THE ROOFTOP RAVEN PROJECT: AN EXPLORATORY, QUALITATIVE STUDY OF PUZZLE SOLVING ABILITY IN WILD AND CAPTIVE RAVENS

by

Emily Faun Cory

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As members of the Dissertation Committee, we certify that we have read the dissertation by Emily Faun Cory, titled The Rooftop Raven Project: An Exploratory, Qualitative Study of Puzzle Solving Ability in Wild and Captive Ravens and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy.

_____ Date: 4/19/16
William J. Jacobs

_____ Date: 4/19/16
Gary Schwartz

_____ Date: 4/19/16
Horst D. Steklis

_____ Date: 4/19/16
Christopher Impey

_____ Date: 4/19/16
James King

Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copies of the dissertation to the Graduate College.

I hereby certify that I have read this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

_____ Date: 4/19/16
Dissertation Director: William J. Jacobs

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SIGNED: Emily Faun Cory

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Abstract

The family Corivdae, which includes crows and ravens, contains arguably some of the most intelligent species the animal kingdom has to offer. Separated from primates by at least 252 million years of evolution, birds bear striking physiological differences from mammals, while displaying similar intellectual abilities. This apparent convergent evolution of intelligence sheds light on what could possibly be a universal phenomenon. While many excellent studies show the abilities of corvids, the majority of them test only captive subjects. This study tested the capabilities of both captive and wild ravens, from three different species. The first portion of the study tested which of the four solutions offered wild ravens would choose when solving a Multi-Access Box. The second portion of the study tested the performance of wild and captive ravens when solving a Multi-Latch Box. The nine raven subjects were split into four different levels of enculturation based on their known histories. Two wild common ravens (*Corvus corax*) on the campus of the University of Arizona were level 1, four wild common ravens in the parking lot of a United States Forest Service parking lot were level 2, two captive and trained Chihuahuan ravens (*Corvus cryptoleucus*) from the Raptor Free Flight program at the Arizona-Sonora Desert Museum comprised level 3, and one captive and trained white-necked raven (*Corvus albicollis*) made level 4. It is possible to run trials with completely wild and free birds. It was found that ravens prefer direct methods of obtaining food, such as opening doors and pulling strings, instead of tool use. It was also found that while the relationship between enculturation level and success solving a puzzle was not linear, captive birds were the best solvers. The data given here suggest that captivity, training and enrichment history, and enculturation should all be considered when performing cognitive studies with animals.

Introduction

The family Corvidae has long fascinated humans. For good or for ill, these animals make an appearance in myths, stories, and poems across cultures. In my personal experience, a close-up view of a raven in a crowd inevitably brings forth quotes from Edgar Allen Poe's poem, The Raven. Tribes across the American Pacific Northwest told the tale of the Raven helping the people, by stealing the sun or fire from the gods as a gift to humans (Reid & Bringhurst, 1984). Across Europe, the raven (probably due to its proclivity for eating unattended dead left after plague and war) is associated with evil, witchcraft, and ill omens (Starovecká, 2010). Chinese culture worships a three-legged raven (Caspari, 2003).

In the modern age, confusion and new myths about the Family Corvidae persist. Crows and ravens in particular have adapted well to the human-modified environment, thriving in and around cities. Making for a convenient scapegoat, ravens supposedly kill livestock and destroy sage grouse. Though research has shown these allegations are not quite true, and killing ravens is not effective for any long-term goals, Idaho, Utah, Nevada, and Wyoming are each spending approximately $100,000 a year to kill thousands of the protected bird, by use of a slow acting poison named DRC-1339 (Ewins, Dymond, & Marquiss, 1986, deCalesta, 1980, Madden, Arroyo, & Amar, 2015, Smith, 2014, Thurermer, 2014). A fog of stories and misinformation has continued to follow these birds through the ages.

The same adaptive and wily intelligence that dooms the birds of the Corvid family in many human interactions also makes them a good candidate for study, both for theoretical comparative purposes, and for practical ones. Wild crows and ravens have

been successfully trained on conditioned taste aversion, to make them avoid eating sandhill crane eggs. Researchers colored turkey eggs to look like crane eggs and injected them with nausea inducing toxins. These, put into the habitats of the corvids, soon trained the resident corvids to avoid sandhill crane eggs. These conditioned corvids kept their territories safe from the unconditioned birds, further protecting the eggs of the cranes (Garcia & Gustavson, 1997). With current knowledge of conditioning and corvid behavior, it is likely that the states participating in the raven killing programs are in fact spending hundreds of thousands of dollars a year to train wild ravens to avoid eating domesticated chicken eggs, which is not a desired goal.

The purpose of this study is to reveal raven problem-solving abilities, and to compare those abilities with the enculturation level of the birds. Discovering how ravens approach novel problems provides clues as to their cognition. Enculturation level could make a difference in the behaviors of birds, and other animals, making it an important variable to consider in future animal cognition studies.

Comparing Avians and Mammals

For comparison purposes, the avian evolutionary history is vastly different from that of mammals. Birds evolved from a group of reptiles called thecodonts, while mammals originated from a group called therapsids, both extant during the Paleozoic age. The last common ancestor of birds and mammals was roaming the Earth before the age of dinosaurs, during the Permian period. Far more closely related to crocodiles than to mammals, birds lay polar, yolked eggs. Mammals use the XY sex-determination system, birds the ZW sex-determination system. In mammals, the males are heterogametic, while in birds the females have the differing sex chromosomes (males are ZZ). The red blood

cells of birds have nuclei while those of mammals do not. Birds have a more efficient flow-through respiratory system, lack teeth, and have hollow bones (Gill, 1995).

Perhaps the most striking difference between mammals and birds is the structure of their brains. The mammal prefrontal cortex, responsible for reasoning abilities, is absent in the avian brain. Instead, birds possess a smooth nidopallium caudolaterale (NCL) near the middle of the brain (Bird Brain, 2005, Newitz, 2013).

Despite the large mammalian-avian differences, their cognition is surprisingly similar. For example, the pigeon hippocampus is vital to navigation and long-term memory, just as in the mammalian brain. Though the avian brain lacks the prefrontal cortex of the mammalian brain, it has a large nidopallium caudolaterale, that appears to serve the same role (Shanahan, Bingman, Shimizu, Wild, & Güntürkün, 2013).

The behaviors and abilities of the animals hint at these internal likenesses. African grey parrots show high levels of language capabilities, verbally answering questions, showing knowledge of same/different categories, and conceptual quantitative abilities (Pepperberg, 1999). Both New Caledonian crows and kea parrots have used tools to retrieve food in laboratory studies (Auersperg, Bayern, Gajdon, Huber, & Kacelnik, 2011, Miyata, Gajdon, Huber, & Fujita, 2011).

The New Caledonian crows are members of a family of birds named Corvidae. This family is of particular interest for comparative psychology as it is a striking example of convergent evolution of intelligence. Occasionally called “Apes of the Sky” by scientists, corvids possess key traits shared with great apes, indicating complex cognition: causal reasoning, imagination, flexibility, and prospection (Emery & Clayton, 2004). The

New Caledonian crows do not simply use tools to retrieve food, but they will make tools to get tools to get food, called Metatool Use, making them the most skilled non-human tool users (Taylor, Hunt, Holzhaider, & Gray, 2007). Heinrich (1995) showed that it is possible for a raven to look at a problem, consider it, then solve it correctly the first time, a capability consistent with insight.

Corvids have learned to make use of the human machines they find. For example, crows' use of crosswalks around the world. They drop hard-shelled nuts in the crosswalk, watch as cars drive over them, wait for the light to change, then venture out for their newly acquired food (BBC Worldwide, 2007). Crows will remember faces of humans who interfere with their nests, and will somehow share the information with other crows (Marzluff, Walls, Cornell, Withey, & Craig, 2010).

Theory of Mind and Animal Cognition

The hypothesized Theory of Mind is the ability for an animal to infer mental states of others, conspecific or heterospecific (Premack & Woodruff, 1978). Though a Theory of Mind is not directly observerable, certain behaviors may indicate its presence. Humans can discuss the doubts, beliefs, likes, etc. of themselves and others. Detection of Theory of Mind is more difficult in species that do not have human language capabilities.

Members of the Corvid family recognize themselves in mirrors, (Prior, Schwarz, & Güntürkün, 2008). Corvids are also able to recognize that others have a different point of view, and will use this information for their benefit. Ravens are capable of following human eye gaze to navigate mazes successfully. Though there are a couple of possible explanations for this result, one possibility is that the ravens know the human researchers

have additional knowledge, and that the researchers will be looking towards the correct answer (Bugnyar, Stöwe, & Heinrich, 2004). Raven understanding of other animals' viewpoints and knowledge is consistent with their use of tactical deception when hiding food for future need. If a raven that has not stolen sees another watching it hide food, it will not change behavior. If however, a previous thief hides the food while another is watching, it will either hide the food, then move it when none are watching, or it will pretend to hide the food, then move on to a new, better hidden location (Bugnyar & Kotrschal, 2002).

When living in large social groups instead of mated pairs, ravens display dominance hierarchies. Perhaps due to having empathy with others, ravens will console the loser of fights (Fraser & Bugnyar, 2010). Not surprisingly, the birds will react with stress and self-directed behaviors if a dominance reversal occurs in their own group. Surprisingly, they will also notice if a dominance reversal occurs within an outgroup, even when the subject birds have never seen the outgroup, only having heard the vocal interactions within the outgroup over speakers. Apparently, ravens are capable of inferring the situations and social structures of other animals not just by watching, but also by listening (Massen, Pašukonis, Schmidt, and Bugnyar, 2014).

In 2013, Veit and Nieder studied both the ability of carrion crows to make rule governed decisions, and how the birds' brains, specifically the nidopallium caudolaterale, responded while making the decisions. Trained to perform a match/nonmatch test, the crows watched a series of pictures, then, depending on the rule in effect (indicated by a specific cue), would choose either the picture that matched a previous picture, or the one

picture that did not match the others. The two birds were both able to switch reliably between rules, and performed above chance levels.

Implanted electrodes allowed the researchers to monitor the activity of individual neurons in the brains. Single neurons would fire at different rates depending on the rule in use. These behavior codings were weaker during trials the birds chose the incorrect picture. The activity of certain neurons predicted the behavior of the birds. Conversely, the behavior was predictive of the firing of certain neurons (Veit & Nieder, 2013).

The finding that an animal with a long evolutionary history diverging from mammals, would, through convergent evolution, have similar cognitive capabilities is important. By learning more about a very different brain, we can learn more about the development of intelligence in general. Due to selective pressures, high intelligence animals arise in a large variety of habitats and forms, and is not restricted to great apes evolving in east Africa. This provides some pieces of the puzzle of how cognition evolves, and what is important along the way.

In addition, this is important for the field of astrobiology. The similarities between mammalian and avian cognition suggest that if an intelligent lifeform exists, though it may look very different from Earth life, the cognition and neuronal tissue could very well be similar.

Animal Cognition and the Alien Life Hypothesis

The probability of the existence of alien life, much less intelligent alien life, has been expressed by an equation. The equation is $N = R^* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$, where N is the number of detectable civilizations in our galaxy, R^* is the rate of star formation in our

galaxy, f_p is the fraction of stars that form planets, n_e is the number of planets able to support life, f_l is the fraction of those planets where life emerges, f_i is the fraction of those where intelligent life appears, f_c is the fraction of those where the life is capable of interstellar communication, and L is the length of time those civilizations are capable of sending messages (The Drake Equation, 2015). While progress on exoplanets has created estimates of some variables, such as f_p and n_e, other variables are not agreed upon, leading to an enormous variety of answers, from 1, Earth, to millions.

Astrophysicist Sara Seager has suggested a parallel equation. $N = N_* \cdot F_Q \cdot F_{HZ} \cdot F_O \cdot F_L \cdot F_S$ where N is the number of planets with detectable biosignature gasses, N_* is the number of stars in a sample, F_Q is the fraction of quiet stars, F_{HZ} is the fraction of rocky planets in the habitable zone, F_O is the fraction of observable systems, F_L is the fraction of those with life, and F_S is the fraction with detectable spectroscopic signatures (Dvorsky, 2013).

With new discoveries every week, the estimated probability that life exists off Earth is unstable. Liquid water is not so rare, still intermittently flowing on Mars (NASA, 2015). Complex organic molecules, such as iso-propyl cyanide, exist in star-forming dust clouds tens of thousands of light years away from Earth (Eyre, 2014). Currently, there are 1,954 confirmed planets, 484 multi-planet systems, and 4,696 planet candidates found by Keplar, with more confirmed every week (NASA Exoplanet Archive, 2015). It is becoming more and more unlikely that life only exists on Earth. The problem is how to find it over such great distances. If someday we do find life elsewhere, the new challenge will be to detect if it, even if very different from Earth life, has intelligence. In all likelihood, though built differently than Earth life, the brains will still operate in similar

ways. Or perhaps, the structure and operation of alien brains would be very different from life on Earth, and yet still achieve high intelligence. If the senses and abilities of alien life are too different from Earth standards, detecting the presence of high intelligence would be even more difficult.

For now, without alien life to study, researchers must instead study animals hugely different from humans, yet with high intelligence. This study took place in Arizona, where birds are high in abundance. Ravens, in particular, are easy to find.

Researching Corvids, Especially in the Wild

There is definite value in researching members of the corvid family, especially in the wild. In Arizona, ravens are the most widespread of the corvids, making them the most accessible, high-intelligence bird to use for study. The remaining question is, how best to study the learning and cognitive abilities of ravens in the wild?

Skittish around humans, and decidedly neophobic, wild ravens are notoriously difficult to research in the field. This fear of new objects, including food, has been hypothesized to be due human persecution of the birds and/or what the birds commonly eat. Being carrion eaters, they will approach an apparently dead animal to feed. There is a possibility that the body belongs to a sleeping, stalking, or perhaps injured but still dangerous animal, making raven caution a vital survival skill (Heinrich, 1988). With a long enough period of habituation, and automated cameras recording behaviors instead of humans, puzzle boxes work well. Puzzle boxes can be set up and left alone with cameras running, leaving wild ravens free to investigate, habituate, and use the boxes on their own time, free of human interference.

As previous reports show, ravens are skilled at manipulating objects, including human contraptions, making them naturally skilled puzzle box users. Researchers have long used puzzle boxes as a method of studying cognitive abilities, learning, and memory of animals, though these studies usually only make use of captive animals. More learning studies performed using wild animals are possible, and would also be highly beneficial for a more well-rounded understanding of the capabilities of animals in general.

In 1898, Edward Thorndike studied the associative processes in animals, mostly cats, using puzzle boxes (McLeod, 2002). Later, B.F. Skinner built on Thorndike's ideas, and used puzzle boxes (aka Skinner boxes) to test operant learning in several species of animals (Immelmann & Beer, 1989). Since then, numerous types of puzzle boxes have been used around the world to study animal cognition, memory, learning, and a mix of all three. The most recent work, done by Benson-Amram, Dantzer, Stricker, Swanson, and Holekamp (2015) describes what happened when researchers gave puzzle boxes to members of 39 carnivore species residing in zoos. Relative brain size predicted the problem-solving ability of the animals studied, while socioecological variables did not. Since the animals with a higher brain to body mass ratio surpassed the more social animals at box solving success, this study failed to support the social brain hypothesis.

There are some limitations to puzzle box use with wild ravens. In some cases, some birds never habituate to a specific box, limiting data collection. Each box can only test so many areas of raven ability, creating a need for multiple boxes to test multiple abilities. In addition, puzzle boxes are a decidedly novel, and artificial, addition to a raven's environment. A raven's inability to solve a puzzle box would not prove a lack of

intelligence or skill. The lack of success could be a result of the box not being compatible with the natural behaviors and abilities of the bird.

There are many excellent studies and experiments showing the adeptness captive corvids have with puzzle boxes. However, as noted previously, research involving completely wild, free roaming birds is lacking. This is understandable, as doing puzzle solving studies with wild, free birds is risky and time consuming. The researchers must rely on the wild birds' desire and timing to approach and solve problems with motion-activated cameras capturing every second. Risky though it may be, this research is important to show the differences in behavior between wild and captive birds.

Training captive corvids to perform complicated tasks using positive reinforcement training is relatively simple. A female Chihuahuan raven at the Arizona-Sonora Desert Museum opens a lunch box to retrieve food to the delight of the audience. Animal trainer Dillon Horger trained a raven to collect and separate trash from recycling, as well as lengthy chained behaviors.

The cognitive feats shown in captivity by various animals may or may not be an accurate reflection of the abilities and behaviors of the animals in the wild. Even without formal training, enculturation with humans seems to increase the likelihood of eliciting the cognitive abilities of laboratory-kept animals. It seems that the more contact an animal has had with humans, the better it is at solving human-made puzzles and using human-made tools. Furlong, Boose, and Boysen (2008) found that chimpanzees with high enculturation (raised and nurtured by humans) solved presented tool use puzzles, semi-enculturated chimps solved some of the puzzles, and non-enculturated chimps solved none of the problems. In today's world, with the spread of human cities and activities, it

is becoming increasingly difficult to find animals that could be classified as having absolutely no enculturation. Instead, animals with low enculturation (e.g. not raised by humans, not interacting with humans) can be compared with high enculturated animals (e.g. raised by humans, constantly interacting with humans, living in human-built shelters).

Purposes of this Research

One of the purposes of this study was to compare the learning and behavior of ravens on puzzle boxes to that of crows and parrots from other experiments with the same types of boxes. The boxes chosen are the Multi-Latch Box (Miyata, Gajdon, Huber, & Fujita, 2011) previously used with kea parrots (*Nestor notabilis*), and the Multi-Access Box (Auersperg et al., 2011) previously used with both kea parrots and New Caledonian crows (*Corvus moneduloides*). This would allow a descriptive comparison between the birds. Availability of subjects resulted in three species of ravens being tested (*Corvus corax, cryptoleucus,* and *albicollis*).

The second purpose of this study was to compare descriptively the behaviors and learning of birds from multiple levels of enculturation. 13 ravens from four different levels of enculturation saw the Multi-latch box. Representing the least enculturated ravens were six common ravens, two adults and their four offspring, living on the campus of the University of Arizona. Though these birds lived in an urban environment, and their history was unknown, there were no reports of these birds interacting with humans or human machines, with the exception of nesting on the Gould-Simpson building. While their nest was viewable from the window next to it, it was still well out of the reach of humans.

Four common ravens, two adults and their two offspring, living around the United States Forest Service buildings and parking lots in the Village of Oak Creek, close to Sedona, AZ, represented the next level of enculturation. While these birds lived in a rural area, they made themselves known by interacting, and occasionally destroying parts of Forest Service vehicles. Less fearful of humans than the University of Arizona ravens, attempts to scare the birds away from the Forest Service area using noisemakers have failed. Though the exact history of these birds is unknown, it is likely they were living in the area before the Forest Service buildings existed, several years ago.

Representing the next highest level of semi-enculturated ravens were two captive Chihuahuan ravens (*Corvus cryptoleucus*), brother and sister, living at the Arizona-Sonora Desert Museum, part of the Raptor Free Flight program. Rescued ten years ago after they were blown out of a nest near the town of Wilcox, AZ, they lived most of their lives in captivity. They lived separately in large outdoor enclosures, and during Raptor Free Flight season were released into the desert every day to fly around audiences before returning to their enclosures. The female, Einstein, the bird mentioned earlier, was trained to open lunch boxes in front of audiences.

Shade the Raven is a nine-year-old African white-necked raven (*Corus albicollis*) representing the most highly-enculturated ravens. She spent the first six weeks of her life with her parents, and with the breeder who took her to work with him at a zoo, where humans and other animals surrounded her. She then came to Arizona to live with the researcher, Emily Cory. Shade has her own bedroom in a house. Shade grew up surrounded and nurtured by humans. Without training, she learned how to operate many machines in the house by watching, including but not limited to light switches, the eject

button on DVD players, the chain switches on ceiling fans, the thermostat, and the power button on computers.

I hypothesized that the more enculturated a bird was, the more success it would have solving puzzle boxes, with fewer errors.

The Boxes

The Multi-Latch box, described in more detail in the Materials and Methods section allows presentation of modifiable puzzles to the birds. By changing the number and position of slide bolt latches, the behavior required for successful retrieval of food could be altered. By watching how the behavior of the birds changes as the solution changes, more clues are provided as to the cognition and adaptability of these animals.

Ravens are known for their adaptability (thriving on all but one of the continents and in an enormous range of environments), and behavioral flexibility. With their well-documented use of human contraptions around the world, it was predicted that they would solve at least the most basic puzzles, if neophobia was overcome. It was also predicted that the more enculturated the bird, the more success it would have with the latches.

The Multi-Access Box, described in more detail in the Materials and Methods section, provides the birds with a variety of solutions to reach the same goal. They can obtain food from the box by opening a door, putting stones down a chute, pulling a string, or using a stick. This this procedure can reveal a natural preference of the birds for particular solution(s).

In the study by Auersperg et al. (2011), kea parrots preferred the chute solution, while the tool-using New Caledonian crows preferred using the stick. Common ravens were previously untested with this box, but as they are not natural tool-users, they were predicted to behave differently from both the kea parrots and New Caledonian crows. The preferred alternate hypothesis is that they will choose the more direct methods of retrieving the food, particularly opening the door.

Box Type	**Hypothesis**
Multi-Access	Wild common ravens (enculturation levels 1 and 2) will employ the door and string solutions.
Multi-Latch	Ravens will adapt to changes in the solution. Ravens will therefore be able to solve the box despite changes in latch number and position.
Multi-Latch	As enculturation amount increases, so too does box solving ability.

Materials and Methods

The Boxes

Puzzle box 1 – Multi-Latch Box.

Though based on a description in the 2011 paper by Miyata, Gajdon, Huber, & Fujita, some changes were necessary to make a multi-latch box suitable for outdoor, wild corvid use. The original Multi-Latch box was wooden, with a Plexiglas lid, metal rods as latches, and a spring to open the lid once unlatched. The present Multi-Latch Box had

Figure 1. The Multi-Latch Box.

stainless steel, 8” cake pan as the base, with acrylic for the border, and a Plexiglas lid with two door hinges. A second cake pan fit inside the first to hold food and was easily removable for cleaning. This box was bolted to a platform table. Bolt latches could be easily changed with pre-drilled holes. To provide a slower lifting of the lid, a small toolbox lift support took the place of a spring.

I started with 15lb lift support, but that proved to be too strong and was straining the Plexiglas lid, as well as making the latches difficult to slide open. I changed it for a 10lb version. Small strings on one to two bolts made for easier opening. The dimensions

of the completed box while closed were 35.6 cm by31.75 cm by 6.35 cm. The simplest solution required the birds to slide a shortened bolt away from the lid, which automatically opened the box. Latches could then be added, subtracted, and rearranged, requiring the birds to move multiple latches in any order, move latches in a specific sequence, or ignore some latches while using others to open the lid. The Multi-Latch Box was used at all locations.

During the wild raven portion of the study, the Multi-Latch Box held raven favored foods, such as raw meat patties, hardboiled eggs, and puppy kibble. To maintain raven involvement in the box, some of the food was placed on top of and around the box.

Puzzle box 2 – Multi-Access Box.

Figure 2. Side one of the Multi-Access Box.

The original version of the Multi-Access Box, described in Auersperg et al. (2011), permitted the examination of differing styles of problem solving used by kea parrots and New Caledonian crows. The Multi-Access Box had a different solution on each side. The food was on a pedestal in the center of the box and is on a ramp.

Some changes were necessary to make the box weather and wild bird resistant. The present version of the Multi-Access Box was built of an aluminum frame, walls were

Figure 3. Side two of the Multi-Access Box.

made of Plexiglas, roof and floor of acrylic, the inside pedestal of stainless steel, and the inside ramp of acrylic. The four possible solutions were the same as in the original Multi-Access box (Auersperg et al., 2011).

Side 1 contained a door held shut by a small piece of Velcro. A bird only needed to pull a string on the door, or use a beak to pry the door open to retrieve food. When opened, this door gave direct access to the food, as well as access to the inside of the box (for maintenance). A successful solution of the other three sides would knock the food down to the ramp, on which the food slid out of a gap in the bottom of the box wall where it became accessible to the bird.

Side 2 gave the birds access to a chute, and rounded river stones, weighing approximately 20g each, laying outside the box. Black stones were first used for their salience. When the Tucson heat became a concern, the black stones were replaced with white stones of the same size and weight. There, the birds could obtain the food by dropping stones down the chute to knock food to the ramp.

Figure 4. Side three of the Multi-Access Box.

Side 3 had a string that pulled the food off the pedestal to the ramp. There was a knot in the string on each side of the wall, that provided enough length to be useful, but not so much as to risk entangling the birds.

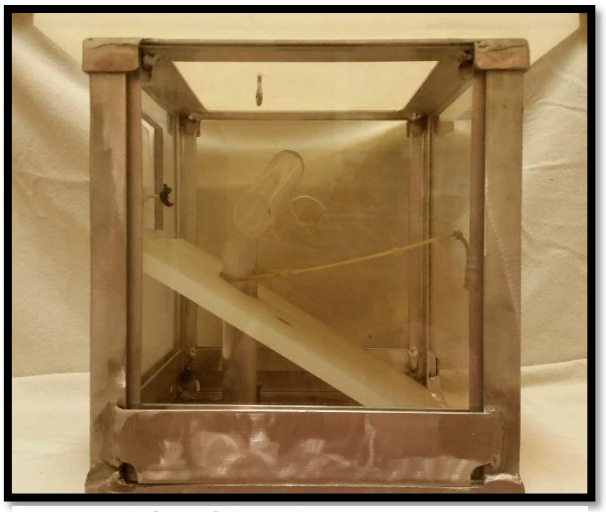


Figure 5. Side four of the Multi-Access Box.

Side 4 had a hole in the wall. A stick inserted through the hole knocked the food onto the ramp. Initially, to prevent theft by birds or loss because of wind, the stick was attached to the box. The constant movement of the stick in the wind triggered the motion activated camera systems, and so the stick was disconnected and placed nearby. The dimensions of this box were 35.56 cm by 35.56 cm by 35 cm. All solutions were accessible at all times, to investigate which solution(s), if any, common ravens preferred.

Food placed inside was restricted in size and texture so it would fit on the pedestal, yet fall down the ramp when a raven successfully solved the problem presented by the Multi-Access Box. Dog treats, yogurt bites, small portions of raw hot dogs, and small hamburger meat balls were used. To maintain raven interest in the box, kibble and raw hamburger meat, the same menu used for the Multi-Latch Box, was also scattered around and top of the box.

Other Equipment

Figure 6. An outdoor bullet camera.

The locations for wild birds had a platform built of steel for the base, with a tabletop made out of white, nonstick, sun resistant acrylic. These are capable of withstanding Arizona weather while being easy to clean. The main camera system for all locations was an outdoor SSC-758HQ real time DVR module with remote control with outdoor, SSC-113HR7WC36 color 700-line bullet camera. This system can withstand the weather, and can be plugged in, operated on battery power, or run using a solar panel. All cameras were motion activated.

Figure 7. The Sedona research platform.

The researcher, Emily Cory (EC), and one other observer, Janni Hawkins (JH), used the program Noldus Observer to code the behaviors seen in the videos for more detailed descriptions of observed behaviors. Due to the large number of videos and in the interest of time, only videos showing successful box openings were coded. JH trained on Noldus Observer over nonconsecutive three days, for a total of approximately six hours. There

was occasional re-training in an effort to avoid observer drift (Barrows, 2011). Noldus Observer only allowed videos to be coded in 60-second segments, requiring raters to take frequent breaks between clips, minimizing a phenomenon known as ipsative drift, which is the decrease of observer sensitivity to behaviors as the work progresses (Jacobs et al., 1988). For a view of the ethogram with modifiers used as it appeared in Noldus, please see Figure 8.

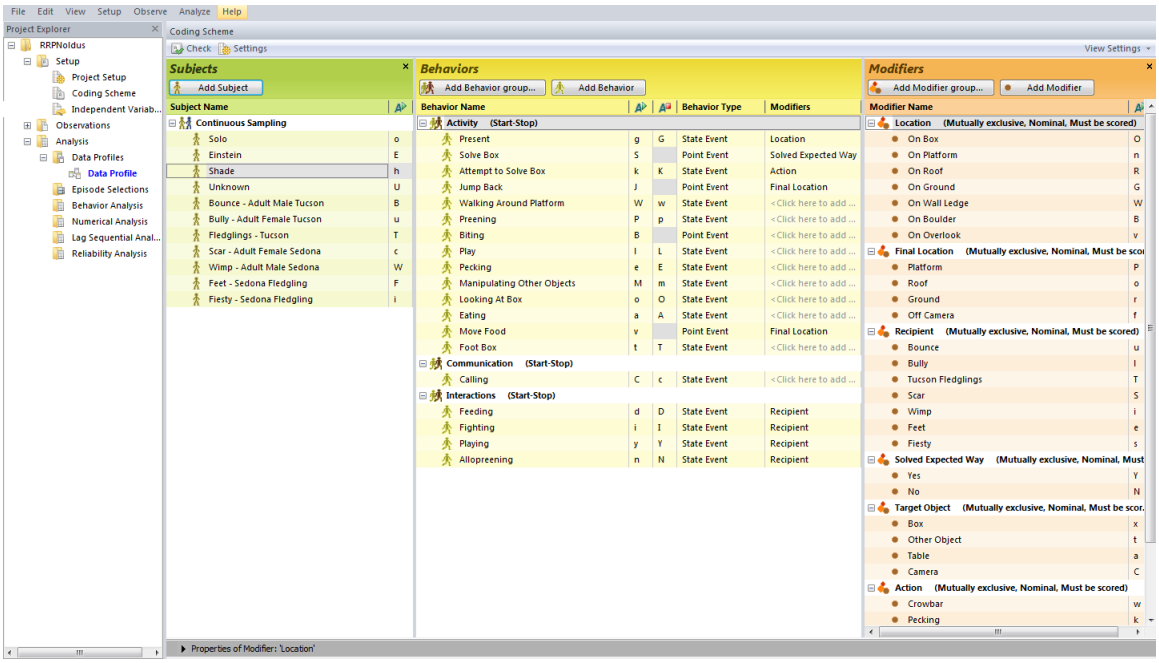


Figure 8. The ethogram used in Noldus Observer.

Box Habituation

To combat neophobia, habituation of the wild ravens to the puzzle boxes and equipment was essential. During habituation, a food tray containing kibble, hardboiled eggs, corn on the cob, and hamburger patties was on the stations, as well as scattered near the stations. After the ravens became frequent visitors, (landing on the roof and station at

least once a day) the Multi-Latch box moved closer to the station over a two-week period, until it replaced the food tray on top. Left open, the puzzle box contained a jackpot of food, including hardboiled eggs, kibble, and meat patties. In the case of the Multi-Latch Box, the puzzle began after the ravens had been comfortably eating from the box. Introduction of new boxes followed the same pattern.

The Locations and Subjects

This work was approved and monitored by the Institutional Animal Use and Care Committee, under Protocol 12-345. A scientific collecting license was issued by the Arizona Game and Fish Department for the work with wild ravens.

Tucson – The University of Arizona campus. The University of Arizona has

Figure 9. Fledgling on the platform with the Multi-Access Box, and an adult on the roof.

been the territory of a mated pair of ravens for at least the past ten years. The initial location of the Rooftop Raven Project was the roof of the Psychology Building on the University of Arizona main campus. After approximately seven months of running without sighting a raven, the station was moved to the Physics and Atmospheric Sciences Building, located next to the Gould-Simpson Building, the raven-nesting site during the

winter of 2013/2014 and the spring of 2014. This location was successful in attracting ravens, though an unexpected construction project on the roof delayed research.

In addition to the main camera system, there was a secondary camera installed. Possibly hit by lightning, the original camera was soon inoperative. A Foscam outdoor, color, night vision, Internet camera later became the secondary system.

Both the Multi-Latch and the Multi-Access boxes were used in this location.

The subjects. All birds in this location were common ravens (*Corus corax*).

Figure 10. Fledgling on the Multi-Access Box.

In early winter of 2013, two adult ravens landed on the roof and ate food, though they never landed on the station itself. They built a nest next door on the Gould-Simpson Building, and had three chicks out of season. An invading pair of ravens supplanted the original pair, killing the chicks, between the end of December 2013 and the start of January 2014. The original pair of birds permanently left the territory.

Figure 11. Bully sitting on the nest with four chicks.

The new ravens visited the station, and habituated to the Multi-Latch Box. Occupying the nest next door, they had four chicks. When the chicks fledged in May, 2014, they also began visiting the station, which was then equipped with the Multi-Access box.

To identify individual ravens for behavior coding, each one was given a name that fit either its appearance or behavior. The adult male raven was easily identified both by his appearance and behavior. Smaller than the female, he had a limp, and a slightly overgrown bill. Extremely wary, he engaged in the jump back behavior more often than average, earning him the name Bounce.

The adult female raven approached new objects more quickly than did the male, and occasionally stole the food from the male, earning her the name Bully.

The four fledglings, while distinguishable in the nest, became indistinguishable after they fledged. Researchers could distinguish fledglings from adults due to the fledglings' pink lips and mouths, blue eyes, and food begging behavior. Therefore, if a fledgling solved a box, it was marked only as a fledgling instead of an individual for the results.

Six birds solved three of the problems presented by the Multi-Latch and Multi-Access boxes at this location. Though the histories of the adult birds are unknown, there were no reports of them interacting in any way with humans or human machines, making them the least enculturated of the birds in this study.

Figure 12. Raven family including four chicks and an adult.

Sedona. In October of 2013, the United States Forest Service Red Rock Ranger District reported having a problem with ravens dismantling employee and work automobiles. The birds were targeting the parking lot named The Warehouse Lot, and were removing weather stripping and windshield wiper blades, as well as smearing saliva on mirrors. The birds' tolerance to human machines and activities created an opportunity for this research. Therefore, the Tucson Raven Research Station moved to The Warehouse Parking Lot in December of 2013, and then moved back to Tucson in January of 2014. A second Raven Research Station was ready for use by May 2014, which allowed both Tucson

Figure 13. Sedona fledgling landing on the platform.

and Sedona stations to run simultaneously during that summer.

Initially, only the main camera system was in use, powered by a long extension cord stretched to a utility shed in the parking lot. Once nighttime visitors started raiding the station, a Moultrie trail camera recording to an SD card caught the raiders, a pair of raccoons and a fox. The Sedona station only used the Multi-Latch Box. The box held raven-appropriate food, including raw hamburger patties, hardboiled chicken eggs, and puppy kibble.

The subjects. All birds in this location were common ravens (*Corvus corax*).

During the winter of 2013, two adult ravens, a mated pair, and assumed automobile vandals, flew over the station, and landed near the station, but never landed on the platform. When the station was repositioned in May, 2014, one bird, assumed to be a female based size and behavior, landed on the station and ate from the box immediately. The second adult served as a lookout, but did not land on the station. On June 28, 2014, two fledglings joined the adults. Both fledglings landed on the platform, and started eating from and manipulating the box.

A scar on the forehead, where the bill meets the skull, permitted identification of the presumably female adult raven, called Scar.

The second adult bird would not touch the box, and only landed on the platform once, when both fledglings were on it eating. His behavior earned him the name Wimp.

Though they were indistinguishable by appearance, the behavior of the fledglings separated them. One fledgling was the first to land on the platform and to solve the Multi-

Latch Box, showed no fear behaviors, and would attempt to push the sibling off the platform. This earned it the name Feisty.

The second fledgling would kick at the first when being pushed from the platform, and occasionally sat on the camera itself, giving video recordings of toes. These habits earned it the name Feet.

Four birds were at this location. Though the histories of these birds is somewhat unknown, their inclination to interfere with human machines, and their relative lack of fear around humans makes them the second least enculturated birds of this study.

Figure 14. Scar, the adult female raven in Sedona.

Tucson – Arizona-Sonora Desert Museum (ASDM). The ASDM is a zoo, botanical garden, and natural history museum located south of the Saguaro National Park, West of Tucson. The Raptor Free Flight program is one of several live animal presentations available seasonally. Many species of birds fly in the twice-daily demonstrations; including two Chihuahuan ravens (*Corvus cryptoleucus*). The female is named Einstein, and the male is named Solo.

Each raven had its own 1.83 meter by 2.13 meter by 3.05 meter enclosure. Built of wire mesh, covered in shade cloth, the enclosures have a gravel floor, and a metal roof. The enclosures are next to each other, and there is an opening in the shade cloth on the ground near the front, allowing the birds to see each other. To keep the main camera system safe from beaks, it was located outside the enclosures. The Multi-Latch Box was placed at the front of each enclosure, just to the right of the doors, so it could be seen by the camera.

Blown from a nest as nestlings, these 11-year-old birds were raised by humans, and lived in outdoor enclosures where they interacted with, and were fed by humans daily. During Raptor Free Flight season, a volunteer released the birds from crates for a five to ten-minute flight around the audience. The ravens received enrichment in their enclosures every day, which consisted of children's toys, popsicles made of produce, and occasionally crickets hidden inside a PVC pipe tube with holes. In the past, they found food hidden inside of toys and bottles.

Figure 15. Past RFF trainer Larisa Thomas calling Solo the Raven to the glove during a demonstration.

The female raven, Einstein, also opened a metal lunchbox in front of theater audiences. Ordinarily, these birds do not have extended contact with humans, and do not live inside a human residence, making them the second most enculturated birds of the study.

Due to time constraints and the Raptor Free Flight demonstration schedule, the number and timing of trials was at the discretion of the Raptor Free Flight staff.

The Multi-Latch box contained a favored treat of the ravens, either quail eggs or half of a hardboiled egg, as an addition to the birds' daily diets. The ASDM ravens are on a tightly controlled diet during demonstration season, which is when the majority of trials were run. Food is the primary reinforcer used to control the ravens' behavior during demonstrations. If the birds are too heavy, they will take food from trainers and break away from the demonstrations to find a hiding place for the food. If the birds are too thin, not only is it not healthy for the birds, but they will tend to perch and not fly, in order to save energy. Consequently, the birds are weighed every day, once before demonstrations and once afterwards. They obtain food during the demonstrations, and if they did not receive enough they are given more in their enclosures. In the afternoons they are also given fruits, vegetables, and some form of enrichment, such as quail wings (not much food value, but apparently fun to destroy). In some cases, the box held the supplementary meat diet, and in some the fruits and vegetables.

Figure 16. Shade the Raven with a toy in the kitchen.

Tucson – Shade the Raven. The last subject tested during this study was a nine-year-old African white-necked (*Coruvs albicollis*) raven named Shade. Bought from a breeder who

also worked at a zoo, Shade spent time as a chick surrounded by children and other animals. Brought to Arizona in 2006 when she was six weeks old, Shade lived her life in human houses. Having her own bedroom, 3m x 3m x 3m tall at the highest point, and supervised playtime in the rest of the house daily, she learned to operate machines, including light switches, fan switches, the power and eject buttons on DVD players, and the power and eject buttons on several computers. Her numerous toys included cat toys, dog toys, and children's toys. Originally trained by EC for the possibility of being a search and rescue animal, she later was tested on her ability to learn English words, and use the knowledge to retrieve asked for objects from an adjacent room (Cory, 2012). She often visited large crowds of people during talks about ravens and raven research, posing for pictures with strangers. Her full integration into a human household and family made this bird the most highly enculturated animal of the study. She worked the Multi-Latch box.

Shade was on a free feeding schedule. She always had access to food. Some foods, such as cheese, have high value to the bird, but are not good for the bird. In the case of cheese, many corvids seem to have a fondness for it, but they lack the enzyme lactase, making them unable to properly digest any diary product. As this is a high value food that is rarely provided, a small amount (approximately 2g worth) was inside the puzzle box as both bait to open the box, and a reinforcer once the box was opened.

The Data

Successful trials are defined as trials where a bird is able to open the Multi-Latch Box, or solve one of the four sides of the Multi-Access Box. In the case of the Multi-Latch Box, there were occasions when the birds either had assistance opening the box, or

opened the box using an unexpected method. The number of those trials are marked in the Results section. Instances when raccoons opened the Multi-Latch Box were not marked as successful trials, though the birds did retrieve the food later.

Results

The Multi-Latch Box

In general, the UA campus ravens performed the poorest while working the Multi-Latch Box, while the ravens at the ASDM, specifically Einstein, had the best performance while working the same device. The UA ravens only solved the box once each, and only with assistance in the form of food tied to the latch. No other ravens required food to be tied to the latches. The Sedona ravens had variation in performance; one adult wouldn't approach the box, one adult approached the box quickly, and solved the box numerous times using different methods, and one fledgling, Feisty, solved the box while keeping the second fledgling, Feet, from attempts. The second fledgling did manipulate the latch, but only when permitted to touch the box by the first, which was always after the box had been solved and the food eaten.

From the ASDM, Solo the Raven started well, solving the box within 28 seconds of his first approach. The next trial had a sticky latch, which Solo could not open. The trial after that, Solo refused the box, and trials were ended. In contrast, Einstein solved the box every time she encountered it, except for one trial when the latch malfunctioned and was not openable. She was also able to solve all variations of the latch problem, reaching four latches. Shade the Raven showed strong neophobia, and spent six days around the latched box before making her approach. She solved the box on the first

approach, just before the end of the study. She refused to approach the box again after witnessing it open.

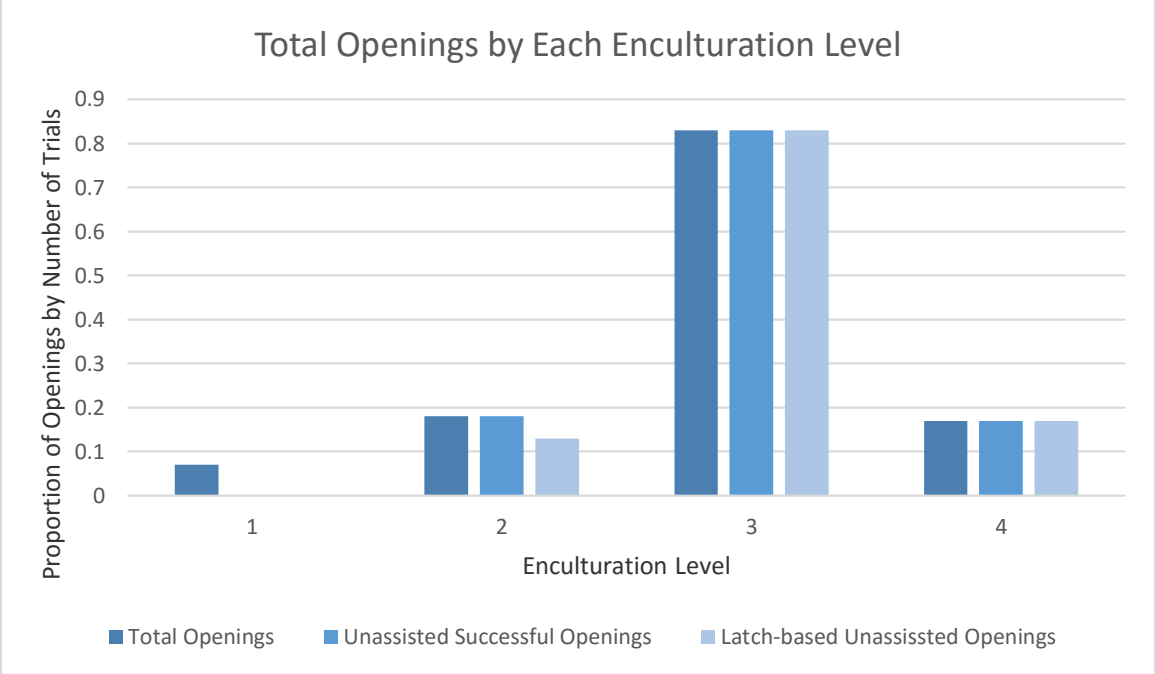
Table 1. The percentage of success by number of trials wild and captive birds had opening the box, by any method. Subjects who did not attempt to open the box are not included.

	Wild Birds	**Captive Birds**
Average Success Opening Box (%)	**7**	**48**

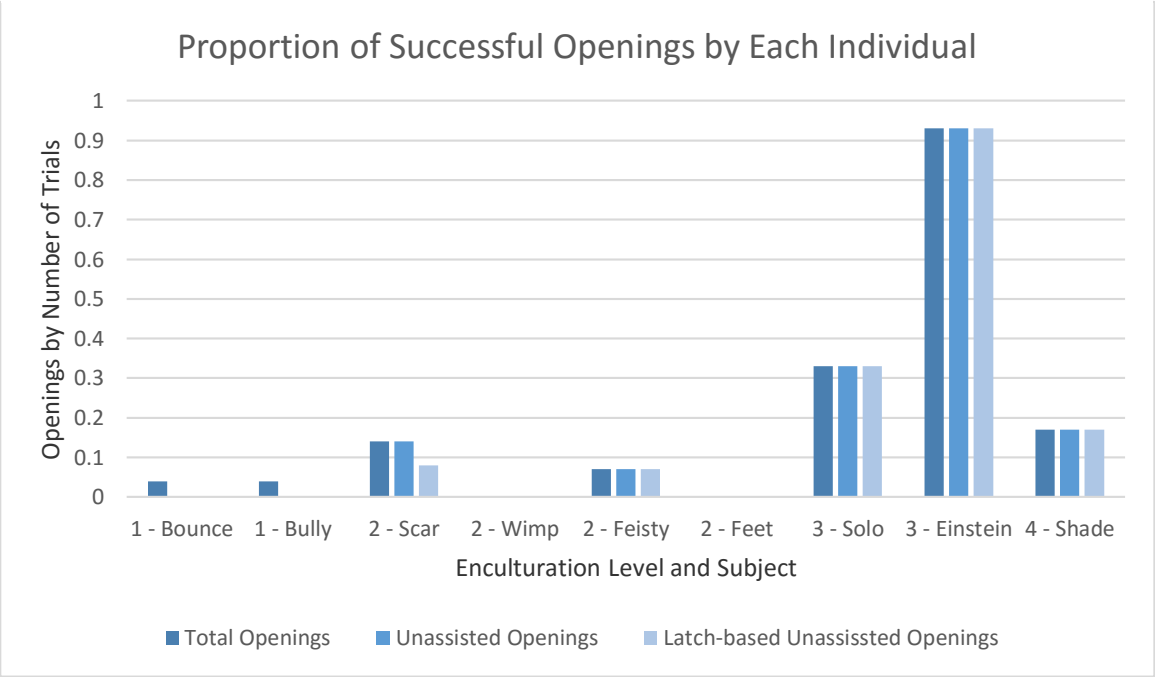
Table 2. Overview of Multi-Latch Box data. All trials resulting in a bird opening the box are classified as Successful Trials. Unassisted Successful Trials are successful openings without food tied to the latch. Trials where the birds opened the box by manipulating the latches are also recorded. The openings are the totals for each level. The individual score with the longest solve period is listed per level as Maximum Time Taken to Solve, while the individual score with the least amount of time taken for each group is listed for the Minimum Time Taken to Solve. Subjects who did not attempt to open the box are not included.

Enculturation Level	**Successful Trials**	**Unassisted Successful Trials**	**Successful Trials by Working Latches**	**Maximum Time Taken to Solve (Hours)**	**Minimum Time Taken to Solve (Minutes)**	**Maximum Number of Latches**
1 (2 subjects)	2	0	0	384	5,760	1
2 (2 subjects)	13	13	9	144	2	1
3 (2 subjects)	15	15	15	0.47	0.07	4
4 (1 subject)	1	1	1	96	5,760	1

Graph 1. The proportion of successful box solves by number of trials within each enculturation level. Methods of opening the box are as described in Table 1.



Graph 2. The proportion of successful box solves by number of trials by each individual. Methods of box openings are as described in Table 1.



University of Arizona Campus Ravens

Location, location, location. The original placement of the station on the roof of the Psychology Building resulted in no raven interactions with the puzzle box. After a year, the station was moved to its final location on the roof of the Physics and Atmospheric Sciences Building (PAS). The building next door, Gould-Simpson, was a raven nesting area, making the PAS Building a logical choice. Staff of the PAS building did not know that a new construction project was due to commence at roughly the same time as the move. Therefore, during the first six months, the researcher, the staff of PAS, and the construction crew had to negotiate placement of safety posts, ribbons, and the station itself while a new air handler system, railings, and stairway were installed next to the station. The ravens had to navigate around human construction workers, and for a short time, a crane. On one occasion, a construction worker swept up the food left for the ravens and threw it away. See Appendix A for a pictorial timeline of events.

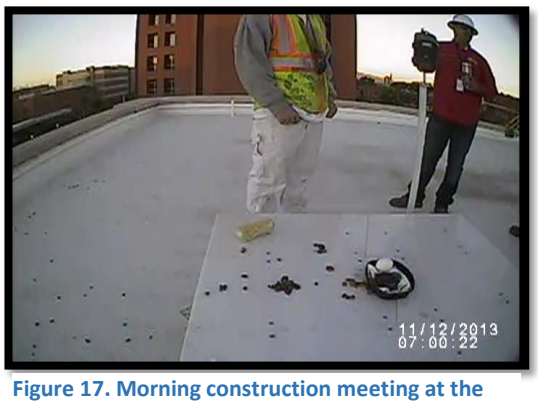


Figure 17. Morning construction meeting at the station.

A subject change. The original mated pair of ravens began flying over the station shortly after it was in place on PAS. On October 22, 2013, the ravens landed, and began eating the food on the roof. They never landed on the platform. This pair of ravens nested early, with three chicks in the nest by mid-December. Exact timing is not known, but an invading pair of ravens attacked the nest in late December 2013 or early January 2014. The invaders killed all chicks, and the original pair of ravens left the territory. The invading pair, named Bounce and Bully by the researcher, became two of the main U of A subjects. They had four chicks successfully fledge in May, 2014. The parent birds had access to the Multi-Latch Box, and the fledglings later worked the Multi-Access Box. The adults refused to approach the Multi-Access Box.

Figure 18. The original female raven sitting on eggs.

Opening the box. The invading pair of adult ravens on the University of Arizona campus had access to the box from February 21, 2014 through April 28, 2014. The box was sometimes left open, and was blown open by the wind twice. The lift support of the box was changed to a lighter, 10lb version early in the study to make the box easier to open. On March 29, 2014, a string was tied to the latch to make the box easier to open.

On April 3, 2014, food was tied to the string to increase the likelihood that the birds would accidentally open the box, thereby learning the correct response. The birds were initially able to retrieve the food without triggering the box opening, but Bounce triggered it on April 5. He immediately flew away from the roof, eating none of the food, and he did not return for three days. Bully triggered the box in the same manner on April 11. She also flew away without eating the food. Afterwards, neither bird made any further attempts to open the box. Those openings were recorded as the birds having assistance to open the box.

Figure 19. A raccoon leaving the station.

The USFS, Sedona, AZ, Ravens

Opening the box. The mated pair of ravens at the Sedona Red Rock Ranger District parking lot, of the United States Forest Service, refused to land on the station when it was running from December 14, 2013 to January 13, 2014. The station was back in operation on May 19, 2014, and the female, Scar, landed and ate food from the box the following day. The male, Wimp, did not touch the box, and only landed on the station once, when both fledglings were also present. Scar did not always solve the box in the expected way, one time using her beak as a crowbar to pry the lid open, and another by dropping a hard boiled chicken egg on the latch. One fledgling, Feisty, solved the box multiple times, and would not allow the second fledgling, Feet, access. Because the station was located in a parking lot, human activity around the station was high, but had little effect on the ravens' behaviors.

Burglars. On July 4, 2014, the first raccoon visited the station. While initially not problematic, by August a pair of raccoons was visiting the station almost every night, and opening the box. The ravens stopped solving the box, instead preferring to eat what the raccoons had left the next morning. A fox also visited the station, but did not disturb the box.

On licking mirrors. USFS staff reported that the ravens were licking side view mirrors on vehicles. This behavior left streaks of raven saliva on the mirrors. In an attempt to investigate this behavior, I placed a two-way mirror box around the main camera, thereby putting a mirror directly in front of the camera, but allowing all behaviors to be recorded. The ravens did not approach the station when this mirror box was present. Raven alarm calls from the land adjacent to the parking lot were heard when I approached the mirror box. It was removed after three days.

Testing tool use. Some of the puppy kibble was placed under the overhang of the puzzle box. The ravens were unable to reach the food closest to the base of the box as the space between the overhang and the platform was too small for raven heads. A stick was placed on the platform which could have been used to move the food. Scar touched the stick only to throw it off the platform. No tool use was observed.

The Raptor Free Flight Ravens

Solo the Raven. Solo solved the box with a single latch 28 minutes after it was first placed in his enclosure. 13 days later the box was put back in his enclosure, but with two latches, one blocking the other, securing the lid. He successfully undid the first latch, but was unable to undo the second. A staff member later discovered that the latch was

stuck, making it impossible for the bird to open. The following day the box was put back into Solo's enclosure, with two working latches. Solo made no attempts to solve the box, instead perching above it and defecating. Trials ended.

Einstein the Raven. Einstein was the best Multi-Latch Box performer of all subjects. Out of 15 trials, she failed to open the box only once as the result of a stuck latch. Her time taken to solve the box ranged from 27 minutes on her first trial, to four seconds on her 14th trial. On the last trial, she solved the box with four latches. One latch did nothing, two latches secured the lid, and the last latch blocked those. She did manipulate all of the latches, including the nonfunctional one.

Shade the Raven

The trails for Shade the Raven were run near the end of the study, limiting the time she had access to the box. In addition, she showed high levels of neophobia, initially refusing to land on the floor if the puzzle box was present. Habituation time was consequently higher than expected for her, with her eating from the already open box only after 10 days. Once the box was latched, another six days elapsed before Shade made an approach. She solved the box on her first approach. After the box opened, she jumped back, left the camera's field of view, and did not make another approach to the box. The food inside went uneaten, and no more trials could be completed.

Figure 20. Shade opening the box.

University of Arizona Campus Fledglings and the Multi-Access Box

The offspring of Bounce and Bully only encountered the Multi-Access Box. They were jumping from the nest on May, 12, 13, and 14. Because there was no way to distinguish between them after they had left the nest, their data were recorded as "fledglings." Two of them landed on the roof on May 16. Neophobia was low, and they opened the door on the box two days later. The food was not retrieved. The following day one of the fledglings pulled the string, which slid food out at its feet. It was startled, fell off the platform, and left the area. None of the birds touched the food. The string was pulled two more times during the study, but the string had not been reset in both instances, so no food was distributed. The door was also opened one more time, but no birds would retrieve the food from inside the box. The birds briefly played with the river stones for the chute. One river stone was carried away and never found. None of the birds used the stones in the chute. None of the birds touched the stick which was also left on the platform. No tool use was observed.

Figure 21. One of the fledglings shortly after jumping from the nest.

Data Profiles

The proportion of agreement between two observers using Noldus Observer was an average of .36. The Cohen's kappa values given by the program averaged out to .152 for all observations. The program provided good visuals of the behaviors witnessed

during this study as data profiles. For full numerical data on the behaviors seen, please see Appendix C.

The behaviors with the highest rates of occurrence are “Present” and “Looking At Box.” The behavior “Present” was coded whenever a raven was in the cameras’ field of view on the ground, platform, box, or perch. A bird was not considered present if it was in the air. As the cameras were motion activated, a bird was present in all videos coded. In some instances, the ravens had a lookout; an adult raven perched nearby that was not involved in the puzzle box, but remained present throughout the data profiles. The lookout did not overtly look at the box. All birds who solved or attempted to solve the box first engaged in the behavior “Looking At Box,” some longer than others. Many of these subjects also engaged in the behavior “Walking Around Platform” while looking at the box from different perspectives. As food was placed around the boxes and inside the boxes, “Eating” was another behavior often coded.

A data profile for every successful box solver is listed below. None of the six UA campus ravens ate the food made accessible by the box solve, instead leaving the platform immediately. The Sedona adult female continued the trend by opening the box, and flying away. However, she returned a short time later for the food. One of her offspring, Feisty, showed less fear than the other wild birds. Feisty jumped back after successfully opening the box, but returned for the food within the video segment. Of the Raptor Free Flight ravens, Solo showed neophobia with reluctance to approach the box, and multiple jump back behaviors. He also jumped back after the box opened, and took over 12 seconds to approach the box. He did not eat the food in the profile shown. In contrast, Einstein, the champion of solving the box, showed less fear. Shade the Raven

decided to approach the box, attempted to solve it, and succeeded within about three seconds. When the box opened she jumped back, left the box, and did not eat the food.

The profiles below also allow for comparison of Einstein's performance in trials over time. As she participated in more trials, she displayed fewer fear behaviors, eventually with no jump backs. Her performance did not steadily improve. One trial took her a little over a minute to solve, the next (with the same single latch setup) eight minutes, then four trials later 20 minutes. She then solves the box with three latches in 11 seconds. Her number of attempts was likewise variable.

The last data profile shows both of the Sedona fledglings in the same area. Feisty did not permit Feet near the box however, and solved the box on her/his own. Feisty was startled by the opening of the box and left, while Feet remained present without approaching the box.

Each subject's successful box solve.

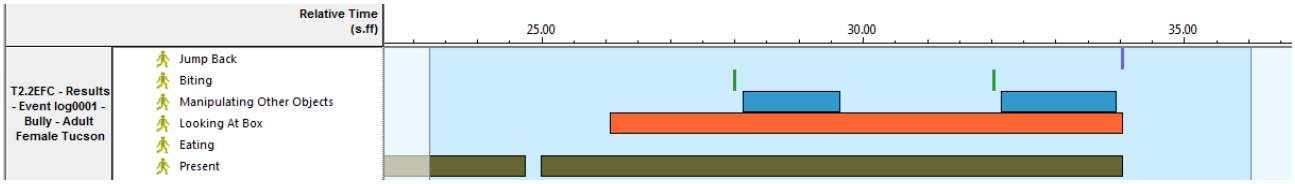


Figure 22. Multi-Latch Box opening by Bully on April 5, 2014, on the University of Arizona campus. The bird briefly leaves the platform, but returns immediately. She spends most of the video segment looking at the box, biting the box, and manipulating the food tied to the box, before successfully triggering the opening of the box. Startled, she leaves the area without obtaining food. This is the only time she opened the box.

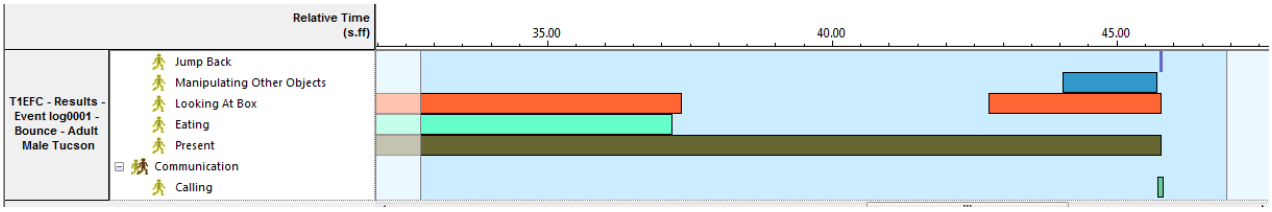


Figure 23. -Multi-Latch Box opening by Bounce on April 11, 2014, on the University of Arizona campus. The bird is present through the entire video segment, except the very end. He spends his time eating while watching the box. At the 44s mark he begins to manipulate the food tied to the box, before successfully triggering the opening. Startled, he simultaneously leaps back, calls, and leaves the area. Though no audio was recorded, it is assumed he emitted an alarm call at the opening of the box. This is the only time he opened the box.

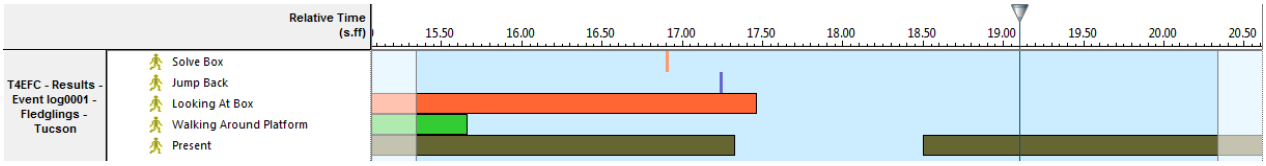


Figure 24. Multi-Access Box opening by a fledgling on May 19, 2014, on the University of Arizona campus. The young bird spends the first section of video walking around the platform and looking at the box (after making a crash landing onto the box and platform, not shown in the data profile). The fledgling solves the box by pulling the string at the 16.90s mark. The reaction occurs .4 of a second later, when the food slides out of the box. The bird is startled, jumps back, falls to the roof, never retrieves the food, and ceases showing interest in the box.

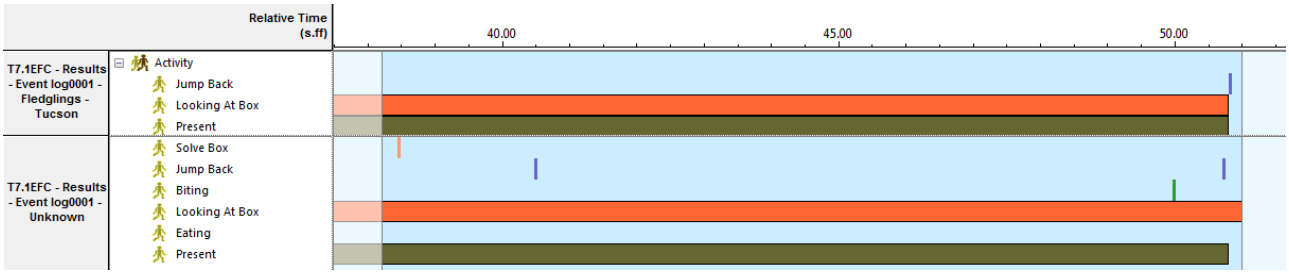


Figure 25. Multi-Latch Box opening by fledgling on May 20, 2014, on the University of Arizona campus. Two young birds are present during this behavior profile. One remains on the platform watching the box and/or the other bird for the duration of the segment, until a final jump back response by both birds near the end. The box-solving bird is on top of the box while reaching down to open the door at the 37.5s mark. There is no immediate reaction. That bird does a jump back two seconds later, but does not leave the box. The bird bites the box 9.5s later. ~.75s after that, both birds jump back and leave the platform. The food is never retrieved from the box.

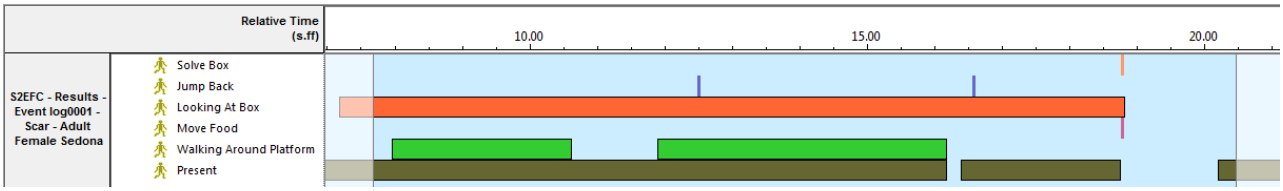


Figure 26. Multi-Latch Box opening by Scar on June 2, 2014, in Sedona USFS Red Rock Ranger District parking lot. Scar spends a large amount of her time walking around the platform, looking at the box, and occasionally jumping back. She grabs food that is next to the latch, triggering the opening of the box. She flies the food to the ground to eat. She later returned for the rest of the food in the box (not shown here).

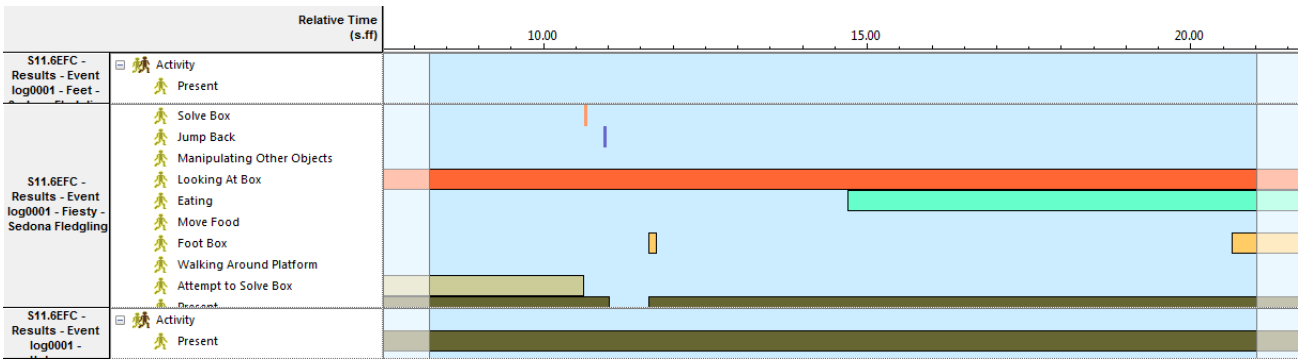


Figure 27. Multi-Latch Box opening by Feisty on July 12, 2014, at the Sedona USFS Red Rock Ranger District parking lot. An adult bird serves as the lookout for the duration of this segment, and can be seen in the background. The fledgling Feet makes a brief attempt to be on the platform, but is removed by Feisty (not shown here). Feisty spends time attempting to solve the box before being successful at the ~10.5s mark. The bird jumps back, lands on the platform next to the box, briefly foots at the box, and stares for approximately 3.5s before eating from the box. Approximately 5.5s later, Feisty puts a foot on the box for easier access to the food, showing little fear.

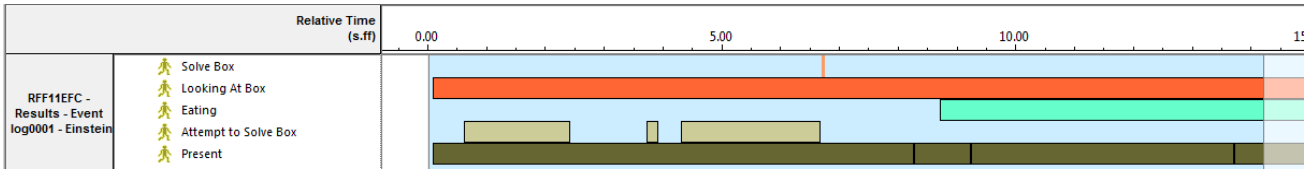


Figure 28. Multi-Latch Box (3 latches) opening for Einstein on November 22, 2015, at the Arizona-Sonora Desert Museum. Einstein is present on the ground of her enclosure interacting with the box for the duration of this segment. In this profile, the box is equipped with three latches: Latch One holds the lid closed, Latch Two blocks Latch One and must be moved first, and Latch Three does nothing. Einstein successfully moves Latch Two aside, unblocking Latch One. She then briefly touches Latch Three with her beak, but does not move the latch. She then unlatches Latch One, successfully opening the box. She looks at the box for approximately two seconds before eating the contents. No fear is shown.

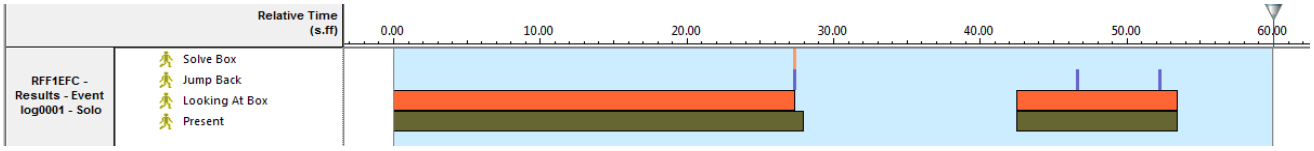


Figure 29. Multi-Latch Box opening for Solo on September 22, 2015, at the Arizona-Sonora Desert Museum. Solo is present and looking at the box for most of this segment. He solves the box just after the 27s mark, jumps back, and leaves camera's field of view. He returns to the ground and looking at the box approximately 14s later. He spends approximately 11 seconds looking at the box, and jumping back twice, before leaving the camera's field of view. Though not shown in this data profile, he did eventually retrieve the food from the box.

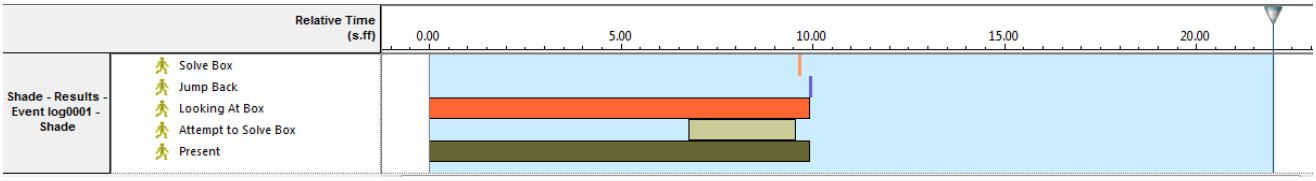


Figure 30. Multi-Latch Box opening by Shade on March 10, 2016, in Tucson, AZ. Shade spends the first portion of the segment on the floor looking at the box. She makes her first and only attempt to open the box at approximately the 5.5s mark. After ~3s of attempting to open the box, she is successful. She jumps back from the box upon its opening, and leaves the camera's field of view. She refused to approach the box again, and did not retrieve the food.

Einstein comparison over time.

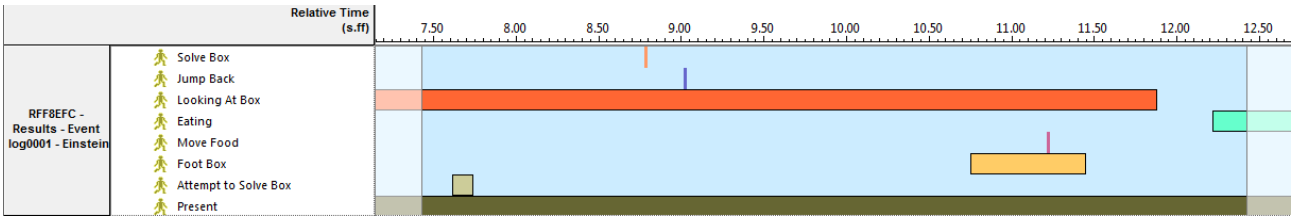


Figure 31. Einstein opening the Multi-Latch Box (3 latches) on November 2, 2015. This is the first 3-latch trial with Einstein. Einstein spends most of the segment looking at the box, with only a brief attempt to solve. After solving, she jumps back, continues looking at the box, foots the box, moves food, and then begins to eat approximately three and a half seconds later.

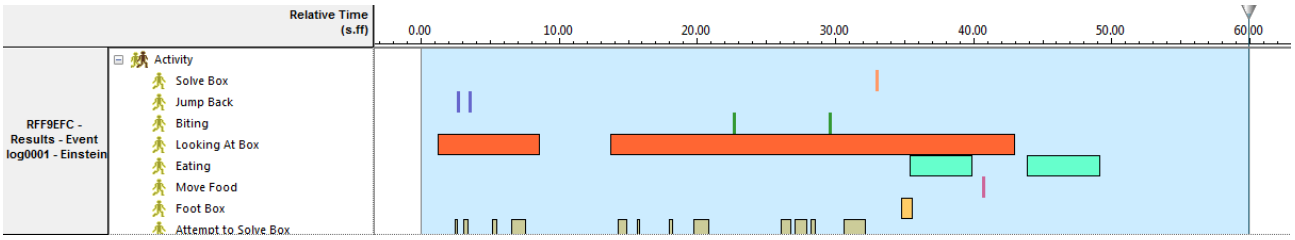


Figure 32. Einstein opening the Multi-Latch Box (3 latches) on November 7, 2015. The second trial with three latches, Einstein appears to be wary. Most of the time is spent looking at the box, with two jump backs early in the segment. Einstein engages in 12 attempts to open the box, all under three seconds in duration. There is no jump back after solving as seen previously. Instead, Einstein foots the box and begins to eat two seconds after the solve. She moves some food away from the box to continue feeding.

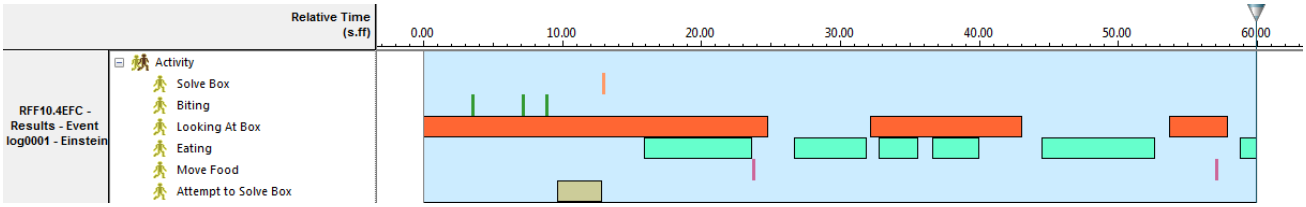


Figure 33. Einstein opening the Multi-Latch Box (2 latches) on November 17, 2015. This is the fourth trail with two latches Einstein had experienced. There are no jump backs, though she does engage in biting the box three times before attempting to solve. The attempt shown ends in a successful solve. She begins eating approximately three seconds after the solve. After initially eating from the box, Einstein begins moving food away from the box to eat.

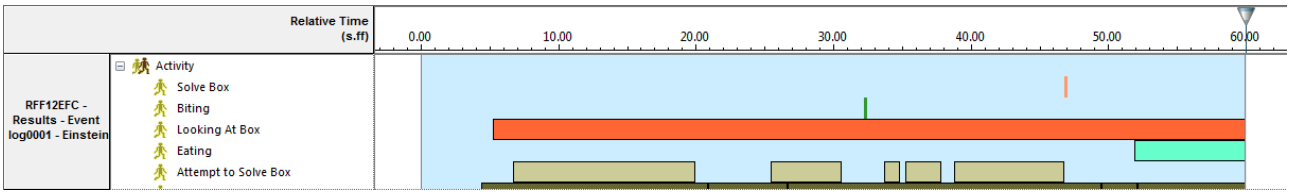


Figure 34. Einstein opening the Multi-Latch Box (4 latches) on February 17, 2016. The last trial performed with Einstein, this is also the first with four latches. There are no jump backs. After two attempts, she bites at the box before continuing with attempts. After five attempts in this segment, she successfully opens the box, and begins eating approximately four seconds later. No food is moved.

Working the box before solving.

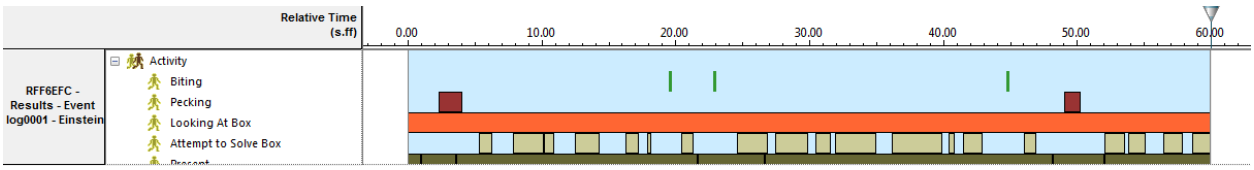


Figure 35. Einstein opening the Multi-Latch Box on September 15, 2015. This is the seventh time Einstein had encountered the box, all with the single latch setup. It took 20 minutes for Einstein to solve the box this day, and is second in duration only to the first trial. The bird spends the entire clip watching the box, pecking and biting the box, and attempting to solve the box.

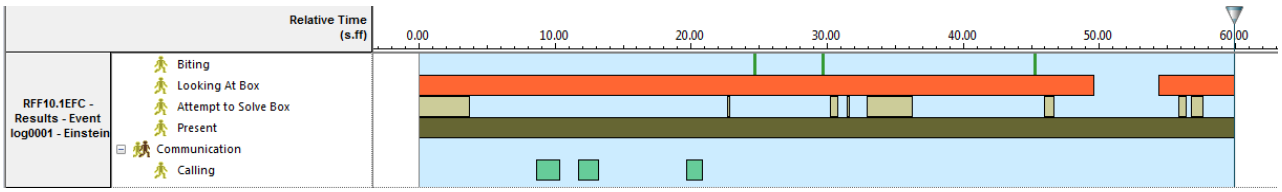


Figure 36. Einstein opening the Multi-Latch Box on November 17, 2015. This is a video segment which precedes the one shown in Figure 16. Much time is spent looking at the box. Many attempts are made to solve the box, with brief breaks to bite the box, and to call.

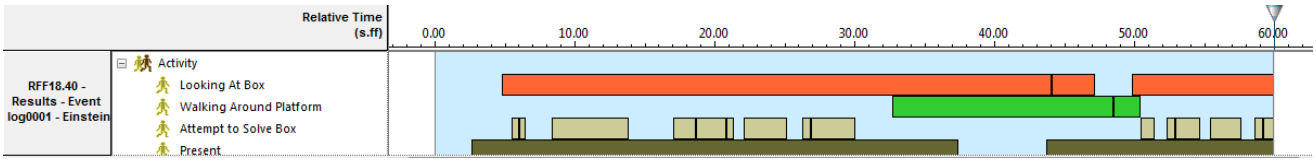


Figure 37. Einstein opening the Multi-Latch Box on February 17, 2016. This segment precedes the one shown in Figure 33. The bird spends a great deal of time attempting to solve the box, and looking at the box. There are no jump backs. There was not a platform for Raptor Free Flight bird trials. The observer coded the bird walking on the ground around the box as "Walking Around the Platform."

Sedona fledglings together.

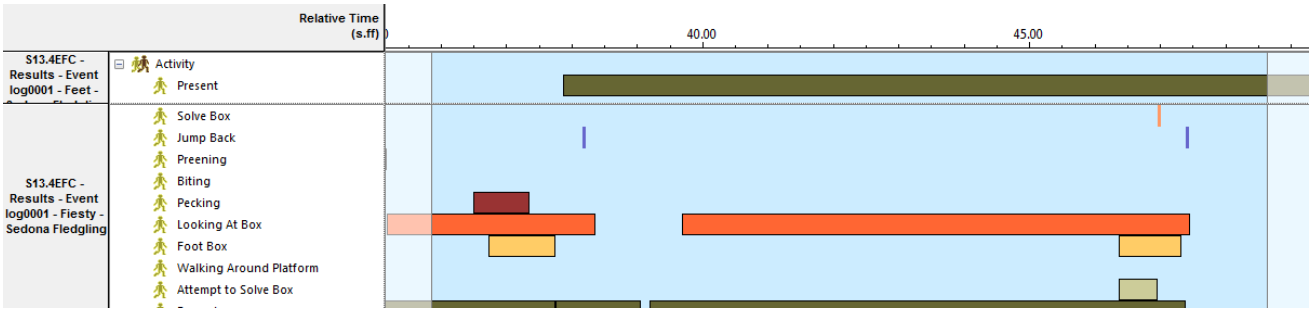


Figure 38. Feisty solving the Multi-Latch Box on July 15, 2014. While the fledgling Feet was present, Feisty would not permit it near the box. Feisty spends most of this segment looking at the box. It pecks at the box, foots the box, and then jumps back, and leaves briefly. Feisty spends another six seconds looking at the box, before putting a foot back on it to attempt to solve. That solve ends successfully, and the bird jumps back. Feisty did later return to eat the food from the box.

Discussion

The results provide an overview of raven behaviors in captivity and in the wild. Wild, free roaming common ravens did choose to visit the research stations and participate in trials. None of the ravens tested showed any inclination for sustained tool use, instead preferring direct methods to retrieve food. Neophobia was a running theme throughout the research. Although food was to be the primary motivator for birds to approach and solve boxes, on occasion other motivators were present. High value foods, such as hamburger meat and hardboiled eggs were provided, but puppy kibble was what ultimately attracted raven attention. While the relationship between enculturation level and success at solving problems was not linear, there is little doubt that enculturation, captivity, and history of training and enrichment activities all contribute to the success of an animal in solving an artificial problem. The UA campus ravens had likely never encountered anything resembling food inside a steel and Plexiglas box, and were both confounded and frightened by the box. ASDM RFF ravens, with strong enrichment histories of getting food out of Lego boxes, lunchboxes, pipes, and bottles, had little trouble with the unnatural puzzle box.

Despite the differences in brain structure and evolutionary history, ravens appear to have intelligence and learning styles similar to those displayed by intelligent mammals. The evolution of enhanced intelligence is certainly not exclusive to primates. Ravens approached the puzzle boxes, recognized the problems, and, with the exception of highly neophobic individuals, attempted to solve the problems using trial and error learning. Once a solution was found, they did not immediately change their responses, even when the box and/or solutions had changed, falling back on trial and error. Though

not officially part of the study, pigeons and doves did not seem to notice the puzzle boxes, even when sitting on top of them, much less make any attempt to solve the problems. A fox that got onto the platform smelled the food in the puzzle box, but made no attempt to solve it. Conversely, both the raccoons and ravens took immediate notice of the box, the problems, and commenced attempting to solve the box, with approximate equal success. Though the raccoons' solves were not recorded on video, the still images and state of the platform (complete with muddy footprints showing the movements of the animals) showed the same trial and error learning the ravens utilized. It would be interesting to see how other intelligent animals, such as various primates, and for more variety, octopi, would approach the same puzzles.

Comparing Previously Studied Species

The original Multi-Access Box used by Auersperg et al. (2011) showed New Caledonian crows to favor the stick solution, while kea parrots favored the chute solution. Two of the birds (one from each species) were able to master all four solutions. In contrast, the common ravens of this study most often used the door solution, and successfully used the string only once. None of the birds attempted the stick or chute solutions. During this study, all solutions were accessible at all times. I hypothesize that if the door and string solutions were blocked, the ravens would not solve the box.

The original Multi-Latch Box used by Miyata et al. (2011) showed some kea parrots to be skilled at opening the box with up to three locks, with locks in different positions. The birds were captive kea parrots, and were trained on how to remove a bar from a lid to open a box before trials began. The parrots showed only trial-and-error

learning, occasionally having side-preference for the latches, and engaging in exploratory behavior. Little planning behavior was witnessed.

In comparison, no pre-trial training was performed with the ravens of the current study. Instead, only a habituation process was used. The wild ravens from the U of A campus were unable to open a single latch box without assistance. The wild ravens from Sedona were able to open a single latch box on their own, but allowed raccoons to solve the two latch problem for them. Shade the Raven showed high neophobia, and only opened the box once, with a single latch, before refusing further trials. The Chihuahuan ravens of the ASDM were highly successful opening the box, especially the female named Einstein. She was capable of opening the box with up to four latches, in several different configurations, in a short amount of time.

Like the kea parrots, all ravens showed inefficient behaviors, exhibiting only trial-and-error learning and exploratory behavior. Unlike the parrots, the ravens did not show any side preference when solving the latches. The Sedona fledgling Feisty did seem to learn how to solve the box from watching Scar, however when the solution changed, he still attempted his old method of solving the box before attempting new methods.

Figure 39. A fledgling making a crash landing across the box, and ultimately onto the platform, where it solved the string solution.

Multi-Access Box

The box, like the other, was slowly introduced to the ravens. While it was on the

roof in view of the platform, the adult ravens continued visiting. As this box moved closer to the platform, the ravens paid little attention, and continued their normal activities around the box. Once the box appeared on the platform however, the adult ravens ceased landing on the platform, and made no attempt to solve the new box.

Shortly afterwards, the adult birds brought their young to the roof. The fledgling birds showed little initial fear of the box, landing on it, around it, and playing, despite the parent birds' refusal to approach. The parents served as lookouts, but made no effort to stop the young from their activities around and with the box. Conversely, when the young had just jumped from the nest and were on the ground beneath the building, the adults showed agitation when a youngster approached a human, or vice versa. Both parents perched close to the ground, screamed alarm calls, and flew from perch to perch above the young until the offending human left the immediate area. Despite their fear of the new box, the adults showed no agitation when the young were around it, hinting that the trademark raven fear behaviors observed are not simplistic, but multi-layered, with a different response for each new stimulus. As ravens experience different threats during their lives, especially when interacting with humans and human-modified environments, this response would allow the successful adaption

Figure 40. A fledgling looking down into the box.

witnessed in ravens. This should be studied further, as the neophobic response of ravens can be put to use in dissuading them from interfering with human activities.

When solving the box, the young birds showed no interest in the stick solution, or in the chute solution, with no inclination for tool use. The most popular solution was opening the door. This made food available, but none of the successful box solvers took the food, instead preferring to rip the Velcro fastener off the door of the box. The string solution was used once successfully, but resulted in a startle response. The young birds then started showing more fear behaviors around the box, landing on it less frequently as time progressed.

During one trial, a pigeon was walking around the platform, and happened to peck the string, which released the food. The pigeon showed no reaction to the food sliding out at its feet, seemingly not noticing, though a few seconds later did start eating the food. The string solution was an easy solution for trial-and-error solving, even when the animal in question was not attempting to solve the box. That pigeon became an almost daily visitor to the station, but never solved the box, or made any attempt to solve the box, again.

Multi-Latch Box

Being the first box used, and the box used with the most subjects, this portion of the study produced most of the data. Responses to the box varied greatly, as did solutions. Some level of neophobia was observed in all subjects. Captive ravens had more success at solving the box than did wild ravens in general, but differences among individuals were apparent.

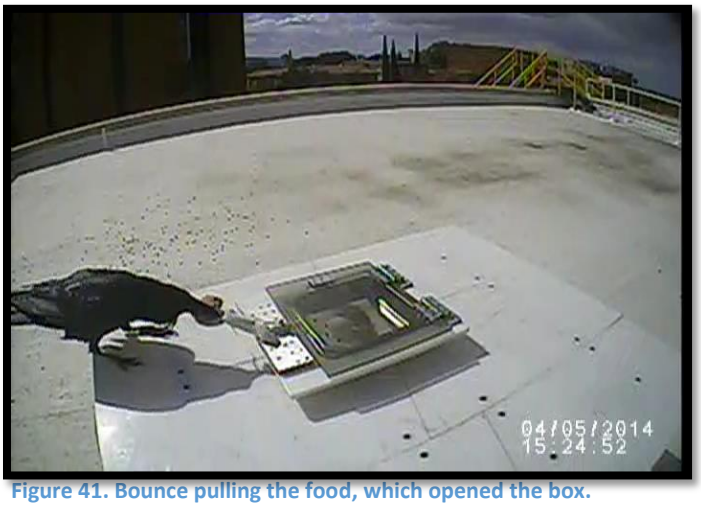


Figure 41. Bounce pulling the food, which opened the box.

The university campus ravens. The UA campus ravens were the first to see the box, and while they ate from it with little signs of stress, they were unable to solve the puzzle with a single latch. Neophobia did not seem to be an obstacle at that point. Both birds attempted to grab the food through the Plexiglas lid, and both birds pecked at the box, but never the latch. A lighter lift support, the latch lubricated with Vaseline, and a string tied to the latch made the box as easy to open as possible. The latch was made progressively shorter, putting the box on a hair trigger, so to speak. The wind blew the box open twice, but the ravens still were not successful. One

of the ravens was present when the wind blew the box open. A startle response was observed, and the birds did not return for several days.

I tied food to the string of the latch with the thought that I could trick the birds into opening the box, thereby showing them the solution. At that point, Bully was sitting on six eggs in the nest, so Bounce was the most frequent visitor to the station. I was able

Figure 42. Bounce and Bully's nest with the first three eggs present.

to watch the station from the Gould-Simpson building next door. Bounce arrived at the platform, tried to approach the food several times, each time jumping back and landing on the roof. He flew away from the roof and disappeared around Gould-Simpson. Approximately a minute later he reappeared, with Bully following. She landed on the platform with no sign of fear, and was able to take the food out of the string without triggering the box. She flew the food back to the nest to eat, and did not share.

For the next day's trial, the food was securely attached to the string. Bounce, perhaps unwilling to lose his food payout again, pulled the food forcibly enough to open the box. He startled back and away, and did not return to the roof for three days. Once the box was reset, Bully also pulled the food forcibly enough to open the box. She behaved much like Bounce, jumped back and away, and did not revisit the roof again for days. Not only did the birds not learn how to open the box from the trick, but they became much warier. Both spent less time on the platform, and neither would touch the latch or food tied to the latch. Trickery is not a successful method for teaching ravens.

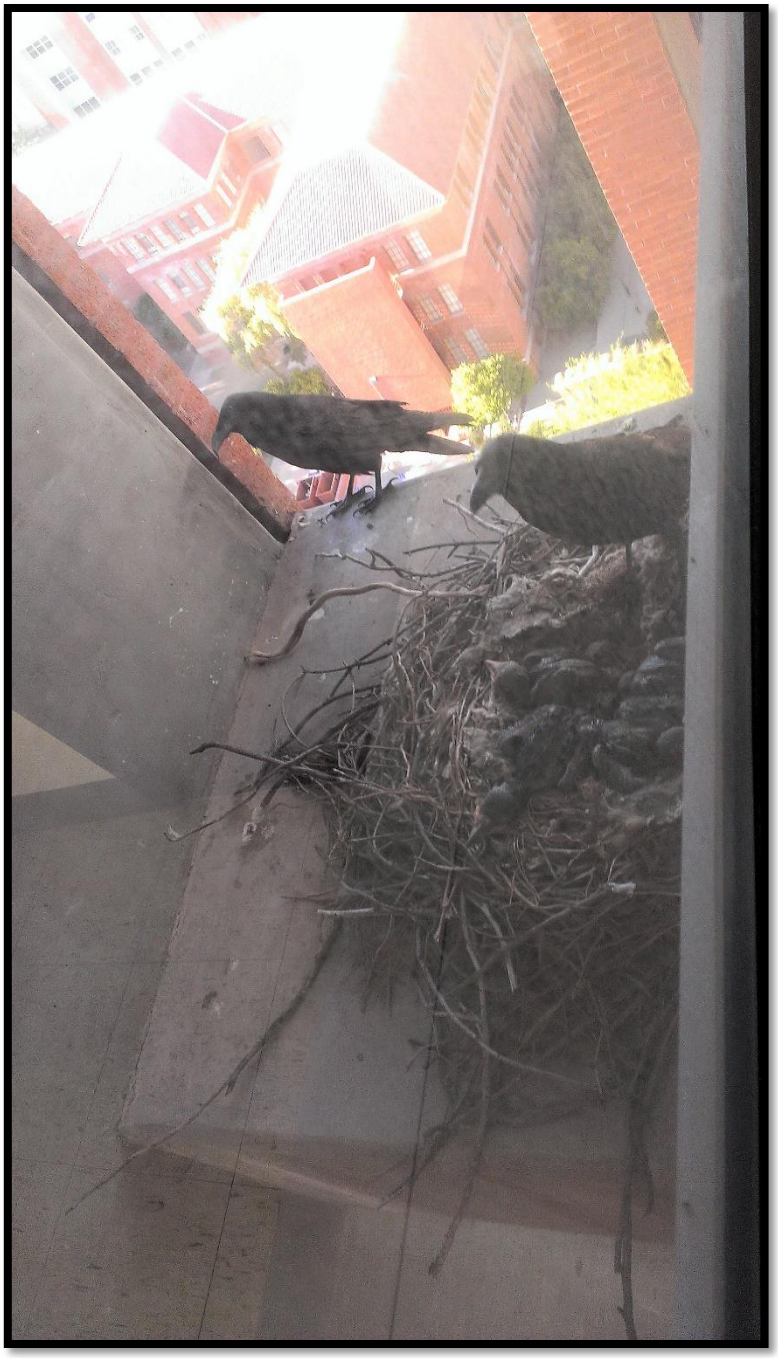


Figure 43. Bounce and Bully at the nest, with four chicks.

At the start of the research the UA adult ravens were fearful of humans. The ravens flew an approximate minimum of 30 m above the roof when researchers appeared. As the research continued, and construction work on the roof continued, the ravens began flying closer to the human-occupied roof. Video then showed the ravens remaining on the roof while construction workers walked by approximately six meters away on the other side of a railing. The ravens then began perching on the roof while researchers reset the box and left more food. I was the researcher most often observed by the ravens. On two different occasions while walking on campus in different locations I witnessed the birds fly high overhead, then turn back to fly low over me while cawing. The caws were not alarm calls, and it appeared as though the birds recognized me. I suspect human facial recognition is in the common raven skills toolbox, though more study is required.

The Sedona ravens. The Sedona ravens in general had much more luck with the box than the university campus ravens. During the winter the birds flew over the box, and landed near the platform, but appeared too neophobic to land on the station itself. Perhaps due to the need to feed fledglings, once the box was set up for summer Scar landed on the platform immediately. She ate and cached food from around the box, but did not immediately find the solution. Instead, she bit the box, pecked at the lid, tried to grab food through the lid, tried to dig the food out from the bottom, and wedged her beak between the lid and the box in an attempt to crowbar the box open. She eventually pulled the string and opened the box. She startled away from the platform, but returned within a minute to retrieve the food.

Scar was also able to open the box in unexpected ways. The first unexpected solution occurred when food was placed next to the latch. Scar grabbed the food, and accidentally hit the latch as well, opening the box. She jumped back to the ground without her food. The second unexpected solution was the same, except with a hardboiled egg next to the latch. She grabbed the egg, dropped it on the way up, and it hit the latch opening the box. Scar jumped away. One unexpected solution happened after Scar bounced off the platform, jarring the lid open. The remaining unexpected solve both occurred when Scar was able to pry the lid open from the sides, after many attempts which knocked the latch loose. Because some of these solutions appeared unintentional, data in the results section is also presented with these trials excluded.

Figure 44. Scar opening the box for the first time.

Wimp, Scar's mate, never approached the box. Neophobia appeared to be the problem, as he would attempt to land on the platform, only to veer away at the last second. He also spent time perched on overlooks looking down at the box. It is unknown

if Scar shared any of the food with Wimp. Wimp finally landed on the platform near the end of that portion of the study, but only because both fledglings were on the platform attempting to solve the box. Wimp perched on the corner of the platform farthest from the box and made no attempt to move closer.

Figure 45. Scar after bouncing the box open.

The first fledgling to land on the box was also somewhat of a bully. He probably observed Scar opening the box at some point. He showed little signs of neophobia, and landed on the box straightaway. His solution was not as instantaneous. Instead, he continued attempts to grab the food through the Plexiglas lid. When that did not work, he pecked viciously at the top and sides of the box. He did finally pull the string to open the box. He did not startle away from the box when it opened, and went directly

Figure 46. Feisty solving the box without using the string.

for the food. The next trial saw him skipping the string, and pecking the latch open directly.

Feisty appeared to have learned the latch well once he was manipulating the latch directly. However, his learning was not complete. A raccoon visited the station one night, and though it did not open the box, it did spin the box around, so the latch had to be pulled in a new direction for the solution. Feisty landed on the platform the next morning and went directly for the string, but tried to pull it in the original direction, instead of modifying behavior with the change in the box. When the box would not open, Feisty reverted to attempting to grab food through the lid, and pecking at and biting the box. He did eventually grab the string and pull in the correct direction, but all behaviors appeared to be trial-and-error learning. No insight was shown by any of the wild ravens solving the box.

The second fledgling, Feet, appeared more timid and neophobic than did Feisty. When Feet did attempt to approach the unsolved box, Feisty kicked it off. Feet would throw up its feet in defense, but did not win any encounter. After Feisty had solved the box and eaten the food Feet was allowed to remain on the platform. Though the box was open and the food was gone, Feet went for the string and pulled. Feet had learned the solution by watching, but had not learned the logic behind the solution,

Figure 47. A camera inspection by Feisty.

Figure 48. Scar landed on the platform before I left the area. (Picture taken with cellphone camera.)

seemingly expecting food to reappear once the string was pulled.

These birds, like the UA campus ravens, seemed to recognize me. They would not flee when I approached the station, instead perching on the ground and truck bumpers within approximately ten meters of me. On two occasions, the birds apparently recognized the car I was driving, and followed it in from the main road, down the long driveway, and into the warehouse parking lot where they waited for food. It would be interesting to study this ability in future research. When I placed a mirror box around the camera system in order to capture video of the mirror licking behavior, all ravens avoided the parking lot entirely. However, they were not unobservant of activities. When I approached the mirror box to change food, memory cards, and after three days to remove the mirror, I heard at least two ravens alarm calling from the woods adjacent to the parking lot. As no ravens were near the mirror or within the parking lot, and the calls occurred only when I approached the platform, the ravens may have been attempting to warn me away from the mirror. Or perhaps, the alarm calls were for me, as they watched me place the mirror on the station in the first place. They did not alarm call at me before the mirror was placed, or after it had been removed. After I removed the mirror, the birds reappeared at the station within an hour of my leaving. Ravens are known for their ability

to work with other species, humans included, calling out to lead hunters to prey. They also note when dominance reversals occur in unseen neighboring ravens by listening to calls. It is not outside the realm of possibility that they would also be calling out warnings to food providers. This would make interesting research in the future.

The birds also watched me placing balloons and pinwheels on Forest Service vehicles. The highly neophobic nature of the ravens precluded them from landing on a vehicle with such items present, making it a successful deterrent. Despite my placing scary items on favored perches, I still did not receive alarm calls until the mirror incident. Pinwheels made the most successful deterrent, as long as the humans remembered to put the pinwheels back in place after driving.

Figure 49. Einstein working the box immediately upon release into her enclosure. The door to her enclosure has not yet been closed.

The Raptor Free Flight ravens. Both birds were successful with the Multi-Latch Box. While they were each presented the box in their individual enclosures and so had separate experience with the box, unlike the wild participants, there is a window between the two enclosures allowing each raven the ability to look in on the other. Einstein was the first to work the box, but Solo was able to watch her. Solo did well solving the box the first time he saw it, solving it in 28s. Neophobia was present in his jump back

behaviors, and his slow approach to retrieve the food after opening the box. He had the fastest first trial solve time.

Einstein was the best performer of all subjects, solving the box the fastest, the most often, and with the highest number of latches. The only time she did not solve the box was when the latch was stuck, making the box impossible for her to open. Unlike her brother, she still participated in trials after encountering the impossible latch.

Given the history of Solo and Einstein, Einstein's easy success with the box is not surprising. Though they are brother and sister, and have been raised in the same environment, they exhibit personality differences. Solo is a troublemaker, and is more neophobic. He is also the more aggressive of the two. He is good at figuring out mechanical problems, and once locked me out of his enclosure. I only was able to gain entry when I asked him to unlock his enclosure while pointing at the latch, and he obeyed.

Figure 50. Einstein working the box with four latches.

Based on Solo's ability with mechanical problems, one may hypothesize that he would be the best puzzle box solver. Due to his high levels of neophobia, that is not the case. Both birds have been presented with boxes in the past, and while Einstein eventually approaches boxes and solves them, Solo usually refuses to go near them.

Consequently, while staff attempted to teach both birds how to open a metal lunchbox for shows, Einstein was the only one who learned. While this confounding variable made Einstein's high performance when opening a box less surprising, it highlights the importance of factoring training and enrichment histories into captive animal studies and experiments.

Shade the Raven. Shade was the last raven tested with the Multi-Latch Box. This limited her time with the box; all of her trials had to be completed within two and a half weeks. I did not expect that this would be a problem, as Shade was expected to be the highest performer with the box. She had seen the box previously in different parts of the house when it was getting moved from one location to another, and had approached the box when it was not in her room and not set. While this may initially seem to be a confound, all birds in this study had access to an opened, not baited box before initial trials began. Shade has the most experience working human-created contraptions, learning how to operate light switches and eject DVD's to name a couple of learned by observation skills. However, Solo and Einstein both outperformed her.

Figure 51. Shade's flight away from the opening puzzle box.

Neophobia seemed to be Shade's biggest limitation. Though she had approached the box before when it was in different areas of the house, once it was in her room she refused to approach it, and indeed refused to land on her floor initially. Habituation took longer than expected. Once she was eating out of the open box, it was latched and put in the middle of the floor. Once it was latched, neophobia reappeared, almost as though it became a different box once closed. She eventually did open it, but jumped away and refused to touch it again. At that point the study had to end, and trials were stopped.

Why Shade experienced more neophobia than Solo or Einstein is unknown. Perhaps the food was a higher quality reinforcer for Solo and Einstein, both of whom have a controlled feeding schedule. Or perhaps Solo and Einstein's performance was a byproduct of ravens looking for something to do. Shade has had over 1,000 toys of all types, with at least 20 of them in her room at any given time. In addition, she often had access to the entire house, including the room where toys are stored, giving her the ability to sort through her own toys, and select some to take back to her room. Solo and Einstein on the other hand, spend most of their time in their enclosures, and have approximately five toys in each enclosure at any given time. The pool of toys for them is much smaller (at about 30 toys), giving them less of a variety of toys. These factors probably made working on a puzzle more reinforcing for the RFF ravens than it did for Shade. This could also partly explain the difference seen among captive and wild birds solving the boxes. The wild birds have the entire world to explore, if they so choose, giving an unlimited number of options of activities.

Noldus Observer results. The proportion of agreement between observers averaged out to .36, with an average Cohen's kappa of .152. Several problems interfered

with observer agreement. The first problem occurred with the observation labels. Each observation file could be no longer than 60s in length, thereby separating longer videos into many observations. One observer labelled these in .1 increments to indicate the order of the observations (example, 10.1, 10.2, 10.3). The other observer labelled with a variable size of increments (example, 10.5, 10.75, 11.25, 11.65). In addition, the second observer skipped numbers while labelling (example, a RFF observation exists for video 18.65, when there are only 12 videos). These labelling discrepancies made lining up the observations for the computer to compare virtually impossible.

Due to technical difficulties with the Observer program, time available to code videos was significantly less than what was initially planned. Unsuccessful trials could not be coded, due to the time limitations and the sheer number of video files (5,876 at last count). All of the successful trials had to be coded, but within time limitations, causing both observers to rush through videos, and take few breaks. The 60s maximum observation time was intended to give observers a break during long videos, in an attempt to minimize observer errors. Observers were also to take breaks between videos. Due to the rush, many breaks were eliminated, and the 60s observation time cutoff became nothing more than aggravation, and a point of confusion when labelling. Both observers made mistakes while coding.

The last contributor to disagreement was within the ethogram. While I tried to cover all important raven behaviors in detail, it was impossible to keep the ethogram to a manageable size while completely covering all behaviors seen in the four different environments tested. Consequently, observers had to interpret the ethogram for each location themselves, and these interpretations did not always agree. For example, the

puzzle box was on the ground for the RFF raven trials, with no platform. One observer coded the bird walking around the box as “Walking Around Platform,” while the other did not code the walking behavior at all.

A more comprehensive ethogram, unsuccessful trials coded, stricter labelling rules, and enough time to take breaks between observations without rush would contribute more reliable information.

Reinforcement

The presence of food certainly attracted raven attention, and brought the birds to the box. Based on the behaviors seen, food was not necessarily what kept the birds’ attention, and was not always the reason for solving the box.

While solving the Multi-Access Box, the fledglings never touched the food made accessible by their solutions, and in one case ran, or rather flew, away from the food. After opening the door of the box, attempting to tear the Velcro off the door became the favored activity.

When raw meat was inside the Multi-Latch Box outdoors, a paper towel was placed under the meat in order to make cleanup easier later. When a bird solved the box, occasionally food would be left, but the paper towel rarely survived the encounter intact. When the box was left open for the UA campus ravens, Bounce and Bully pulled the paper towel out from under the food, and ripped the towel to shreds. Only once when the paper towel was in enough small pieces did the birds turn to the food. Though covered in meat sauce and bits of meat, none of the paper towels were ever eaten. Most scraps were left to blow around the roof, although some were later spotted as nest lining.

Behavior of the Sedona ravens was similar, though they tended to go after the food first, and the paper towel second. These ravens were brought to my attention after they had been caught destroying wiper blades and weather stripping on Forest Service automobiles. Despite the presence of the station and a jackpot of food, reports of ravens interfering with automobiles continued, though they lessened. It seems as though the raven proclivity to search and destroy was the highest reinforcer for the wild birds.

Figure 52. Bounce and Bully at their nest. Shredded paper towel from the station is visible lining the nest.

The ASDM ravens are food motivated, and when the birds did open the box, they ate all food made available. However, some food was already available. When releasing the ravens into their enclosures, a 1g piece of meat is left on the main perch in order to encourage the birds to go directly into their enclosures from their crates. The majority of the time Einstein, while knowing that free piece of food was available, ignored it to go directly to the box, even when the box contained a less favored food.

Conversely, Shade the Raven opened the box, startled away from the box, and never retrieved her high value cheese reinforcement. After two days, suspecting the cheese may no longer be good, I threw the cheese away in the kitchen garbage can. Shade

promptly dove into the garbage can headfirst to retrieve the cheese. The cheese was indeed high value, but not high enough to combat the fear experienced by the bird upon the opening of the box.

For the Future

While research with captive birds provides exciting data, similar research needs to also be performed with their wild brethren. Performing studies with completely wild and free animals is possible, if time consuming and occasionally stressful. In the future, more studies could be performed with wild ravens, but with more controls, such as restricted station access and known subject histories, than were possible here. Histories of the birds, both wild and captive, make a difference in the performance of ravens, and are valuable to know.

The territorial nature of mated pairs of ravens usually allows for more complete knowledge of the histories of resident wild ravens for specific locations. Usually, a mated pair will spend at least ten years in a nesting territory, protecting it from other ravens. Bird watchers and backyard bird feeders often provide valuable information on individual differences among ravens. I have had many people approach me during talks and lectures with long, detailed histories and informal behavior profiles, complete with pictures, of the raven families living in their neighborhoods. Bird watchers are constantly posting pictures and information of ravens in favored bird watching locations, such as wetlands and preserves. In March, naturalists were excitedly posting information about the first nesting pair of ravens to be seen in Washington D.C. in the last 100 years. With a love of ravens, and corvids in general, spreading across the globe, there is not a lack of corvid

information. All of this information can be put to use, enabling studies to be run on already well known birds.

On occasion, ravens make themselves known even to even the bird-blind, tricking both humans and their companion dogs, breaking into tents and backpacks, vandalizing automobiles, and raiding dumpsters. These annoyances could be put to use, not only better controlling their negative impact on humans, but also providing valuable data. During the course of this study I was notified of a pair of common ravens working together within the city of Tucson to raid a company's dumpster. One bird held the lid open while the other bird entered, then dragged the goods outside, at which point they would share out the food and hide the best bits. I was preparing to get permission to study those birds, and get them added to permits. Before all permissions could be obtained, they left for the summer. I have not heard if they have returned, but it is likely. Similar observations of raven dumpster behaviors have been reported in the Grand Canyon, Flagstaff, and uptown Sedona, all rich areas for future raven subjects.

Having more control over the raven stations would be preferable when running future studies with wild birds. A large obstacle encountered with this study was the stations sharing the area with humans, even when the platforms were located in secure areas. The original raven station located on the roof of the Psychology Building was interfered with by a pair of vandals who climbed up the outside of the building, opened the outdoor DVR (the primary camera's digital video recorder) exposing it to the elements, and then entered the building itself to throw printers down stairwells and burn bulletin boards, just to name a couple of activities. Thankfully, no damage was done to the station, and an alarm set on the rooftop door due to the presence of the raven station

assisted in ending the human-caused vandalism in the building. When the station moved to the Physics and Atmospheric Sciences Building, construction workers became the main subjects of videos coming from the station. The construction supervisor attempted to have the station removed completely, citing OSHA concerns. Compromises were made, and the station was moved one foot farther from the edge of the roof. Unintended species, including humans, visiting the station was a problem. A better study would be performed in a more controlled environment, without unpermitted human access. Perhaps a residential backyard would be more secure than what was used here. Unauthorized local wildlife would need to be factored into future studies, as it is difficult to avoid. The platforms used for this study kept small rodents away from the puzzle boxes, but was ineffective at dissuading larger animals.

Neophobia was also a large obstacle to this work, as well as most work with wild corvids. To attempt to work around this, future studies should be long in duration, with long habituation times planned. Some individuals will not need the extra time, in which case more data can be collected. Most individuals will need the extra time. The remaining individuals may never approach the box. Study of those particular individuals could provide meaningful data as well.

The neophobia seen in ravens is probably evolutionary adaption to their scavenger natures. I have recently witnessed training sessions with a black vulture named Elvira at the Arizona-Sonora Desert Museum. That bird shares the same neophobia seen in ravens, avoiding anything new, including small toys, and jumping back mid-approach. It would be especially interesting to expand future corvid studies to include vultures, in order to gain more information about neophobia when approaching novel problems.

The perfect raven study would have many stations running simultaneously to gather as much data on as many subjects as possible. The small N of this study put limitations on what could be concluded by the data collected. This would create an enormous study, both time consuming and with many workers dedicated to caring for stations and sorting videos, but the end results would make the cost well worth the investment.

Some experiments need to be performed indoors with captive birds in order to achieve the level of control needed. In these cases, the training and enrichment histories of all subjects, avian and otherwise, are critical variables to consider when viewing the results. It is no accident that the best performer of this study, Einstein, is also the most well versed and practiced at opening boxes in general.

Intelligence Profile

Which bird species is the most intelligent? That is an often asked question during bird presentations, especially those featuring parrots or corvids. It is also, quite possibly, unanswerable. Each species has its own evolved capabilities and limitations, some of which are not completely understandable in human terms. For example, current data suggests that birds can see ultraviolet and infrared light, and possibly magnetic fields. As a human, it is difficult to imagine how these animals actually see the world and read the information they gather. Consequently, behaviors that make little sense, or perhaps seem stupid, to humans, are in fact the animals responding to their habitats in perfectly appropriate ways.

Some behaviors remain constant throughout the corvid species. Neophobia is a common theme, and obstacle for corvid researchers. Though this is a limitation in terms of gathering research, it is evidently a trait necessary for survival of corvids. Related to that, corvid species in general appear to be watchful, wary, fast, and, to some extent, easy to distract. Evidently, escaping predation has been shaping the behaviors of these birds for a very long time.

In general, corvids are a caching family, hiding food away for future use, and remembering where it has been hidden. This has contributed to strong locational memory skills among the corvids.

Tool use seems to be the domain of the New Caledonian crows. Living in thick vegetated areas, shaping sticks into hooks to pull insects out of holes is an advantageous behavior. Tool use was not seen in any of the species of ravens during this study. Being scavengers, more used to stealing fish from eagles, garbage from bins, and road kill from vultures, ravens have little use for tools.

The wild common ravens, encountering a Plexiglas covered box for the first time, all initially attempted to grab the food through the Plexiglas. Scar, used to dealing with vehicle windows, immediately attempted to remove the lid. The knowledge that food cannot be grabbed through a see-through lid had to be learned. As Plexiglas is not found in natural environments, it is logical that the animals would have no concept of how to handle the novel situation. It is unknown if other species of corvids have to learn the same lesson. To my knowledge, all past puzzle box studies with corvids have only used captive, and to some extent trained, birds.

Once the ravens had learned a method for opening the Multi-Latch Box, they stuck with that method, even when the solution changed. Only once the old method failed did the birds start attempting new methods. This trial-and-error learning seems to be similar across species, and families. Kea parrots solved the original latch box presented by Miyata, Gajdon, Huber, & Fujita (2011), and they used the same trial-and-error learning, though they gained information from watching the box being solved. This is an efficient way of approaching problems. It would be inefficient to think about a solution to an already solved problem on each encounter. Instead, it is faster to attempt what has worked in the past, and only modify behavior if that changes. Habits can be efficient and useful, though they may appear to be unintelligent behavior when the situation changes.

Disregard for food reinforcements was an interesting factor in this study. Food certainly attracted the birds to the stations. On many occasions, the food made available by the solving of a puzzle box went uneaten. Neophobia was to blame in many instances. This behavior would be similar for all corvids. However, in some cases, the birds had more interest in other things. It has been hypothesized that ravens and crows, with their relatively large brains, have become so good at finding and caching food, that food collection is no longer the priority behavior seen in the wild. Consequently, ravens and crows around the world are spotted, and videotaped, simply playing. Crows use jar lids to slide down snowy rooftops, ravens slide down snowy hills on their backs, crows and ravens tease other animals as though testing their mettle, and crows and ravens occasionally destroy human contraptions. This seemingly curiosity-driven, exploratory, and occasionally destructive behavior is also seen in kea parrots, a species notorious for stripping cars of all rubber parts, including the ones holding windows, headlights, and

taillights in place. Interestingly, this same type of destructive behavior has also been filmed in the social Galapagos hawk.

Highly intelligent social behavior is a hallmark of corvids, especially crows and ravens, worldwide. In this study Feisty the Fledgling seemed to have little trouble on his first box solve, most likely from watching Scar solve the box. Other studies have shown the ability of corvids in general to learn from others. Thankfully, the fear parent birds displayed towards boxes did not pass to the fledglings. Being able to learn from others is vitally important in all habitats, especially more challenging ones, and corvids have mastered the skill.

Conclusion

This study provides a view of what could, in the future, be studied in more controlled situations. Though there was not a linear correlation between enculturation level and success solving the boxes, there was a trend. The lowest enculturation level ravens did perform the worst, but they were able to perform. It is possible to run experiments with completely free and wild birds. Trial-and-error was the learning style employed by all birds, and some puzzle solutions, such as the string solution, were happenstance during normal foraging/exploring behavior. The best performers were captive ravens. The most successful box solving raven was Einstein, who also had the most experience with opening boxes in general, as she opened a lunch box several times a week in front of an audience for years. Given this data, I propose that enculturation level, and the training and enrichment histories of captive animals, should all be factored into future animal behavior and intelligence studies. Interactions between humans and ravens result in the birds' learning, whether intentional or not. This idea is especially important

for humans to consider who do not desire wild raven interference with human machines and locations. It is also a key concept when dissuading ravens from certain behaviors and/or areas. The birds are always learning.

APPENDIX A – TIMELINE OF UA RAVEN APPROACH

A timeline of the Tucson station in still shots taken from the research videos.

Figure 53: Camera footage from the roof of the Psychology Building. The station was in position here with no raven activity seen from October 2012 to April 2013.

Figure 54: The station in its new home on the roof of the Physics and Atmospheric Sciences Building.

Figure 55: The first raven seen, flying past the station without landing.

Figure 56: The first raven to land on the roof.

Figure 57: Construction workers put up a fence around part of the roof. Each stake has a long ribbon attached to the top, a sure way to keep ravens away. After negotiations, the ribbons were removed.

Figure 58: Construction workers take over the roof.

Figure 59: The ravens, with an early nest on the building pictured, begin flying around the construction to land on the roof and eat.

Figure 60: An invading pair of ravens killed the chicks in the early nest. Ravens were not seen again until February. One of the invading pair landed on the station.

Figure 61: The first puzzle box, covered in food, attracts the birds.

Figure 62: The mated pair of ravens.

Figure 63: The birds eat comfortably from the box.

Figure 64: The box is latched for the first time. Neither bird solves the problem.

Figure 65: A string is added to the latch in the hopes of making it easier to solve. The birds take no notice.

Figure 66: A piece of food is tied to the latch, in order to trick the ravens into pulling it, and opening the box. The raven does open the box, then flies away in fear without obtaining the food. He refused to approach the box again for four days.

Figure 67: The slow introduction of the new box, the Multi-access box, has started.

Figure 68: The new box is placed on the station. Both birds refuse the station.

Figure 69: The adult ravens never approached the new box. Their four fledglings flew to it immediately.

Figure 70: The fledglings solve the door problem on Side 1.

Figure 71: A fledgling solves the string problem, on Side 3.

Figure 72: The last time the full raven family is seen on campus. They migrated away on this day.

Figure 73: The mated pair returns to Tucson.

Figure 74: They return sporadically to the roof.

APPENDIX B – RAW DATA FROM BOX SOLVES

Date	# Raven Vids	Type Box	Box Closed?	Solved?	Notes
Tucson - UA					
9/16/2013	1	Habituation			
6-Oct	2	H			
7-Oct	1	H			
8-Oct	3	H			
12-Oct	3	H			
17-Oct	2	H			
19-Oct	1	H			
22-Oct	3	H			
31-Oct	1	H			
1-Nov	1	H			
2-Nov	1	H			
3-Nov	5	H			
8-Nov	1	H			
23-Nov	4	H			
24-Nov	1	H			
25-Nov	2	H			
26-Nov	5	H			
27-Nov	4	H			
28-Nov	2	H			
29-Nov	13	H			
30-Nov	5	H			
1-Dec	5	H			Construction
2-Dec	6	H			
3-Dec	9	H			
4-Dec	1	H			
5-Dec	8	H			
6-Dec	14	H			Human Activity
7-Dec	18	H			
8-Dec	2	H			
9-Dec	7	H			
10-Dec	1	H			
2/9/2014	1	H			
15-Feb	29	H			
16-Feb	6	H			
17-Feb	9	H			
18-Feb	19	H			
19-Feb	37	H			

20-Feb	54	H			
21-Feb	23	Latchbox	Yes	No	Food on top
22-Feb	22	Latchbox	Yes	No	
23-Feb	18	Latchbox	Yes	No	
24-Feb	27	Latchbox	Yes/No	No	Wind blew box open
25-Feb	22	Latchbox	N	N	
26-Feb	47	Latchbox	N	N	
27-Feb	60	Latchbox	N	N	
28-Feb	19	Latchbox	N	N	
1-Mar	46	Latchbox	N	N	
2-Mar	10	Latchbox	N	N	
3-Mar	30	Latchbox	N	N	
4-Mar	15	Latchbox	N	N	
5-Mar	27	Latchbox	N	N	
6-Mar	17	Latchbox	Y	N	
7-Mar	8	Latchbox	Y	N	
8-Mar	22	Latchbox	Y	N	
9-Mar	21	Latchbox	Y	N	
10-Mar	26	Latchbox	N	N	
12-Mar	37	Latchbox	N	N	
13-Mar	20	Latchbox	N	N	
14-Mar	15	Latchbox	N	N	
15-Mar	11	Latchbox	N	N	
16-Mar	31	Latchbox	N	N	
17-Mar	42	Latchbox	N	N	
18-Mar	29	Latchbox	N	N	
19-Mar	46	Latchbox	N	N	HA
20-Mar	20	Latchbox	N	N	
21-Mar	33	Latchbox	N	N	
22-Mar	34	Latchbox	N	N	
23-Mar	28	Latchbox	N	N	
24-Mar	23	Latchbox	N	N	
25-Mar	20	Latchbox	Y	N	
26-Mar	20	Latchbox	Y	N	
27-Mar	24	Latchbox	Y	N	
28-Mar	30	Latchbox	Y	N	
29-Mar	21	Latchbox	Y	N	String Added
30-Mar	23	Latchbox	N	N	
31-Mar	37	Latchbox	Y	N	
1-Apr	33	Latchbox	Y	N	

2-Apr	20	Latchbox	Y/N	N	Wind blew box open
3-Apr	22	Latchbox	Y	N	Meatball Tied to String
4-Apr	36	Latchbox	y	N	Mouse Tied to String
5-Apr	8	Latchbox	Y	Y	M
6-Apr	16	Latchbox	N	N	
7-Apr	17	Latchbox	N	N	
8-Apr	14	Latchbox	Y	N	
9-Apr	24	Latchbox	Y	N	
10-Apr	18	Latchbox	Y	N	
11-Apr	10	Latchbox	Y	Y	M
12-Apr	6	Latchbox	N	N	Other box on roof
13-Apr	18	Latchbox	N	N	
14-Apr	22	Latchbox	N	N	
15-Apr	21	Latchbox	N	N	
16-Apr	12	Latchbox	N	N	
17-Apr	17	Latchbox	N	N	
18-Apr	16	Latchbox	N	N	
19-Apr	3	Latchbox	N	N	
20-Apr	13	Latchbox	N	N	
21-Apr	15	Latchbox	N	N	
22-Apr	17	Latchbox	Y	N	
23-Apr	11	Latchbox	Y	N	
24-Apr	12	Latchbox	Y	N	
25-Apr	7	Latchbox	Y	N	
26-Apr	19	Latchbox	Y	N	
27-Apr	13	Latchbox	Y	N	
28-Apr	23	Latchbox	Y	N	
29-Apr	29	Multi-Access	N	N	
30-Apr	11	Multi-Access	N	N	
1-May	15	Multi-Access	N	N	
2-May	15	Multi-Access	N	N	
3-May	15	Multi-Access	N	N	
4-May	13	Multi-Access	N	N	

5-May	18	Multi-Access	N	N	
6-May	18	Multi-Access	N	N	
7-May	23	Multi-Access	N	N	
8-May	21	Multi-Access	N	N	
9-May	22	Multi-Access	N	N	
10-May	30	Multi-Access	N	N	
11-May	20	Multi-Access	N	N	
12-May	22	Multi-Access	Y	N	
13-May	28	Multi-Access	Y	N	
14-May	19	Multi-Access	Y	N	
15-May	3	Multi-Access	Y	N	
16-May	24	Multi-Access	Y	N	Fledglings appear
17-May	9	Multi-Access	y	N	
19-May	40	Multi-Access	Y	Y	Door
20-May	59	Multi-Access	Y	Y	String
21-May	71	Multi-Access	Y	Y	Door
22-May	74	Multi-Access	Y	N	Wind blew box open
23-May	48	Multi-Access	Y/N	N	String not set
24-May	121	Multi-Access	N	N	
25-May	56	Multi-Access	N	Y	String pulled but not set
26-May	20	Multi-Access	N	N	
27-May	5	Multi-Access	Y	N	
28-May	25	Multi-Access	Y	N	

29-May	56	Multi-Access	y	N	
30-May	24	Multi-Access	Y	N	
31-May	15	Multi-Access	Y	N	
2-Jun	14	Multi-Access	Y	N	
3-Jun	7	Multi-Access	Y	N	
5-Jun	37	Multi-Access	Y	N	
6-Jun	56	Multi-Access	Y	N	
7-Jun	35	Multi-Access	Y	N	
8-Jun	45	Multi-Access	Y	N	
9-Jun	31	Multi-Access	Y	N	
10-Jun	14	Multi-Access	Y	?	
11-Jun	24	Multi-Access	N	N	
12-Jun	36	Multi-Access	Y	N	
13-Jun	8	Multi-Access	Y	N	
14-Jun	4	Multi-Access	Y	N	
19-Jun	23	Multi-Access	N	Y	String not set
20-Jun	86	Multi-Access	N	N	
21-Jun	7	Multi-Access	N	N	
22-Jun	3	Multi-Access	N	N	
23-Jun	3	Multi-Access	Y	N	
24-Jun	5	Multi-Access	Y	N	
25-Jun	2	Multi-Access	Y	N	
20-Nov	1	Latchbox	Y	N	
5-Dec	5	Coop	Y	N	
10-Dec	6	Coop	Y	N	

Sedona					
12/14/2013	3	Habituation			
15-Dec	5	H			
16-Dec	1	H			
22-Dec	0	H			
23-Dec	0	H			
25-Dec	0	H			
26-Dec	0	H			
1/4/2014	1	H			
5-Jan	0	H			
6-Jan	1	H			
7-Jan	0	H			
8-Jan	0	H			
9-Jan	0	H			
10-Jan	0	H			
13-Jan	0	H			
5/19/2014	4	Latch	No		
20-May	41	L	No		
22-May	9	L	Yes	No	
23-May	22	L	Yes	No	
24-May	7	L	Yes	No	
26-May	23	L	Yes	No	
27-May	11	L	Yes	No	
28-May	21	L	Yes/No	No	
29-May	8	L	Yes	No	
30-May	16	L	No	No	Human Activity
31-May	2	L	No	No	HA
1-Jun	3	L	No	No	
2-Jun	17	L	Yes	Yes	
3-Jun	19	L	Yes	Yes	Jumped on box to open it
4-Jun	26	L	Yes	No	
5-Jun	15	L	Yes	No	
6-Jun	19	L	Yes	No	
7-Jun	6	L	Yes	No	
8-Jun	4	L	Yes	No	
9-Jun	30	L	Yes	Yes	Threw egg at latch to open
10-Jun	20	L	Yes	No	

11-Jun	25	L	Yes	No	
12-Jun	27	L	Yes	No	
13-Jun	29	L	Yes	No	Wind blew box open
14-Jun	15	L	No	No	
15-Jun	9	L	No	No	
16-Jun	39	L	Yes	No	
17-Jun	33	L	Yes	No	
18-Jun	24	L	Yes	No	
19-Jun	17	L	Yes	No	Wind blew box open
20-Jun	33	L	Yes	No	
21-Jun	8	L	Yes	No	HA, Wind blew box open
22-Jun	7	L	No	No	
23-Jun	26	L	Yes	No	
24-Jun	18	L	Yes	No	
25-Jun	17	L	Yes	No	
26-Jun	38	L	Yes	No	Wind blew box open
27-Jun	33	L	Yes	No	
28-Jun	17	L	Yes	No	
29-Jun	40	L	Yes	Yes	
30-Jun	21	L	Yes	No	
1-Jul	44	L	Yes	Yes	Solved 2x in one day
2-Jul	22	L	Yes	Yes	Pecked open
3-Jul	37	L	Yes	Yes	Bounced on box until it opened
4-Jul	0	L	Yes	No	1st Raccoon Visit
5-Jul	44	L	Yes	No	
6-Jul	16	L	Yes	No	
7-Jul	38	L	Yes	Yes	
8-Jul	7	L	Yes	No	Added mirror box around camera
9-Jul	62	L	Yes	No	Mirror box around camera

10-Jul	44	L	Yes	Yes	Mirror removed - too scary
11-Jul	26	L	Yes	No	
12-Jul	51	L	Yes	Yes	
13-Jul	33	L	No	No	Raccoon
14-Jul	22	L	Yes	Yes	
15-Jul	61	L	Yes	Yes	
16-Jul	19	L	Yes	No	
17-Jul	3	L	Yes	No	
18-Jul	7	L	Yes	No	
19-Jul	8	L	Yes	No	
22-Jul	10	L	Yes	No	
24-Jul	3	L	Yes	No	
25-Jul	1	L	Yes	No	
26-Jul	1	L	Yes	No	Raccoon
27-Jul	14	L	No	No	
28-Jul	20	L	Yes	No	Raccoon
29-Jul	28	L	Yes	No	
30-Jul	5	L	Yes	No	
31-Jul	5	L	Yes	No	
1-Aug	2	L	No	No	
2-Aug	3	L	Yes	No	
3-Aug	2	L	No	No	
4-Aug	2	L	Yes	No	Raccoon
5-Aug	6	L	Yes	No	
6-Aug	4	L	Yes	No	Raccoons
7-Aug	5	L	Yes	No	Raccoon
8-Aug	8	L	Yes	No	
9-Aug	4	L	Yes	No	Fox
11-Aug	11	L	Yes	No	
12-Aug	12	L	Yes	No	
13-Aug	12	L	Yes	No	
14-Aug	18	L	Yes	No	Raccoon
15-Aug	3	L	Yes	No	Raccoon
16-Aug	2	L	No	No	Raccoon
17-Aug	2	L	No	No	
18-Aug	1	L	No	No	
20-Aug	11	L	Yes	No	2nd latch added
21-Aug	19	L	Yes	No	
22-Aug	9	L	No	No	

RFF					
12-Jun	0	Latchbox	NA	NA	Habituation
15-Jun	0	Latchbox	NA	NA	Habituation
15-Jul	0	Latchbox	NA	NA	Habituation
27-Jul	9	Latchbox	Y	Y	Single latch E
29-Jul	1	Latchbox	Y	Y	Single latch E
30-Jul	2	Latchbox	Y	Y	Single latch E
2-Aug	1	Latchbox	Y	Y	Single latch E
15-Aug	0	Latchbox	NA	NA	Habituation
31-Aug	24	Latchbox	Y	Y	Single latch E
1-Sep	64	Latchbox	N	NA	Single latch E Habitutation
4-Sep	0	Latchbox	Y	Y	Single latch E
15-Sep	0	Latchbox	Y	Y	Single latch E
22-Sep	21	Latchbox	Y	Y	Single latch S
5-Oct	22	Latchbox	Y	N	Double latch touching S
25-Oct	0	Latchbox	Y	Y	Double latch E
27-Oct	0	Latchbox	Y	N	Double latch E
6-Oct	17	Latchbox	Y	N	Double latch touching S
2-Nov	1	Latchbox	Y	Y	Double latch E - +1
7-Nov	10	Latchbox	Y	Y	Double latch +1 E
16-Nov	9	Latchbox	Y	Y	Double latch touching E
17-Nov	0	Latchbox	Y	Y	Double latch touching E
22-Nov	1	Latchbox	Y	Y	Double latch touching +1 E
2/17/2016	46	Latchbox	Y	Y	Double latch touching +1 +1 E

Shade					
20-Feb-16	0	Latchbox	N	N	Habituation
21-Feb-16	0	Latchbox	N	N	Habituation
22-Feb-16	0	Latchbox	N	N	Habituation
23-Feb-16	0	Latchbox	N	N	Habituation
24-Feb-16	0	Latchbox	N	N	Habituation
25-Feb-16	0	Latchbox	N	N	Habituation
26-Feb-16	0	Latchbox	N	N	Habituation
27-Feb-16	0	Latchbox	N	N	Habituation
28-Feb-16	0	Latchbox	N	N	Habituation
29-Feb-16	0	Latchbox	N	N	Habituation
1-Mar-16	0	Latchbox	N	N	Single Latch
2-Mar-16	0	Latchbox	N	N	Single Latch
3-Mar-16	0	Latchbox	N	N	Single Latch
4-Mar-16	0	Latchbox	N	N	Single Latch
5-Mar-16	0	Latchbox	Y	N	Single Latch
6-Mar-16	91	Latchbox	Y	N	Single Latch
7-Mar-16	238	Latchbox	Y	N	Single Latch
8-Mar-16	238	Latchbox	Y	N	Single Latch
9-Mar-16	133	Latchbox	Y	N	Single Latch
10-Mar-16	196	Latchbox	Y	Y	Single Latch
11-Mar-16	0	Latchbox	N	N	Single Latch

APPENDIX C – NUMERIC DATA GIVEN BY NOLDUS OBSERVER

Observations	Subjects	Behaviors	Mean	Std. deviation	Standard error	Latency
RFF1.00	Solo	Solve Box	-	-	-	32.10
RFF1.00	Solo	Looking At Box	19.20	19.89	14.06683	14.30
RFF1.00	Solo	Present	7.52	5.43	2.713093	5.13
RFF1.25	Solo	Looking At Box	4.77	5.56	3.933294	34.62
RFF1.25	Solo	Present	9.34	8.85	4.426771	15.96
RFF1.50	Solo	Looking At Box	13.27	4.38	3.099969	17.84
RFF1.50	Solo	Present	27.07	11.69	8.266584	0.94
RFF10.1EFC	Einstein	Biting	-	-	-	24.57
RFF10.1EFC	Einstein	Looking At Box	27.65	31.18	22.04948	0.00
RFF10.1EFC	Einstein	Calling	1.56	0.24	0.136534	8.67
RFF10.1EFC	Einstein	Attempt to Solve Box	1.30	1.42	0.500845	0.00
RFF10.1EFC	Einstein	Present	60.00	0.00	0	0.00
RFF10.2EFC	Einstein	Biting	-	-	-	38.00
RFF10.2EFC	Einstein	Looking At Box	19.98	5.21	3.685845	1.64
RFF10.2EFC	Einstein	Attempt to Solve Box	1.59	0.92	0.528448	1.94
RFF10.2EFC	Einstein	Present	58.36	0.00	0	1.64
RFF10.3EFC	Einstein	Pecking	3.10	0.00	0	31.80
RFF10.3EFC	Einstein	Looking At Box	35.90	0.00	0	24.10
RFF10.3EFC	Einstein	Attempt to Solve Box	5.92	5.73	3.308336	25.33
RFF10.3EFC	Einstein	Present	29.63	34.98	24.73436	0.73
RFF10.4EFC	Einstein	Solve Box	-	-	-	12.86
RFF10.4EFC	Einstein	Biting	-	-	-	3.46
RFF10.4EFC	Einstein	Looking At Box	13.35	10.51	6.068096	0.00

RFF10.4EFC	Einstein	Eating	4.78	2.81	1.146562	15.86
RFF10.4EFC	Einstein	Move Food	-	-	-	23.70
RFF10.4EFC	Einstein	Attempt to Solve Box	3.20	0.00	0	9.66
RFF10.4EFC	Einstein	Present	7.50	5.57	1.969413	0.00
RFF10EFC	Einstein	Looking At Box	20.71	25.16	17.78788	1.64
RFF10EFC	Einstein	Attempt to Solve Box	4.23	6.81	3.933718	29.30
RFF10EFC	Einstein	Present	14.60	8.67	5.002761	1.64
RFF11EFC	Einstein	Solve Box	-	-	-	6.70
RFF11EFC	Einstein	Looking At Box	37.45	0.00	0	0.08
RFF11EFC	Einstein	Eating	28.83	0.00	0	8.70
RFF11EFC	Einstein	Attempt to Solve Box	1.46	1.12	0.649376	0.61
RFF11EFC	Einstein	Present	9.36	10.08	5.040825	0.08
RFF12EFC	Einstein	Solve Box	-	-	-	46.84
RFF12EFC	Einstein	Biting	-	-	-	32.24
RFF12EFC	Einstein	Looking At Box	54.73	0.00	0	5.27
RFF12EFC	Einstein	Eating	8.13	0.00	0	51.87
RFF12EFC	Einstein	Attempt to Solve Box	6.05	4.84	2.164659	6.71
RFF12EFC	Einstein	Present	11.13	8.32	3.72169	4.37
RFF13.00	Einstein	Looking At Box	14.47	4.38	3.099969	9.03
RFF13.00	Einstein	Walking Around Platform	7.77	0.00	0	44.30
RFF13.00	Einstein	Attempt to Solve Box	2.65	0.97	0.683327	15.10
RFF13.00	Einstein	Present	18.03	17.26	9.962481	5.90
RFF13.10	Einstein	Looking At Box	16.78	0.00	0	43.22
RFF13.10	Einstein	Walking Around Platform	7.27	4.78	2.761681	13.09
RFF13.10	Einstein	Attempt to Solve Box	9.28	0.00	0	50.72
RFF13.10	Einstein	Present	59.31	0.00	0	0.69
RFF13.15	Einstein	Looking At Box	26.75	0.00	0	33.25
RFF13.15	Einstein	Walking Around Platform	9.22	9.83	6.949931	4.68
RFF13.15	Einstein	Attempt to Solve Box	1.05	0.02	0.016666	37.45
RFF13.15	Einstein	Present	28.23	30.04	21.23886	3.55
RFF13.20	Einstein	Looking At Box	22.90	0.00	0	36.31
RFF13.20	Einstein	Walking Around Platform	10.63	0.00	0	25.67

RFF13.20	Einstein	Present	23.51	13.27	9.386195	12.97
RFF13.25	Einstein	Looking At Box	12.16	10.02	5.787304	5.38
RFF13.25	Einstein	Walking Around Platform	11.78	0.63	0.445599	28.18
RFF13.25	Einstein	Attempt to Solve Box	1.70	0.00	0	51.24
RFF13.25	Einstein	Present	14.83	13.92	6.958513	0.68
RFF13.30	Einstein	Looking At Box	18.42	14.36	8.288774	2.90
RFF13.30	Einstein	Walking Around Platform	11.04	12.32	7.113523	15.23
RFF13.30	Einstein	Attempt to Solve Box	1.92	0.57	0.284919	38.30
RFF13.30	Einstein	Present	19.69	11.59	6.689404	0.93
RFF13.35	Einstein	Looking At Box	1.40	0.00	0	58.60
RFF13.35	Einstein	Attempt to Solve Box	2.61	1.89	0.457995	0.77
RFF13.35	Einstein	Present	19.96	14.15	8.168677	0.13
RFF13.40	Einstein	Manipulating Other Objects	1.71	1.25	0.885178	35.07
RFF13.40	Einstein	Looking At Box	27.60	27.34	19.33129	4.80
RFF13.40	Einstein	Walking Around Platform	4.32	3.09	1.784829	22.57
RFF13.40	Einstein	Attempt to Solve Box	1.41	0.80	0.252188	1.14
RFF13.40	Einstein	Present	8.42	6.66	2.517501	1.07
RFF13.45	Einstein	Solve Box	-	-	-	56.92
RFF13.45	Einstein	Jump Back	-	-	-	55.22
RFF13.45	Einstein	Manipulating Other Objects	2.12	1.87	1.081883	9.99
RFF13.45	Einstein	Looking At Box	27.45	14.87	10.51169	5.09
RFF13.45	Einstein	Attempt to Solve Box	1.75	1.35	0.327015	1.36
RFF13.45	Einstein	Present	19.78	18.40	10.62429	0.66
RFF13.50	Einstein	Jump Back	-	-	-	41.06
RFF13.50	Einstein	Looking At Box	28.60	1.70	1.20365	2.79
RFF13.50	Einstein	Eating	11.90	0.00	0	7.03
RFF13.50	Einstein	Walking Around Platform	10.17	7.87	5.566611	25.33
RFF13.50	Einstein	Present	19.07	26.39	15.23831	2.79
RFF13.55	Einstein	Present	22.97	0.00	0	0.38
RFF14.00	Solo	Solve Box	-	-	-	32.07
RFF14.00	Solo	Looking At Box	19.73	19.00	13.4335	14.37
RFF14.00	Solo	Walking Around Platform	1.45	0.21	0.149999	12.77
RFF14.00	Solo	Attempt to Solve Box	28.37	0.00	0	31.63

RFF14.00	Solo	Present	5.95	6.16	2.756089	5.00
RFF14.25	Solo	Looking At Box	3.87	0.00	0	20.00
RFF14.25	Solo	Present	15.96	21.42	12.36891	0.63
RFF14.50	Solo	Present	1.57	0.00	0	1.77
RFF16.15	Einstein	Solve Box	-	-	-	38.90
RFF16.15	Einstein	Jump Back	-	-	-	9.30
RFF16.15	Einstein	Looking At Box	36.60	0.00	0	23.40
RFF16.15	Einstein	Eating	19.00	0.00	0	41.00
RFF16.15	Einstein	Attempt to Solve Box	1.10	0.43	0.143095	8.13
RFF16.15	Einstein	Present	11.89	9.17	4.583309	7.37
RFF16.25	Einstein	Looking At Box	4.93	0.00	0	16.18
RFF16.25	Einstein	Eating	12.67	0.00	0	19.35
RFF16.25	Einstein	Present	37.23	0.00	0	16.18
RFF16.50	Einstein	Manipulating Other Objects	1.43	0.14	0.099999	13.22
RFF16.50	Einstein	Looking At Box	15.37	0.00	0	11.82
RFF16.50	Einstein	Present	22.67	0.00	0	8.89
RFF18./50	Einstein	Looking At Box	24.79	26.66	18.8544	8.42
RFF18./50	Einstein	Walking Around Platform	14.18	10.87	7.683257	18.49
RFF18./50	Einstein	Attempt to Solve Box	1.39	1.49	0.563886	2.86
RFF18./50	Einstein	Present	44.00	0.00	0	2.86
RFF18.00	Einstein	Looking At Box	13.19	9.61	4.803403	5.83
RFF18.00	Einstein	Walking Around Platform	21.43	0.00	0	24.27
RFF18.00	Einstein	Attempt to Solve Box	2.69	1.22	0.431077	6.30
RFF18.00	Einstein	Present	54.60	0.00	0	5.40
RFF18.15	Einstein	Manipulating Other Objects	2.10	0.00	0	21.69
RFF18.15	Einstein	Looking At Box	13.40	0.05	0.033333	1.29
RFF18.15	Einstein	Walking Around Platform	22.36	30.33	21.44354	15.29
RFF18.15	Einstein	Attempt to Solve Box	1.42	0.69	0.208614	2.62
RFF18.15	Einstein	Present	58.71	0.00	0	1.29
RFF18.20	Einstein	Manipulating Other Objects	4.52	4.78	3.3833	31.71
RFF18.20	Einstein	Looking At Box	4.20	1.60	1.133322	16.51
RFF18.20	Einstein	Walking Around Platform	11.23	7.99	3.995407	0.54
RFF18.20	Einstein	Attempt to Solve Box	1.43	0.34	0.195314	17.64
RFF18.20	Einstein	Present	59.46	0.00	0	0.54

RFF18.25	Einstein	Looking At Box	21.73	0.00	0	38.27
RFF18.25	Einstein	Walking Around Platform	18.35	8.69	6.146675	1.14
RFF18.25	Einstein	Attempt to Solve Box	1.39	1.02	0.294391	36.61
RFF18.25	Einstein	Present	11.41	11.65	6.725707	1.14
RFF18.30	Einstein	Manipulating Other Objects	2.23	0.05	0.032032	48.14
RFF18.30	Einstein	Looking At Box	24.17	8.16	5.766609	5.40
RFF18.30	Einstein	Walking Around Platform	1.40	0.85	0.599994	42.20
RFF18.30	Einstein	Attempt to Solve Box	1.53	0.93	0.207228	0.84
RFF18.30	Einstein	Present	19.72	12.44	7.184202	0.84
RFF18.35	Einstein	Manipulating Other Objects	3.43	0.00	0	33.16
RFF18.35	Einstein	Looking At Box	2.07	0.00	0	38.99
RFF18.35	Einstein	Walking Around Platform	18.43	2.74	1.580224	4.72
RFF18.35	Einstein	Attempt to Solve Box	1.12	0.53	0.153429	1.06
RFF18.35	Einstein	Present	58.94	0.00	0	1.06
RFF18.40	Einstein	Looking At Box	17.52	19.18	11.07588	4.81
RFF18.40	Einstein	Walking Around Platform	8.90	9.81	6.933264	32.68
RFF18.40	Einstein	Attempt to Solve Box	1.66	1.42	0.367823	5.48
RFF18.40	Einstein	Present	25.58	13.14	9.288576	2.61
RFF18.55	Einstein	Solve Box	-	-	-	41.78
RFF18.55	Einstein	Manipulating Other Objects	1.73	0.00	0	30.41
RFF18.55	Einstein	Looking At Box	8.28	9.50	6.7166	1.41
RFF18.55	Einstein	Eating	6.13	4.80	3.394575	46.88
RFF18.55	Einstein	Attempt to Solve Box	1.24	1.02	0.239771	1.78
RFF18.55	Einstein	Present	19.53	8.35	4.822521	1.41
RFF18.60	Einstein	Eating	9.03	11.83	5.290071	0.74
RFF18.60	Einstein	Present	19.29	13.60	7.853899	0.74
RFF18.65	Einstein	Eating	5.54	0.00	0	1.57
RFF18.65	Einstein	Present	5.54	0.00	0	1.57
RFF1EFC	Solo	Solve Box	-	-	-	27.26
RFF1EFC	Solo	Jump Back	-	-	-	27.26
RFF1EFC	Solo	Looking At Box	19.23	11.59	8.195711	0.00
RFF1EFC	Solo	Present	19.51	11.99	8.479042	0.00
RFF2.00	Einstein	Solve Box	-	-	-	26.13
RFF2.00	Einstein	Play	2.40	0.00	0	6.63

RFF2.00	Einstein	Looking At Box	5.17	0.00	0	12.47
RFF2.00	Einstein	Walking Around Platform	2.93	0.00	0	17.17
RFF2.00	Einstein	Attempt to Solve Box	0.83	0.00	0	25.30
RFF2.00	Einstein	Present	50.80	0.00	0	3.73
RFF2EFC	Einstein	Solve Box	-	-	-	27.40
RFF2EFC	Einstein	Jump Back	-	-	-	27.43
RFF2EFC	Einstein	Manipulating Other Objects	2.43	0.00	0	6.50
RFF2EFC	Einstein	Looking At Box	25.00	26.35	18.63315	0.00
RFF2EFC	Einstein	Present	56.03	0.00	0	0.00
RFF3.00	Einstein	Jump Back	-	-	-	54.10
RFF3.00	Einstein	Looking At Box	15.37	0.00	0	43.40
RFF3.00	Einstein	Walking Around Platform	8.70	0.00	0	34.70
RFF3.00	Einstein	Present	14.60	16.50	11.66655	1.00
RFF3.1EFC	Einstein	Solve Box	-	-	-	6.63
RFF3.1EFC	Einstein	Jump Back	-	-	-	6.69
RFF3.1EFC	Einstein	Looking At Box	56.54	0.00	0	3.46
RFF3.1EFC	Einstein	Eating	0.81	0.00	0	59.19
RFF3.1EFC	Einstein	Move Food	-	-	-	58.79
RFF3.1EFC	Einstein	Foot Box	0.17	0.09	0.050917	27.06
RFF3.1EFC	Einstein	Present	60.00	0.00	0	0.00
RFF3.20	Einstein	Solve Box	-	-	-	2.67
RFF3.20	Einstein	Jump Back	-	-	-	3.43
RFF3.20	Einstein	Looking At Box	29.42	27.08	19.15011	1.17
RFF3.20	Einstein	Eating	2.07	0.00	0	54.70
RFF3.20	Einstein	Foot Box	0.37	0.00	0	39.73
RFF3.20	Einstein	Walking Around Platform	9.98	15.78	7.890296	4.27
RFF3.20	Einstein	Present	59.97	0.00	0	0.03
RFF3.50	Einstein	Jump Back	-	-	-	18.91
RFF3.50	Einstein	Looking At Box	22.99	30.68	21.69401	6.51
RFF3.50	Einstein	Eating	2.40	1.37	0.966657	24.48
RFF3.50	Einstein	Walking Around Platform	26.26	28.04	19.82736	7.48
RFF3.50	Einstein	Present	12.97	12.59	8.899911	5.58
RFF3EFC	Einstein	Jump Back	-	-	-	37.73
RFF3EFC	Einstein	Looking At Box	13.12	15.58	11.01656	0.00
RFF3EFC	Einstein	Present	17.37	14.94	10.56686	0.00
RFF4.00	Einstein	Jump Back	-	-	-	1.10
RFF4.00	Einstein	Walking Around Platform	4.22	2.76	1.949981	28.80
RFF4.00	Einstein	Present	6.73	5.48	3.16248	0.67

RFF4.10	Einstein	Walking Around Platform	3.37	0.89	0.628211	18.92
RFF4.10	Einstein	Present	4.71	2.26	1.594868	16.62
RFF4.1EFC	Einstein	Looking At Box	11.59	7.17	5.072554	0.95
RFF4.1EFC	Einstein	Present	14.98	11.72	8.289489	0.95
RFF4.20	Einstein	Manipulating Other Objects	0.97	0.00	0	36.17
RFF4.20	Einstein	Walking Around Platform	6.20	4.38	3.099969	11.04
RFF4.20	Einstein	Present	9.00	9.99	7.066596	10.27
RFF4.25	Einstein	Present	0.27	0.00	0	59.73
RFF4.2EFC	Einstein	Manipulating Other Objects	53.77	0.00	0	6.23
RFF4.2EFC	Einstein	Looking At Box	1.70	0.00	0	6.30
RFF4.2EFC	Einstein	Present	8.47	0.00	0	0.00
RFF4.30	Einstein	Jump Back	-	-	-	14.45
RFF4.30	Einstein	Looking At Box	19.44	14.57	8.412991	1.69
RFF4.30	Einstein	Walking Around Platform	4.73	0.00	0	4.49
RFF4.30	Einstein	Attempt to Solve Box	2.53	1.55	0.515646	9.22
RFF4.30	Einstein	Present	59.28	0.00	0	0.72
RFF4.35	Einstein	Looking At Box	59.92	0.00	0	0.08
RFF4.35	Einstein	Attempt to Solve Box	2.70	1.68	0.752986	3.58
RFF4.35	Einstein	Present	22.97	0.00	0	0.08
RFF4.3EFC	Einstein	Jump Back	-	-	-	18.40
RFF4.3EFC	Einstein	Biting	-	-	-	18.30
RFF4.3EFC	Einstein	Looking At Box	58.40	0.00	0	1.60
RFF4.3EFC	Einstein	Present	58.40	0.00	0	1.60
RFF4.40	Einstein	Looking At Box	29.54	0.00	0	30.46
RFF4.40	Einstein	Walking Around Platform	2.52	0.97	0.683327	27.26
RFF4.40	Einstein	Attempt to Solve Box	2.25	1.73	0.865642	36.19
RFF4.40	Einstein	Present	35.31	0.00	0	24.69
RFF4.45	Einstein	Jump Back	-	-	-	57.97
RFF4.45	Einstein	Manipulating Other Objects	15.30	0.00	0	17.97
RFF4.45	Einstein	Looking At Box	56.03	0.00	0	3.97
RFF4.45	Einstein	Foot Box	0.63	0.00	0	5.47
RFF4.45	Einstein	Walking Around Platform	1.83	0.00	0	16.14
RFF4.45	Einstein	Attempt to Solve Box	3.12	0.54	0.383329	9.64
RFF4.45	Einstein	Present	56.03	0.00	0	3.97

RFF4.4EFC	Einstein	Jump Back	-	-	-	8.46
RFF4.4EFC	Einstein	Biting	-	-	-	3.00
RFF4.4EFC	Einstein	Looking At Box	26.10	0.00	0	0.00
RFF4.4EFC	Einstein	Attempt to Solve Box	2.13	2.83	1.99998	8.33
RFF4.4EFC	Einstein	Present	27.76	0.00	0	0.00
RFF4.50	Einstein	Solve Box	-	-	-	15.81
RFF4.50	Einstein	Jump Back	-	-	-	31.94
RFF4.50	Einstein	Looking At Box	1.23	0.00	0	52.41
RFF4.50	Einstein	Eating	14.70	0.00	0	37.71
RFF4.50	Einstein	Attempt to Solve Box	3.09	0.65	0.373336	5.31
RFF4.50	Einstein	Present	57.52	0.00	0	2.48
RFF4.55	Einstein	Looking At Box	8.40	0.00	0	18.39
RFF4.55	Einstein	Present	15.13	0.00	0	16.43
RFF4.5EFC	Einstein	Biting	-	-	-	37.03
RFF4.5EFC	Einstein	Looking At Box	46.30	0.00	0	13.70
RFF4.5EFC	Einstein	Present	60.00	0.00	0	0.00
RFF4.6EFC	Einstein	Solve Box	-	-	-	57.10
RFF4.6EFC	Einstein	Jump Back	-	-	-	44.50
RFF4.6EFC	Einstein	Biting	-	-	-	33.97
RFF4.6EFC	Einstein	Manipulating Other Objects	25.90	0.00	0	3.50
RFF4.6EFC	Einstein	Looking At Box	15.85	19.96	14.11683	0.00
RFF4.6EFC	Einstein	Attempt to Solve Box	1.29	1.10	0.491636	46.97
RFF4.6EFC	Einstein	Present	60.00	0.00	0	0.00
RFF4.70	Einstein	Looking At Box	1.26	0.00	0	58.74
RFF4.70	Einstein	Present	4.06	0.00	0	55.94
RFF4.725	Einstein	Jump Back	-	-	-	3.38
RFF4.725	Einstein	Looking At Box	32.93	0.00	0	1.05
RFF4.725	Einstein	Foot Box	1.13	0.00	0	13.35
RFF4.725	Einstein	Present	18.69	24.05	17.00772	1.05
RFF4.750	Einstein	Walking Around Platform	7.80	1.08	0.766659	3.28
RFF4.750	Einstein	Present	23.27	0.00	0	0.68
RFF4.90	Einstein	Looking At Box	11.51	0.00	0	36.90
RFF4.90	Einstein	Present	18.31	0.00	0	30.10
RFF4EFC	Einstein	Jump Back	-	-	-	0.67
RFF4EFC	Einstein	Looking At Box	3.62	2.50	1.250349	0.60
RFF4EFC	Einstein	Present	6.84	4.81	2.779283	0.00
RFF5.00	Einstein	Looking At Box	7.05	4.85	2.170657	4.37
RFF5.00	Einstein	Walking Around Platform	3.50	0.00	0	44.00

RFF5.00	Einstein	Attempt to Solve Box	2.68	2.21	1.103795	19.13
RFF5.00	Einstein	Present	56.20	0.00	0	3.80
RFF5.15	Einstein	Jump Back	-	-	-	19.75
RFF5.15	Einstein	Manipulating Other Objects	1.52	1.06	0.749993	4.78
RFF5.15	Einstein	Looking At Box	8.72	8.58	3.83846	1.85
RFF5.15	Einstein	Walking Around Platform	1.27	0.61	0.433329	14.45
RFF5.15	Einstein	Attempt to Solve Box	1.51	0.79	0.278275	7.08
RFF5.15	Einstein	Present	19.68	13.67	7.890982	0.95
RFF5.1EFC	Einstein	Solve Box	-	-	-	35.77
RFF5.1EFC	Einstein	Jump Back	-	-	-	26.13
RFF5.1EFC	Einstein	Biting	-	-	-	23.43
RFF5.1EFC	Einstein	Looking At Box	43.80	0.00	0	0.00
RFF5.1EFC	Einstein	Eating	3.50	0.00	0	40.30
RFF5.1EFC	Einstein	Move Food	-	-	-	43.80
RFF5.1EFC	Einstein	Attempt to Solve Box	2.19	1.27	0.401876	0.00
RFF5.1EFC	Einstein	Present	48.40	0.00	0	0.00
RFF5.25	Einstein	Looking At Box	8.40	1.80	1.269944	4.36
RFF5.25	Einstein	Walking Around Platform	11.45	13.13	9.283241	10.63
RFF5.25	Einstein	Attempt to Solve Box	1.31	0.79	0.263742	0.79
RFF5.25	Einstein	Present	10.59	7.40	3.701496	0.73
RFF5.40	Einstein	Jump Back	-	-	-	36.93
RFF5.40	Einstein	Manipulating Other Objects	1.70	0.00	0	41.36
RFF5.40	Einstein	Looking At Box	16.56	18.26	10.54508	1.39
RFF5.40	Einstein	Walking Around Platform	0.63	0.00	0	53.66
RFF5.40	Einstein	Attempt to Solve Box	1.36	1.17	0.412911	3.26
RFF5.40	Einstein	Present	19.79	9.19	5.3083	0.63
RFF5.50	Einstein	Solve Box	-	-	-	24.16
RFF5.50	Einstein	Jump Back	-	-	-	14.56
RFF5.50	Einstein	Manipulating Other Objects	2.47	0.00	0	9.03
RFF5.50	Einstein	Looking At Box	44.04	0.00	0	15.96
RFF5.50	Einstein	Eating	31.17	0.00	0	28.83
RFF5.50	Einstein	Walking Around Platform	0.30	0.00	0	13.20
RFF5.50	Einstein	Attempt to Solve Box	7.19	13.26	5.010259	4.63

RFF5.50	Einstein	Present	33.00	0.00	0	4.06
RFF5EFC	Einstein	Biting	-	-	-	8.55
RFF5EFC	Einstein	Pecking	6.43	0.00	0	35.15
RFF5EFC	Einstein	Looking At Box	53.92	0.00	0	6.08
RFF5EFC	Einstein	Attempt to Solve Box	4.52	2.49	1.438655	15.65
RFF5EFC	Einstein	Present	10.94	10.80	4.831859	5.28
RFF6.00	Einstein	Jump Back	-	-	-	13.00
RFF6.00	Einstein	Looking At Box	9.53	0.00	0	9.47
RFF6.00	Einstein	Walking Around Platform	15.09	22.28	12.8626	7.77
RFF6.00	Einstein	Present	24.27	0.00	0	6.53
RFF6.15	Einstein	Jump Back	-	-	-	2.43
RFF6.15	Einstein	Looking At Box	58.40	0.00	0	1.60
RFF6.15	Einstein	Walking Around Platform	4.22	4.43	1.808105	0.50
RFF6.15	Einstein	Attempt to Solve Box	0.97	0.57	0.142381	13.27
RFF6.15	Einstein	Present	59.93	0.00	0	0.07
RFF6.1EFC	Einstein	Solve Box	-	-	-	4.92
RFF6.1EFC	Einstein	Jump Back	-	-	-	5.05
RFF6.1EFC	Einstein	Biting	-	-	-	7.88
RFF6.1EFC	Einstein	Looking At Box	8.96	3.86	2.226797	0.33
RFF6.1EFC	Einstein	Eating	9.21	7.60	4.390364	14.08
RFF6.1EFC	Einstein	Move Food	-	-	-	9.45
RFF6.1EFC	Einstein	Attempt to Solve Box	2.08	0.16	0.116666	0.65
RFF6.1EFC	Einstein	Present	59.67	0.00	0	0.33
RFF6.25	Einstein	Jump Back	-	-	-	2.35
RFF6.25	Einstein	Biting	-	-	-	39.75
RFF6.25	Einstein	Manipulating Other Objects	1.36	0.31	0.178815	20.28
RFF6.25	Einstein	Looking At Box	54.02	0.00	0	5.98
RFF6.25	Einstein	Walking Around Platform	0.62	0.00	0	59.38
RFF6.25	Einstein	Attempt to Solve Box	1.47	0.72	0.192755	7.71
RFF6.25	Einstein	Present	59.05	0.00	0	0.95
RFF6.35	Einstein	Manipulating Other Objects	4.14	2.66	1.534324	1.15
RFF6.35	Einstein	Walking Around Platform	1.33	0.00	0	40.75
RFF6.35	Einstein	Attempt to Solve Box	1.81	0.79	0.227255	2.25
RFF6.35	Einstein	Present	11.86	8.06	3.605681	0.68

RFF6.45	Einstein	Manipulating Other Objects	6.28	7.20	2.719961	16.01
RFF6.45	Einstein	Walking Around Platform	7.41	7.70	5.445859	45.17
RFF6.45	Einstein	Attempt to Solve Box	6.12	3.84	1.28144	4.88
RFF6.45	Einstein	Present	14.81	13.92	6.962465	0.74
RFF6EFC	Einstein	Biting	-	-	-	19.53
RFF6EFC	Einstein	Pecking	1.50	0.38	0.266664	2.33
RFF6EFC	Einstein	Looking At Box	60.00	0.00	0	0.00
RFF6EFC	Einstein	Attempt to Solve Box	1.56	0.90	0.206576	5.30
RFF6EFC	Einstein	Present	8.57	8.04	3.038685	0.00
RFF7.00	Einstein	Solve Box	-	-	-	8.91
RFF7.00	Einstein	Jump Back	-	-	-	1.07
RFF7.00	Einstein	Biting	-	-	-	11.34
RFF7.00	Einstein	Looking At Box	4.79	1.30	0.917565	2.60
RFF7.00	Einstein	Eating	4.74	0.00	0	11.58
RFF7.00	Einstein	Attempt to Solve Box	2.41	3.59	1.795885	0.87
RFF7.00	Einstein	Present	16.12	0.00	0	0.20
RFF7EFC	Solo	Solve Box	-	-	-	29.35
RFF7EFC	Solo	Jump Back	-	-	-	29.45
RFF7EFC	Solo	Looking At Box	19.70	11.13	7.866588	2.01
RFF7EFC	Solo	Present	19.72	11.15	7.883255	2.01
RFF8.00	Einstein	Solve Box	-	-	-	12.65
RFF8.00	Einstein	Jump Back	-	-	-	38.44
RFF8.00	Einstein	Manipulating Other Objects	0.13	0.00	0	21.92
RFF8.00	Einstein	Looking At Box	9.78	5.00	2.884143	9.04
RFF8.00	Einstein	Eating	3.34	3.70	1.850435	14.95
RFF8.00	Einstein	Attempt to Solve Box	8.52	15.11	7.55485	6.41
RFF8.00	Einstein	Present	9.27	8.09	4.044569	6.21
RFF8EFC	Einstein	Solve Box	-	-	-	8.78
RFF8EFC	Einstein	Jump Back	-	-	-	0.93
RFF8EFC	Einstein	Looking At Box	11.88	0.00	0	0.00
RFF8EFC	Einstein	Eating	4.10	0.00	0	12.21
RFF8EFC	Einstein	Move Food	-	-	-	11.21
RFF8EFC	Einstein	Foot Box	0.70	0.00	0	10.74
RFF8EFC	Einstein	Attempt to Solve Box	0.53	0.72	0.417186	1.63
RFF8EFC	Einstein	Present	16.32	0.00	0	0.00
RFF9EFC	Einstein	Solve Box	-	-	-	32.90
RFF9EFC	Einstein	Jump Back	-	-	-	2.63
RFF9EFC	Einstein	Biting	-	-	-	22.60

RFF9EFC	Einstein	Looking At Box	18.33	15.51	10.96656	1.27
RFF9EFC	Einstein	Eating	4.95	0.54	0.38333	35.37
RFF9EFC	Einstein	Move Food	-	-	-	40.63
RFF9EFC	Einstein	Foot Box	0.87	0.00	0	34.77
RFF9EFC	Einstein	Attempt to Solve Box	0.67	0.44	0.127853	2.47
RFF9EFC	Einstein	Present	10.79	7.42	3.316351	1.23
S1	Scar - Adult Female Sedona	Looking At Box	1.59	1.46	0.405358	21.43
S1	Scar - Adult Female Sedona	Eating	17.47	0.00	0	42.53
S1	Scar - Adult Female Sedona	Move Food	-	-	-	42.33
S1	Scar - Adult Female Sedona	Walking Around Platform	1.32	0.69	0.26031	11.13
S1	Scar - Adult Female Sedona	Attempt to Solve Box	0.20	0.14	0.099999	26.00
S1	Scar - Adult Female Sedona	Present	27.02	31.89	22.55007	5.97
S1.1EFC	Scar - Adult Female Sedona	Solve Box	-	-	-	0.37
S1.1EFC	Scar - Adult Female Sedona	Jump Back	-	-	-	0.96
S1.1EFC	Scar - Adult Female Sedona	Looking At Box	5.68	1.06	0.749993	5.29
S1.1EFC	Scar - Adult Female Sedona	Foot Box	28.89	0.00	0	0.00

S1.1EFC	Scar - Adult Female Sedona	Present	7.39	8.16	5.771873	0.00
S10.1EFC	Scar - Adult Female Sedona	Looking At Box	17.96	4.26	2.457675	0.00
S10.1EFC	Scar - Adult Female Sedona	Eating	11.04	4.58	2.289482	0.00
S10.1EFC	Scar - Adult Female Sedona	Walking Around Platform	1.73	0.00	0	21.44
S10.1EFC	Scar - Adult Female Sedona	Attempt to Solve Box	0.50	0.00	0	19.34
S10.1EFC	Scar - Adult Female Sedona	Present	60.00	0.00	0	0.00
S10.1EFC	Unknown	Present	15.26	0.00	0	44.74
S10.1EFC	Wimp - Adult Male Sedona	Present	60.00	0.00	0	0.00
S10.25	Scar - Adult Female Sedona	Looking At Box	0.77	0.00	0	31.23
S10.25	Scar - Adult Female Sedona	Eating	10.92	3.77	1.885569	3.33
S10.25	Scar - Adult Female Sedona	Walking Around Platform	3.40	0.00	0	18.89
S10.25	Scar - Adult Female Sedona	Attempt to Solve Box	0.69	0.44	0.256277	2.09
S10.25	Scar - Adult	Present	58.01	0.00	0	1.99

	Female Sedona Scar - Adult						
S10.2EFC	Female Sedona Scar - Adult	Solve Box	-	-	-		20.31
S10.2EFC	Female Sedona Scar - Adult	Jump Back	-	-	-		20.51
S10.2EFC	Female Sedona Scar - Adult	Looking At Box	10.63	9.94	5.738173		0.00
S10.2EFC	Female Sedona Scar - Adult	Move Food	-	-	-		2.71
S10.2EFC	Female Sedona	Present	20.51	0.00	0		0.00
S10.2EFC	Unknown	Present	23.74	0.00	0		0.00
S10.2EFC	Wimp - Adult Male Sedona	Jump Back	-	-	-		22.24
S10.2EFC	Wimp - Adult Male Sedona	Present	18.54	4.15	2.937773		0.00
S10.50	Female Sedona Scar - Adult	Solve Box	-	-	-		17.50
S10.50	Female Sedona Scar - Adult	Looking At Box	0.87	0.00	0		13.87
S10.50	Female Sedona Scar - Adult	Eating	5.38	4.41	3.116636		0.94
S10.50	Female Sedona	Attempt to Solve Box	17.70	0.00	0		17.00

S10.50	Scar - Adult Female Sedona	Present	16.67	0.00	0	0.94
S10EFC	Scar - Adult Female Sedona	Jump Back	-	-	-	5.13
S10EFC	Scar - Adult Female Sedona	Looking At Box	17.11	17.15	9.902311	7.43
S10EFC	Scar - Adult Female Sedona	Eating	8.83	9.76	6.899931	19.83
S10EFC	Scar - Adult Female Sedona	Walking Around Platform	2.65	1.06	0.749993	9.27
S10EFC	Scar - Adult Female Sedona	Present	54.90	0.00	0	5.10
S10EFC	Wimp - Adult Male Sedona	Present	59.84	0.00	0	0.16
S11	Scar - Adult Female Sedona	Looking At Box	5.18	3.04	2.149979	9.13
S11	Scar - Adult Female Sedona	Eating	18.57	0.00	0	41.43
S11	Scar - Adult Female Sedona	Attempt to Solve Box	8.34	2.23	1.289117	23.70
S11	Scar - Adult Female Sedona	Present	26.52	14.50	10.2502	6.97
S11.15	Scar - Adult Female Sedona	Eating	3.38	1.44	1.016657	6.94

S11.15	Scar - Adult Female Sedona	Walking Around Platform	1.17	0.00	0	45.17
S11.15	Scar - Adult Female Sedona	Attempt to Solve Box	5.01	2.63	0.992808	2.94
S11.15	Scar - Adult Female Sedona	Present	58.20	0.00	0	1.80
S11.1EFC	Fiesty - Sedona Fledgling	Looking At Box	18.31	7.74	4.469336	0.00
S11.1EFC	Fiesty - Sedona Fledgling	Eating	17.82	7.38	4.262738	0.00
S11.1EFC	Fiesty - Sedona Fledgling	Present	60.00	0.00	0	0.00
S11.1EFC	Unknown	Present	60.00	0.00	0	0.00
S11.20	Scar - Adult Female Sedona	Jump Back	-	-	-	18.20
S11.20	Scar - Adult Female Sedona	Eating	15.68	8.41	5.949941	26.73
S11.20	Scar - Adult Female Sedona	Walking Around Platform	2.28	1.51	0.872903	5.27
S11.20	Scar - Adult Female Sedona	Attempt to Solve Box	2.54	1.52	0.678587	1.57
S11.20	Scar - Adult Female Sedona	Present	58.43	0.00	0	1.57
S11.25	Scar - Adult Female Sedona	Looking At Box	5.97	0.00	0	47.36
S11.25	Scar - Adult	Eating	4.90	0.00	0	6.53

	Female Sedona Scar - Adult					
S11.25	Female Sedona Scar - Adult	Walking Around Platform	1.83	1.43	0.827527	16.93
S11.25	Female Sedona Scar - Adult	Attempt to Solve Box	3.97	2.54	0.847553	1.86
S11.25	Female Sedona Scar - Adult	Present	29.47	27.06	19.13106	1.06
S11.2EFC	Fiesty - Sedona Fledgling	Jump Back	-	-	-	21.94
S11.2EFC	Fiesty - Sedona Fledgling	Looking At Box	60.00	0.00	0	0.00
S11.2EFC	Fiesty - Sedona Fledgling	Eating	25.77	6.40	4.52869	0.00
S11.2EFC	Fiesty - Sedona Fledgling	Foot Box	0.67	0.00	0	21.24
S11.2EFC	Fiesty - Sedona Fledgling	Present	60.00	0.00	0	0.00
S11.2EFC	Unknown	Present	60.00	0.00	0	0.00
S11.30	Scar - Adult Female Sedona	Looking At Box	11.62	7.33	4.234113	1.67
S11.30	Scar - Adult Female Sedona	Foot Box	0.93	0.00	0	22.41
S11.30	Scar - Adult Female Sedona	Walking Around Platform	1.53	0.71	0.499995	29.94
S11.30	Scar - Adult Female Sedona	Attempt to Solve Box	3.74	2.09	0.697386	3.11
S11.30	Scar - Adult	Present	11.67	7.44	3.326286	1.67

S11.3EFC	Female Sedona Fiesty - Sedona Fledgling	Looking At Box	29.80	4.42	3.125198	0.00
S11.3EFC	Fiesty - Sedona Fledgling	Eating	6.09	3.38	1.69004	0.00
S11.3EFC	Fiesty - Sedona Fledgling	Foot Box	0.89	0.76	0.437723	10.67
S11.3EFC	Fiesty - Sedona Fledgling	Attempt to Solve Box	0.99	0.85	0.492281	7.47
S11.3EFC	Fiesty - Sedona Fledgling	Present	30.00	37.72	26.6745	0.00
S11.3EFC	Unknown	Present	60.00	0.00	0	0.00
S11.40	Scar - Adult Female Sedona	Play	4.53	0.00	0	27.34
S11.40	Scar - Adult Female Sedona	Looking At Box	2.63	0.00	0	9.04
S11.40	Scar - Adult Female Sedona	Eating	2.77	0.00	0	43.94
S11.40	Scar - Adult Female Sedona	Walking Around Platform	1.78	0.40	0.28333	36.17
S11.40	Scar - Adult Female Sedona	Attempt to Solve Box	3.07	1.56	0.493876	0.67
S11.40	Scar - Adult Female Sedona	Present	11.87	18.93	8.463634	0.67
S11.40	Wimp - Adult Male Sedona	Play	3.97	0.00	0	27.90
S11.40	Wimp - Adult	Present	10.17	0.00	0	20.90

S11.4EFC	Male Sedona Fiesty - Sedona Fledgling	Biting	-	-	-		0.22
S11.4EFC	Fiesty - Sedona Fledgling	Pecking	3.91	5.31	3.066731		8.68
S11.4EFC	Fiesty - Sedona Fledgling	Looking At Box	59.42	0.00	0		0.58
S11.4EFC	Fiesty - Sedona Fledgling	Eating	13.23	0.00	0		35.41
S11.4EFC	Fiesty - Sedona Fledgling	Foot Box	0.42	0.02	0.016666		24.98
S11.4EFC	Fiesty - Sedona Fledgling	Present	11.88	8.91	3.98524		0.58
S11.4EFC	Unknown	Present	59.42	0.00	0		0.58
S11.50	Scar - Adult Female Sedona	Biting	-	-	-		45.87
S11.50	Scar - Adult Female Sedona	Looking At Box	2.70	0.24	0.166665		0.60
S11.50	Scar - Adult Female Sedona	Walking Around Platform	2.12	1.04	0.518093		12.70
S11.50	Scar - Adult Female Sedona	Attempt to Solve Box	4.00	3.03	1.144967		3.47
S11.50	Scar - Adult Female Sedona	Present	29.78	13.79	9.749603		0.43
S11.5EFC	Feet - Sedona Fledgling	Jump Back	-	-	-		26.15
S11.5EFC	Feet - Sedona Fledgling	Looking At Box	3.60	0.00	0		28.65

S11.5EFC	Feet - Sedona Fledgling	Calling	0.17	0.00	0	32.25
S11.5EFC	Feet - Sedona Fledgling	Present	16.73	10.74	7.593573	26.18
S11.5EFC	Fiesty - Sedona Fledgling	Pecking	11.18	0.00	0	0.00
S11.5EFC	Fiesty - Sedona Fledgling	Looking At Box	17.39	11.35	6.555125	0.00
S11.5EFC	Fiesty - Sedona Fledgling	Eating	7.92	7.90	5.583278	39.01
S11.5EFC	Fiesty - Sedona Fledgling	Foot Box	0.74	0.71	0.411107	13.15
S11.5EFC	Fiesty - Sedona Fledgling	Calling	0.47	0.00	0	25.81
S11.5EFC	Fiesty - Sedona Fledgling	Fighting	2.67	0.00	0	32.85
S11.5EFC	Fiesty - Sedona Fledgling	Walking Around Platform	1.73	0.00	0	40.95
S11.5EFC	Fiesty - Sedona Fledgling	Attempt to Solve Box	0.69	0.39	0.273015	14.35
S11.5EFC	Fiesty - Sedona Fledgling	Present	15.00	18.63	9.314007	0.00
S11.5EFC	Unknown	Present	60.00	0.00	0	0.00
S11.6EFC	Feet - Sedona Fledgling	Present	10.42	0.00	0	49.58
S11.6EFC	Fiesty - Sedona Fledgling	Solve Box	-	-	-	10.62
S11.6EFC	Fiesty - Sedona Fledgling	Jump Back	-	-	-	10.92
S11.6EFC	Fiesty - Sedona Fledgling	Manipulating Other Objects	2.50	0.00	0	1.38

S11.6EFC	Fiesty - Sedona Fledgling	Looking At Box	59.18	0.00	0	0.00
S11.6EFC	Fiesty - Sedona Fledgling	Eating	39.00	0.00	0	14.68
S11.6EFC	Fiesty - Sedona Fledgling	Move Food	-	-	-	53.98
S11.6EFC	Fiesty - Sedona Fledgling	Foot Box	13.48	21.60	12.47142	1.35
S11.6EFC	Fiesty - Sedona Fledgling	Walking Around Platform	0.35	0.00	0	59.65
S11.6EFC	Fiesty - Sedona Fledgling	Attempt to Solve Box	3.62	3.22	2.27526	0.00
S11.6EFC	Fiesty - Sedona Fledgling	Present	19.80	24.85	14.34792	0.00
S11.6EFC	Unknown	Present	60.00	0.00	0	0.00
S11.70	Scar - Adult Female Sedona	Solve Box	-	-	-	58.89
S11.70	Scar - Adult Female Sedona	Looking At Box	2.70	0.00	0	2.79
S11.70	Scar - Adult Female Sedona	Eating	7.73	0.00	0	37.56
S11.70	Scar - Adult Female Sedona	Playing	3.07	0.00	0	20.83
S11.70	Scar - Adult Female Sedona	Walking Around Platform	2.17	0.28	0.199998	29.99
S11.70	Scar - Adult Female Sedona	Attempt to Solve Box	7.07	3.75	1.676912	8.06
S11.70	Scar - Adult	Present	9.81	17.68	7.217969	0.63

	Female Sedona Wimp - Adult Male					
S11.70	Sedona Scar - Adult Female	Present	10.77	0.00	0	14.46
S11.80	Sedona Scar - Adult Female	Eating	20.98	2.62	1.849982	1.76
S11.80	Sedona Fiesty - Sedona	Present	48.77	0.00	0	0.83
S11EFC	Fledgling Fiesty - Sedona	Jump Back	-	-	-	22.93
S11EFC	Fledgling Fiesty - Sedona	Pecking	1.67	0.00	0	9.93
S11EFC	Fledgling Fiesty - Sedona	Looking At Box	26.18	1.67	1.183021	6.63
S11EFC	Fledgling Fiesty - Sedona	Eating	17.37	10.04	7.100229	23.60
S11EFC	Fledgling Fiesty - Sedona	Foot Box	2.50	0.00	0	20.37
S11EFC	Fledgling Fiesty - Sedona	Calling	0.43	0.00	0	20.53
S11EFC	Fledgling	Present	14.59	15.86	7.930255	0.87
S11EFC	Unknown	Present	16.20	0.00	0	43.80
S12.00	Scar - Adult Female Sedona	Pecking	3.40	0.00	0	56.60
S12.00	Scar - Adult Female Sedona	Looking At Box	3.81	1.79	0.798564	20.97
S12.00	Scar - Adult Female Sedona	Walking Around Platform	2.54	0.73	0.419137	29.43

S12.00	Scar - Adult Female Sedona	Present	8.34	5.22	2.333216	18.30
S12.1EFC	Fiesty - Sedona Fledgling	Solve Box	-	-	-	57.85
S12.1EFC	Fiesty - Sedona Fledgling	Pecking	1.93	0.80	0.358798	0.13
S12.1EFC	Fiesty - Sedona Fledgling	Looking At Box	13.43	14.51	7.254193	0.00
S12.1EFC	Fiesty - Sedona Fledgling	Foot Box	5.06	4.72	2.362274	0.00
S12.1EFC	Fiesty - Sedona Fledgling	Walking Around Platform	5.99	7.44	3.718469	7.85
S12.1EFC	Fiesty - Sedona Fledgling	Attempt to Solve Box	1.54	1.11	0.555168	1.58
S12.1EFC	Fiesty - Sedona Fledgling	Present	8.57	10.20	3.85603	0.00
S12.25	Scar - Adult Female Sedona	Biting	-	-	-	36.32
S12.25	Scar - Adult Female Sedona	Looking At Box	3.95	2.63	1.177027	7.02
S12.25	Scar - Adult Female Sedona	Walking Around Platform	3.87	2.38	1.190926	15.32
S12.25	Scar - Adult Female Sedona	Attempt to Solve Box	1.73	0.80	0.32784	8.52
S12.25	Scar - Adult Female Sedona	Present	9.46	7.56	3.087179	3.22
S12.2EFC	Fiesty - Sedona Fledgling	Looking At Box	60.00	0.00	0	0.00

S12.2EFC	Fiesty - Sedona Fledgling	Eating	53.87	0.00	0	6.13
S12.2EFC	Fiesty - Sedona Fledgling	Foot Box	16.57	0.00	0	38.70
S12.2EFC	Fiesty - Sedona Fledgling	Walking Around Platform	2.73	0.00	0	3.20
S12.2EFC	Fiesty - Sedona Fledgling	Present	30.00	35.73	25.26702	0.00
S12.35	Scar - Adult Female Sedona	Solve Box	-	-	-	3.63
S12.35	Scar - Adult Female Sedona	Biting	-	-	-	2.70
S12.35	Scar - Adult Female Sedona	Looking At Box	5.08	5.92	4.183292	1.06
S12.35	Scar - Adult Female Sedona	Eating	48.77	0.00	0	11.23
S12.35	Scar - Adult Female Sedona	Walking Around Platform	4.07	0.00	0	6.26
S12.35	Scar - Adult Female Sedona	Attempt to Solve Box	56.37	0.00	0	3.63
S12.35	Scar - Adult Female Sedona	Present	29.47	35.73	25.26762	1.06
S12.50	Scar - Adult Female Sedona	Eating	58.46	0.00	0	1.54
S12.50	Scar - Adult Female Sedona	Present	58.46	0.00	0	1.54

S12.60	Scar - Adult Female Sedona	Eating	11.72	1.96	1.38332	0.74
S12.60	Scar - Adult Female Sedona	Walking Around Platform	4.30	0.00	0	15.37
S12.60	Scar - Adult Female Sedona	Present	15.87	1.74	1.233321	0.74
S12EFC	Fiesty - Sedona Fledgling	Biting	-	-	-	35.43
S12EFC	Fiesty - Sedona Fledgling	Pecking	1.65	0.61	0.306863	17.93
S12EFC	Fiesty - Sedona Fledgling	Looking At Box	4.03	2.40	0.908271	12.87
S12EFC	Fiesty - Sedona Fledgling	Foot Box	6.00	7.54	5.33358	42.60
S12EFC	Fiesty - Sedona Fledgling	Walking Around Platform	1.77	0.00	0	44.63
S12EFC	Fiesty - Sedona Fledgling	Present	9.78	5.96	2.433801	0.50
S13.00	Fiesty - Sedona Fledgling	Biting	-	-	-	18.30
S13.00	Fiesty - Sedona Fledgling	Looking At Box	1.83	0.00	0	20.10
S13.00	Fiesty - Sedona Fledgling	Eating	2.47	0.00	0	36.30
S13.00	Fiesty - Sedona Fledgling	Walking Around Platform	2.28	1.19	0.685919	7.83
S13.00	Fiesty - Sedona Fledgling	Attempt to Solve Box	4.45	2.47	1.102539	23.77
S13.00	Fiesty - Sedona Fledgling	Present	17.87	17.35	10.01658	6.40

S13.15	Fiesty - Sedona Fledgling	Biting	-	-	-		36.40
S13.15	Fiesty - Sedona Fledgling	Walking Around Platform	4.87	3.35	2.366643		25.33
S13.15	Fiesty - Sedona Fledgling	Attempt to Solve Box	2.87	1.88	0.941522		6.40
S13.15	Fiesty - Sedona Fledgling	Present	41.40	0.00	0		1.40
S13.1EFC	Feet - Sedona Fledgling	Jump Back	-	-	-		45.22
S13.1EFC	Feet - Sedona Fledgling	Present	45.18	0.00	0		14.82
S13.1EFC	Fiesty - Sedona Fledgling	Biting	-	-	-		27.52
S13.1EFC	Fiesty - Sedona Fledgling	Pecking	1.03	0.00	0		56.69
S13.1EFC	Fiesty - Sedona Fledgling	Looking At Box	7.27	5.52	2.467433		0.00
S13.1EFC	Fiesty - Sedona Fledgling	Foot Box	2.95	1.30	0.916658		4.29
S13.1EFC	Fiesty - Sedona Fledgling	Walking Around Platform	4.77	4.34	3.066636		16.62
S13.1EFC	Fiesty - Sedona Fledgling	Attempt to Solve Box	4.02	2.85	2.016647		2.45
S13.1EFC	Fiesty - Sedona Fledgling	Present	14.81	14.81	7.405615		0.00
S13.25	Fiesty - Sedona Fledgling	Biting	-	-	-		5.24
S13.25	Fiesty - Sedona Fledgling	Looking At Box	1.57	0.00	0		4.31
S13.25	Fiesty - Sedona Fledgling	Walking Around Platform	1.97	0.00	0		55.21

S13.25	Fiesty - Sedona Fledgling	Attempt to Solve Box	10.24	3.35	1.674264	8.81
S13.25	Fiesty - Sedona Fledgling	Present	19.37	28.23	16.29773	1.88
S13.2EFC	Feet - Sedona Fledgling	Present	60.00	0.00	0	0.00
S13.2EFC	Fiesty - Sedona Fledgling	Looking At Box	60.00	0.00	0	0.00
S13.2EFC	Fiesty - Sedona Fledgling	Foot Box	2.77	3.49	2.466642	0.00
S13.2EFC	Fiesty - Sedona Fledgling	Walking Around Platform	2.46	0.00	0	1.57
S13.2EFC	Fiesty - Sedona Fledgling	Present	60.00	0.00	0	0.00
S13.3	Feet - Sedona Fledgling	Jump Back	-	-	-	26.58
S13.3	Feet - Sedona Fledgling	Looking At Box	1.17	0.00	0	25.41
S13.3	Feet - Sedona Fledgling	Present	16.53	21.40	15.12918	25.28
S13.3	Fiesty - Sedona Fledgling	Pecking	0.80	0.75	0.533328	3.68
S13.3	Fiesty - Sedona Fledgling	Manipulating Other Objects	12.03	0.00	0	37.21
S13.3	Fiesty - Sedona Fledgling	Looking At Box	9.77	6.24	3.118679	0.36
S13.3	Fiesty - Sedona Fledgling	Foot Box	2.31	1.34	0.600864	6.68
S13.3	Fiesty - Sedona Fledgling	Calling	0.73	0.00	0	26.71
S13.3	Fiesty - Sedona Fledgling	Attempt to Solve Box	2.33	1.20	0.598833	6.88

S13.3	Fiesty - Sedona Fledgling	Present	6.60	9.42	3.139335	0.36
S13.30	Feet - Sedona Fledgling	Present	1.93	0.00	0	32.82
S13.30	Fiesty - Sedona Fledgling	Looking At Box	0.68	0.02	0.016667	12.02
S13.30	Fiesty - Sedona Fledgling	Walking Around Platform	1.28	0.12	0.083333	9.25
S13.30	Fiesty - Sedona Fledgling	Attempt to Solve Box	3.23	1.47	0.521298	3.79
S13.30	Fiesty - Sedona Fledgling	Present	8.11	7.52	2.841365	3.25
S13.45	Fiesty - Sedona Fledgling	Solve Box	-	-	-	56.43
S13.45	Fiesty - Sedona Fledgling	Biting	-	-	-	18.33
S13.45	Fiesty - Sedona Fledgling	Looking At Box	1.50	0.00	0	46.09
S13.45	Fiesty - Sedona Fledgling	Walking Around Platform	2.67	1.65	0.825777	16.09
S13.45	Fiesty - Sedona Fledgling	Attempt to Solve Box	4.11	1.63	0.57645	0.73
S13.45	Fiesty - Sedona Fledgling	Present	11.29	10.45	4.674573	0.73
S13.4EFC	Feet - Sedona Fledgling	Present	22.14	0.00	0	37.85
S13.4EFC	Fiesty - Sedona Fledgling	Solve Box	-	-	-	46.95
S13.4EFC	Fiesty - Sedona Fledgling	Jump Back	-	-	-	38.15
S13.4EFC	Fiesty - Sedona Fledgling	Preening	2.33	0.24	0.166665	16.31

S13.4EFC	Fiesty - Sedona Fledgling	Biting	-	-	-	8.75
S13.4EFC	Fiesty - Sedona Fledgling	Pecking	0.87	0.00	0	36.48
S13.4EFC	Fiesty - Sedona Fledgling	Looking At Box	7.74	4.06	1.817058	0.00
S13.4EFC	Fiesty - Sedona Fledgling	Foot Box	1.00	0.05	0.033333	36.71
S13.4EFC	Fiesty - Sedona Fledgling	Walking Around Platform	2.18	1.32	0.764321	4.58
S13.4EFC	Fiesty - Sedona Fledgling	Attempt to Solve Box	0.60	0.00	0	46.35
S13.4EFC	Fiesty - Sedona Fledgling	Present	9.42	10.53	4.708446	0.00
S13EFC	Feet - Sedona Fledgling	Present	58.97	0.00	0	1.03
S13EFC	Fiesty - Sedona Fledgling	Pecking	3.73	0.00	0	11.73
S13EFC	Fiesty - Sedona Fledgling	Manipulating Other Objects	1.80	0.00	0	22.40
S13EFC	Fiesty - Sedona Fledgling	Looking At Box	9.13	8.08	3.614207	2.23
S13EFC	Fiesty - Sedona Fledgling	Eating	5.30	0.00	0	27.30
S13EFC	Fiesty - Sedona Fledgling	Foot Box	4.18	2.52	1.783616	44.40
S13EFC	Fiesty - Sedona Fledgling	Walking Around Platform	1.53	0.68	0.394871	2.23
S13EFC	Fiesty - Sedona Fledgling	Attempt to Solve Box	2.65	0.64	0.449996	43.57
S13EFC	Fiesty - Sedona Fledgling	Present	19.82	20.51	11.84408	0.53

S1EFC	Scar - Adult Female Sedona	Jump Back	-	-	-	4.20
S1EFC	Scar - Adult Female Sedona	Pecking	1.23	0.00	0	18.93
S1EFC	Scar - Adult Female Sedona	Looking At Box	3.14	1.13	0.341468	1.33
S1EFC	Scar - Adult Female Sedona	Eating	1.27	0.00	0	36.03
S1EFC	Scar - Adult Female Sedona	Foot Box	3.18	3.76	2.171306	32.47
S1EFC	Scar - Adult Female Sedona	Walking Around Platform	3.15	2.15	0.960523	3.13
S1EFC	Scar - Adult Female Sedona	Attempt to Solve Box	0.17	0.00	0	38.70
S1EFC	Scar - Adult Female Sedona	Present	20.00	10.72	6.189996	0.00
S2	Scar - Adult Female Sedona	Solve Box	-	-	-	24.97
S2	Scar - Adult Female Sedona	Jump Back	-	-	-	11.63
S2	Scar - Adult Female Sedona	Looking At Box	5.83	9.01	5.200395	16.83
S2	Scar - Adult Female Sedona	Move Food	-	-	-	24.80

S2	Scar - Adult Female Sedona	Walking Around Platform	7.58	9.43	5.441896	13.57
S2	Scar - Adult Female Sedona	Present	7.88	10.87	7.683257	6.77
S2EFC	Scar - Adult Female Sedona	Solve Box	-	-	-	18.74
S2EFC	Scar - Adult Female Sedona	Jump Back	-	-	-	4.48
S2EFC	Scar - Adult Female Sedona	Looking At Box	11.63	0.00	0	7.18
S2EFC	Scar - Adult Female Sedona	Move Food	-	-	-	18.74
S2EFC	Scar - Adult Female Sedona	Walking Around Platform	3.48	1.15	0.816658	7.94
S2EFC	Scar - Adult Female Sedona	Present	7.33	5.16	2.58221	0.98
S3	Scar - Adult Female Sedona	Jump Back	-	-	-	15.23
S3	Scar - Adult Female Sedona	Looking At Box	0.75	0.92	0.649994	53.77
S3	Scar - Adult Female Sedona	Eating	8.22	11.53	6.656388	31.67
S3	Scar - Adult Female Sedona	Present	44.93	0.00	0	15.07

S3.1EFC	Scar - Adult Female Sedona	Jump Back	-	-	-		7.76
S3.1EFC	Scar - Adult Female Sedona	Looking At Box	9.39	5.74	3.313396		0.00
S3.1EFC	Scar - Adult Female Sedona	Eating	3.50	0.00	0		45.59
S3.1EFC	Scar - Adult Female Sedona	Present	14.01	8.24	4.119514		0.00
S3.2EFC	Scar - Adult Female Sedona	Solve Box	-	-	-		15.85
S3.2EFC	Scar - Adult Female Sedona	Jump Back	-	-	-		10.55
S3.2EFC	Scar - Adult Female Sedona	Biting	-	-	-		10.42
S3.2EFC	Scar - Adult Female Sedona	Looking At Box	10.89	6.54	4.625524		0.00
S3.2EFC	Scar - Adult Female Sedona	Move Food	-	-	-		15.18
S3.2EFC	Scar - Adult Female Sedona	Present	12.55	2.94	1.698871		0.00
S3.5	Scar - Adult Female Sedona	Jump Back	-	-	-		14.16
S3.5	Scar - Adult Female Sedona	Looking At Box	1.37	1.04	0.329493		2.42

S3.5	Scar - Adult Female Sedona	Eating	0.70	0.00	0	54.79
S3.5	Scar - Adult Female Sedona	Walking Around Platform	1.78	0.58	0.259734	9.62
S3.5	Scar - Adult Female Sedona	Present	19.80	5.83	3.36423	0.00
S3EFC	Scar - Adult Female Sedona	Jump Back	-	-	-	9.17
S3EFC	Scar - Adult Female Sedona	Looking At Box	22.02	25.29	17.88285	14.00
S3EFC	Scar - Adult Female Sedona	Eating	39.63	0.00	0	15.50
S3EFC	Scar - Adult Female Sedona	Present	29.62	30.19	21.35009	0.00
S4	Scar - Adult Female Sedona	Biting	-	-	-	28.50
S4	Scar - Adult Female Sedona	Pecking	0.63	0.00	0	21.27
S4	Scar - Adult Female Sedona	Looking At Box	1.64	1.96	0.620702	13.93
S4	Scar - Adult Female Sedona	Walking Around Platform	3.04	0.86	0.494533	17.80
S4	Scar - Adult Female Sedona	Attempt to Solve Box	0.97	0.48	0.238579	31.97

S4	Scar - Adult Female Sedona	Present	54.90		0.00	0	5.10
S4.1EFC	Scar - Adult Female Sedona	Biting	-	-	-		10.63
S4.1EFC	Scar - Adult Female Sedona	Looking At Box	56.46		0.00	0	0.00
S4.1EFC	Scar - Adult Female Sedona	Foot Box	0.23		0.00	0	25.30
S4.1EFC	Scar - Adult Female Sedona	Walking Around Platform	1.67		0.80	0.355899	4.60
S4.1EFC	Scar - Adult Female Sedona	Attempt to Solve Box	0.94		0.19	0.09267	16.83
S4.1EFC	Scar - Adult Female Sedona	Present	60.00		0.00	0	0.00
S4.2EFC	Scar - Adult Female Sedona	Solve Box	-	-	-		39.03
S4.2EFC	Scar - Adult Female Sedona	Jump Back	-	-	-		39.26
S4.2EFC	Scar - Adult Female Sedona	Biting	-	-	-		33.60
S4.2EFC	Scar - Adult Female Sedona	Looking At Box	23.60		21.82	15.42866	0.00
S4.2EFC	Scar - Adult Female Sedona	Walking Around Platform	2.10		1.29	0.642605	0.00

S4.2EFC	Scar - Adult Female Sedona	Attempt to Solve Box	1.63	1.07	0.536616	3.96
S4.2EFC	Scar - Adult Female Sedona	Present	17.61	19.69	11.36881	0.00
S4.2EFC	Unknown	Present	1.00	0.00	0	59.00
S4.2EFC	Wimp - Adult Male Sedona	Present	60.00	0.00	0	0.00
S4.3EFC	Scar - Adult Female Sedona	Jump Back	-	-	-	20.34
S4.3EFC	Scar - Adult Female Sedona	Manipulating Other Objects	0.23	0.00	0	49.70
S4.3EFC	Scar - Adult Female Sedona	Looking At Box	24.24	15.37	10.86878	0.00
S4.3EFC	Scar - Adult Female Sedona	Eating	8.73	3.24	1.872986	15.34
S4.3EFC	Scar - Adult Female Sedona	Foot Box	5.25	5.26	2.147307	11.07
S4.3EFC	Scar - Adult Female Sedona	Walking Around Platform	4.13	0.00	0	0.90
S4.3EFC	Scar - Adult Female Sedona	Present	49.74	0.00	0	0.00
S4.3EFC	Unknown	Present	53.97	0.00	0	0.00
S4.3EFC	Wimp - Adult Male Sedona	Present	60.00	0.00	0	0.00
S4.5	Scar - Adult	Biting	-	-	-	11.72

	Female Sedona Scar - Adult					
S4.5	Female Sedona Scar - Adult	Looking At Box	0.97	0.81	0.363681	0.27
S4.5	Female Sedona Scar - Adult	Walking Around Platform	1.67	1.13	0.46319	5.02
S4.5	Female Sedona Scar - Adult	Attempt to Solve Box	1.59	1.14	0.343745	0.93
S4.75	Female Sedona Scar - Adult	Biting	-	-	-	26.25
S4.75	Female Sedona Scar - Adult	Looking At Box	7.88	10.61	4.743671	3.15
S4.75	Female Sedona Scar - Adult	Walking Around Platform	1.62	1.45	0.650088	6.32
S4.75	Female Sedona Scar - Adult	Attempt to Solve Box	1.18	0.68	0.189169	9.12
S4.85	Female Sedona Scar - Adult	Solve Box	-	-	-	53.83
S4.85	Female Sedona Scar - Adult	Biting	-	-	-	2.17
S4.85	Female Sedona Scar - Adult	Looking At Box	1.52	0.91	0.454092	14.03
S4.85	Female Sedona Scar - Adult	Walking Around Platform	1.82	1.70	0.852059	6.53
S4.85	Scar - Adult	Attempt to Solve Box	2.03	1.90	0.460224	4.53

	Female Sedona Scar - Adult					
S4.85	Female Sedona Scar - Adult	Present	54.63	0.00	0	0.00
S4.90	Female Sedona Scar - Adult	Jump Back	-	-	-	30.73
S4.90	Female Sedona Scar - Adult	Manipulating Other Objects	0.08	0.02	0.016367	58.47
S4.90	Female Sedona Scar - Adult	Looking At Box	2.38	2.56	0.683622	6.27
S4.90	Female Sedona Scar - Adult	Eating	1.94	2.12	0.748927	27.20
S4.90	Female Sedona Scar - Adult	Foot Box	10.42	1.84	1.064742	22.43
S4.90	Female Sedona Scar - Adult	Walking Around Platform	3.04	3.57	1.78388	2.90
S4.90	Female Sedona Scar - Adult	Present	29.75	1.39	0.983024	0.10
S4EFC	Female Sedona Scar - Adult	Biting	-	-	-	21.10
S4EFC	Female Sedona Scar - Adult	Looking At Box	51.87	0.00	0	8.13
S4EFC	Female Sedona Scar - Adult	Walking Around Platform	6.00	4.99	2.883128	15.47
S4EFC	Scar - Adult	Attempt to Solve Box	1.67	0.00	0	31.67

	Female Sedona Scar - Adult					
S4EFC	Female Sedona Scar - Adult	Present	29.42	36.18	25.58338	0.00
S5	Female Sedona Scar - Adult	Solve Box	-	-	-	34.50
S5	Female Sedona Scar - Adult	Biting	-	-	-	22.37
S5	Female Sedona Scar - Adult	Looking At Box	2.18	0.62	0.253808	7.93
S5	Female Sedona Scar - Adult	Walking Around Platform	2.08	1.19	0.685919	4.50
S5	Female Sedona Scar - Adult	Attempt to Solve Box	2.87	5.26	2.14663	8.90
S5	Female Sedona Scar - Adult	Present	34.23	0.00	0	0.77
S5EFC	Female Sedona Scar - Adult	Solve Box	-	-	-	34.43
S5EFC	Female Sedona Scar - Adult	Jump Back	-	-	-	34.56
S5EFC	Female Sedona Scar - Adult	Looking At Box	3.91	2.93	1.195757	0.00
S5EFC	Female Sedona Scar - Adult	Foot Box	3.63	0.00	0	20.73
S5EFC	Scar - Adult	Walking Around Platform	2.83	1.08	0.766659	4.20

	Female Sedona Scar - Adult					
S5EFC	Female Sedona Scar - Adult	Attempt to Solve Box	1.56	0.74	0.300449	8.80
S5EFC	Female Sedona Scar - Adult	Present	7.09	10.00	4.472322	0.00
S6	Female Sedona Scar - Adult	Looking At Box	3.99	2.26	1.305294	12.97
S6	Female Sedona Scar - Adult	Eating	39.83	0.00	0	20.17
S6	Female Sedona Scar - Adult	Walking Around Platform	1.93	1.16	0.471595	8.50
S6	Female Sedona Scar - Adult	Attempt to Solve Box	1.71	0.92	0.291744	22.07
S6	Female Sedona Scar - Adult	Present	53.70	0.00	0	6.30
S6.1EFC	Female Sedona Scar - Adult	Solve Box	-	-	-	20.48
S6.1EFC	Female Sedona Scar - Adult	Jump Back	-	-	-	20.78
S6.1EFC	Female Sedona Scar - Adult	Looking At Box	4.17	2.82	1.410959	0.00
S6.1EFC	Female Sedona Scar - Adult	Eating	1.30	0.00	0	3.81
S6.1EFC		Walking Around Platform	1.97	0.00	0	17.44

S6.1EFC	Female Sedona Scar - Adult	Attempt to Solve Box	1.42	0.78	0.391233	0.00
S6.1EFC	Female Sedona Scar - Adult	Present	21.01	0.00	0	0.00
S6.5	Female Sedona Scar - Adult	Solve Box	-	-	-	27.02
S6.5	Female Sedona Scar - Adult	Looking At Box	7.08	6.66	3.330538	5.36
S6.5	Female Sedona Scar - Adult	Walking Around Platform	15.53	0.00	0	23.76
S6.5	Female Sedona Scar - Adult	Attempt to Solve Box	2.78	4.41	1.559293	1.56
S6.5	Female Sedona Scar - Adult	Present	25.77	0.00	0	1.56
S60	Female Sedona Scar - Adult	Jump Back	-	-	-	14.12
S60	Female Sedona Scar - Adult	Biting	-	-	-	1.95
S60	Female Sedona Scar - Adult	Pecking	13.88	0.00	0	46.12
S60	Female Sedona Scar - Adult	Looking At Box	6.68	7.95	3.553128	4.45
S60	Scar - Adult	Walking Around Platform	12.70	0.00	0	15.55

S60	Female Sedona Scar - Adult	Attempt to Solve Box	13.97	0.00	0	19.55
S60	Female Sedona Scar - Adult	Present	8.29	8.92	3.369814	1.95
S6EFC	Female Sedona Scar - Adult	Biting	-	-	-	57.30
S6EFC	Female Sedona Scar - Adult	Looking At Box	4.94	3.67	1.223397	0.97
S6EFC	Female Sedona Scar - Adult	Eating	0.87	0.00	0	21.77
S6EFC	Female Sedona Scar - Adult	Walking Around Platform	3.60	1.55	0.895246	2.50
S6EFC	Female Sedona Scar - Adult	Attempt to Solve Box	1.07	0.36	0.181918	32.13
S6EFC	Female Sedona Scar - Adult	Present	19.86	13.59	7.843978	0.43
S7	Female Sedona Scar - Adult	Looking At Box	0.57	0.00	0	19.17
S7	Female Sedona Scar - Adult	Eating	7.51	5.80	2.898386	21.37
S7	Female Sedona Scar - Adult	Walking Around Platform	1.62	0.35	0.249697	12.70
S7	Scar - Adult	Present	54.17	0.00	0	5.83

	Female Sedona Scar - Adult					
S7.1EFC	Female Sedona Scar - Adult	Solve Box	-	-	-	30.63
S7.1EFC	Female Sedona Scar - Adult	Jump Back	-	-	-	30.79
S7.1EFC	Female Sedona Scar - Adult	Looking At Box	9.84	11.58	6.684939	0.00
S7.1EFC	Female Sedona Scar - Adult	Eating	2.54	1.08	0.623807	1.67
S7.1EFC	Female Sedona Scar - Adult	Walking Around Platform	4.40	0.00	0	12.76
S7.1EFC	Female Sedona Scar - Adult	Attempt to Solve Box	0.81	0.54	0.270242	19.89
S7.1EFC	Female Sedona Scar - Adult	Present	15.60	21.59	15.26363	0.00
S7.5	Female Sedona Scar - Adult	Solve Box	-	-	-	34.40
S7.5	Female Sedona Scar - Adult	Looking At Box	4.49	5.77	2.579692	0.83
S7.5	Female Sedona Scar - Adult	Eating	4.72	7.63	4.406026	7.23
S7.5	Female Sedona Scar - Adult	Walking Around Platform	4.40	0.00	0	16.37
S7.5	Scar - Adult	Attempt to Solve Box	2.20	3.99	1.204316	1.83

	Female Sedona Scar - Adult					
S7.5	Female Sedona Scar - Adult	Present	34.80	0.00	0	0.00
S7EFC	Female Sedona Scar - Adult	Jump Back	-	-	-	1.67
S7EFC	Female Sedona Scar - Adult	Looking At Box	6.96	6.99	2.640503	2.40
S7EFC	Female Sedona Scar - Adult	Eating	1.60	0.66	0.191548	17.30
S7EFC	Female Sedona Scar - Adult	Walking Around Platform	1.82	0.12	0.083333	8.24
S7EFC	Female Sedona Scar - Adult	Attempt to Solve Box	0.63	0.00	0	58.17
S7EFC	Female Sedona Scar - Adult	Present	29.70	40.68	28.76395	0.00
S8	Female Sedona Scar - Adult	Solve Box	-	-	-	10.70
S8	Female Sedona Scar - Adult	Present	1.60	0.00	0	10.53
S8EFC	Female Sedona Scar - Adult	Solve Box	-	-	-	10.50
S8EFC	Female Sedona Scar - Adult	Jump Back	-	-	-	10.57
S8EFC	Scar - Adult	Present	6.97	5.92	3.417612	0.00

S9	Female Sedona Scar - Adult Female Sedona Scar - Adult	Walking Around Platform	3.82	1.53	1.083323	13.60
S9	Female Sedona Scar - Adult	Attempt to Solve Box	0.87	0.48	0.277553	16.97
S9	Female Sedona Scar - Adult	Present	53.57	0.00	0	6.43
S9.1EFC	Female Sedona Scar - Adult	Biting	-	-	-	37.05
S9.1EFC	Female Sedona Scar - Adult	Looking At Box	3.79	2.72	0.82088	0.00
S9.1EFC	Female Sedona Scar - Adult	Eating	2.67	2.37	0.969351	10.72
S9.1EFC	Female Sedona Scar - Adult	Walking Around Platform	1.62	0.54	0.269213	1.39
S9.1EFC	Female Sedona Scar - Adult	Attempt to Solve Box	0.82	0.37	0.212856	42.82
S9.1EFC	Female Sedona Scar - Adult	Present	60.00	0.00	0	0.00
S9.25	Female Sedona Scar - Adult	Looking At Box	1.05	1.09	0.487574	27.58
S9.25	Female Sedona Scar - Adult	Eating	3.31	2.18	1.089958	3.01
S9.25	Female Sedona Scar - Adult	Walking Around Platform	5.28	8.46	4.230108	1.14

	Female Sedona Scar - Adult					
S9.25	Female Sedona Scar - Adult	Attempt to Solve Box	0.87	0.38	0.126685	15.98
S9.25	Female Sedona Scar - Adult	Present	58.86	0.00	0	1.14
S9.2EFC	Female Sedona Scar - Adult	Solve Box	-	-	-	14.62
S9.2EFC	Female Sedona Scar - Adult	Jump Back	-	-	-	14.89
S9.2EFC	Female Sedona Scar - Adult	Biting	-	-	-	7.96
S9.2EFC	Female Sedona Scar - Adult	Looking At Box	3.03	2.64	1.321743	0.00
S9.2EFC	Female Sedona Scar - Adult	Attempt to Solve Box	0.20	0.00	0	12.59
S9.2EFC	Female Sedona Scar - Adult	Present	15.06	0.00	0	0.00
S9.5	Female Sedona Scar - Adult	Solve Box	-	-	-	49.39
S9.5	Female Sedona Scar - Adult	Eating	5.52	5.11	2.949505	1.79
S9.5	Female Sedona Scar - Adult	Attempt to Solve Box	2.84	3.17	1.057088	10.99
S9.5	Scar - Adult	Present	47.90	0.00	0	1.79

	Female Sedona Scar - Adult					
S9EFC	Female Sedona Scar - Adult	Looking At Box	6.12	5.30	2.003819	6.49
S9EFC	Female Sedona Scar - Adult	Eating	1.57	0.76	0.311673	18.49
S9EFC	Female Sedona Scar - Adult	Walking Around Platform	1.48	0.17	0.096863	11.43
S9EFC	Female Sedona Scar - Adult	Attempt to Solve Box	1.23	0.00	0	40.49
S9EFC	Female Sedona Bounce - Adult	Present	29.77	37.86	26.77383	0.00
T1.00	Male Tucson Bounce - Adult	Solve Box	-	-	-	51.30
T1.00	Male Tucson Bounce - Adult	Jump Back	-	-	-	25.73
T1.00	Male Tucson Bounce - Adult	Looking At Box	10.87	0.00	0	49.13
T1.00	Male Tucson Bounce - Adult	Eating	7.37	0.00	0	35.50
T1.00	Male Tucson Bounce - Adult	Attempt to Solve Box	10.00	0.00	0	50.00
T1.00	Male Tucson Bounce - Adult	Present	27.07	0.00	0	24.97
T1EFC	Bounce - Adult	Jump Back	-	-	-	18.94

	Male Tucson Bounce - Adult					
T1EFC	Male Tucson Bounce - Adult	Manipulating Other Objects	1.67	0.00	0	44.04
T1EFC	Male Tucson Bounce - Adult	Looking At Box	10.27	10.23	7.233261	19.84
T1EFC	Male Tucson Bounce - Adult	Eating	6.42	1.25	0.883325	2.34
T1EFC	Male Tucson Bounce - Adult	Calling	0.10	0.00	0	45.70
T1EFC	Male Tucson Bounce - Adult	Present	22.48	6.39	4.516622	0.60
T2.00	Male Tucson Bounce - Adult	Looking At Box	3.77	1.06	0.532459	21.33
T2.00	Male Tucson Bounce - Adult	Attempt to Solve Box	0.63	0.00	0	31.07
T2.00	Male Tucson Bounce - Adult	Present	10.71	5.86	3.382401	7.23
T2.1EFC	Female Tucson Bully - Adult	Jump Back	-	-	-	25.60
T2.1EFC	Female Tucson Bully - Adult	Biting	-	-	-	25.37
T2.1EFC	Female Tucson Bully - Adult	Manipulating Other Objects	0.30	0.13	0.076979	46.03
T2.1EFC	Bully - Adult	Looking At Box	26.08	5.35	3.783595	3.43

	Female Tucson Bully - Adult					
T2.1EFC	Female Tucson Bully - Adult	Eating	1.60	0.00	0	43.67
T2.1EFC	Female Tucson Bounce - Adult	Present	19.48	16.02	9.251675	0.53
T2.25	Male Tucson Bounce - Adult	Jump Back	-	-	-	47.86
T2.25	Male Tucson Bounce - Adult	Looking At Box	19.93	9.00	6.366603	5.20
T2.25	Male Tucson Bounce - Adult	Attempt to Solve Box	0.77	0.44	0.165633	26.70
T2.25	Male Tucson Bully - Adult	Present	27.73	4.20	2.968285	2.33
T2.2EFC	Female Tucson Bully - Adult	Jump Back	-	-	-	11.34
T2.2EFC	Female Tucson Bully - Adult	Biting	-	-	-	1.97
T2.2EFC	Female Tucson Bully - Adult	Manipulating Other Objects	1.73	1.05	0.471683	11.01
T2.2EFC	Female Tucson Bully - Adult	Looking At Box	14.49	9.17	6.486581	0.00
T2.2EFC	Female Tucson Bully - Adult	Eating	2.07	0.00	0	2.87
T2.2EFC	Bully - Adult	Present	11.07	9.01	5.199081	0.00

	Female Tucson Bounce - Adult Male						
T2.50	Tucson Bounce - Adult Male	Solve Box	-	-	-		33.32
T2.50	Tucson Bounce - Adult Male	Jump Back	-	-	-		10.42
T2.50	Tucson Bounce - Adult Male	Biting	-	-	-		6.59
T2.50	Tucson Bounce - Adult Male	Attempt to Solve Box	3.78	5.17	1.95517		0.92
T2.50	Tucson Bounce - Adult Male	Present	21.07	2.03	1.434164		0.92
T2EFC	Tucson Bully - Adult Female	Looking At Box	9.22	4.86	2.807655		7.30
T2EFC	Tucson Bully - Adult Female	Present	7.65	5.09	2.076047		2.37
T3.00	Tucson Fledgling s -	Jump Back	-	-	-		40.97
T3.00	Tucson Fledgling s -	Move Food	-	-	-		10.53
T3.00	Tucson Fledgling s -	Walking Around Platform	49.47	0.00	0		10.53
T3.00	Tucson Fledgling s -	Present	26.83	1.70	1.200288		2.83
T3.15	Tucson Fledgling s -	Move Food	-	-	-		14.58
T3.15	Tucson	Present	12.87	10.94	5.468545		0.64

T3.1EFC	Fledglings - Tucson	Eating	4.78	3.29	1.902135	2.57
T3.1EFC	Fledglings - Tucson	Move Food	-	-	-	10.90
T3.1EFC	Fledglings - Tucson	Present	30.00	36.21	25.60411	0.00
T3.25	Fledglings - Tucson	Looking At Box	3.42	2.47	1.749683	27.47
T3.25	Fledglings - Tucson	Move Food	-	-	-	0.63
T3.25	Fledglings - Tucson	Walking Around Platform	3.80	0.00	0	32.63
T3.25	Fledglings - Tucson	Present	19.79	21.88	12.63399	0.63
T3.2EFC	Fledglings - Tucson	Looking At Box	10.82	10.54	6.088083	4.97
T3.2EFC	Fledglings - Tucson	Eating	4.31	2.45	1.227171	0.36
T3.2EFC	Fledglings - Tucson	Present	19.88	20.70	11.95264	0.36
T3.35	Fledglings - Tucson	Looking At Box	11.71	6.84	3.947596	2.90
T3.35	Fledglings - Tucson	Walking Around Platform	5.07	0.00	0	11.40
T3.35	Fledglings - Tucson	Attempt to Solve Box	3.50	0.00	0	44.67
T3.35	Fledglings - Tucson	Present	59.40	0.00	0	0.60
T3.3EFC	Fledglings - Tucson	Solve Box	-	-	-	51.01
T3.3EFC	Fledglings - Tucson	Looking At Box	17.12	17.59	10.15534	0.28

T3.3EFC	Fledglings - Tucson	Attempt to Solve Box	7.02	9.59	6.783266	23.64
T3.3EFC	Fledglings - Tucson	Present	59.72	0.00	0	0.28
T3.50	Fledglings - Tucson	Move Food	-	-	-	19.71
T3.50	Fledglings - Tucson	Walking Around Platform	4.09	1.05	0.606848	4.35
T3.50	Fledglings - Tucson	Present	29.26	31.87	22.53898	1.48
T3EFC	Fledglings - Tucson	Jump Back	-	-	-	40.30
T3EFC	Fledglings - Tucson	Looking At Box	16.00	22.34	12.89599	1.43
T3EFC	Fledglings - Tucson	Eating	1.17	0.00	0	13.97
T3EFC	Fledglings - Tucson	Move Food	-	-	-	9.43
T3EFC	Fledglings - Tucson	Present	19.80	12.37	7.143274	0.60
T4.00	Fledglings - Tucson	Looking At Box	2.63	0.00	0	14.97
T4.00	Fledglings - Tucson	Present	6.73	4.04	2.021943	0.83
T4EFC	Fledglings - Tucson	Solve Box	-	-	-	16.90
T4EFC	Fledglings - Tucson	Jump Back	-	-	-	17.23
T4EFC	Fledglings - Tucson	Looking At Box	2.93	2.97	2.099979	8.60
T4EFC	Fledglings - Tucson	Walking Around Platform	2.80	0.00	0	12.87

T4EFC	Fledglings - Tucson	Present	7.10	4.93	2.465911	0.00
T5.00	Fledglings - Tucson	Present	12.52	8.88	4.43785	4.07
T5EFC	Fledglings - Tucson	Solve Box	-	-	-	20.70
T5EFC	Fledglings - Tucson	Looking At Box	18.47	0.00	0	7.47
T5EFC	Fledglings - Tucson	Attempt to Solve Box	3.10	0.00	0	10.17
T5EFC	Fledglings - Tucson	Present	26.20	3.16	2.233611	6.73
T5EFC	Unknown	Present	60.00	0.00	0	0.00
T6.00	Fledglings - Tucson	Biting	-	-	-	17.83
T6.00	Fledglings - Tucson	Walking Around Platform	1.60	0.00	0	2.10
T6.00	Fledglings - Tucson	Present	17.63	17.58	12.43321	1.30
T6EFC	Fledglings - Tucson	Solve Box	-	-	-	13.27
T6EFC	Fledglings - Tucson	Biting	-	-	-	16.03
T6EFC	Fledglings - Tucson	Looking At Box	14.63	1.13	0.799992	0.00
T6EFC	Fledglings - Tucson	Present	18.18	16.95	11.98321	0.00
T7.00	Fledglings - Tucson	Eating	9.56	1.49	0.859003	13.60
T7.00	Fledglings - Tucson	Present	27.15	32.60	23.05007	5.70

T7.1EFC	Fledglings - Tucson	Jump Back	-	-	-	50.79
T7.1EFC	Fledglings - Tucson	Looking At Box	19.83	0.00	0	30.96
T7.1EFC	Fledglings - Tucson	Present	20.30	0.00	0	30.49
T7.1EFC	Unknown	Solve Box	-	-	-	38.43
T7.1EFC	Unknown	Jump Back	-	-	-	40.46
T7.1EFC	Unknown	Biting	-	-	-	23.23
T7.1EFC	Unknown	Looking At Box	15.93	8.09	4.668176	0.00
T7.1EFC	Unknown	Eating	11.39	0.00	0	0.00
T7.1EFC	Unknown	Present	29.53	30.07	21.26047	0.00
T7.25	Fledglings - Tucson	Move Food	-	-	-	3.38
T7.25	Fledglings - Tucson	Present	29.24	30.30	21.42503	0.65
T7.50	Fledglings - Tucson	Present	16.43	0.00	0	42.08
T7EFC	Fledglings - Tucson	Jump Back	-	-	-	5.87
T7EFC	Fledglings - Tucson	Looking At Box	8.95	5.26	2.628538	6.57
T7EFC	Fledglings - Tucson	Eating	32.77	0.00	0	13.23
T7EFC	Fledglings - Tucson	Walking Around Platform	5.33	0.00	0	53.43
T7EFC	Fledglings - Tucson	Present	17.74	18.26	10.54353	5.53
T7EFC	Unknown	Biting	-	-	-	36.50
T7EFC	Unknown	Looking At Box	26.03	0.00	0	22.23
T7EFC	Unknown	Eating	6.68	1.53	1.083023	43.87
T7EFC	Unknown	Present	19.38	2.10	1.483019	21.23
rff6.55	Einstein	Manipulating Other Objects	4.27	0.00	0	12.15
rff6.55	Einstein	Looking At Box	56.58	0.00	0	3.42

rff6.55	Einstein	Walking Around Platform	2.33	0.00	0	18.25
rff6.55	Einstein	Attempt to Solve Box	3.40	2.42	0.913888	7.62
rff6.55	Einstein	Present	15.23	18.56	10.7176	0.82

References

Auersperg, A.M.I, Bayern, A.M.P., Gajdon, G.K., Huber, L., & Kacelnik, A. (2011). Flexibility in problem solving and tool use of kea and New Caledonian crows in a multi access box paradigm. *PLoSONE*, 6 (6), e20231. doi: 10.1371/journal.pone.0020231

BBC Worldwide. (2007, February 12). Wild crows inhabiting the city use it to their advantage, hosted by David Attenborough. *BBC Wildlife.* Retrieved from http://youtu.be/BGPGknpq3e0

Benson-Amram, S., Dantzer, B., Stricker, G., Swanson, E.M., & Holekamp, K.E. (2015). Brain size predicts problem-solving ability in mammalian carnivores. Proceedings of the National Academy of Sciences, 113(9), 2,532 – 2,537. doi:10.1073/pnas.1505913113

Bird Brain. (2005). PBS: NOVA. Retrieved from http://www.pbs.org/wgbh/nova/sciencenow/3214/03-brain.html

Bugnyar, T. & Kotrschal, K. (2002). Observational learning and the raiding of food caches in ravens, *Corvus corax*: is it ‘tactical’ deception?. *Animal Behaviour*, 64 (2), 185-195.

Bugnyar, T., Stöwe, M., & Heinrich, B. (2004). Ravens, Corvus corax, follow gaze direction of humans around obstacles. *The Royal Society, 271*, 1331 – 1336.

Caspari, E. (2003). *Animal life in nature, myth and dreams*. Wilmette, IL: Chiron Publications.

Cory, E.F. (2012). *Rule governance in an African white-necked raven (Corvus albicollis)*. Retrieved from University of Arizona Repository.

deCalesta, D.S. (1980). Predation by coyotes and other animals. Oregon State University Extension Service. Retrieved from http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/24574/ECNO909.pdf?sequence=1

Dvorsky, G. (2013). A new equation reveals our exact odds of finding alien life. *Io9.* Retrieved from http://io9.com/what-a-brand-new-equation-reveals-about-our-odds-of-fin-531575395

Emery, N.J., & Clayton, N.S. (2004). The mentality of crows: Convergent evolution of intelligence in corvids and apes. *Science, 306,* 1903 – 1907.

Ewins , P.J., Dymond, J.N., & Marquiss M. (1986). The distribution, breeding and diet of Ravens Corvus corax in Shetland, *Bird Study*, *33*(2), 110-116. doi:10.1080/00063658609476906

Eyre, M. (2014). Complex organic molecule found in interstellar space. *BBC: Science and Environment*. Retrieved from http://www.bbc.com/news/science-environment-29368984

Filmer, J. (2013, December 19). Crows could be the key to helping humanity understand alien intelligence. *From Quarks to Quasars.* Retrieved from http://www.fromquarkstoquasars.com/crows-could-be-the-key-to-helping-humanity-understand-alien-intelligence/

Fraser O.N., Bugnyar T. (2010) Do ravens show consolation? Responses to distressed others. *PLoS ONE 5*(5): e10605. doi:10.1371/journal.pone.0010605

Furlong, E.E., Boose, K.J., & Boysen S.T. (2008) Raking it in: the impact of enculturation on chimpanzee tool use. *Animal Cognition*, 11(1), 83-97. doi:10.1007/s10071-007-0091-6

Garcia, J. & Gustavson, A.R. (1997). Carl R. Gustavson (1946-1996) Pioneering Wildlife Psychologist. *Association for Psychological Science; Observer*, 10(1), 34-35.

Gill, F.B. (1995). *Ornithology*. New York, NY: W. H. Freeman and Company.

Heinrich, B. (1988). Why do ravens fear their food? *The Condor*, 90(4), 950-952. doi: 10.2307/1368859

Heinrich, B. (1995). An Experimental Investigation of Insight in Common Ravens (Corvus corax). *The Auk*, 112 (4), 994-1003.

Immelmann, K. & Beer, C. (1989). A dictionary of ethology. Cambridge, MA: Harvard University Press.

Madden, C.F., Arroyo, B., & Amar, A. (2015). A review of the impacts of corvids on bird productivity and abundance**.** *Ibis*, 157(1), 1-16. doi:10.1111/ibi.12223

Massen, J.J.M., Pašukonis, A., Schmidt, J., & Bugnyar, T. (2014). Ravens notice dominance reversals among conspecifics within and outside their social group. *Nature Communications, 5*(3679). doi: 10.1038/ncomms4679

Massen, J.J.M., Ritter, C., & Bugnyar, T. (2015). Tolerance and reward equity predict cooperation in ravens (Corvus corax). *Scientific Reports 5*, 15021. doi:10.1038/srep15021

Marzluff, J.M., Walls, J., Cornell, H.N., Withey, J.C., & Craig, D.P. (2010). Lasting recognition of threatening people by wild American crows. *Animal Behaviour, 79(3)*, 699 – 707.

McLeod, S. A. (2007). Edward Thorndike. Retrieved from www.simplypsychology.org/edward-thorndike.html

Miyata, H., Gajdon, G.K., Huber, L., & Fujita, K. (2011). How do keas (Nestor notabilis) solve artificial-fruit problems with multiple locks?. *Animal Cognition*, 14, 45 – 58. doi: 10.1007/s10071-010-0342-9

NASA. (2015, September 28). NASA confirms evidence that liquid water flows on today's Mars. Retrieved from https://www.nasa.gov/press-release/nasa-confirms-evidence-that-liquid-water-flows-on-today-s-mars

NASA Exoplanet Archive. (2015, October 15). Retrieved from http://exoplanetarchive.ipac.caltech.edu/

New Avian Brain Terminology. (n.d.) Retrieved from http://avianbrain.org/new_terminology.html

Newitz, A. (2013, December 16). Crows could be the key to understanding alien intelligence. *io9*. Retrieved from http://io9.com/crows-could-be-the-key-to-understanding-alien-intellige-1480720559

Pepperberg, I.M. (1999). The Alex studies: cognitive and communicative abilities of grey parrots. Cambridge, MA: Harvard University Press.

Premack, D. & Woodruff, G. (1978). Does the chimpanzee have a theory of mind?. *The Behavioral and Brain Sciences*, 4, 515 – 526.

Prior, H., Schwarz, A., & Güntürkün, O. (2008). Mirror-induced behavior in the magpie (*Pica pica*): Evidence of self-recognition. *PLoS Bio, 6*(8), 1642-1650. doi: 10.1371/journal.pbio.0060202

Reid, B. & Bringhurst, R. (1984). The raven steals the light. Vancouver, Canada: Douglas & McIntyre.

Shanahan, M., Bingman, V.P., Shimizu, T., Wild, M., & Güntürkün, O. (2013). Large-scale network organization in the avian forebrain: a connectivity matrix and theoretical analysis. *Frontiers in Computational Neuroscience*, 7. doi: 10.3389/fncom.2013.00089

Starovecká, Z. (2010). Ravens and crows in mythology, folklore, and religion. *Perspectives*. Retrieved from http://www.perspectivesmagazine.sk/news/ravens-and-crows-in-mythology-folklore-and-religion/

Stiehl, R.B., & Trautwein, S.N. (1991). Variation in diets of nesting common ravens. *The Winson Bulletin, 103*(1), 83-92.

Smith, B. (2014, April 4). Poisoning ravens to save sage grouse? *Times-News*. Retrieved from http://magicvalley.com/news/local/poisoning-ravens-to-help-sage-grouse/article_4cd847e4-bbae-11e3-82ee-001a4bcf887a.html

Taylor, A.H., Hunt, G.R., Holzhaider, J.C., & Gray, R.D. (2007). Spontaneous Metatool Use by New Caledonian Crows. *Current Biology, 17*, 1504 – 1507.

The Drake Equation. (2015). The SETI Institute. Retrieved from http://www.seti.org/drakeequation

Thuermer Jr, A.M. (2014, August 5). Poison a tool in Wyoming's war on ravens. *Wyofile*. Retrieved from http://wyofile.com/angus_thuermer/poison-tool-wyomings-war-ravens/

Tomasello, M., & Call, J. (2004). The role of humans in the cognitive development of apes revisited. *Animal Cognition, 7*, 213 – 215. doi: 10.1007/s10071-004-0227-x

Veit, L., & Nieder, A. (2013). Abstract rule neurons in the endbrain support intelligent behaviour in corvid songbirds. *Nature Communications, 4*(2878), 1 – 11. doi: 10.1038/ncomms3878