Echolocation in Mammals

Introduction:

Echolocation can be defined as a physiological Process of locating distant or invisible objects (Such as prey) by means of Sound waves reflected back to the emitter (such as bat) by the objects.

Echolocation is used for orientation, obstacle avoidance, food procurement, and social interactions

Echolocation is mainly observed in the higher vertebrates like mammals and birds. Among the mammals, echolocation is known to be employed by most bats. Most, if not all, toothed whales and porpoises, but apparently no baleen whales; and a few shrews.

Echolocation pulses consist of short bursts of Sound at frequencies ranging from about 1000 hertz in birds to at least ~~2000,0~~ 200,000 hertz in whales. Bats utilize ~~freq~~ frequencies from about 30,000 to 120,000 hertze. The pulses are repeated at varying rates beginning at about one per second, to hundred per second.

Functions of Echolocation:

1. Orientation:

Bats of the suborder Microchiroptera orient acoustically by echolocation (Sonar). They emit short, high frequency pulses of Sound and listen to the echoes ~~retur~~ returning from objects in the vicinity. By interpreting returning echoes, bats may identify the direction distance, velocity, and some aspects of the size or nature or both of objects that draw their attention. Echolocation is used to locate and track flying and terrestrial prey, to avoid obstacles, and possibly to regulate altitude; orientation pulses may also serve as communication signals between mammals of the same species. Echolocation pulses are produced by vibrating membranes in the larynx and emitted via the nose or mouth.

2. Predation:

Many insectivorous bats hunt by echolocation, emitting a high-frequency sound pulse while flying; the sensory data thus gained guides them to the prey. Greater and lesser bulldog bats use sound to detect small ripples in the water created by fish or fluttering insects on the surface. The bat then uses its hind limbs to catch the pray while flying over the water surface.

Some shrew, sea lion, mole and two kind of birds: oilbirds of northen South America and cave swiftlets (Collocalia) also echolocate.

(A) In Bats:

Bats are divided into the large bats and the Small bats. with ~~over~~ one or two exceptions. the large bats live on fruits and find their way visually. The Small bats feed mostly on ~~as~~ insects, Catching them on the wing by a process known as echolocation. Echolocation is a process in which an animal produces sounds and listens for the echoes reflected from surfaces and objects in the environment. From the information Contained in these echoes, the animal is able to ~~pre~~ perceive the objects and their spatial relations.

Echolocation Pulses:

The characteristics of echolocation pulses vary with family and even with Species, Echolocation pulses of a substantial number of bat species have been analyzed in ~~termed~~ terms of frequency, frequency pattern, duration, repetition rate, intensity, and directionality. The prominent frequecy or frequecies range from 12kilohertz to about 150kilohertz or more. Factors influencing frequency may include bat Size, the energetics of Sound production, inefficiency of propagation of ~~highly~~ high frequencies, and ambient noise levels.

Orientation pulses may be of several types. The individual pulse may include a frequency drop from beging to end (frequency modulation, FM) or the frequency may be held Constant (CF) during part of the pulse, followed by a brief FM Sweep; either FM or CF Pulses may have high harmonic content.

Organs for echolocation:

(a) Sound-producing organs:

Bats produce sounds with the larynx, an organ in the throat that has undergone certain adaptations that make it unusually effective in producing intense, high-frequency sounds. The entire laryngeal structure is enlarged and the fleshy folds of the vocal cords are ~~excepti~~ exceptionally thin. The character of the Sounds varies with the species and also with the particular activity.

(b) Sound-emitting organs:

The sounds produced by the larynx are emitted through the open mouth or the nose, depending on the family of bat. Mouth calls have a wide angle of dispersion (180° or more). The noses of those bats that use them to broadcast are complex structures. They have epidermal flaps and a nostril spacing that Concentrates and focuses the sound in a narrow cone ~~(>90°)~~ (90°>) in front of the bat, much like a megaphone. The calls travel through the air in radially expanding waves at about 34cm Per millisecond.

(c) Sound-receiving organs:

Because of the dispersion pattern, the amount of sound energy striking a target decreases as the square of the distance traveled. A small object intercepts very little sound energy and thus can reflect very little. As the echo is reflected back toward the bat, its energy continues to diminish as the square of the distance. Thus, the returned sound—despite its initial loudness—is exceedingly faint. In addition, only those wavelengths in the emitted call that are approximately equal to or shorter than the diameter of the reflecting object will be returned. Despite these problems, bats can detect and locate remarkably small objects. Several features of the morphology and neurology of the auditory system of ~~echolocation~~ echolocating bats contribute to the sensitivity of their hearing and their ability to process the information contained in echo.

Phases of echolocation:

During insect persuit, obstacle avoidance, and landing ~~manoeuvr~~ ~~there~~ manoeuvres, there are three phases of pulse output designes - search, approach, and terminal.

(a) The initial search phase:

This phase of little brown bat (Myotis sp.) is characterized by fairly straight flight and the emission of ten or 30 pulsed Sounds Separated by silent periods of more than 50 milliseconds. Each of the ten pulses in a Call is about 2 milliseconds in duration, and each pulse constitutes a downward sweep of frequencies starting at about 85 kilohertz and ending near 35 kilohertz. This calls are therefore FM. Other bats use different pulse lengths and frequencies that vary from family to family of bats. Some produce constant frequency calls that either terminate in a short downward FM sweep or like the calls of Some FM species includes several simultaneous harmonics.

(b) The approach phase:

The Second of the hunting pattern starts when the bat detects an objects to which it subsequently devotes its attention. The interval between pulses pulses shortens, the silent intervals falling to less than 10 milliseconds for M. lucifugus 100 cries per second, each lasting only 0.5 to one millisecond, are typical as the bat alters flight path to intercept its prey.

(c) The terminal phase:

This phase of the hunting pattern is characterized by a buzz-like emission of ~~ultr~~ ultrasound. The intervals between pulses are less than 10 ms, the parts do nation is about to receive a 0.5 ML a second, and the frequencies drop to 25 to 30 kilohertz. The exact details ~~varie f~~ vary from species to species, but the general behaviors are consistent. When the bat is within a few millimeters of the pray, it often scoops with the wing or with the membrane between its legs and pulls the insect toward the mouth.

The echolocation pulse ceases as the bat intercepts the target or passes it; another search phase follows. During the brief terminal phase, the bat is engaged in final interception manoeuvres and appears to pay little ~~attent~~ attention to other objects.