RULE GOVERNANCE IN AN AFRICAN WHITE-NECKED RAVEN (*CORVUS ALBICOLLIS*)

by

Emily Faun Cory

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STATEMENT BY AUTHOR

SIGNED: Emily Cory

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

W. Jake Jacobs	7/12/2012
Professor of Psychology	Date

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ABSTRACT

Rule governance is critical to human society. However, could rule governance be found in non-human animals? A six year old, female, African white-necked raven (*Covrus albicollis*) named Shade correctly followed informal verbal commands to retrieve specified objects in the past. This ability was tested using two different methods. Both methods involved the researcher verbally asking the bird to retrieve one object out of two either from the same room or an adjacent room. While initial results were not significantly different than chance, review of trial recordings revealed that it is possible to predict when the bird will retrieve an incorrect object based solely on specific behaviors, termed inattentive or uninterested. Trials marked as inattentive by observers were significantly more likely to be incorrect than correct. This indicates that the bird was capable of retrieving the correct object, but that she also occasionally, intentionally retrieved the incorrect object.

INTRODUCTION

A friend and I visited the tomb of Vladimir Lenin in Moscow, Russia in the spring of 1998. Upon entering the tomb, a soldier approached us and, judging by his tone of voice, began giving a command. Not knowing Russian, we could only listen with a puzzled look on our faces. We did not understand what the soldier was saying and could not follow him, no matter how agitated he became. Thankfully, someone else visiting the tomb informed my friend, who had a habit of keeping his hands in his pockets, to get his hands out of his pockets because of a simple rule the soldier was trying to convey – when in the tomb, keep your hands out of your pockets. We were unable to understand what the consequences would be for not obeying this rule, but they did not seem like they would be pleasant.

Such a barrier can exist between humans and it clearly exists between humans and other species. Nevertheless, this barrier does not appear to be hard and fast. As most dog owners attest, dogs follow verbal commands given by their owners. More recently, researchers have convincingly demonstrated that apes (Savage-Rumbaugh et al., 1993), dogs (Kaminski & Fischer, 2004), dolphins (Herman et al.,1984), and parrots (Pepperberg, 2006), under proper circumstances, respond appropriately to verbal commands. This raises the question, do these animals understand the words given in the command, or are they simply responding to discriminative stimuli?

Enter Shade, a four year old, female, African white-necked raven (*Corvus albicollis*). While playing in her room one night with my family, my mother told Shade to “Go to Emily.” She ran over to me and jumped into my lap. I took no notice. At the time, I thought it was a coincidence. A week later, during playtime, my father told Shade to "Get the duck." She ran, wings half out, to her stuffed duck chew toy. Grabbing it in her beak, she turned and flew with it back to my father. She dropped it in his lap. Thinking to test Shade's recent behavior, we both told her to "Get the glove." She bolted off the couch, ran to a red glove, picked it up, flew back, and dropped it in my lap. My father, mother, and I informally observed this relation between our requests and Shade's behaviors roughly two years ago, and since that time, it appears that a command appropriate-response sequence has become a normal, and common, part of Shade's behavioral repertoire.

This may be a form of a natural behavior called information sharing. Ravens form lifelong pair bonds and claim territories. If a lone juvenile raven discovers a large food source in the territory of a mated pair, it will be unable to obtain the food since the mated pair will quickly chase it away. However, juvenile ravens live together in large roosts. While in those roosts, any individual food discoverer will share the location of the food source. The entire roost may then fly together to the food source and, outnumbering the mated pair, eat without disturbance (Wright, Stone & Brown, 2003). There is some question of how the information is shared. At the most basic level of behavior a flock will follow a member who appears especially well fed. If however, the one who has discovered a large source of food was unable to reach it due to the defense of the local residents that method would be unsuccessful. How then, do the birds know who to follow? Most likely there is a verbal behavior which cues the birds to follow a particular individual. At the higher level of behavior the birds would be able to relate the exact location of the food with body movements or verbal behaviors. In either case, this behavior is at least related to rule governance behavior. The rule becomes, “Follow me and you will receive food.” It should be noted that these large group of invading young birds would also be breaking a rule by entering the territory claimed by a mated pair.

Shade does not always respond in accordance with verbal commands. Once, when my father told her to “Get the duck,” Shade instead ran over, grabbed a dirty cleaning cloth and dropped that in his lap. This did not appear to be a mistake on the part of the bird. Shade had repeatedly retrieved the duck when so asked and we knew my father would never ask for a dirty cleaning cloth, although his visible disgust at having such an object thrown in his lap could have been reinforcing to Shade.

Shade also appears to use deception in response to verbal commands – a behavioral strategy often observed in the wild raven. When a wild raven discovers a large source of food, more than can be eaten in one sitting, the bird will cache the extra food for later consumption. If another raven has seen the hiding place, the bird will move the food to prevent theft. If a raven observes potential thieves watching it, it will act as though it is hiding its food in one location, only to fly to a more secure hiding spot later with the food (Bugnyar & Kotrschal, 2002). Shade displays this behavior often, with both food and toys. When Shade has hidden an object, and I ask for it, she will pull it out of hiding, show it to me, and then hide it again. On other occasions, upon asking for an object, she will simply stare at me. Although I would normally assume she had not understood the command, she sometimes gives a split second glance toward the target object’s hiding place; this could be a clue that she understands, but will not obey.

Recently when this occurred, I started moving towards the hiding place. She flew ahead of me, retrieving her toy. I was not able to obtain the toy that night.

Apes also follow verbal commands. An example shown by Sue Savage-Rumbaugh and colleagues (Savage-Rumbaugh et al., 1993) comparing language comprehension of a two-year-old human child and a bonobo is illustrative. Savage-Rumbaugh raised a human child, Alia, and a bonobo, Kanzi in similar linguistic surroundings, without formally training either to talk. To make the study as natural and comfortable as possible, Savage-Rumbaugh et al. tested Alia and Kanzi in their home environments. The study did not use food deprivation or aversive stimuli - trials commenced only when the subject indicated he or she was ready. Food and play were allowed between trials. The experiment occurred in two phases: nonblind and blind. During nonblind trials, a researcher sat in the room in full sight of the subject and gave a verbal request in the form of a sentence. To comply with the request, the subject manipulated objects in the room. An example is, “Get the paper… put the paper in the backpack.” An appropriate response consisted of the subject taking a piece of paper and putting it in a backpack. There were many different types of novel sentences used, sorted according to what was being asked of the subject. During blind trials, the researcher issued verbal requests while sitting behind a one-way mirror. This prevented the researcher from giving unintentional cues to the subject. Independent observers coded video-records of the trials as correct, partially correct, or incorrect. If the subject performed an incorrect action and then immediately completed the requested action, the trial was marked as correct. On occasion, the researcher would repeat or rephrase the request. If the subject successfully followed the new request immediately, the trial was marked as correct. It was later determined that a more comprehensive code was needed that would better describe these types of situations. Three people watched and scored the coded videos to ensure reliability of the results. The proportion of agreements between the different coders was .98 for Kanzi and .89 for Alia. The coders also marked whether the actions of the researcher might have assisted the subjects in correctly following requests (by cueing the animals). Agreement between coders for this was .83 for Kanzi and .64 for Alia.

When the researcher made verbal requests from behind a one-way mirror, both subjects required extensive urging before following requests. Once habituated, however, they followed requests appropriately. When the researcher used a formal tone of voice, instead of tones used in everyday conversation, neither subject responded. Some requests required the subject to interact with another person in the room. To maintain the double-blind status of those trials the person in the room would keep their eyes covered with their hands for the duration of the trial. Neither subject interacted with a person having covered eyes. The people in the rooms had to have their eyes uncovered or neither subject complied with verbal requests. The researchers solved this problem by having the people in the room with the subjects wear headphones that played music loudly enough to mask the requests completely.

Alia correctly completed 66% of all trials and 65% of the blind trials. Kanzi correctly completed 72% of all trials and 74% of blind trials. The results suggest that both the two-year-old child and the bonobo comprehended requests given in English, comprehended novel sentences, and followed verbal commands given by a researcher.

Researchers have also observed the ability of sea mammals to follow verbal commands. Herman, Richards and Wolz (1984) studied two female, bottlenose dolphins. Researchers trained one dolphin, named Phoenix, with an acoustic language; underwater speaker transmitted computer generated sounds. Researchers trained the other dolphin, Akeakamai (Ake), with a visual language; the trainer's motions with arms and hands were the words. Both dolphins learned objects' names such as Frisbee, surfboard, and basket. Both dolphins learned action words, such as fetch, go to and toss. Phoenix learned location names, or modifiers, such as surface or bottom, while Ake learned left or right. Combined words created novel commands for the dolphins to follow. For example, "SURFBOARD FETCH SPEAKER" was the command for Phoenix to find and take the surfboard to the underwater speaker. These sentences could be as short as two words, or as long as five words. A researcher sat in a tower overlooking the tank, directing the trainer below and sending the commands to the dolphins by using an ASCII keyboard. An assistant, who was also in the tower, recorded the commands given as well as the dolphins' responses. The trainer had no knowledge of the commands Phoenix was receiving, so was unable to give unintentional cues. When training Ake, the trainer wore opaque goggles to avoid unintentional cueing while performing the hand and arm gestures. Both dolphins correctly followed the commands given by novel sentences more often than chance levels. Phoenix correctly followed all three-word, novel, acoustic commands given 91% of the time.

A similar example, which appears to involve no more than simple discrimination learning, appears in dogs. Virtually all people know that, after appropriate training, dogs follow verbal commands. Dogs carefully trained with operant training methods commonly follow commands such as “sit, “play dead,” and “roll over”. However, Kaminski and Fischer (2004) showed that a dog, Rico, could do more than learn basic auditory discriminations. Rico is a border collie owned by a couple who bragged that their dog understands the names of over 200 objects. To demonstrate this, the couple asked Rico to fetch a certain object from around their apartment; when he brought the correct object, they rewarded him with food or play. To learn the names of novel objects, they showed Rico the new object, repeating its name two or three times, and then allowed Rico to play with the new item. To guard against a Clever Hans effect (Spitz, 1997), Kaminski and Fischer designed an experiment to test the dog’s word comprehension and learning abilities.

While the dog and the owner were in one room, an experimenter in a second room arranged ten items reported to be in the dog’s vocabulary. The experimenter then returned to the first room with the dog and owner and randomly chose two objects. The owner then gave a command to fetch one of the items and waited while the dog ran to the second room. The dog could see neither the owner nor experimenter from the second room. Rico correctly fetched 37 out of 40 objects on command.

Those data are an example of conditional discrimination training, but then the researchers added an important variation. The experimenters placed seven objects from Rico’s vocabulary and one novel object in the second room. The owner gave a command to retrieve the novel object, using a name Rico had never before heard. Rico retrieved the correct, novel object on seven of the ten trials. While this number is not significantly different from what can be expected by chance, Kaminski and Fischer asserted that these data are consistent with a dog being able to "fast map." Fast mapping, a hypothetical mental process that allows for learning of a new concept after encountering the new information only once, is a way that children learn new words quickly. In this instance, the dog matched an unknown name to an unknown object in the next room, thus learning by exclusion.

Irene Pepperberg (2006) provided data consistent with language learning in African grey parrots, specifically one parrot named Alex. To train the parrot, two humans model the behavior by asking each other about and for different objects in front of the parrot. A trainer asks the model. The model then responds, receives praise, and the object. The model receives a scolding and the object is hidden contingent upon an incorrect response. The roles are then changed. The parrot takes an active role in this next step, and has the chance to answer questions to earn the reward before the human. Researchers treated the bird in the same manner as the model, including the punishment of removing a toy and attention when an incorrect answer is given. Pepperberg et al. named this the Model/Rival (M/R) technique.

Alex correctly answered when asked what an object was, what it was made of, what color it was, or if it was the same or different to other objects placed on a tray in front of him. He answered what shape an object was and counted up to six. It should be noted that, according to Pepperberg, when Alex no longer wished to participate in the work he gives intentional, very wrong answers and refuses to cooperate. In these cases, Alex gives every answer except the correct one, or Alex would throw the items off the presentation tray. During one trial researchers asked Alex "What color three?" when there were sets of two, three and six objects on the tray. Alex persisted in replying, "Five." Researchers finally asked, "What color five?" Alex correctly answered, "None," apparently showing understanding of the absence of an object.

To our knowledge, there are no word learning studies in members of the Family Corvidae, although due to previously studied examples of high intelligence in this family, it is an obvious group to study. Species in this family have high levels of skills in areas such as tool use (Kacelnik, 2009) and insight Heinrich (1995), once thought reserved for members of the great ape family. Considering data such as these, Emery and Clayton (2004) provide an overview of how convergent evolution might have brought together similar mental capabilities in corvids and apes. The authors state that although at first glance birds appear very unlike apes; corvid cognitive abilities suggest their mental world is at least somewhat similar. Like apes, corvids have large brains for their body size and are highly social animals. Emery and Clayton call attention to the fact that corvids and apes cope with quite similar adaptive social problems, in particular how to handle complex interactions with many conspecifics. This fact suggests to them that corvids, like apes, may be capable of complex cognitive capabilities, including causal reasoning, flexibility, imagination, and prospection – all of which appear associated with complex social problems.

For example, it was once assumed that tool making is a solely human ability, but chimpanzees make their own tools (Goodall, 1990). Moreover, observational studies show that species of corvids, including rooks and New Caledonian Crows, make and use tools, (Kacelnik, 2009). New Caledonian Crows are especially skilled at tool use, even selecting the best tool to use from many – without apparent trial-and-error learning. Chappell and Kacelnik (2002), for example, tested two captive birds, a female and a male. During the first phase of the experiment, the experimenters left sticks of differing lengths near a transparent pipe, sealed at one end, placed on its side with food inside. To obtain food, the birds had to choose the correct length of stick and use it as a tool. The researchers watched the birds solve the problem through a one-way window. Both birds choose a tool that would enable them to get the food on 15 out of 20 trials. They chose the matching length tool on five out of 20 trials, and a longer than necessary (but still useable) tool on 10 out of 20 trials. During the second phase, the experimenters placed the puzzle on one side of a room and the sticks on the other side of the room behind two barriers and hence out of sight of the puzzle. Under this arrangement, the birds could not compare the length of the sticks to the distance they were required to reach directly. The male bird, after spending a great deal of time not attempting to retrieve the food, eventually approached the food tube, flew to the tools, chose a tool and flew back to the puzzle. The male chose the longest tool on five out of 20 trials, and the matching tool on three out of 20 trials. The bird, after choosing a tool that was too short, was still able to retrieve the food two times by holding the stick by the very end. On two other occasions, the bird chose a tool that was too short, flew back to the tools to make a new choice and was able to retrieve the food. The female never attempted the puzzle, instead using the tools in other locations in the room.

Other work demonstrates that common ravens can solve problems without trial-and-error learning. Heinrich (1995), for example, showed that some ravens are capable of what he termed insight. He writes, "According to Webster's dictionary, insight is defined as 'the power or act of seeing into a situation'" (pg 994). For this experiment, the experimenter attached food to one end of a string and attached the other end to a tree branch; hence, the food dangled out of reach of the raven both from the branch and from the ground. The experimenters introduced both wild and captive common ravens to this novel situation one at a time. At the beginning, the captive birds were 1.5 years old, were hand reared by Heinrich, and had never before encountered a puzzle like the one used here. Some of the captive birds pecked at the string, and then jumped back several times before solving the puzzle by sitting on the branch, pulling the string up with the beak, placing a foot on the string to hold it in place, and pulling more string up with the beak until the food was within reach. A wild bird, and one that would not have seen such a problem before, approached and immediately obtained the food by pulling the string up with a beak and holding onto it with a foot. Without insight, Heinrich writes, the learning process of retrieving the food would have been much longer, and involved trial-and-error learning. With or without insight, it is clear that this species is particularly skilled at problem solving.

To make the puzzle more challenging, while out of sight of the ravens, Heinrich (1995) secured two strings of differing colors to the branch, one attached to food and the other to a rock. He then crossed the strings. The color of the correct string was changed between trials. One raven solved the problem at a glance on the very first trial and pulled the correct string immediately, which was the string farthest from the food. This bird pulled the correct string far more often than not, demonstrating insight according to Heinrich. Three other birds did not solve the problem and continually pulled the incorrect string. Though these birds did not successfully solve the puzzle, their behavior did not fit trial-and-error learning. Out of 79 trials these birds pulled in incorrect string 79 times, for an unknown reason, never deviating from their mistakes. Perhaps the rock was far more reinforcing than the food to these particular individuals and pulling that up instead of the food was actually not a mistake.

In 2003, the Raptor Free Flight program at the Arizona-Sonora Desert Museum, a program supporting research and in possession of a common raven, replicated this study. The raven was a two-year-old female. The curator of the department, Dr. Sue Tygielski, attached two uncrossed strings from a perch. She tied food to one and a metal washer to the other. Upon release from her crate, the raven ran directly to the food and looked up at it from the floor. Instead of working from the top, however, she leapt from the ground, grasped the string, dangled upside-down with one foot clamped around the string, and released the food from that position. Though not insight, this same behavior was witnessed by Heinrich with some of his birds, showing that individuals of these species will each have very different solutions to the same problems.

In some of the above-mentioned examples, animals are in fact responding appropriately to their environments as well as commands given by humans. The question is, how much do the animals comprehend? Alternatively, are these results simply examples of stimulus discrimination, conditional discrimination, or some other type of instrumental conditioning by well-trained animals?

Classical conditioning occurs when, following the contiguous pairing of a ‘neutral’ and ‘biologically potent’ stimuli, the behavior of the organism in response to the formerly neutral stimulus changes in a ‘biologically appropriate’ direction. More formally, following contiguous pairings of a conditional stimulus and an unconditional stimulus, the conditional stimulus comes to elicit a conditioned response.

The most well-known example of this is the work done by Ivan P. Pavlov (1927) with dogs. In this case, food served as an unconditional stimulus and salivation as an unconditional response. A tone (serving as a conditional stimulus) sounding immediately before the dogs received food served as an unconditional stimulus. After conditioning, the dogs exhibited a conditioned response; they salivated to the sound of the tone. According to North American interpretations of data such as these, once an animal formed an association between the conditional and unconditional stimuli, salivation became an involuntary response to the conditioned stimulus.

From this, scientists moved into the realm of instrumental conditioning. Organisms learn to react to their environment – thereby solving adaptive problems – based on the consequences of their behavior. If the consequence is reinforcement, positive or negative, the frequency of behavior will increase, while punishment, positive or negative, will decrease the frequency of the behavior. Positive reinforcement is particularly important in animal training (Pryor, 1999). When an animal performs a desired behavior, the trainer gives the animal immediate reinforcement, thereby increasing the likelihood that, given the same conditions, the animal will perform the behavior again in the future. Animal shows use this method to train animals to run across stages, climb specified objects and return to crates. Zoos are also using this method in order to train the more dangerous animals to approach the bars of their enclosures and accept shots or blood drawings, thereby removing the zookeepers' need to dart the animals for simple procedures (Laule, 2003).

Originally, animal trainers mainly used punishment, and in some cases, it is still in use (Pryor, 1999). In this instance, an undesirable consequence follows an animal's unwanted behavior, thus, given the same conditions, decreasing the chances the animal will persist in the unwanted behavior. A rolled up newspaper to the nose when a dog misbehaves is a clear example of this training method. Some trainers believe that this is not an effective training method (Pryor, 1999). Negative punishment (also known as a penalty procedure) has proven to be a successful addition to the training of animals. Also used to decrease the probability of an animal performing an unwanted behavior, negative punishment consists of the trainer stopping or taking away something desirable to the animal. In many cases, simply ceasing to pay attention to an animal when it acts incorrectly proves a useful way to mold the animal's behavior.

There are abundant examples of instrumental conditioning in animal training. Clicker training is a popular method for training dogs (Pryor, 1999). After a short period of conditioning, a dog will form a classical association between the sound of a clicker and a treat, and is a secondary reinforcer. When the animal displays a wanted behavior, the sound of the clicker functions as positive reinforcer. When made contingent on 'appropriate' behavior, the probability of that behavior, in the extant context, increases. The dog then receives a treat. This is an efficient way to train dogs to respond to commands, such as "sit." The dog does not necessarily understand the actual word, but, through instrumental conditioning, learns a relation between 'sitting' and the clicker/treat.

Not only does this style of training work with dogs, but with many species of animals if appropriate stimuli are used. People train animals to perform a vast array of behaviors. Bears ride bicycles in circuses. Pet squirrels ride water skis to the delight of some TV viewers. Ravens take money and put it in a donation box at zoos. Ringtails run across a stage and climb a rock on cue and captive raptors soar, dive and fly to certain perches on cues provided by trainers.

Methods of training, especially classical conditioning, are so powerful that even single-celled organisms will respond. Consider, for example, an amoeba-like cell, the plasmodium from a species of slime mold, *Physarum polycephalum* (Nakagaki, Yamada, & Tóth, 2000). This cell is made of tube-like structures called pseudopodia. When researchers place two food sources in a maze, one on each end, and put the plasmodium on one end, the pseudopodia will first grow throughout the maze. The pseudopodia that reach dead ends on the maze will shrink. The ones that reach food will grow. Once the pseudopodia find the food on the other end of the maze, the plasmodium will alter its shape, bridging the gap between the two food sources using the shortest route possible. This could be intelligence, albeit of a primitive variety.

Consider another example, seen in the same species of slime mould. This single celled organism apparently learns from past experience and alters its behavior based on experience (Tero & Nakagaki, 2008). Researchers placed the plasmodium in a narrow lane and allowed it to grow with the environmental conditions being 26°C and 90% humidity. Researchers measured the length and rate of growth of the organism. After a few hours, researchers changed the conditions to 23°C and 60% humidity for ten minutes, before setting them back to the starting conditions. Ten minutes later the conditions the researchers reset the conditions to cool and dry. Researchers did this seven times on the ten-minute schedule. During the cool, dry conditions, the plasmodium decreased its movement. After the seventh trial, researchers left the temperature and humidity at the starting condition levels. Though these conditions no longer changed, the plasmodium continued to decrease its locomotion following the ten-minute schedule. This behavior stopped after 60 minutes of steady conditions. This simple organism is capable of altering its behavior in response to stimuli.

The main question becomes, what is the level of response in a raven who retrieves an object on command? The level of response is certainly above that of a slime mould. Most simply, conditional discrimination could explain the behavior, whereby the animal learns an association between a specific sound and a specific object. If she hears that sound (a word) and retrieves that object, then she is reinforced. The answer could be more complex than that however. Possibly the animal has some idea as to the meaning of the word.

PRESENT STUDY

METHODS

Subject

The subject is a female, African white-necked raven (*Corvus albicollis*) hatched May 1st, 2006 (IACUC protocol # 10-225).

Materials

The raven was housed in a 3x3 meter room with a sloping ceiling 2.5 meters high at the lowest point and 3 meters at the highest within a private home. This room was the Raven's Room. There was one window (1.2m x 1.2m), covered at night by a drop cloth, and one closet with sliding doors (2m high x 1.2m wide). An alcove (36cm deep x 147cm wide) existed in the wall 2.4 meters above the floor on the south wall. Due to the sloping ceiling, this alcove was 43cm high at the lowest point and 74cm high at the highest point. Tiles lined the alcove as well as plastic matting, towels and a bow perch that was a roost for the bird. Solid plates covered all electrical outlet covers. A layer of rugs covered by a layer of thick office mats protected the floor. A TV box (69cm wide x 102cm long x 79cm tall) covered with a drop cloth and a plastic runner provided an extra level for the bird. The TV box was next to a traveling crate (46cm wide x 66cm long x 53cm tall) with a perch installed on the inside and a gate latch installed on the outside. Next to that, was a 40cm wide x 58cm long x 15cm deep container sitting on two towels and used as a water dish. A disabled ceiling fan with four light bulb sockets attached to the base provided lighting in the room. Two of the sockets had 60W bulbs for use while the bird was awake, one socket had a 4W nightlight bulb for night use and the other socket was empty. A 2.4m ladder was in the room as a perch for the bird and a means for humans to reach the alcove roosting area. A Logitech Alert 700i security camera, mounted on the wall and covered with a sturdy box, was in the raven's living quarters.

A second room, the Testing Room, adjacent to the bedroom with the same dimensions, contained a three-camera Logitech Alert 700i security camera system. One camera, placed on the ceiling, pointed down. A second camera, placed on the south wall, covered the length of the room. A third camera, placed on the west wall, covered the width of the room. Illustration 1 shows the camera placement.

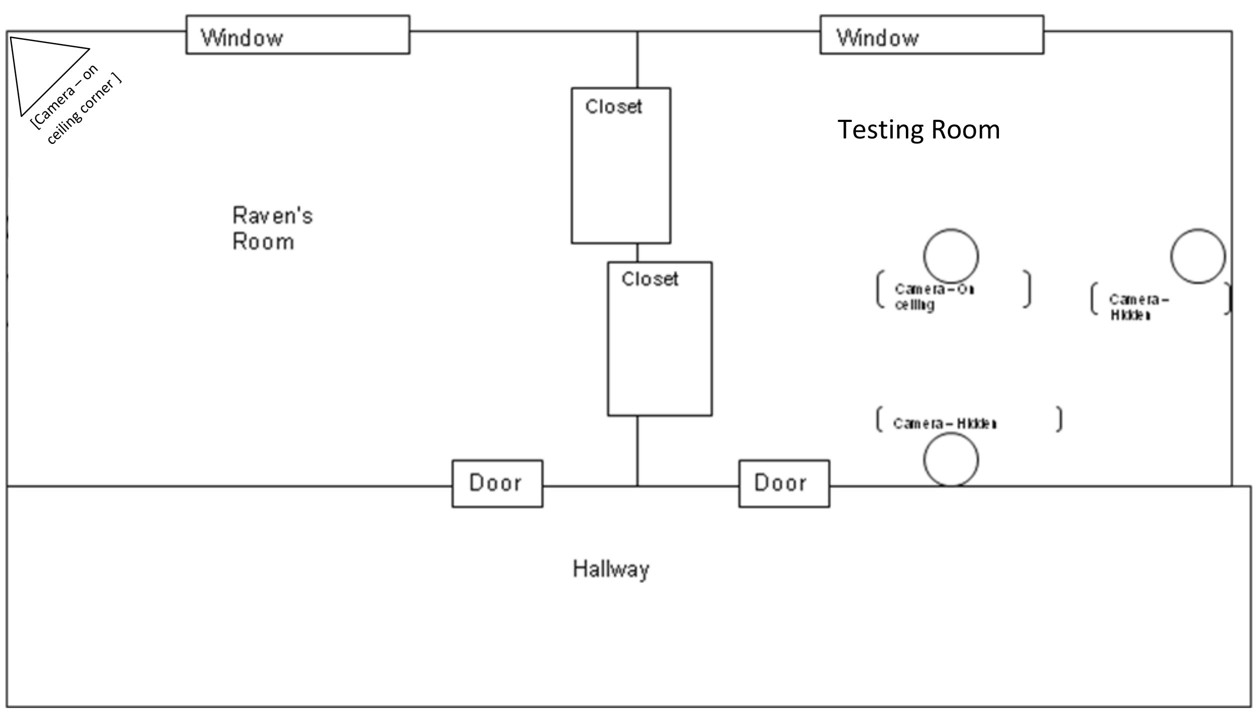


Illustration 1. Drawing of the room and camera arrangement. Not to scale.

Prior to beginning this work, Shade's retrieval behavior was informally tested. Shade therefore had experience with every stimulus object before they were used here. The 13 stimulus objects used were: Star (wooden star painted blue), Chapstick (Natural Ice lip protectant), Glove (red wool glove), Sock (black wool sock), Mouse (squeaky cat toy), Ball (foam children's toy), Monkey, Cow, Lion, Frog, Square, Fish and Snake (all squeaky dog toys). During testing, two of these items were on the Testing Room floor. For single room trials the researcher and the bird were both in the Testing Room, and for two-room trials the researcher was in the Raven's Room, next to the Testing Room.

Procedures

Pilot Trials – Single Room

The number of trials was determined by the bird. Although I attempted to complete ten trials per day, the bird often balked after five or fewer trials, even if breaks were taken. The researcher placed two objects in the center of the room. The correct object was determined by use of the Gellermann Sequence (Gellermann, 1933). This sequence was created and meets the following five criteria: "1. Each series must contain five rights and five lefts. 2. No series could have more than three rights or three lefts in succession. 3. At least two rights and two lefts must appear in both the first and last halves of each series. 4. Each series must contain only five reversals from right to left or from left to right. 5. Each series must offer a chance score of 50% correct from either simple or double alternation of response" (Gellermann, 1933). Each request to the bird started with the researcher saying the raven's name, Shade. This served as a cue to begin. During each trial, the researcher asked for one of the objects. The objects and their locations did not change during a day's trials. In order to avoid habituation to the stimulus objects, different items were used for the next day's trials. The door to The Testing Room remained open during trials so the bird could leave. The raven left the room and the door was closed before each trial so the raven could not watch the placement of the objects.

When the bird retrieved the correct object, she was allowed to play with the object for one minute before she had to leave the room for the setup of the next trial. If the bird retrieved the incorrect object, she received neither play nor praise. The researcher would cross her arms, close her eyes and not respond for 30 seconds. If the bird hid the correct object, the researcher still rewarded her with praise and a one-minute period of play. If the bird approached neither object, the researcher persisted in asking until it was clear from the bird's behavior that she would not comply. If the bird had not responded after five minutes of asking, it was likely she would not comply. If the bird was not cooperating she would leave the room and the researcher closed the door for only a few seconds, and then opened it again, allowing the bird to reenter the Testing Room. This acted as a reset for the bird and sometimes interested her in the task once again. When that was unsuccessful, trials ended. If it was late in the day (10pm or later), all trials ended. If this occurred earlier in the day, the researcher tried trials again after three hours.

All trial objects were hidden from the bird when they were not in use. This was to prevent habituation to the objects as well as object preference for any given object. Shade had experienced all objects prior to the start of this work. She also experienced the objects with the pairing of their names. This was unintentionally done as people tend to talk to her while cleaning her enclosures and putting clean toys out.

Two-room Trials

Two objects were thrown randomly into the Testing Room while the researcher and the bird were in the neighboring Raven's Room. There were five trials per day. During each trial, the researcher asked for one of those objects. While cleaning, or pretending to clean the Raven's Room, the researcher said, "Shade, get the *object name*." This command was used for all trials. Different variations were attempted three times during the earliest trials, but the main command phrase was the only one that gained any response. The correct object was determined by the Gellermann Sequence (Gellermann, 1933). The raven then left the Raven's Room, entered the Testing Room, selected an object, and brought it back to the Raven's Room. If it was the correct object, the raven was praised and given time to play with the object and the researcher. The researcher then threw the object back into the Testing Room randomly. If the object retrieved was incorrect, the bird was ignored and the object was thrown back into the Testing Room. If the raven refused to participate in the trial (as evidenced by not responding to the researcher for at least five minutes, entering the rest of the house, or playing with other objects around the house) the trial was marked as a refusal. The bird was brought back into the Raven's Room and the next trial commenced.

As with the Single Room Trials, in order to avoid habituation to the objects being used, they were hidden from the bird until they were used in the trials. Also to avoid habituation, one or both of the objects would occasionally be changed with a different one. Performance increased when both objects were changed. Performance remained unchanged when one object was changed. When neither object was changed for multiple trial days, performance decreased. Prior to the start of a trial day the door to the Testing Room was left open and the raven was allowed to enter and interact with the objects freely. This revealed any possible object preference before trials. If the raven entered the room and played with both objects equally, it was determined there was no object preference. If however, she entered the room and only played with one of the objects, object preference was suspected and the preferred object was replaced.

Study One – Choice Data with Groups One and Two

Twenty response clips from the two-room trials, ten showing Shade retrieving a correct object and ten showing her retrieving an incorrect object, were put into two different files on a computer. These clips were shown without sound to two different groups of people. Group One included three volunteers and three staff from the Interpretive Animal Collection Department at the Arizona-Sonora Desert Museum. All were females ranging in ages from 30 to 65. Group Two was comprised of three volunteers from the Raptor Free Flight Department of the Arizona-Sonora Desert Museum, all females ranging in ages from 45 to 64. Both groups were told to watch the clips and, based on what they saw of Shade's behavior, select which file they thought contained correct responses from Shade, and which contained incorrect responses. No other information was given. They were then asked what behaviors they were watching to make their decisions.

Study Two – Video Observations by Group One and Individual Observers

All video clips showing Shade's responses during two room trials were compiled into a single file. Each clip shows one trial. The clips were labeled by the date they were created followed by the trial number. A table was made listing each clip. A listing of the key behaviors from Study One was created. Group One from the above study was verbally instructed on the list, shown the clips by the researcher, and asked to come to a group decision about whether Shade was attentive/interested or inattentive/uninterested in each one. The instructions were then written and given to three individual observers. These instructions can be found in the appendix. Observer 1, a 29 year old female, completed the table while in a separate room from the researcher. Observer 2, a 45 year old female, and Observer 3, a 30 year old male, were both sent the materials via e-mail and completed the table at their homes. Observers 1 and 2 can be considered bird naïve because they have never worked with or handled birds. Observer 3 was a bird expert who has been working with and/or training birds (including African white-necked ravens) around the United States for approximately 15 years.

RESULTS

Pilot Studies – Single Room Trials

The total number of trials was 136, but only 108 trials were completed without refusals. Of the 108 completed trials, 61 or 57% were correct responses. Table 1 shows the proportion of correct answers by trial day without refusals. Table 2 shows the proportion of refusals by trial day.

The frequency of correct responses was not significantly different from chance ($\chi^2 = 1.814$, df = 1, $p = 0.185$).

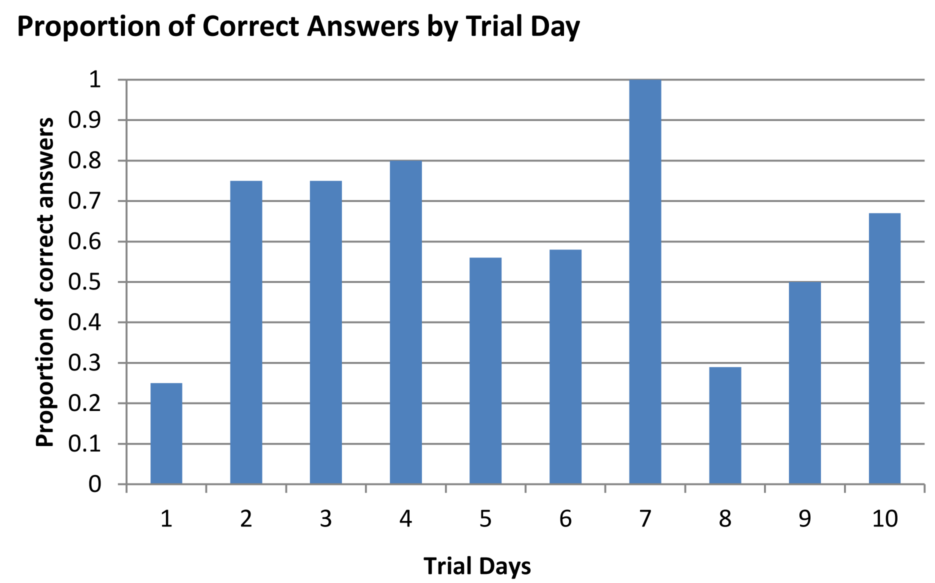


Table 1. The frequency of correct objects retrieved during single room trials by trial day, not including refusals.

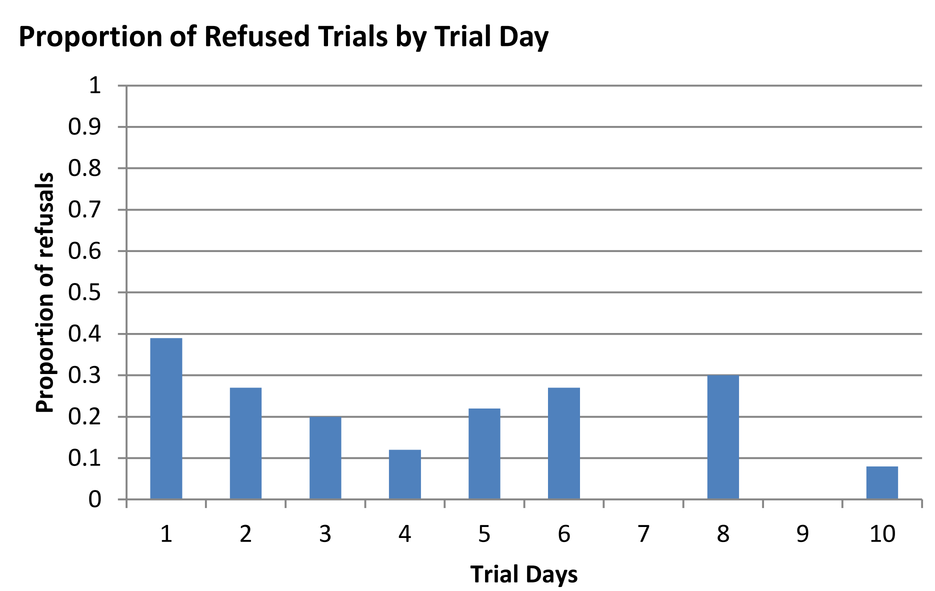


Table 2. The frequency of refusals during single room trials by trial day.

Two-Room Trials

During two-room trials, a total of 82 trials were presented with 13 refusals. A total of 40 completed trials or 58% were correct. Table 3 shows the proportion of correct answers and if new objects were used by trial day. Table 4 shows the proportion of refusals and if new objects were used by trial day.

Though the percentage of correct responses for the two-room trials (58%) was similar to the percentage of correct responses for the single room trials (57%), the frequency of correct responses was not significantly different from chance ($\chi^2 = 1.754$, df = 1, $p = 0.178$).

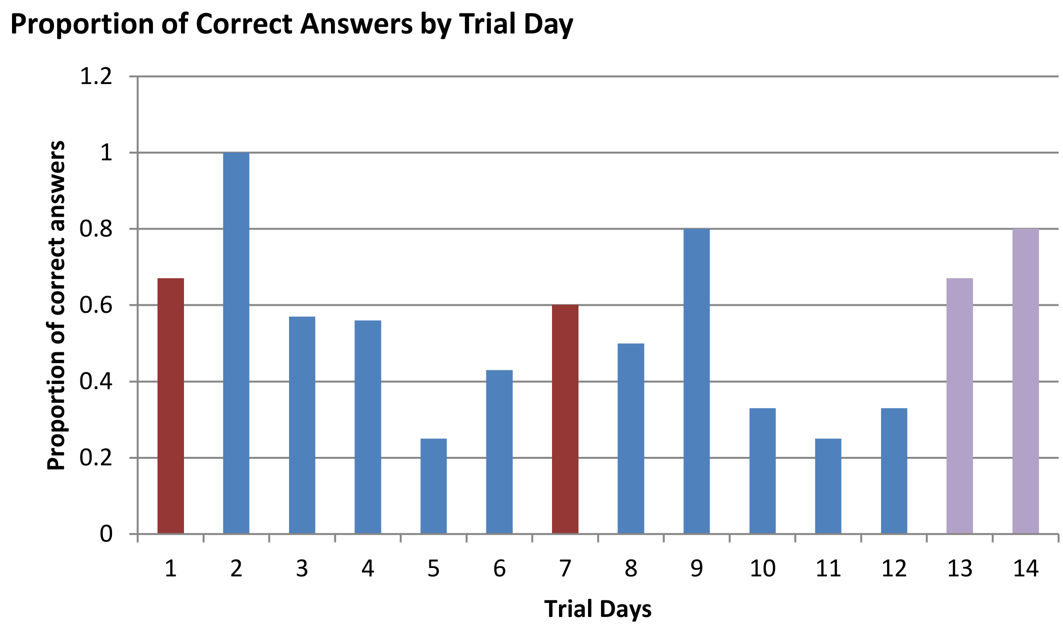


Table 3. The proportion of correct answers, not including refusals during two-room trials. The red bars indicate two new objects were used that trial day. The purple bars indicate that one of the two objects was new.

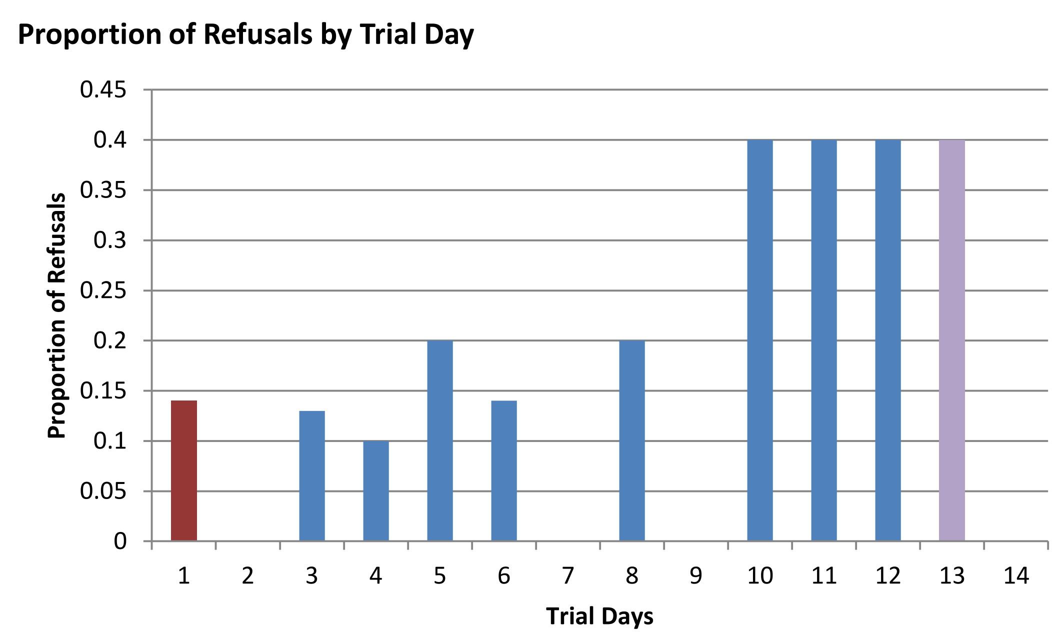


Table 4. Proportion of the total trials that were refused. The red bar indicates that new objects were used. New objects were also used on Day Seven. The purple bar indicates that one object was new. One new object was also used on Day 14.

The data combined from both Single Room and Two-Room Trials was also not significantly different from chance ($\chi^2 = 3.568$, df = 2, $p = 0.168$).

Note that as the same objects were used on consecutive days the refusal rate, in general, rose while the percentage of correct responses decreased until new objects were used.

Study One – Choice Data

Each group was able to successful determine which computer file was which with 100% accuracy. When asked what behaviors they were watching to make their decisions they reported the following:

1. Correct
    a. Fast response times
    b. Shade seems focused and intent on her task
    c. No deviation from task
2. Incorrect
    a. Slower response times
    b. Shade does not go directly to the objects
    c. Shade plays with items in the room and hallway other than the trial objects
    d. Shade looks at other items
    e. Shade does not bring an object all of the way to the other room

This list includes all behaviors mentioned by group members, even if reported by only a single group member.

Study Two – Video Observation Data

Group Data

Of the 21 trials that Group One scored Shade as being uninterested and inattentive, she retrieved the correct object five times and the incorrect object 16 times. The trials which were marked as uninterested and had the incorrect object retrieved was significantly higher than chance ($\chi^2 = 5.762$, df = 1, $p = 0.0164$).

The group marked 47 of the trials as Shade being interested and attentive. Of those, Shade retrieved the correct object 34 times, and the incorrect object 13 times. One trial was marked as unknown. The trials marked as interested and had the correct object retrieved was significantly higher than chance ($\chi^2 = 9$, df = 1, $p = 0.0022$).

Observer One (O1) Data

Of the eight trials O1 marked as Shade being uninterested and inattentive, Shade retrieved the correct object once and the incorrect object seven times. The trials marked as uninterested and had the incorrect object retrieved was significant ($\chi^2 = 4.5$, df = 1, $p = 0.0339$).

O1 marked 52 of the trials as Shade being interested and attentive. Of those, Shade retrieved the correct object 34 times, and the incorrect object 18 times. Nine trials were marked as unknown. The trials marked as interested and had the correct object retrieved was significant ($\chi^2 = 4.923$, df = 1, $p = 0.0265$).

Observer Two (O2) Data

Shade retrieved the incorrect object for all six trials O2 marked as uninterested. The trials marked as uninterested and had the incorrect object retrieved was significant (χ^2 = 6, df = 1, p = 0.0143).

O2 marked 60 of the trials as Shade being interested and attentive. Of those, Shade retrieved the correct object 38 times, and the incorrect object 22 times. Three trials were marked as unknown. The trials marked as interested and had the correct object retrieved was significant (χ^2 = 4.267, df = 1, p = 0.0389).

Observer Three (O3) Data

Of the 12 trials O3 marked as Shade being uninterested and inattentive, Shade retrieved the correct object twice and the incorrect object 10 times. The trials marked as uninterested and had the incorrect object retrieved was significant (χ^2 = 5.333, df = 1, p = 0.0209).

O3 marked 51 of the trials as Shade being interested and attentive. Of those, Shade retrieved the correct object 35 times, and the incorrect object 16 times. Six trials were marked as unknown. The trials marked as interested and had the correct object retrieved was significant (χ^2 = 7.078, df = 1, p = 0.0078).

Table 1 shows correct and incorrect compared to all observers' choices on if the bird was interested or not interested. For more detailed information refer to the table in the appendix.

Table 5

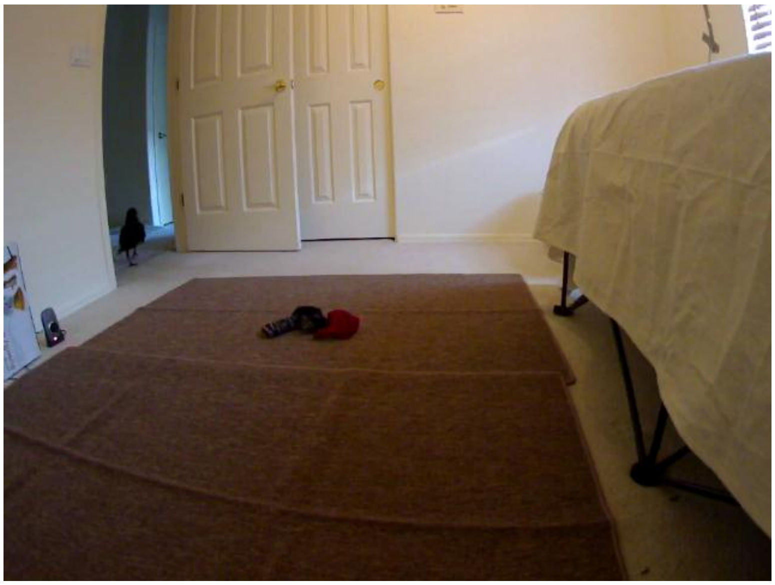
Correct/Incorrect and Interested/Uninterested Trials as Decided by All Observers

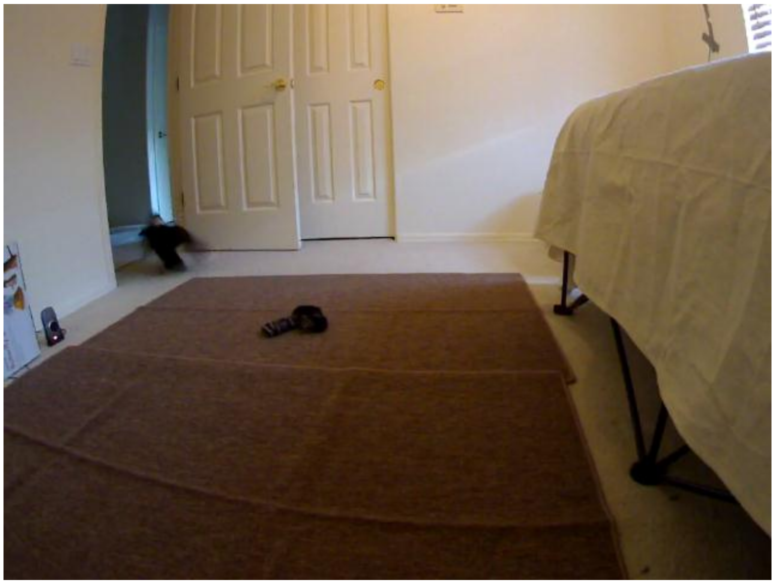
	Interested	Uninterested
Correct	141	8
Incorrect	69	39

Combined, the results of the individual observations were significant, both for uninterested and wrong object retrieval (χ^2 = 15.833, df = 3, p = 0.001) and interested and correct object retrieval (χ^2 = 16.268, df = 3, p = 0.009).

Illustrations 2 - 6. An Interested Trial

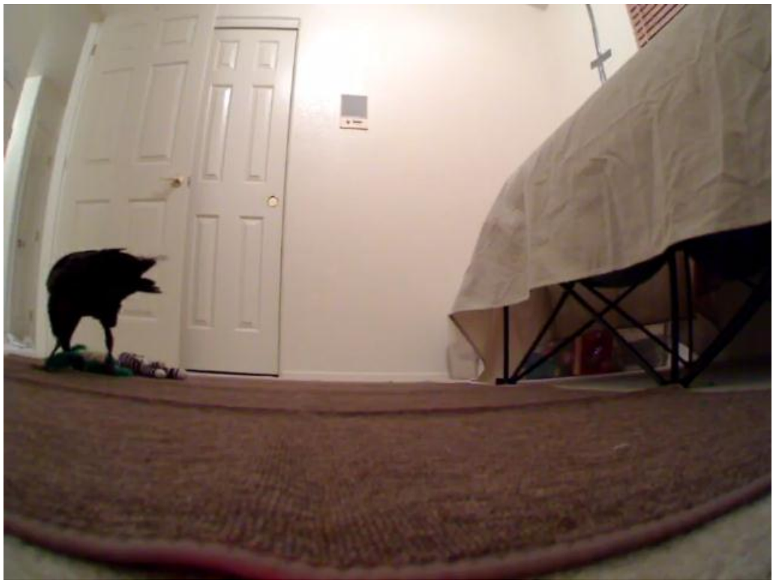
The following pictures are taken from trial five, from 9/24/11. All observers agreed Shade was interested during this trial.

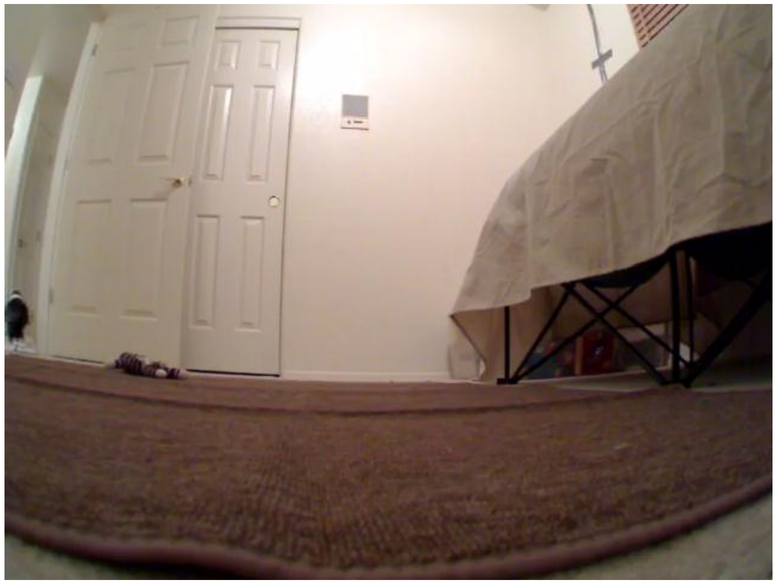




Illustrations 7 - 18. An Uninterested Trial

The following pictures are taken from trial three, from 10/27/11. All observers agreed Shade was uninterested during this trial.





DISCUSSION

Can a raven appropriately respond to a verbal command to retrieve a specific object? The answer to this question is more complex than was originally thought. Initially, examination of the total percentage of correct responses indicated that the answer is no. However, the video footage indicated otherwise. The video footage suggests that not only is the bird capable of retrieving asked for objects, she is also capable of intentionally retrieving incorrect objects. By intentional, I mean to say that, often, no mistake was made by the bird when the wrong object was retrieved. It is not that the bird did not comprehend the rule, but instead that she, for some reason, decided to break the rule.

The raven seems to have understood the command phrase, “Shade, get the *object name*.” When told, “Shade, I’d really like the *object name*” there was never a response. “Where is the *object name*?” sometimes resulted in the bird showing the correct object, but not bringing it to the researcher, which resulted in the command, “Bring it here” which was always obeyed. “Shade, get the *object name*” resulted in the bird retrieving an object and bringing it to the researcher, except in the case of refusals. In some refused trials the raven would enter another room of the house and retrieve a completely new and unexpected object (a cardboard paper towel tube from the kitchen for example). This behavior matches with that observed prior to testing, for example when the raven retrieved a dirty cleaning cloth instead of a toy as described earlier.

During Single Room Trials effort was made to ensure that the bird was not using a visual cue (any body language provided by the researcher) to respond with the correct object. It is possible that the researcher could have unintentionally provided visual cues with these trials, however, once the Two Room Trials began that possibility was eliminated. The objects were then where the researcher could not possibly give any visual hints as to the correct response. As there is very little difference between the results of the two trial types, visual cues were most likely not used by the bird to find the correct object at any time during the trials.

The results of both the Single Room Trials and the Two-Room Trials were not significantly different from chance, suggesting the bird does not understand the names of the objects used in the trials. A closer look at the individual trial days and the behavior of the bird however, suggests differently. While some trial days did show the bird responding at chance levels, the incorrect responses were usually preceded by refusals and delays in responses. This often occurred after a string of correct responses, possibly indicating habituation of the bird to the trials or objects being used that day. Other trial days had very high percentages of correct answers, far above chance levels (up to 100%), while other days had very low percentages of correct answers, far below chance levels (down to 25%). Pepperberg (2006) writes that Alex the parrot would intentionally respond with incorrect answers when he no longer wished to participate in trials. Though no statistics as to how often this occurred were given, it proved to be problematic at times. This seems to be what Shade was also doing.

During the Two-Room Trials the researcher was unable to see what the bird was doing while in the neighboring room. When the raven did not appear after several minutes, or when a telling crash issued from the room, the researcher was able to surmise that the bird was not on task. Later viewings of the videos from those trials revealed clear differences in the bird's behavior upon entering the room that would hint at whether or not the raven would be retrieving the correct object. When on task, interested and attentive, Shade would quickly enter the room, run immediately to the objects, pick one up, and return to the other room and the researcher. When uninterested and inattentive Shade would enter the room and then proceed to do a variety of behaviors, including wandering around the room, looking at other items in the room, and playing with other items in the room.

The question then became, could anyone predict if Shade would retrieve the correct object from behavior alone? Optimally, latency time would be a telling predictor. Due to camera error in the camera located in the Raven's Room no video is available of the researcher giving the commands. On occasion the other cameras were able to record the command being given, but not reliably, making calculating the latency time of each trial impossible. Instead, Study One was run to create a list of key behaviors. One group and three observers were able to predict if Shade was going to retrieve an incorrect object based on the list.

Without exception, all observer data used shows that trials marked as uninterested are also significantly more likely to be incorrect responses by the bird. Once the trials marked uninterested are removed, the data for correct trials also becomes significantly different from those expected by chance. The observers have approximately 90% agreement. This suggests that not only does the bird understand the words, but she is also occasionally retrieving an incorrect object intentionally. Combined, the results of these observations are significantly higher than chance, both for uninterested with wrong object retrieval and interested with correct object retrieval.

These data create a new question; why would Shade be intentionally retrieving the incorrect object? Her behaviors prior to retrieving the wrong item could be described as the bird being bored. These behaviors do appear usually after a long string of trials with the same target objects used. Perhaps the bird is looking for something more reinforcing than toys to which she has habituated. Perhaps the reinforcer used, praise and play, was no longer reinforcing. Maybe after a long enough period the praise (a loud "Yay," or "Yes," followed by, "What a good bird! You got the *object name*!") became more of a punisher than a reinforcer. However, in those cases I would predict the bird would simply refuse more trials, yet she made a point to bring the incorrect object. Perhaps Shade was testing the rule to see what would happen when she brought the incorrect object. However, I would predict she would not continue with the test repeatedly if her goal was simply testing consequences. Maybe the bird is on occasion uncertain as to what is expected of her, and wanders the Testing Room not knowing what to do, until she finally decides to just bring something back. If this were the case however, I would expect her to have brought back the incorrect object approximately 50% of the time instead of an average of 83% of the time.

Tactical deception is part of the natural behavior repertoire of ravens. While caching food, some ravens, upon noticing they are being watched, will either pretend to hide the food then fly off to a more secure location, or they will hide it only to return once they are unobserved and move the cache (Bugnyar & Kotrschal, 2002). Infamous raven tricks and play earn these birds food in the wild, when they pester and trick other carnivores in order to steal food (Heinrich, 1989). Though not scientifically tested, these birds have also traditionally been accused of possessing a sense of humor. After being on the receiving end of a raven prank, Kilham (1989) writes, "The experience left me with a feeling that ravens, in addition to being sharp mentally, may have a sense of humor" (p. 185). Perhaps bringing the wrong object is a form of deception on the part of Shade, to see if I would be tricked into reinforcing an incorrect response, or even, at the risk of being anthropomorphic, the bird's sense of humor. Other than running a great deal more trials and watching for patterns, I do not know how this could be tested.

One of the big questions of this work was what type of learning is taking place in Shade the Raven. Instrumental Conditioning plays a role, as reinforcement is used. It is possible that the bird is using conditional discrimination, whereby instead of understanding a word as a concept, or category, Shade could have learned that when she hears a specific sound and then brings a specific object she will be reinforced. I was unable to perform any work that could successfully test this hypothesis, however the results suggest that the answer is not that simple. Though Shade had encountered the objects paired with their names before this work, she was not trained for the task. I would show her an object and say the name more out of habit than by any intention of training her, and she was not reinforced for any behavior related to the objects. She seems to have tied the words to their corresponding objects on her own, with no punishment or reinforcement, which does not match conditional discrimination training. Though not tested in this work, Shade also seems to be capable of, when encountering a brand new object, learning its name within one or two trials. Her habit of retrieving incorrect objects when she seems uninterested in trials also suggests conditional discrimination is not the answer.

Modifications Made During Testing

The procedures were extensively modified before the final stage described in the Methods section, especially the Single Room Trials. The first goal was to capture the retrieval on command behavior on camera. In order to ensure the bird would continue the behavior, the environment was left as was (i.e. cluttered). This created a problem as the bird was easily distracted by the other objects in the room. The room was cleaned out, except for large objects, cameras, boxes to hide the outlets where the cameras were plugged in, and two large rugs. The rugs turned into a distraction since the bird would spend time hiding objects, trial and otherwise, under them. The rugs were removed, but then the raven spent her time destroying the carpet. The rugs were replaced, and then partly rolled up leaving just the area around the objects clear. This was also a distraction, so the rugs were then left flat and objects placed on top of them.

When the raven first started taking the opportunity to leave the trials early through the open door, the door was then closed for the next round of trials. Shade then spent that entire trial period at the door looking through the gap at the floor. From then on the door was left open during trials and only closed when the objects were put into place. At the beginning of the trials no timeout was given for incorrect objects. This meant Shade could choose an incorrect object without any consequences, which she did often. It was decided to begin a 30s timeout for any incorrect answer. In the beginning of the trials a correct answer would provide unlimited playtime which only ended when Shade stopped playing with the object. For some objects this took up to ten minutes, which made the trial period especially long. It was decided to cut the playtime to one minute.

What to do with the objects between trials was also in question. Originally, objects were used whether or not they had been in the Raven's Room between trials for her to play with freely. When object preference was encountered for an object that had not been in the Raven's Room, it was decided that all trial objects would be left in her room for free play at all times. This created a problem however, when the bird habituated to the objects, no longer would retrieve them, and did not seem to be reinforced by playing with them. From then on all trial objects were hidden from the raven when trials were not being run.

Habituation also proved to be a problem during the Two Room Trials. It was decided that the same two objects would be used every single trial day until Shade reached 90% accuracy in any string of ten trials. This worked for the first pair of objects, though when trials continued to be run with the same objects the accuracy quickly declined. Shade started exhibiting the uninterested behaviors, getting the incorrect object, and then refusing all trials. When the objects were changed interest increased, but when those objects were not changed for days the uninterested behaviors and incorrect answers once again appeared. It was then decided to change at least one of the objects every single trial day. Once that was started the refusal rate dropped and no trials were marked as uninterested by any observers.

CONCLUSION

If Shade the Raven is capable of using verbal cues to distinguish between objects, is she simply under stimulus control or does she actually understand the words? This would be very difficult to answer with the proposed study, but future work could separate the two. Learning by exclusion could be tested, whereby several known objects are placed in a room with one unknown object. The researcher would use an unknown name to ask for the unknown object. Simple stimulus control would not be able to direct to the bird to the correct answer in this case.

Another possible addition to this study would be to bring in different types of the same category of object. For example, right now the Frog refers to one specific toy; it’s a green, frog shaped chew toy. A completely new toy that is also a frog, but perhaps a different color or style, could be used in place of the old object but used with the old title. If Shade understands the concept, she should be capable of expanding the word from a single object to an entire category of like items. If however, this is stimulus control the Frog should remain the only object that matches the title.

Yet another possible method of testing this would be to begin using pictures of items in a specified category to discover if Shade is capable of matching the picture to the word. In the above mentioned example, several pictures of different species of frogs, or perhaps even cartoon frogs, could be used with the title the Frog. If she understands the word she should be able to match even to pictures. If this is stimulus control, she would be unable to do anything with the pictures.

In conclusion, the results indicate that Shade the Raven is capable of understanding a command phrase as well as object names, and following rules as well as intentionally breaking them. In future research it would be important to test the level of word understanding and learning, by testing abilities such as learning by exclusion, and the bird's understanding of categories instead of single object names. Though it would be difficult, it would also be interesting to test the tactical deception abilities of this species further.

APPENDIX A

THE UNIVERSITY OF ARIZONA.

Institutional Animal Care and Use Committee

P.O. Box 210409
Tucson, AZ 85721
(520) 621-9305 (520) 621-3355 fax
http://orcr.vpr.arizona.edu/IACUC

Verification of Review
By The Institutional Animal Care and Use Committee (IACUC)
PHS Assurance No. A-3248-01 – USDA No. 86-3

The University of Arizona IACUC reviews all sections of proposals relating to animal care and use.

The following listed proposal has been granted ***Authorization to Commence*** according to the review policies of the IACUC:

PRINCIPAL INVESTIGATOR/DEPARTMENT: Emily Faun Cory
Psychology

PROTOCOL CONTROL NUMBER/TITLE:

#10-225 - "Rule Governance in a Raven (Corvus albicollis)"

ACTIVE AUTHORIZATION PERIOD*:

INITIATION DATE: December 14, 2010 **EXPIRATION DATE:** December 14, 2013

* Projects scheduled to continue longer than the originally approved 3-year authorization period, will require the submission of a new protocol proposal to undergo full review.

GRANTING AGENCY: Unfunded

REVIEW INFORMATION:
SUBMISSION DATE: 9/14/10 FINAL REVIEW DATE: 12/14/10

RESULTS OF GRANT to PROTOCOL REVIEW:
☐ No Significant Discrepancies noted ☐ Discrepancies noted below ☒ Not Applicable ☐ No Grant Provided

REVISIONS/MINORITY OPINIONS (if any):

None

Institutional Official: Leslie P. Tolbert, PhD
Vice President for Research

AUTHORIZATION STATUS FOR THIS PROJECT WAS CONFIRMED ON: 12/22/2010

Approval of this protocol does not guarantee approval of subsequent experimental protocols planned for these animals. This approval authorizes only information as submitted on the Animal Protocol Review Form, Amendments, and any supplemental information contained in the file noted as reviewed and approved by the IACUC.

Arizona's First University – Since 1885

APPENDIX B

Instructions Given to Observers

What you will see

The recordings you are about to see were recorded in a room next to Shade the Raven's room. I will call this the Camera Room. Each clip represents one trial. Each trial begins with Shade and me in Shade's room and two objects on the floor in the Camera Room. In each trial I tell Shade to get a specific object by saying, "Shade, get the [object name]." Shade will then run into the Camera Room, select an object, and bring it back to me. If she brings me the correct object she is reinforced with praise and play. If she brings the incorrect object she is ignored. I then throw the object back into the Camera Room before starting the next trial (this is shown in some clips). Which object I throw into the room in no way relates to which object is the correct one for the upcoming trial. In some trials Shade seems to be very interested and attentive to the task, in others she seems to be uninterested and inattentive to the task. Please watch each clip and mark on the table if she seems attentive, inattentive, or if you do not know. It is important that you make your decision based on Shade's behavior alone without knowing the outcome of each trial, so please keep the sound turned off while playing the clips. If there are any trials you wish to know the outcome of, please make a note of them and I can look them up when you are finished watching all of the clips. Below are descriptions of behaviors to watch for.

Attentive/Interested

Shade enters the room and goes directly to the objects. She will play with no other objects. She will grab one object and bring it to the other room.

Note: Some clips begin before I have given the retrieve command. In these clips you will see Shade in the hall, standing and looking towards the other room. This is her listening to the command and does not show if she is attentive or inattentive. Her behavior once she turns around to complete the task is the key.

Inattentive/Uninterested

Any behavior that is not directly related to retrieving an object will show that she is inattentive. These behaviors include: playing with other objects (the runner in the hallway, the rug, bed, cameras, and carpet), wandering around the room, looking at objects other than the target objects, and picking up a target object and dropping it without bringing it to me in the other room.

Note: Shade occasionally trips or is startled on her way to the target objects. These do not indicate that she is inattentive. These are very short behaviors lasting only a second or two, and the bird quickly returns to her original task of retrieving an object.

Please begin by watching the clips from 10.15.11, then work your way through them all. Refer to the table to ensure you don't miss any. Thank you!

	Interested	Uninterested	Unknown
10.15.11			
1			
2			
3			
4			
5			
6			
7			
8			
10.18.11			
2			
3			
4			
10.22.11			
1			
2			
3			
4			
5			
6			
10.26.11			
1			
2			
3			
4			
5			
10.27.11			
1			
2			
3			
5			
10.30.11			

1			
2			
3			
4			
11.2.11			
1			
2			
3			
11.6.11	Interested	Uninterested	Unknown
1			
2			
5			
11.10.11			
1			
2			
3			
1.19.12			
1			
2			
3			
1.26.12			
2			
3			
4			
5			
1.30.12			
1			
2			
3			
4			
5			
9.23.11			
1			
2			
3			
4			
5			
6			
9.24.11			

1			
2			
3			
4			
5			
10.2.11			
1			
2			
3			
4			
5	Interested	Uninterested	Unknown
6			
7			

Correct Trials and Uninterested

Correct	Incorrect	Uninterested and correct	Uninterested and Incorrect

	Correct	Uninterested - Group	Uninterested – Observer 1	Uninterested – Observer 2	Uninterested – Observer 3
9.23.11					
1	✓				
2					
3	✓	✓			
4	✓				
5	✓				
6		✓		✓	
9.24.11					
1	✓				
2	✓				
3	✓				
4	✓				

5	✓				
10.2.11					
1	✓				
2	✓	✓			
3	✓				
4					
5	✓	✓	✓		✓
6					
7		✓	✓		✓
10.15.11					
1					
2		✓		✓	
3		✓	✓	✓	
4		✓			
5	✓				
6	✓				
7	✓				
8	✓				✓
10.18.11					
2					
3	✓				
4		✓	✓	✓	✓
10.22.11					
1	✓				
2					
3	✓				
4	✓				
5		✓			
6		✓	✓		✓
10.26.11					
1	✓				
2					
3					
4	✓	✓	✓	✓	✓
5	✓	✓			✓
10.27.11					
1	✓				
2	✓				
3		✓	✓	✓	✓

5		✓	✓	✓	✓
10.30.11					
1	✓	✓			
2		✓	✓	✓	✓
3	✓				
4	✓				
11.2.11					
1	✓				
2		✓	✓		✓
3					
11.6.11					
1					
2	✓				
5		✓			✓
11.10.11					
1	✓				
2		✓			
3					✓
1.19.12					
1	✓				
2	✓				
3		✓	✓		✓
1.26.12					
2	✓				
3	✓				
4					
5	✓				
1.30.12					
1	✓				
2					
3	✓				
4	✓				
5					

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