive individual (Dwyer & Cole, 2018). Petter (2009) tested dogs in a two-choice task, where one opaque container held a reward and the other was empty. A cooperator repeatedly pointed to the container with a reward, while a deceiver repeatedly pointed to the empty container. Both the cooperator and deceiver demonstrated five trials each. Demonstrators called the dog's name and pointed to a designated container; the dog was then allowed to make a choice. Dogs showed greater reluctance to approach the container identified by the deceiver compared to the cooperator (Petter, Musolino, Roberts, & Cole, 2009). Although some subjects showed an increased latency to approach or refusal to make a choice during the deceptive trials, a majority of subjects still frequently approached the empty container, perhaps showing that it was difficult for them to disobey a command. As an extension to this study, an inanimate object (two cardboard boxes painted either white or black) were used to identify the containers. The white box identified the truthful location, whereas the black box identified the deceptive location of the reward. Once the dog recognized the pattern, they approached the cooperative box more than the deceptive box. On deceptive trials, dogs were able to successfully choose the rewarded container and quickly learned to associate the cooperative box with rewards and avoid the deceptive box, which previously was difficult for them when a human was used (Petter, Musolino, Roberts, & Cole, 2009). This suggests that interaction with a human may alter a dog's decision making and ability to prioritize rewards.

Dwyer and Cole (2018) ran a similar study used transparent containers with larger food rewards, which they believed would make the task easier. Dogs again chose the empty container during the deceptive trials close to 50% of the time. Even when more trials were conducted, dogs still approached the empty container more often than the container holding the reward. Both the transparent containers and larger food rewards should have encouraged dogs to distrust the deceiver, but they still showed no evidence of learning to completely ignore the information given by the deceiver (Dwyer & Cole, 2018).

This research may explain the lack of human focused behaviours seen during the VoE trials. Given that dogs already have a poor ability to ignore deceptive information and that during habituation trials the experimenter was a truthful source of food, dogs may have seen the experimenter as someone unaware of the trick. Rather than seek assistance from the experimenter who has not seen the reward disappear or even behaviourally acknowledged its disappearance, the dog exhibited behaviours of frustration and confusion through biting the apparatus or searching the surrounding area.

Although dogs may not have shown an increase in human focused behaviours in Study 1, the effect of humans was demonstrated through the search times. In Study 2, we saw longer search times during the VoE trial for both the LPR and MPR. This finding was not unexpected since Bräuer and Call (2011) found canines did not reject or hesitate to eat undesirable food after a negative surprise, but rather continued searching for the hidden desirable food. Given that there were olfaction and visual cues which suggested the desirable food was present, we expected the dogs to continue their search when they received something unexpected. In Study 2 the increase in search times during the VoE trials show a persistence to obtain the desired reward, but during Study 1 the search times support Udell's (2015) lack of persistence when a human was present. While the experimenter did not encourage or interact with the dog, subjects may have found the human presence a diversion from a task they could not solve. Rather than continue to search for the food reward, the experimenter became the reward. A number of dogs during the VoE trials stopped searching and rubbed their body against the hands or legs of the experimenter or sat at the foot of the experimenter. Although this was not encouraged, some dogs were persistent, eventually laying down near the experimenter's feet. This finding supports the research suggesting humans significantly affect how dogs behave during problem solving (Miklósi et al., 2003), whereas Study 2 illustrates the innate capacities of canine problem solving when facing a task alone and their ability to remain flexible through their acceptance of changing rewards.

Future Research

In the current study canine subjects were recruited from a training school. Many of the subjects were breed specific, although not intentionally sought out. To fully understand canine expectation and its development, future researchers may want to expand the range of breeds tested in order to investigate if there are any breed differences in how expectation is created. Age may also play a factor. Since puppies have yet to learn that humans are reward dispensers, they may not be as hindered by the human social cues. Furthermore, testing of primitive canines, such as the Australian Dingo and the New Guinea Singing Dog, or ancient breeds, such as Besenjis, Akitas, and Salukis, may reveal evolutionary differences as these breeds are known to have evolved with little human interaction. Finally, as shown in previous research and the current study, efforts to conduct research with canines where human involvement is minimal may be vital in understanding their capabilities in problem solving. It may be advantageous to replicate Study 1 and have the human experimenter leave the testing area, which may affect searching time outcomes. Without a human present, dogs may persist in looking for the reward and show more frustrated behaviours similar to Study 2.

Conclusion

In this study we explored violation of expectation. In Study 1, there was an increase in frustration related behaviours during the VoE trial compared to the habituation trials, but dogs did not search for the reward longer during these trials. In Study 2, I found an increase in frustration related behaviours and an increase in searching time during the VoE trials compared to the habituation trials. The major difference between the two studies was the presence of the human experimenter in Study 1. Without intending to, human experimenters may be blocking natural behaviours simply due to their presence. The more we design experiments where human interaction is not necessary, the more we can come to understand canines as a separate species apart from their co-evolution with humans.

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Tables

Table 1

Study 1 Breed Demographics

Breed	**Number of Participants**	**Average Age**
Golden Retriever	13	6
Border Collie	4	3
Other	6	6

Table 2

Study 2a Breed Demographics

Breed	**Number of Participants**	**Average Age**
Golden Retriever	2	4.5
Border Collie	2	4
Other	5	5.8

Table 3

Study 2b Breed Demographics

Breed	**Number of Participants**	**Average Age**
Golden Retriever	2	3
Border Collie	0	-
Other	7	3

Table 4

Behaviour Categories

Original Behaviours	**Category Name**
Investigates experimenter's hands	Human Focused Behaviours
Investigates experimenter's pockets/pants	
Jumps on experimenter	
Approaches camera person	
Looks at camera person	
Looks at handler	
Looks at experimenter's face	
Bites cup	Frustration Behaviours

Licks/touches cup	
Puts face in cup/box	
Head tilt	
Moves box with muzzle	
Tries to get into liver scented section	
Paws at box	
Flips box	
Picks up box and runs away	
Investigates floor	Looking Behaviour
Searches behind experimenter	
Looks away	
Mouths celery	Eating Behaviour
Eats celery	
Eats broccolli	

Figures

Figure 1. Three compartment plastic container used for Study 2.

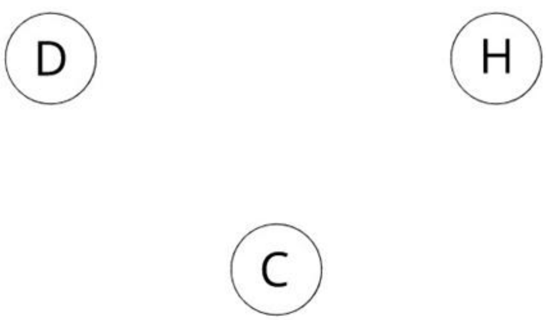
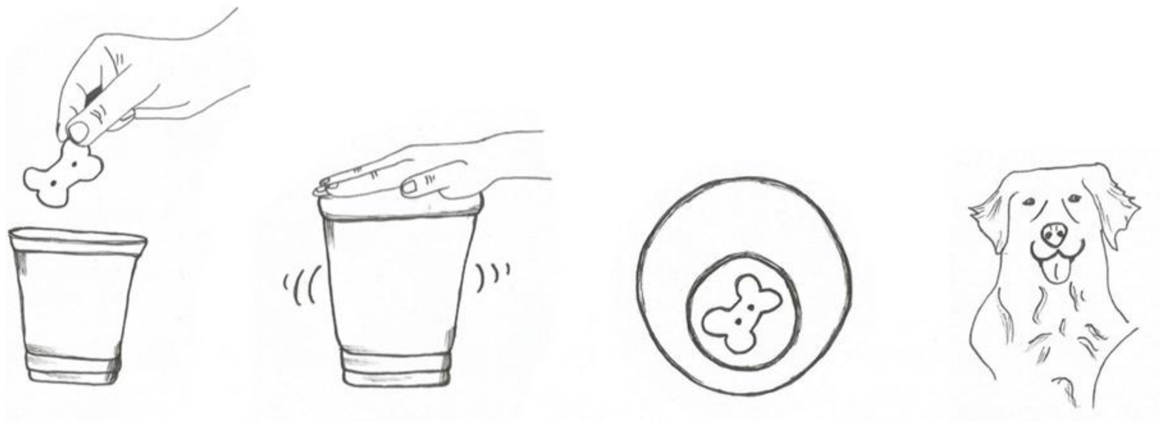


Figure 2. Experimental set up for both Study 1 and 2. D denotes demonstrator, H handler, and C cameraperson.



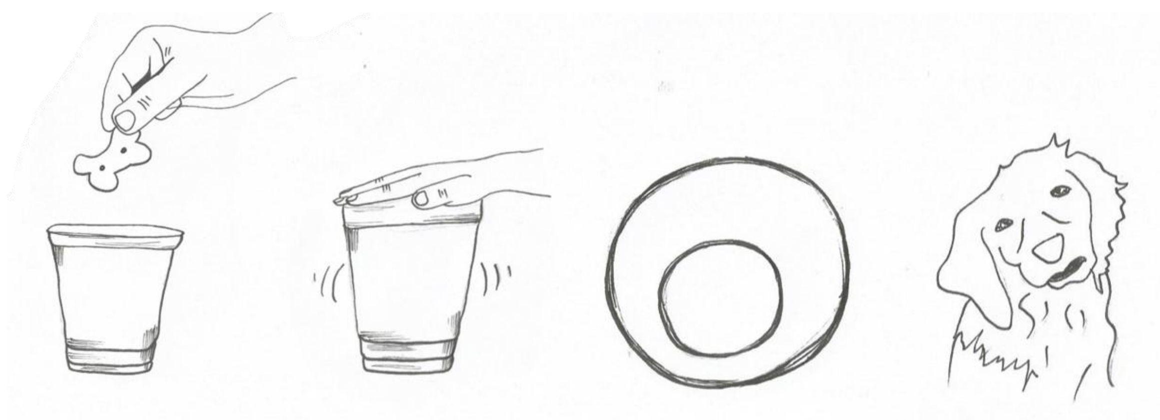
a. Place treat in cup

b. Shake cup with treat inside

c. Reveal treat inside cup

d. Allow dog to explore

Figure 3a. Habituation Trial



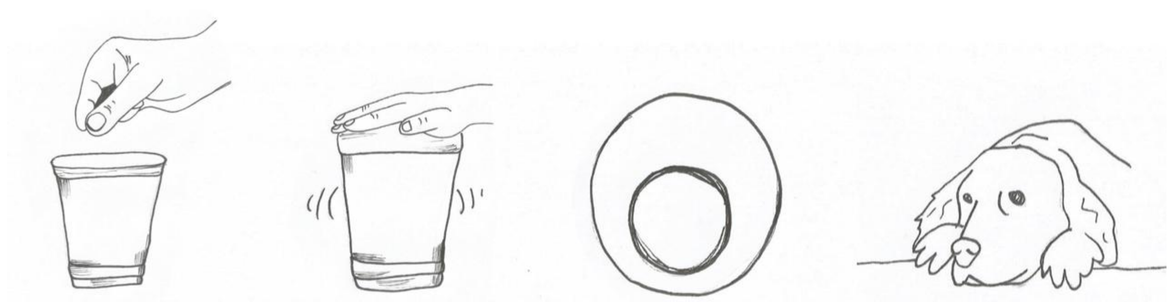
a. Place treat in cup

b. Shake cup and pocket treat

c. Reveal cup with missing treat

d. Allow dog to explore

Figure 3b. Magic Trial



a. Pretend to place treat in cup

b. Shake cup

c. Reveal empty cup

d. Allow dog to explore

Figure 3c. Control Trial

A. Preferred reward placed in compartment A
B. Preferred reward placed in compartment B
C. Preferred reward placed in compartment C

Figure 4a. Habituation Trial

A. Preferred reward placed in compartment A
B. Less preferred reward placed in compartment B
C. Preferred reward placed in compartment C

Figure 4b. Magic Trial

A. Less preferred reward placed in compartment A
B. Less preferred reward placed in compartment B
C. Preferred and less preferred reward placed in compartment C

Figure 4c. Control Trial