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Physics of Music

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**Animals and Infrasound**

At first I planned for this project to be about the audible noises that animals make:

How do they produce these sounds? How do they receive them? And how do they differ

from other animals? But while I researched, what I found much more interesting were the

amount of animals that use *in*audible sounds, or rather, sounds that humans find

inaudible. These sounds are classified as infrasound, and have frequencies under 20 Hz.

Infrasound is used by many different animals for different reasons. Themes seem to be in

communication and mating, but there are other purposes to infrasound as well. I

researched four very different animals: The whale, the alligator, the bird, and the

elephant. Each section answers three questions: What is the infrasound used for?, What

does the infrasound specifically do?, and how does human interference affect the

animal’s use of infrasound?

**Whale**:

What is the infrasound used for?

Blue whales on the other side of the ocean can hear infrasound calls. This is how pods

keep in communication with one another. Other whales also use infrasound to

communicate, whether it to used as a method to attract mates, communicate between the

individuals of their own pods or of another pod, warn rivals, or to find food. Such whales

include the humpback whale, which has one of the most complex song of all organisms,

where they can use "rhyme" just like humans in order to recall the complex tunes- their

infrasound may travel more than 965.6 km (600.0 miles).

Besides using infrasound to communicate, whales may also employ the use of ultrasound:

they are capable of transmitting and receiving sound such as clicks, grating, "rusty-hinge

creaks", "muffled smashing sounds" and several high-pitched ultrasonic wavelengths

which are believed to be for echolocation purposes, as well as communication in attempts

to keep the pods together as the group moves on, especially during migration. The

sounds may be used to signal warnings, greetings, as part of defense mechanisms, or as

general signals.

What does the infrasound do?

A Blue whale’s infrasound travels thousands of kilometers through the ocean water,

which, because of its salty content, acts as a good conductor of sound. The temperature

and pressure variations found at the different depths of the oceans act as voice tubes and

channel whale calls further than is usual, which allows whales on the other side of the

ocean to hear the calls.

Human interference in infrasound

Human interference such as shipping, oil drilling, research equipment, navy sonar, and

submarines jam the signals of whales. These things each have especially low frequency

wavelengths and travel very well in water. The loud noises could enforce serious impacts

on the whales, from subtle behavioral changes like the shortening or lengthening of

activity, to physiological impairment like permanent hearing loss. The whales may also

be disrupted in their mating patterns, resulting in a lower population in whales. The pods

could also suffer disturbances in migration, feeding, or other critical activities. In some

cases, the whales consider the sources of the loud noise as an enemy. The cows will

protect their calves; keeping them from the open sea in fear that something will harm

them. It is also believed to be a possibility that certain beaching cases may be because of

navy sonar. The noises effect every individual whale found within a 650.0 square mile

radius, a diameter of 1300.0 square miles.

**American Alligator**:

What is the infrasound used for?

During the mating season, alligator bulls of Florida are known to use infrasound to

establish status amongst the other bulls.

What does the infrasound do?

The infrasound waves are emitted, which encourages the bulls to challenge one another to

duels of strength and status to win over the female. The bulls convulse vertically in the

water, causing the water to vibrate vertically along their body to the rhythm of the

emitted infrasound waves.

Philip Henry, a magazine nature photographer witnessed this movement and described it:

“A big male alligator noticeably inflated as he arched his tail and head out of the

water. Slowly waving his tail back and forth, he puffed out his throat, and with mouth

closed, began to bellow by vibrating the air. Through the lens, I saw hundreds of fine

water droplets dancing over its back as he began to vibrate the air inside his throat. It

seemed motionless but I know that underwater, its whole torso vibrated, projecting

infrasound notes, too low for the human to hear but which travel long distances and can

be heard by other alligators. The sparkling droplets leaping all around the back of the

calling male is a unique phenomenon called the alligator “water dance”. Very soon, this

was like the rumbling of thunder coming from all parts of the swamp. Tens of alligators

bellowed together.”

Human Interference

Humans provide three artificial competitors: cars, boat propellers, and even the NASA

space shuttle, all of which transmit infrasound.

**Birds**:

The common thought used to be that only large animals could generate

infrasound, we now know that smaller animals do produce infrasound. It has been

difficult to prove that birds can actually produce infrasound. The cassowary (also known

as the Auk), is a very large bird. It produces bellowing noises that approach the

infrasound region, but do not necessarily reach it. However, birds can almost definitely

detect infrasound. Rock Doves and some other species of birds reportedly can detect

frequencies of sound as low as 0.5 Hz at low thresholds of amplitude. A case study

involving pigeons shows that these small birds can detect infrasound.

What is the infrasound used for?

Pigeons are presumably capable of perceiving infrasound waves, which may help them in

determining the exact location at which they may find themselves, and also help

determine where they are going. Support of this theory comes from a pigeon race which

was held in 1997: The pigeons were set free in France and were expected to fly over the

English Channel to their home in England. (However, most of the pigeons did not make it

on this particular trek. As the pigeons made their way across the English Channel, a

Concorde supersonic transport airliner flying from Paris to New York flew over the

Channel at the same time. When in flight, the jet generates an intense shock wave down

towards the earth. Therefore, the pigeons below the jet could not have escaped the sound

wave.

What does the infrasound do?

It is possible that one way that birds determine their location is by use of atmospheric

infrasound. They are able to hear infrasound well since their hearing apparatus is

designed to detect low frequency sound waves. It is feasible that the low frequency shock

waves produced by the ocean waves crashing against one another in the Channel, as well

as the infrasound reflected from cliffs, mountains, or any other steep-sided characteristics

of the earth’s surface, were what can guide the pigeons to their lofts in England.

However, in the 1997 case, if the jet’s sonic boom eliminated the infrasound, the birds

could have easily become disoriented and changed direction, having finished the race.

Human Interference

Nuclear bombs are one example of the effects of human infrasound on birds. One year,

France detonated a nuclear bomb. When it finally reached US, none of us could hear it.

However, it was observed that pigeons found in the United States were disturbed by the

waves, which they could detect very well with their ability to hear infrasonic waves.

**Elephants**:

Although they live in completely different environments, Elephants and whales

have the most similarities for uses of infrasonic waves. Major differences are that

Elephant waves are much higher. The lowest frequency of an elephant rumble is 14 to 40

hertz. The other is that Elephants use the air and ground as mediums for their infrasound

whereas whales obviously use water.

What is the infrasound used for?

Elephants possess an extraordinary sense of hearing and emit infrasonic calls with

overtones. They can both hear and determine the origin of the call. Most elephant

communication is in the form of infrasonic rumbles, which may be heard by other

elephants in herds at least 10.0 km away. These are used as calls of warning, greeting,

rally, mating, food location, excitement, fear, or other calls. Infrasound is the elephants’

long-distance communication system, which aids in keeping herds together in

coordinated movements without losing contact or meeting with scarce resources. It also

allows for males to locate fertile females in order to mate and for cows to keep track of

their calves.

Ground Waves: As elephants send infrasonic calls to one another, a replica of the signal

is sent as seismic waves, which are able to travel through the ground more than 1.5 times

further than the infrasound in air (between 16.0 to 32.0 km). Vibrations in the earth may

also be generated through stomping of the foot and flapping of the ears, both of which are

used as defense mechanisms (mock charges). Ground vibrations may be used to greet or

warn other herds, to locate mates or resources of water and food, or convey basic details

about the location and moods of the herds, perhaps invoking anger or fear in other herds,

many of these calls seem to be better received by the cows in the herd.

Elephants’ use of infrasound solves the mystery attending the ability of males to find

females for breeding, and the ability of separated family groups to coordinate their

patterns of movement for weeks at a time without losing communication or converging

on the same scarce resources.

What does the infrasound do?

Like the whales’ infrasound traveling further in saltwater, the rumbles of the elephant

travel further in the dry savannah and during the night.

Elephants’ infrasound is produced in the throat where sinuses and trunks may manipulate

the sound texture. An elephant's forehead skin will flutter and vibrate as air is passed

through the nasal passage. Researchers recognize this as the activity of infrasonic

vocalizations. However, theories on how elephants are able to detect seismic waves and

use them for their benefit are unclear. Some theories have been proposed, mostly based

on two physical properties of the elephant: their toes and their trunk. The feet of

elephants are more than mere simple, leveled cylinders, but they are composed of fatty

tissue, which allows for silent movement, as the elephant walks on their toes. Vibrations

from the ground cause the tissue to oscillate, which triggers Pacinian corpuscles

(vibration sensors) within the elephant. Vibrations manipulate the layer and transmit

signals to the brain. It may also be possible that elephants may sense vibrations through

the toenails, which carry to the ear by bone conduction. The other theory is that the waves

are felt through the trunk. There is believed to be a sensitive tip on the trunk with very

perceptive tissue, consisting of a large amount of Pacinian corpuscles, which can detect

vibrations when touched to the ground. However, it is difficult to obtain such a part of the

trunk because it is a sacred relic and is used as a charm for good luck in South-east Asia.

According to geophysicists, seismic waves become diluted after traveling a long distance.

However, elephants have a mass of brain cortex, which allows for increased processing

power of weak signals.

Human Interference

A small town is able to produce noise within the ground for a 100.0 km diameter, and

traffic on one road may be detected 30.0 km away. This creates concerns for elephants

found in zoos. Jets, water pumps, construction, explosions, helicopters and loud city

noises are all sources of noise and ground pollution, which may play an important factor

in the well-being for an elephant, especially since it applies stress upon communication.

The above information has been collected from the following websites:

http://members.fortunecity.com/anemaw.htm

http://birds.cornell.edu/brp/HumanMadeSound.html

http://www.animalvoice.com/about%20bioacoustics.htm

http://www.bioone.org/bioone/?request=get-document&issn=0004-

8038&volume=120&issue=04&page=1062

http://www.news.cornell.edu/releases/June02/ocean\_noise.hrs.html

http://www.naturephotographers.net/articles0902/ph0902-1.html