

Role and Outcomes of Ultrasound in Humans and Animals

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Commentary

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ABOUT THE STUDY

The American National Standards Institute defines ultrasound as "sound at frequencies greater than 20 kHz". Ultrasonic waves have wavelengths of 1.9 cm or less in air at atmospheric pressure. Ultrasound refers to sound waves with frequencies greater than the human hearing's upper audible limit. In terms of physical properties, ultrasound is identical to "normal" (audible) sound, except that humans cannot hear it. This limit varies from person to person, but in healthy young adults it is around 20 kilohertz (20,000 hertz). Ultrasound devices use frequencies ranging from 20 kHz to several gigahertz. Ultrasound is used in a variety of applications. Ultrasonic devices are used to detect and measure objects and distances. Sonography, or ultrasound imaging, is commonly used in medicine.

Ultrasound is used to detect invisible flaws in products and structures during nondestructive testing. Ultrasound is used in industry to clean, mix, and speed up chemical processes. Ultrasound is used by animals such as bats and porpoises to locate prey and obstacles. Acoustics, or the science of sound, dates back to the 6th century BC, when Pythagoras wrote about the mathematical properties of stringed instruments. Lazzaro Spallanzani discovered echolocation in bats in 1794, demonstrating that bats hunted and navigated using inaudible sound rather than vision. In 1893, Francis Galton invented the Galton whistle, an adjustable whistle that produced ultrasound, which he used to measure the hearing range of humans and other animals, demonstrating that many animals could hear sounds that humans could not. Paul Langevin's attempt to detect submarines in 1917 was the first technological application of ultrasound.

Ultra sound perception in humans

The upper frequency limit in humans (approximately 20 kHz) is due to middle ear limitations. If high intensity ultrasound is fed directly into the human skull and reaches the cochlea *via* bone conduction without passing through the middle ear, auditory sensation can occur. Children can hear some high-pitched sounds that adults cannot, because the upper limit pitch of hearing decreases with age in humans. An American cell phone company used this to create ring signals that are supposedly only audible to younger humans, but many older people can hear the signals, which may be due to the wide range of age-related deterioration in the upper hearing threshold.

Ultra sound perception in animals

Bats detect their prey using a variety of ultrasonic ranging (echolocation) techniques. They are capable of detecting frequencies above 100 kHz and possibly up to 200 kHz. Many insects have excellent ultrasonic hearing, and the majority of them are nocturnal insects looking for echo-locating bats. Many moths, beetles, praying mantids, and lacewings are among them. When they hear a bat, some insects will make evasive manoeuvres to avoid being caught. Ultrasonic frequencies cause the noctuid moth's flight to drop slightly in order to avoid being attacked. Tiger moths also produce clicks, which can interfere with bat echolocation and in some cases, by emitting sound; they may advertise the fact that they are poisonous. The hearing range of dogs and cats extends into the ultrasound range; the top end of a dog's hearing range is around 45 kHz, while a cat's is 64 kHz. Cats and dogs evolved this higher hearing range in order to hear high-frequency sounds made by their preferred prey, small rodents. A dog whistle is an ultrasound-emitting whistle used for training and calling dogs. Most dog whistles have a frequency range of 23 to 54 kHz. Toothed whales and dolphins can hear ultrasound and use it in their navigational system (bio sonar) to orient and capture prey. The highest known upper hearing limit in porpoises is around 160 kHz. Ultrasound can be detected by a variety of fish. Members of the subfamily *Alosinae* (shads) of the order Clupeiformes have been shown to be able to detect sounds up to 180 kHz, whereas other subfamilies (e.g. herrings) can only hear up to 4 kHz. Ultrasound generator/speaker systems are marketed as electronic pest control devices, claiming to scare away rodents and insects, but there is no scientific evidence that the devices work.