5-2017

A Discussion Regarding Various Animals' Abilities to Make Music and Move Rhythmically to Songs

Emilie R. Bufford
California State University, Monterey Bay, ebufford@csumb.edu

A Discussion

Regarding Various Animals' Abilities to

Make Music and Move Rhythmically to Songs

By

Emilie Bufford

A Capstone Project

B.A., California State University, Monterey Bay, 2017

Abstract

This project involves exploring the presence of music and rhythmic abilities in specific animal species. The main subjects are whales, sea lions, gorillas, elephants, birds, and mice. The goal of this project was to compare their abilities to those of humans, and overall, determine whether such abilities are considered musical. Cases where animals demonstrate the ability, both learned and innate, to move to a beat are analyzed, along with animals who demonstrate musical vocal abilities naturally in the wild. The previously unknown frequencies of whales, mice, and elephants, are brought to light. These findings bring up the possibility of even more animals having musical abilities than those examined in this project.

Music is a fluid, ever-changing entity, evolving with time. Most people would agree they enjoy listening to music. Some seek it actively and incorporate it into every aspect of their lives, while there are those who could take it or leave it. The enjoyment of of music comes from different aspects such as culture, what music one has been exposed to already, and personal preference. However, it can be argued that humans are not the only animals capable of creating it.

If music is "a combination of sounds, and sound in vibration" according to *Psychology Today*, or "an agreeable sound," from *Merriam-Webster*, then does every creature on Earth have the capability of creating it? Dissected, music is comprised of sound. Sound is the vibration of air particles called *sound waves* (Science Buddies). Under these guidelines, the range of what can be called music is vast. However, in general, music needs to have at least one or more of the following elements: pitch, rhythm, melody, timbre, dynamics, and texture, for it to be considered musical (Estrella).

Humans are known for their egos with where they fit into the world. Most see themselves at the very top of the food chain, and therefore, at the very top of the world. Because of their "'more complex'" brains, opposable thumbs, and domination of much of the natural surroundings, humans believe they are above all other creatures. This mindset can interfere with the true reality: despite the plethora of knowledge scientists have gathered throughout the centuries, there is still much humans do not understand.

Throughout time, people have appreciated the sounds of nature". As modern societies have grown farther apart from the natural world, perhaps people appreciate them even more. There are recordings available for those who are having trouble sleeping, want help with concentration, or relaxation, that incorporate nature sounds: frog choruses, crickets, birds, etc. People travel to places where nature is more abundant to relax. Studies have found benefits to listening to birdsong such as improved mood and attention (Winterman).

Composers throughout the centuries have heard music in the voices of nature. One 15th - 16th century French composer, Josquin des Prez, heard it in the voice of the cricket. He composed a song called, "El Grillo", *the cricket* in Italian. The piece was inspired by its namesake as des Prez explained: "The cricket is a good singer…[he] always stays put, and when the weather is hottest, he sings solely for love" (qtd. In Shulbank-Smith). Nikolai Rimsky-Korsakov, another composer validating an animal's voice, wrote the famous piece, "Flight of the Bumblebee" in his opera *The Tale of the Tsar Saltan*. In the plot, a magical swan turns a prince into a bumblebee so that he can be invisible to the Tsar. The piece emulates the movements of a bumblebee using the different instruments: violin, flute, and other strings (Cummings).

Humans generally enjoy singing. Many can attest to singing in the shower, humming while they do an activity, or even sometimes, while they eat. Singing in a group releases oxytocin, a stress-managing chemical, into our bodies. Feelings of trust and bonding are also enhanced (Horn). Our closest relatives, gorillas, have been found to hum while they eat together. "Each gorilla has its own voice: you can really tell who's singing," said Ali Vella-Irving, keeper at Toronto Zoo in Canada "And if it's their favourite food, they sing louder"(Daily News). Primatologist Eva Luef studied wild gorillas to see if they hummed as well. She discovered two unique types of vocalizations gorillas make while eating. One is a low-frequency sound similar to humming. When heard, it resembles a groaning sound. Luef said it is “a bit like a sigh of contentment”. The second recording is even more melodic. Also a deep tone, it sounds very much like a human humming. “They don’t sing the same song over and over,” Luef continued. “It seems like they are composing their little food songs” (*Wild Gorillas Compose Happy Songs That They Hum during Meals*).

Other wild animals sing too. The Northern Mockingbird chooses specific birds to mimic that are close to its own vocal range. Each mockingbird has its own unique repertoire, accumulated and refined over the course of its lifetime (The Cornell Lab of Ornithology). In many different cultures of the world, someone will break into song, and the rest will follow suit. The Northern Pacific Treefrogs create choruses where one frog will “break the silence” as it were, and the rest will join in (*Sounds of Northern Pacific Treefrog*). These are just a few examples of the many voices of nature.

Birds learn song in two stages. The first, sensory learning, involves the juvenile listening to its father, and other birds of its species, and memorizing what they hear. Songs are not exclusive to males. The second stage, sensorimotor learning, involves the juvenile producing its own songs and practicing them until it matches the “song template”. Birds are able to learn songs because they possess mirror neurons. These neurons were first discovered in macaque monkeys. However, more recent research shows these neurons to be present in other animals, humans included (Welberg). These neurons exhibit both sensory and motor properties. They are also “action-specific,” meaning they are only active when “the individual is performing or observing a certain type of action” (Levy).

Apparently, many bird species have cognitive abilities that surpass the abilities of mammals. It is even said corvids (the crow family) and parrots are the most superior cognition-wise, competing with great apes. These birds "share with humans and a few other animal groups a rare capacity for vocal learning, and parrots can learn words and use them to communicate with humans" (Olkowicza).

To address the vocal mimicry aspect of other birds, there are some species known to have very complex song abilities. These include Canaries, Zebra Finches, and Marsh Wrens. The complexity of song seems to be determined by certain factors (Ehrlich). Neurobiologist Fernando Nottebohm has worked primarily on the basic biology of vocal learning in birds. He and his colleagues came across that "seem to have no function other than their involvement in the acquisition and production of learned song" (Leonhardt). Nottebohm also found the Pacific Coast Marsh Wren to have a song repertoire three times larger than Atlantic Coast birds. This seems to be because their brains show a 30-40% larger "song control area" (Ehrlich).

Birds, like humans, have an innate urge to sing. It has been discovered that birds raised away from other birds will still sing. In 1954, professor of animal ethology, William Thorpe, conducted experiments. He isolated birds and found they produce "isolate song," which resembles a wild bird's song but has very different characteristics. Isolate songs also lack the complexity of wild bird songs. In these studies, birds were also deafened before a certain crucial period of development called song-crystallization. These birds still sang, but their songs were even more different from the isolate and wild bird songs (Baker).

An African Grey, also named Ollie, mimicked the song “Always Look on the Bright Side of Life” after their owner played it on the piano (DandTbird). In this situation when the person began playing piano, Ollie began making a clicking noise to imitate someone snapping their fingers. He even did the motion of “snapping” with his foot. He was clicking right on the beat except for a slight delay once. This might have been because the person playing had paused slightly, throwing the bird off tempo. Or Ollie was listening to the tempo and matching the delay. The person played the tune again, and Ollie sang the notes. His pitch was exact. He added a few extra notes, but they were all within the correct key. He paused after the first half, the person played it again, and he imitated the second part. The film is edited to show that Ollie had moved around on his perch. It is not completely known how long this process took place or how long he paused in between singing. This could indicate he did not always mimic the song directly after it was played. Or it could have been the person paused the recording for some reason. Ollie was also rewarded with praise at the end. There are many examples of male birds singing and dancing. However, females are not exempt from these abilities, and they also sing in 71% of songbird specie” (Morell).

Human babies learn speech the same way baby birds learn song: by listening to adults. Scientists have found many similarities between humans and birds. Exploration and research is still being conducted on the reason why the “forebrain regions” in both birds and humans, which are distantly related vocal learners, are similar. The research of neurobiologist Erich Jarvis suggests the pathways in both brains evolved before the “split from the common ancestor of birds and mammals” (Jarvis). Evidence also suggests that possibly all vertebrates are capable of auditory learning. However, very few of these have the ability of vocal learning. Vocal learning has only been studied in parrots, hummingbirds, songbirds, and humans. Auditory learning is "the ability to make sounds associations, such as a dog learning how to respond to the sound 'sit'," whereas vocal learning "is the ability to imitate sounds that you hear, such as a human or a parrot imitating the sound 'sit'" (Jarvis). The knowledge obtained from birds has been helping to shed light on the neurology responsible for human speech (Jarvis).

Aside from singing, another important component of music is rhythm. It can even be argued that rhythm is the very root from which music evolved as the " tendency to move in rhythmic synchrony with a musical beat (e.g., via head bobbing, foot tapping, or dance) is a human universal"(Patel). Many cultures value rhythm above all other aspects, making the beat the focus. However, there have been many claims that only animals with vocal mimicry capabilities have the ability to follow rhythm. Vocal mimicry is "when an individual learns a sound from another species or the environment" (Kelley).

Internet sensation Snowball the sulphur-crested cockatoo is credited as the one of the first non-human vocal mimics to demonstrate rhythm. He first came to the Bird Lovers Only Rescue site in 2007 because he required more attention than his owner at the time could provide. The Bird Lovers Only Rescue is a non-profit bird sanctuary for neglected, unwanted, abused, special-needs parrots. The organization's goal is to give these parrots a new home, as well as to educate the public about these birds (Bird Lovers Only Rescue). Snowball, a permanent resident, is the sanctuary's mascot. The organization observed the more applause and praise Snowball gained from the audience, the more enthusiastic and animated he became (Bird Lovers Only Rescue). Snowball's first owner recounted he and his children would encourage his dancing with their own rhythmic gestures (Ball).

Irena Schulz, CEO of Bird Lovers Only Rescue and Snowball's keeper and agent, performed a "two-tempo study" experiment with Snowball that sought "to study whether the social aspect of dancing with a partner would take precedence over dancing to the rhythm that was audible to Snowball® or vice versa" (Bird Lovers Only Rescue). Schulz would dance along with Snowball and would start to purposefully dance off tempo. Snowball appeared to become frustrated by this. Schulz said he would try and dance with her but would then stop when her rhythm did not match the music. He would turn his back to her and continue dancing in time with the music. Occasionally, he would peek over his shoulder at her, but this appeared to "throw off his groove." Then he would pause and continue dancing. The evidence of the experiment showed Snowball chose keeping the rhythm over the social aspect of the activity: "He would prefer to dance with me absent any music than to dance with me if I were not dancing on the beat of the song playing. This shows us that Snowball® has the ability to analyze the beat" (Bird Lovers Only Rescue). Snowball's actions are a prime example demonstrating not only the ability, but the drive of a non-human animal to move their body along with a beat simply for the sake of movement. This is dancing. Dance is defined as "[moving] one's body rhythmically usually to music" (*Dance*).

One of the most popular videos of Snowball dancing is to the Queen song "Another One Bites the Dust" (Bird Lovers Only). For the most part, with exceptions to a few changes in dynamics, Snowball moves right on the beat. The video begins right as the song begins.

Snowball, perched atop an arm chair, waits for a few seconds. Then he puffs his feathers out, his yellow crest flares up, and he immediately begins bobbing his head and body in rhythm. He starts moving his left foot up and down to the tempo along with alternating each of his feet in time. A voice, presumably Schulz's, can be heard saying, “Yeah! Go Snowball!” as he continues to move. Ten seconds in, his crest is completely flared and it goes up and down depending on how enthusiastically he is moving. Forty-three seconds into the song, and he begins “banging” his head up and down like a human head-banging at a concert. His crest is held very high, indicating great excitement. He does this for about 7 seconds before scooting further over to the left. He dances emphatically for the entirety of the song, which is three minutes and 48 seconds long. He is not given any treats at any point during the song, and he appears to want to continue dancing even when the song ends. It takes him several seconds to stop dancing. He seems to respond strongest to the sections of the song where the beat is heaviest and stands out the most.

Snowball’s ability to follow a beat is known as beat perception and synchronization, or BPS. The presence of BPS in a specimen equates to having many other neural capacities other than the ability to mimic sounds. BPS has become known as a new form of rhythmic synchronization in animals that were once believed to not have the ability. As a bird, especially a parrot, Snowball and his kind are more well known for their vocalization abilities. Snowball’s skill opens up the possibility that other species could have similar rhythmic abilities.

Snowball is not the only of his kind with the ability to move in rhythm. Although he is a particularly talented and motivated cockatoo, others have also been recorded doing similar actions in response to music. An umbrella cockatoo named Ollie responded to his owner playing guitar and singing an Elvis song (Jukinmedia.com). Like Snowball, Ollie responded immediately with similar movements and body language. However, he did not move in tempo quite as well as Snowball. This could have been because there were no drums to follow like Snowball had. It could have also had something to do with the amplification of his owner's voice and guitar, whereas Snowball was responding to a recording played through speakers. As highly social, long-lived birds, they have decades of human interaction. This could be a huge factor in their seemingly spontaneous dancing (Bird Lovers Only Rescue).

The theory that an animal's capability of keeping a beat depended on their capacity for "complex vocal learning" originally included only parrots and other birds (Stephens). For the first time in 2010, a mammal without vocal mimicry abilities demonstrated the ability to keep a beat. A graduate student at the University of California, Santa Cruz, Peter Cook, conducted a study on Ronan, the sea lion. Ronan and her fellow sea lions do not have the ability of vocal mimicry. They do, however, have a wider range of vocal capabilities than previously believed. As members of the pinniped family, sea lions, along with all the other members, are capable of both land and water sound production. Listeners have likened their vocalizations to a wide range of sounds including creaks, growls, barks, buzzes, snorts, songs, trills, thumps, sirens, yelps, roars, hums, whistles, coos, puffs, burps, bellows, drones, mews, belches, and much more. The type of vocalization a sea lion makes depends on many different factors, such as gender, age, geographic location, species, and the vocal ability of the particular individual (Schusterman). However, despite all of these characteristics sea lions possess, they are still not noted as species capable of vocal mimicry.

“There was this idea that had been floated,” said Cook, “that only vocal mimicking species could move in time to a beat, which I didn't believe was true. No one had shown it w/ a non-vocal mimic like a sea lion, so I decided to try w/ Ronan.” Born in the wild in 2008, Ronan was rescued by the Marine Mammal Center in Sausalito the following year after her third stranding incident. According to Cook, she seemed to be having difficulty making her own way in the wild. Ronan’s mother had most likely had to wean her early because there had not been enough fish that year. Evidently, sea lions like Ronan do not gain enough strength or skills needed to fish on their own and often start relying on humans for survival. Ronan had been repeatedly found interacting with people, was very underweight, and so was taken into rehab. It was then decided by the Pinniped Laboratory in 2010 that Ronan would be adopted into permanent captivity. It would have been too unsafe for her, as well as humans, if she had remained in the wild (Cook).

The lab’s research program explores the sensory, cognitive, and behavioral ecology of marine mammals. Cook’s study with Ronan had started out with the sea lion as a healthy control in Cook’s research project. The project focused on the cognitive effects of a neurotoxin produced by the algae, called Pseudo-nitzschia which is found along the California coast. Pollution from chemicals such as fertilizers, along with warming ocean temperatures are believed to be the cause of the algae becoming larger, and more rampant every year (Cooney). During algal blooms, the toxin enters the food chain and causes mass strandings of sea lions. The toxin has been found to cause brain damage, resulting in neurological and behavioral changes in the sea lions. These changes impair their ability to navigate the ocean, and impedes their survival. Many of these sea lions end up at the Marine Mammal Center to be rehabilitated. (Stephens).

Ronan was chosen for the experiment because it became clear she was a particularly intelligent sea lion. Cook described the details of the process:

> [Her] training began with a simple sound, like a metronome. I trained her explicitly, and BEFORE she was given any auditory stimuli. I had her target her nose on my hand and then waggled my hand up and down and gave her fish. Then, w/ her on one side of a fence and me on the other, I waggled my hand up and down in front of her just out of reach and gave her fish for moving her head up and down. Then I worked on it until she'd waggle her head just when I raised my hand w/ no movement. Then, we faded in a metronome sound and always matched that w/ my hand being raised. When she waggled for a bit, she was rewarded, but there was no criterion at this point for beat matching. We checked, and there was no tempo/phase relationship between her head bobbing on these first sessions w/ a sound. Eventually she learned that the sound WAS the cue for head bobbing, and didn't need me standing there w/ my hand up in the air. But she still wasn't in time w/ the beat. That took a good deal more selective training. (Cook)

Once she got the initial beat-keeping down, it became apparent that it was not a difficult task for her to do. She simply had to figure out what the scientists wanted from her. As Cook explains, “Ronan’s success poses a real problem for the theory that vocal mimicry is a necessary precondition for rhythmic entrainment” (Stephens). Rhythmic entrainment is "the ability to synchronize with an external beat" (Newby). Ronan was soon able to find the beat in complex music without further training. She appears to have a particular affinity for "Boogie Wonderland" by Earth, Wind, and Fire. Cook explained why this appears to be so: "As a psychologist, I have to be careful about determining that something is an animal's 'favorite.'" However, Ronan demonstrated "extra vigor and apparently high motivation" whenever she heard this song. She was also even more on time with her head-bobbing to the rhythm than any other song; even more than with a simple metronome. Ronan is still thriving at her home, the Pinniped Cognition and Sensory Systems Laboratory in Santa Cruz (Cook).

Another animal that lacks the ability of vocal mimicry is the whale. However, the concept that whales "sing" is not a new one. Humpback whales, in particular, are some of the most famous whales for their complex songs. What makes this animal especially unique in the exploration of music in nature is they have learned to sing all on their own. It is unknown as to the exact reason why these whales create these complex vocalizations. As the primary singers are male, the songs are most likely for the purpose of obtaining a mate. The reasons could be competitive behavior with other males, defending territory, or even "flirting" with females (*Humpback Whales - BBC Documentary Excerpt)*.

A recent study has shown new evidence that males are not the only ones who sing. New technology has allowed new sounds to be recorded near the island of Maui in the whale breeding and birthing region. Jim Darling is a research biologist and works with Whale Trust Maui, a nonprofit organization that dedicates themselves to the research and awareness of whales with the goal of conservation (Whale Trust Maui). Darling was perplexed by the new sounds they were picking up. The typical frequency of a male humpback song is between 80 and 4,000 hertz. The new sounds were described as "pulse sounds" and were around 40 hertz, which is much lower. Darling is still not completely sure as to whether these new sounds are indeed female humpbacks. However, vertebrate ecologist Alison Stimpert from the Moss Landing Marine Laboratories in California, says the sounds are indeed whale-made. Stimpert added that humpbacks are not the only baleen whales that produce pulses in this low frequency: so do blue and fin whales. These supposed female humpbacks appear to be creating sound in connection to the "mating game" (Owen).

Whales' hearing and vocalizations evolved with them over a period of 50 million years to be able to communicate through water and across large distances. Unlike toothed whales, which use echolocation, baleen whales use low-frequency sounds. Scientists Maya Yamato, Peter Buck, and Nick Pyenson, conducted a study to better understand the evolution of whales' hearing, as well as the differentiation in this area between baleen whales and toothed whales. By looking at fetal whales, they found the ears had similar features to land mammals. At a later stage of the fetal development, the ears developed "acoustic funnels" (Frost). Acoustic funnels, or "ear trumpets" in baleen whales are "V-shaped structures made by [two specific] bones of the ear" (National Geographic).

Without vocal chords, scientists are not completely certain how humpbacks produce their sounds. It is believed that they probably "sing" through the act of circulating air through the tubes and chambers of their respiratory system (Nature). Katy Payne and her husband, Roger, are credited as some of the first scientists to call humpback sounds “songs.” Katy is an acoustic biology researcher at the Cornell Lab of Ornithology. Katy started off as a music major with biology as her second major. She has spent her entire life listening to animals. In 1964, the Paynes met engineer Frank Watlington on a trip to Bermuda. Based off their passion for whales, they had all been recommended to meet one another by a mutual friend. Watlington played the song of a humpback whale he had recorded with hydrophones, or underwater microphones. His initial intent had been to listen to enemy submarines. When Watlington had heard what his microphones had picked up, he kept it a secret, fearing whalers would have used it to find and kill these whales (McQuay).

"I had never heard anything like it," Katy said when she first listened, "Oh, my God, tears flowed from our cheeks” (McQuay). Utterly entranced, Katy kept going back to these recordings: analyzing, and, essentially, memorizing them. She got spectrograms, or visual representations of sound, of these songs. Tracing them onto paper, she learned they had very specific structures - even melodies and rhythms. She even recorded herself singing along with the whales. Dissecting them, she named the first passage of notes in the song the “beginning sound.” She said, “the pattern's not random, and that's key. Lots of animals have calls or vocalizations. But the humpback whales' long, intricate songs change — they evolve” (McQuay).

It was then discovered that the particular group of whales from which these original recordings had come from had evolved further. The songs grew from having six elements to 14 (McQuay). Elements in music are: pitch, rhythm, melody, timbre, dynamics, and texture (Estrella). One particular humpback’s song begins with two long-held notes. The first lilts up into a higher note at the end, and the second note slides down slightly at the end. The next eight seconds are comprised of a drawn out gurgling, growling-type sound that then immediately shifts into another note. This note is shorter than the first notes at the very beginning. This shorter note is followed by seven more. From first listen, even the untrained ear can decipher the differences. There are definite patterns the whale is creating with these notes. There are specific inflections on each note, and some match one another.

The first song that was recorded in 1964 evolved into a new song with the whales adding a "musical coda" of sorts to the end of it. Upon listening to these recordings, the initial song had nine added "grunts" on the end of it after the almost "growling" section of the song. They may recite half a dozen themes in one session (McQuay). Katy relates the whales' songs to jazz, saying that improvisation is implemented. It has been determined humpbacks compose songs collectively, as well as singularly. Katy discovered they change their songs in predictable manners (Brody). Katy dissected songs until she could pick out each individual whale voice in a quartet, and then assembled the score. She found that each whale will sing the same song, and all change their song the same way. However, not every whale will sing the same phrases. She related it to "a round in which some of the singers leave out some of the lines" (Payne). She stresses that there is incredible order in which the whales sing their songs: "[They] sing the same themes in the same sequence, each changing the phrases in the same way as the singing season progresses, and each resuming the next season with roughly the same song [they] had sung when the previous season ended" (Brody).

Christopher Clark, director of the bioacoustics research program at Cornell University, said "Whales have their own listening culture. It will take a long time to begin to understand it" (Joyce). Clark recorded many whales in the Arctic. He described listening to the recordings as being suddenly lowered into a "cacophony of voices and singers" and as though one is stepping into a jungle beneath the ice (Joyce).

The new discovery that female whales do sing after all, when the belief for a long period of time was they do not, demonstrates an aspect of the unknown humans are still discovering. Katy Payne also spent much of her life studying elephants. She described the time she discovered there was a new area of elephant communication that was believed to be non-existent. "I happened to notice after some days" she recalled, "that every now and then I was feeling a throbbing in the air - kind of a pulsation in my ears - sort of the feeling you get when the windows are rolled down wrong in your car. And it occurred to me that this might be sound below the frequencies that I as a human being could hear" (Listening to Elephants). She went on to describe a time when she was observing and recording two elephants in a zoo, a male and a female. The female had walked to the end of her large cage to the 2-foot concrete wall. She had been flapping her ears very loudly, and "blowing out" loudly. The male was directly on the other side of the wall. There had then come the "throbbing in the air - kind of pulsation in (Katy's) ears". After that Katy reviewed her recording and sped it up. In between the flapping sound of the female elephant's ears, Katy heard the voices of the two elephants where she had previously heard only vibrations in the air; they had been making groaning sounds back and forth (*Listening to Elephants*). This discovery supports the idea that there is even more communication and song in the animal world than humans are aware. We just simply cannot hear it because it is out of our range of hearing, or it has not been recorded yet.

On the other side of the size spectrum, mice have their own songs as well. Biologist Matina Kalcounis-Rueppell recorded mice singing in a pine forest in North Carolina. Kalcounis-Rueppell is a behavioral ecologist and an “expert in how animals use sound” (Dunn). She based her idea that mice do in fact create song off of previous studies, the earliest taking place in 1925. Just as Katy Payne recorded whales and graphed the sounds visually, Kalcounis-Rueppell did the same with the mice. She discovered some songs were either sung exclusively by males or by females. She also noted that some species’ songs grew more complex as the mouse aged. One of the songs recorded was made up of four notes and was sung by a deer mouse: “Played back at slow speed, it sounded a little like the wooing song of a whale, a plaintive rise and fall” (Dunn). Kalcounis-Rueppell said juvenile mice raised in a lab by a “different strain” than their own, meaning a different species, still sang only their own species particular song. Additionally, accordingly to Kalcounis-Rueppell, “There are even greater differences from one species to the next, akin to those, say, between a robin and a wren” (Dunn). When asked by journalist, Rob Dunn, of the *Smithsonian Magazine*, if Kalcounis-Rueppell believed there could be a species of mice that behaved like a mockingbird as far as mimicking other mice, she said that was definitely a possibility (Dunn). Dunn says”

Her discovery reminds us that each species perceives the world in a unique way, with a finely tuned set of senses, and so finds itself in a slightly different world. Bacteria call to each other with chemicals. Mosquitoes detect the carbon dioxide we exhale. Ants see polarized light. Turtles navigate using the earth's magnetic field. Birds see ultraviolet markings on flowers, signs invisible to us. Snakes home in on the heat in a cougar's footprint or a rabbit's breath. Most of these different worlds are little understood because of the narrow reach of our own perceptions.

In the words of Peter Cook, "Human musical ability may in fact have foundations that are shared with animals. People have assumed that animals lack these abilities. In some cases, people just hadn't looked." Ronan the sea lion surpassed the boundary scientists had drawn that had separated non-vocal mimics abilities from vocal mimics. Her ability to learn to follow a beat unearths many new questions about other non-vocal mimics regarding their abilities with beat perception synchronization and perhaps with other musical elements. Snowball represents an even more in-depth view to the musical abilities of vocal mimics besides humans. His perception of rhythm and skills of synchronizing to it also bring up many unanswered questions as to the abilities of other vocal mimics. The recent discoveries of frequencies we previously had no awareness of stretches the boundaries even further. The unheard songs of female humpbacks, mice, and elephants represent just a few voices of the animals that had been overlooked. This all leads back to one important question: Just how many more musical and rhythmic abilities of the animal kingdom are there to be found?

Works Cited

Baker, Myron C. "Working Papers 2." *Architectural Research and Teaching* 2.2 (1972): 138-40. Cognizant Comm. Corp., 2001. Web. 10 Feb. 2017.

Ball, Philip. "Birds That Boogie." *Nature News*. Nature Publishing Group, 25 June 2008. Web. 13 Apr. 2017.

Bird Lovers Only Rescue. "About Bird Lovers Only." *Bird Lovers Only RSS*. Bird Lovers Only Rescue, 2012. Web. 12 Apr. 2017.

Bird Lovers Only, BirdLoversOnly. "Snowball - Another One Bites The Dust." *YouTube*. YouTube, 26 Dec. 2007. Web. 5 Apr. 2017.

Brody, Jane E. "SCIENTIST AT WORK: Katy Payne; Picking Up Mammals' Deep Notes." *The New York Times*. The New York Times, 08 Nov. 1993. Web. 15 Mar. 2017.

Cooney, Peter. "Toxic Algae Causing Brain Damage in Sea Lions along California Coast."*Scientific American*. Scientific American, A Division of Nature America, Inc., 16 Dec. 2015. Web. 15 Feb. 2017.

Cummings, Robert. “The Flight of the Bumble Bee, Musical Picture for Orchestra (from the Tale of Tsar Sultan).” *AllMusic*. AllMusic, 2017. Web. 30 Apr. 2017.

"Dance." *Merriam-Webster*. Merriam-Webster, n.d. Web. 13 Apr. 2017.

DandTbird. "Ollie the African Grey Clicking and Whistling along to 'Always Look on the Bright Side of Life'." *YouTube*. YouTube, 25 Mar. 2011. Web. 15 May 2017.

Dunn, Rob. "The Mystery of the Singing Mice." *Smithsonian.com*. Smithsonian Institution, 01 May 2011. Web. 17 March 2017.

Ehrlich, Paul R., et al. "Bird Voices." *Bird Voices*. Stanford University, 1988. Web. 5 Feb. 2017.

Estrella, Espie. "Can You Name the Basic Elements of Music?" *ThoughtCo*. ThoughtCo, 17 Feb. 2017. Web. 18 May 2017.

Frost, Emily. "Keeping An Ear Out For Whale Evolution." *Ocean Portal*. Smithsonian's National Museum of Natural History, 23 Aug. 2016. Web. 15 Mar. 2017.

Horn, Stacy. "Why Joining a Choir Is the Easiest Way to Make Yourself Happier." *Slate Magazine*. The Slate Group, 25 July 2013. Web. 19 May 2017.

"Humpback Whales - BBC Documentary Excerpt." *YouTube*. YouTube, 09 Aug. 2012. Web. 15 Feb. 2017.

Jarvis, Erich D. "Neural Systems for Vocal Learning in Birds and Humans: A Synopsis."*Journal of Ornithology*. U.S. National Library of Medicine, 01 Dec. 2007. Web. 25 Apr. 2017.

Jarvis, Erich. "Evolution of Brain Structures for Vocal Learning." *Erich Jarvis*. Rockefeller University, n.d. Web. 15 May 2017.

Joyce, Christopher, and Bill McQuay. "Listening To Whale Migration Reveals A Sea Of Noise Pollution, Too." *NPR*. NPR, 13 Aug. 2015. Web. 15 Mar. 2017.

Jukinmedia.com, 256muldoon. "Cockatoo Loves Elvis." *YouTube*. YouTube, 08 Feb. 2015. Web. 30 Apr. 2017.

Kelley, Laura A. "Vocal Mimicry." *Sciencedirect.com*. Elsevier B.V., 11 Jan. 2011. Web. 16 May 2017.

Leonhardt, Dorothea L. "Scientists & Research." *The Rockefeller University » Scientists & Research*. The Rockefeller University, n.d. Web. 15 March 2017.

Levy, Florence. "Mirror Neurons, Birdsong, and Human Language: A Hypothesis." *Frontiers in Psychiatry*. Frontiers Research Foundation, 2011. Web. 30 Apr. 2017.

Listening to Elephants. Dir. The Elephant Listening Project. Perf. Katy Payne. *The Elephant Listening Project*. N.p., n.d. Web. 15 Mar. 2017.

McQuay, Bill, and Christopher Joyce. "It Took A Musician's Ear To Decode The Complex Song In Whale Calls." *NPR*. NPR, 6 Aug. 2015. Web. 15 Mar. 2017.

Morell, Virginia. "Why Some Female Birds Don't Sing." *Science | AAAS*. American Association for the Advancement of Science, 21 Jan. 2016. Web. 19 May 2017.

"Music." *Merriam-Webster.* Merriam-Webster, n.d. Web. 20 Apr. 2017.

National Geographic. "Acoustic Fats, Ear Trumpets, and How Whales Hear." *Phenomena*. National Geographic | Phenomena, 13 Mar. 2015. Web. 16 May 2017.

Nature. "Humpback Whales." *PBS*. Public Broadcasting Service, 24 Oct. 2014. Web. 15 Mar. 2017.

Newby, Anna. "“Rhythmic Entrainment in Non-Human Animals,” or the Science of Dancing Birds." *Slate Magazine*. The Slate Group, 18 Feb. 2014. Web. 20 Mar. 2017.

Olkowicza, et al. "Seweryn Olkowicz." *Proceedings of the National Academy of Sciences*. National Acad Sciences, 6 May 2016. Web. 30 April 2017.

Owen, James. "Mysterious New Humpback Whale "Song" Detected?" *National Geographic*. National Geographic Society, 10 May 2017. Web. 15 Mar. 2017.

Patel, Aniruddh D., et al. "Experimental Evidence for Synchronization to a Musical Beat in a Nonhuman Animal." *Cell.com*. Elsevier Inc., 30 Apr. 2009. Web. 21 Apr. 2017.

Rentfrow, Peter J. "The Structure of Musical Preferences: A Five-Factor Model."*Journal of Personality and Social Psychology*. U.S. National Library of Medicine, June 2011. Web. 18 May 2017.

Schusterman, Ronald, et al. "Pinniped Vocal Communication: An Introduction." *Aquatic Mammals* (n.d.): n. pag. *Aquaticmammalsjournal.org*. Aquatic Mammals, 2003. Web. 20 Apr. 2017.

Science Buddies. "Making Sound Waves." *Scientific American*. Scientific American, A Division of Nature America, Inc., n.d. Web. 30 May 2017.

Shulbank-Smith, Sarah. ""El Grillo" by Josquin Des Prez." *Exploring Music.* Exploring Music, 5 Feb. 2013. Web. 09 May 2017.

"Sounds of Northern Pacific Treefrog - Pseudacris Regilla."*Californiaherps.com*. Baird and Girard, 1852, n.d. Web. 21 Apr. 2017.

Stephens, Tim. "Sea Lion Defies Theory and Keeps the Beat." *UC Santa Cruz News*. University of Santa Cruz, 1 Apr. 2013. Web. 13 May 2017.

The Cornell Lab of Ornithology. "Mockingbirds Can Learn Hundreds of Songs, But There's a Limit." *All About Birds*. Cornell University, 07 Sept. 2016. Web. 11 Mar. 2017.

Welberg, Leonie. "Research Highlights." *Research Highlights : Neuroscience Gateway*. Neuroscience Gateway, Mar. 2008. Web. 30 Apr. 2017.

Whale Trust Maui. "ABOUT US." *WHALE TRUST MAUI*. Whale Trust Maui, n.d. Web. 20 Mar. 2017.

"Wild Gorillas Compose Happy Songs That They Hum during Meals."*New Scientist*. New Scientist, 24 Feb. 2016. Web. 11 Mar. 2017.

Winterman, Denise. "The Surprising Uses for Birdsong." *BBC News*. BBC, 08 May 2013. Web. 19 May 2017.