The Effect of Pitch on the Auditory Discrimination of Wolves

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Abstract

Auditory discrimination is something thats present in both wolves and humans and is something that is not fully understood. Our knowledge on wolf communication is rather slim and misunderstood. The problem here is that auditory discrimination in wolves and regarding how it works has never been looked at before, and I formed two hypotheses. The first being that wolves would respond to howls produced by a speaker and the second being that wolves would respond more to howls of a higher pitch. I played howls, familiar and unfamiliar, to three wolves located at a conservation center using a stage speaker. Whenever I played a howl, it would increase by 100 hz from the howl that came before it. My first hypothesis was supported, however my second hypothesis was rejected. I did get howls from the wolves, but the results showed that wolves respond to howls closer to the original pitch. However, the trend showed that the wolves responded to familiar howls more than stranger howls.. Auditory discrimination and wolf communication is still very unknown to us aside from the bare basics. However with further study, we can certainly figure it out and in turn discover our own history

1. Introduction

1.1 Importance of wolves

Wolves are an endangered member of the canine family and are recognized as a keystone species in areas such as tundras in Alaska or the forests in Idaho (Fritts, 2019). A keystone species is a species that the environment largely depends on for a balanced ecosystem. This was shown in the 1920s when wolves were completely wiped out in Yellowstone due to hunting (Peglar, 2018). The elk population, the wolves main source of prey, increased dramatically without any wolves to hunt them (Peglar, 2018). The overabundance of elk ate away at the shrubbery which included any grasses, bushes, or tree bark (Peglar, 2018). As a result, the environment rapidly deteriorated. Eventually, the best possible solution was to reintroduce wolves in 1995 (Peglar, 2018). As the wolf population increased, the elk population decreased (Peglar, 2018). With less elk, the shrubbery began to grow back and the environment improved (Peglar, 2018).

1.2 Communication of Wolves

One way wolves can keep such good control of the environment is by being in a pack, and being in a pack requires good communication (Mazzini, 2013). They have short range of communication such as snarling, having their tail raised, or rolling over (Mazzini, 2013). However they also have long range communication which is done through howling (Mazzini, 2013). Packs will often use howling to communicate with other packs usually as a sign of aggression, as howling can cover a span of up to ten miles and can reveal information such as

location, gender, or if the wolf is aggressive or friendly (Grannan, 2018). This is done through a process called auditory discrimination.

1.3 Auditory Discrimination

Auditory discrimination is the ability to decipher small differences in sound, so for example being able to tell a voice from another voice (Logsdon, 2018). Wolves have this same process of being able to tell differences in sound within their howls. They can tell one wolf apart from another based on their howls alone (Theburge, 1967). Humans are also capable of this process (Logsdon, 2018) and the way we communicate is very similar to the way wolves communicate (Theburge, 2016). This similarity may sprout from auditory discrimination, which is what I plan to study.

Previous Research

Mazzini in 2013 wanted to determine if a wolf's howl is mediated by emotional stress such as if the wolf is happy or distressed, or if the wolf has more control over their howls and will use it to their advantage. He discovered that wolf howls are not necessarily motivated by emotional stress, but can be used more flexibility and at will. They can use their howls more selectively, so they can pick and choose when they respond. Palacios in 2007 was analyzing differences in Iberian wolf howls, seeing what caused their individuality much how humans have individual voices. Theburge in 1967 studied if wolves could tell the difference between live and recorded wolf howls and they discovered that wolves could possibly tell the difference between recorded vs live howls. This is because Theburge got responses for the live howls, however there

was no howls for the ones that were recorded and played off of a speaker. This may have been caused by the wolves determining differences in the live vs. recorded howls, meaning they could tell the subtleties in the sounds. However, I believe it was caused by a low quality speaker. This study was completed in 1967, meaning the speaker was much lower quality then they are today. This could lead to higher audio distortion meaning the wolves possibly couldn't tell the recorded howl was actually a howl at all. The speaker used in the experiment was listed as a Uher tape recorder with the latest model they could be using built in 1964. What this means is that the quality of the audio may be much poorer compared to the quality of today, and the wolves may have been able to tell that the howl was unnatural or they couldn't distinguish it as a howl to begin with.

Problem and Goal

The problem here is that it is unknown if wolves are able to detect pitch differences or if this effects with the wolf will respond or not. I am hoping to determine if wolves will respond to howls based on pitch difference or if they can detect a difference at all.

Hypothesis

I have two separate hypotheses, the first one relating to Theburge's article. The first one being that wolves can respond to howls produced by a speaker. This is because I believe that Theburge's speaker was much lower in quality, as this study was done in 1964, and the wolves may have not realized the sound was a howl. I am also hypothesizing that wolves will respond to howls of a higher pitch increased by 100-400 Hz. This is because higher pitches correlate to higher excitement levels, and more excitement may mean less hostility (Theburge 2016).

2. Methodology

This study is based off of Theburge's 1967 study where they played recorded howls and measured the amount of responses or lack of responses. This experiment deals with specific pitch differences and a most sophisticated speaker system.

2.1 Speakers

I used Behinger Eurolive B212A Loudspeakers which are often used to place across a wide distance span for example a stage and are highly durable with low audio distortion. Since the quality of the speaker I am using is higher than the Uher Tape Recorder used in Theburge's study, this will allow me to see if my first hypothesis is supported while testing the others. The speakers were placed roughly ten feet away from the enclosure to create a small distance between the wolves and the speaker while remaining close enough to the enclosure for me to see and control both the wolves and the speaker. The speaker was mostly hidden from the wolves, as there was a thick brush often separating the wolves from the speaker. However there were instances where the wolves were in a position to see the speaker. We ensured none of the wolves are irritated or injured by the pitches by not going over 25,000 Hz (Foden, 2019). At the termination of this study, there was little to no change to the wolves.

2.2 Participants

3 Canadian Rocky Mountain Gray Wolves, two males and one female, all were located within the conservation center as these three wolves are the only wolves I can have access to within the center. For this experiment I will refer to the wolves as Wolf A, Wolf B, and Wolf C. All three wolves had distinct appearances and personalities that allowed me to tell them apart.

Wolf A had dark gray fur and would often come up to the fence, and was not shy at all. Wolf B and Wolf C had similarly colored tan fur, but Wolf C was slimmer and was much more shy than Wolf B. These wolves are fed daily four times a week and are kept in a 2 acre enclosure. These wolves in particular are known as ambassador wolves, meaning they assist in teaching people about wolves so they are accustomed to the presence of humans, and therefore my presence did not not cause them distress.

2.3 Recordings of Wolf Howls

I used 2 types of howls; howls that the wolves were familiar with and ones that they were not familiar with. I received the familiar howls from a public social media site run by the conservation center I conducted my experiment in. I received the unfamiliar howls from a public social media site from wolves all over the world, and I never used the same wolf howl more than once throughout all the trials. In order to change the pitch I used a program called Audacity. This program is free and open to the public, and allowed me to make specific pitch differences to the wolves.

2.4 Procedure

This experiment was held in a Conservation Center in Westchester County, New York. The independent variable is the pitch of the howls which is controlled using a program called Audacity, the dependent variable is if the wolves will respond, and the control is which wolves were tested which are the ambassador wolves in the sanctuary. Using Audacity I changed the pitch of the howl and then played it to the wolves. In this case I played both howls that are familiar to the wolves I am testing, and howls that the wolves have never heard before. If there was a previous howl, then the pitch of the current howl went up by 100 Hz. The wolf was then

checked if they respond via howling. If there was a howl response, then that means the wolves felt comfortable enough to do so. We then asked the question: “Was there a response?” If there was a response by at least one of the wolves, we marked down which specific wolf responded for which specific pitch increase. If there was no response for any of the wolves, we marked down that no wolf responded for that specific pitch increase. Each pitch increase (Ex. 100 Hz, 200 Hz, 300 Hz) has its own section for whether or not the wolves responded to it and which wolf responded to it.

2.4 Determination of Response

A determined response was a howl from the wolf while the howl was being played on the speaker. A proper howl was observed if the wolf tilted their head back to let out a howl, no matter how long or short the howl ended up being. I was able to observe the wolves in their enclosure behind a metal fence and was able to determine which wolf responded. The wolves had the duration of the howl being played to response along with about a minute after the howl was played to give the wolves enough time to build up an urge to howl.

2.5 Analysis

We ran a t-test comparing responses for familiar wolf howls to stranger wolf howls. This was done to be able to combine the data for all future analysis. If this was found to be not significant we could then combine the results for all future analysis. We then ran another t-test comparing the number of wolf responses for each specific hertz increase. We then graphed the average percent of response at each of the different hertz values, looking for significant differences.

3. Results

3.1 Data Table

The results for each individual wolf was recorded the day it was completed, and was based off a response to the howl being played. Depending on if the howl was produced in response to that of a stranger wolf or one that the wolf was familiar with, the responses were placed into one of two groups: “Familiar Howls” and “Stranger Howls” (Table 1). The total number of howls for both the individual pitch increase responses and the total number of the familiar and stranger howl responses were recorded along with percentages of responses. It is interesting to note that Wolf 1 responded the most often, and the two other wolves, when they would howl, would not howl without Wolf 1.

Table 1- Displaying Percent of howl responses to non-responses for individual wolves along with total howls and % successes

Familiar Howls					
Hz Increase	0	100	200	300	400
Wolf 1	60	40	20	0	0
Wolf 2	20	0	0	0	0
Wolf 3	20	0	0	0	0
Total howls	5	2	1	0	0
% success	33.33333333	13.33333333	6.666666667	0	0
Stranger Howls					
Hz Increase	0	100	200	300	400
Wolf 1	25	0	0	0	0
Wolf 2	0	0	0	0	0
Wolf 3	25	0	0	0	0
Total Howls	2	0	0	0	0
% success	13.33333333	0	0	0	0

3.2 Graphs

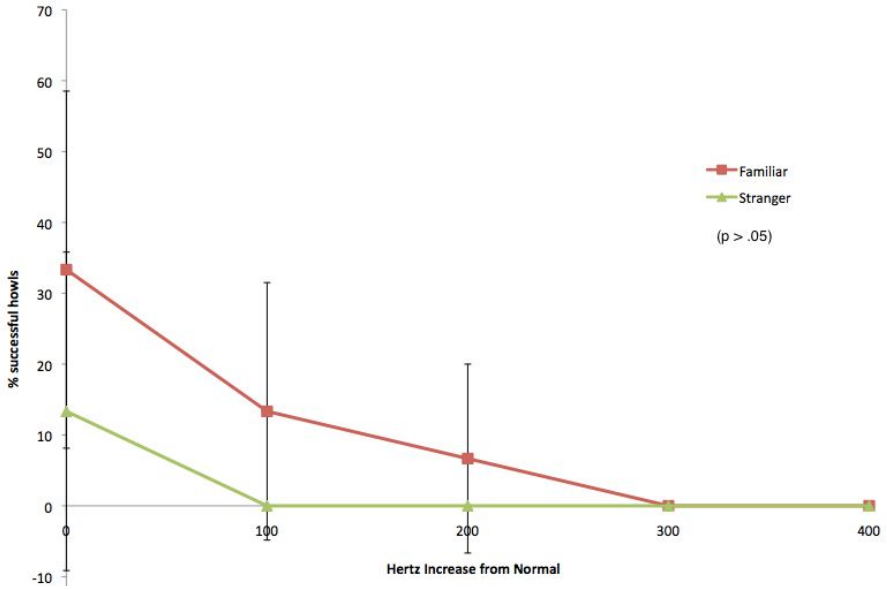

Figure 1- Comparing the percent of successful howl responses of both the stranger and familiar wolf howls to each group for all hertz values. All p values > .05

Figure 1 compared the percent of successful howls for each of the three wolves for both the familiar and stranger howl recordings. There was no significant difference between the stranger and the familiar wolf howl recordings.

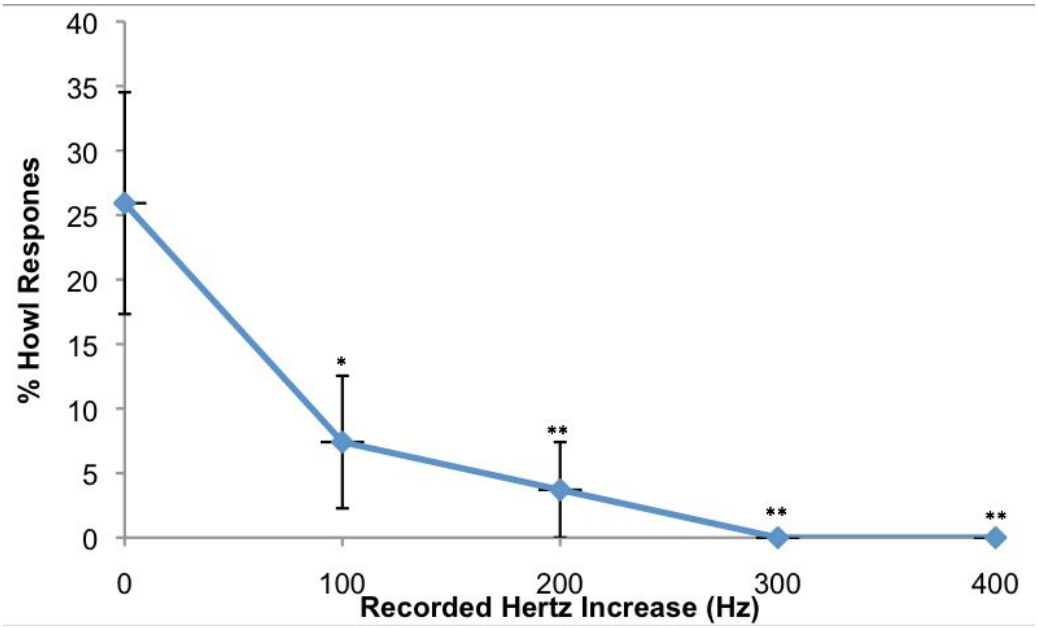

Figure 2- Percentage of Howl Responses at different Hertz increases from normal recordings * indicated a p value<.05 and ** indicated a p value<.01. Error bars indicated SEM.

Figure 2 depicts the percentage of howl responses as each of the Hertz values. Significance is compared to the 0 Hertz response at each of the Hertz increases. It was also found that each Hertz increase from one hundred to four hundred Hertz was not significantly different to each other. This is because the p value between the 0 hertz increase to the 100 hertz increase is less than .05, and the p value from the 0 hertz increase to any hertz increase between the 200 and the 400 was less than .01.

4. Discussion

4.1 Results

While my first hypothesis was supported, my second hypothesis was rejected. I did end up getting responses from all three of my wolves, despite Theburge's article saying they got little to no responses with the speaker and that the wolves will not respond to howls produced by a

speaker. Not only that, I got howls from the same wolf repeatedly (Table 1). Not only does this disprove a claim from an article written in 1967, it also could possibly become a form of non-harmful and non-invasive control of the movement of wolf packs. If wolves can recognize howls produced by a speaker, perhaps howls can be used to either lure a wolf pack to a certain area with a friendly howl or drive them away with the sounds of a hostile pack. My second hypothesis, however, was rejected. This is because there is a significant difference in the amount of responses between no hertz to a 100 hertz through 400 hertz increase in pitch. This means there were significantly more responses for a howl that has not had any increase in pitch, as the difference between 100 hertz to a 200 hertz through 400 hertz increase was not significant. This could be because of a number of reasons. One reason could be because the pitch got too non-wolf like and the wolves didn't recognize it as a howl and didn't respond. Another reason could be that the wolves were uninterested in the howls of a higher pitch perhaps because it didn't sound like any howl they've heard before, no matter if it's familiar or not. There could be a plethora of reasons these wolves didn't respond to the howls of a higher pitch, many of which would need further testing to be a viable reason.

4.2 Stranger VS Familiar

The error bars are too large for the difference in responses between stranger and familiar wolf howls to be significant from each other. This could be changed with a larger sample size, however I was pressed with a timeframe of only 2 months and only had access to 3 wolves. Despite there not being a significant difference, the trend shows that there is a possible difference in how often the wolves will respond (Figure 1). This is because there are a higher amount of responses for the familiar howls when compared to the stranger howls. Even though they are not

significant, the trend shows the possibility of a significant difference with further testing. What this shows is that wolves may possibly be able to differentiate between certain “voices” that they are familiar with, just like how we humans have individual voices and can identify each other with. It is even possible to assume that our voices is how we would identify friend from foe, just like how wolves may be able to do. However, because these results are not significantly different, I could combine the samples from both the familiar and stranger howls to increase my overall sample size for the t-tests.

4.3 Outside Observations

There were many behaviors outside of what I was testing for that I observed in the wolves. Not just the three wolves I had access too, but also those who I was not allowed access to. For instance while I was playing a familiar howl at a 300 Hz increase, I received howls from either the red wolves or the mexican gray wolves located in the sanctuary. I was not given permission to use these wolves for my study as my mentor informed me that the wolves needed to keep their innate fear of humans as they will be released to the wild and they were rather shy so responses were highly unlikely. Despite their shyness, I still managed to get howls from them. I was far out of sight of their enclosure without any intention of using them for my study, so the fact that they howled was rather interesting. It does not surprise me that they would howl back for the familiar howls, as those wolves were also familiar with the howls I was playing. However, the fact that these particular species responded for the 300 Hz increase is a mystery. I could be for any number of reasons. Maybe the pitch was totally irrelevant, and the wolves simply responded to the howl because it sounded familiar. Maybe the pitch a wolf is comfortable with depends on it subspecies, and the red wolves and mexican gray wolves prefer howls of a

higher pitch rather than a lower one (McCarley, 1978). Another behavior I noticed was a sort of play fight between Wolf 1 and Wolf 2. While I was playing a howl, Wolf 1 and Wolf 2 initiated in what first appeared to be something aggressive. I quickly realized this was not the case. What at first seemed to be Wolf 1 attacking Wolf 2 with Wolf 2 whining rather loudly quickly turned out to be Wolf 2 seeming to annoy Wolf 1. Wolf 2 would walk around beside Wolf 1 even when Wolf 1 tried to walk away while whining, and then Wolf 1 appeared to chastise Wolf 2. It was almost like watching a younger sibling fight with an older sibling. I do not know if this behavior was caused by the howl I was playing at the time, or if the howl was irrelevant in this situation. Despite not knowing exactly what spurred on this behavior, there are a few possible reasons as to why. It is possible that the howling spurred on the behavior, which would require further testing to determine. However what I believe to be more plausible is that this is just a simple sibling fight. Wolf packs work in family units (Theburge, 2015), and Wolf 1 and Wolf 2 are from the same litter. This could be just an example of two siblings play fighting but, again, this would take more observation and further testing. If we could determine the cause of this behavior, it could help us further understand wolves. The more we understand about wolves, the better we will be able to protect them. On top of being able to protect them, an understanding of wolf communication can also mean we may be able to determine how we humans communicated without any language.

4.4 Limitations

Unfortunately every experiment has some kind of limitation that we cannot change. I am limited by a small sample size of only three wolves. I did not have access to any wolves outside of the 3 wolves I was given permission to observe, and I couldn't travel out of state to find

additional wolves. I also had to deal with the wolves ever changing moods. There could be days where they are excited and more willing to howl and others where the wolves would be tired and not as willing to howl.

5. Conclusion

The way wolves communicate and interpret communication using auditory discrimination is unknown. It could be a numerous variables that affect how a wolf distinguishes one sound from the next, one of which could be pitch. Using Behinger Eurolive B212A Loudspeakers, I played both familiar and stranger wolf howls to three wolves at increasing pitches at 100 Hz increments (100, 200, 300…) from the original pitch.

The first hypothesis was supported. I ended up getting responses from the wolves despite the fact that I was using a speaker, which refutes the claim of Theburge's 1967 study on auditory discrimination titled "*Howling as a Means of Communication in Timber Wolves*" that claimed that wolves would not respond to howls produced by a speaker. Unfortunately, the second hypothesis was refuted because my results showed a significant increase in howls of a lower pitch when compared to howls of a higher pitch. I also noticed a few outside observations such as the red wolves and mexican gray wolves responding to one of my howls for a currently unknown reason and the play fighting that occured between Wolf 1 and Wolf 2. This information can be used to help further our understanding of wolf communication. Wolves are often misunderstood, but with further study and if we can stop the spread of misinformation, we can build a better future for both humans and wolves to coexist in.

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