**Hearing and listening, survival and satisfaction in sentient animals**

John Webster, Professor Emeritus, University of Bristol

**Sound**

Sound is defined by physicists as

Oscillation in pressure, particle displacement, particle velocity, etc., propagated in a medium (i.e. air, water, solids). This creates sound waves whose frequency may or may not be within the audible range.

It is defined by physiologists as

Auditory sensation evoked by the oscillation described above

The old philosophical question “When a tree falls in the forest, does it create a sound if there is no one there to hear it?” is mere semantics. It depends on which definition you use. The more recent assertion that “in space, no one can hear you scream” is, of course, absolutely correct.

**Hearing** in the first instance, requires a receiver to register the oscillations and convert them into electrical nerve impulses that are carried to and interpreted by the brain, where they are interpreted with exquisite precision as the elements of sound; volume, pitch, timbre and with the clarity and discrimination that makes it possible for us humans to interpret sound as speech. The most obvious receiver is the ear, which operates like a telephone receiver or microphone. However, the brain can interpret as sound oscillations from elsewhere. The whale receives most of its sound signals via the jawbones. The classical percussionist Evelyn Glennie, deaf since the age of eight, “hears” (i.e. interprets as sound) the vibrations she picks up from her bare feet.

There is great variation within the animal kingdom in the frequency range for sound signals that fall within the audible spectrum. (Figs 1 and 2). Upper limits for most mammals much greater than for humans. Rats, mice and cats high, little brown bat very high, marine mammals: highest of all. Birds, perhaps surprisingly, have a relatively small frequency range.

Some implications of these differences will emerge as we go along.

**Listening:** Hearing and listening are two different things. Normal animals have the potential to hear all sounds within their audio frequency range. The brain (unlike a conventional microphone) has the ability to filter out sounds that it considers unimportant so that it can focus on what it thinks it wants to hear. Human psychologists (severely limited by the fact that they only think about humans) call this the “cocktail party effect”. I don’t go to many cocktail parties these days but I live in between Yeovil and the Royal Navy Air Base, which means that most of the time there is a helicopter in the sky, which I do not consciously hear unless it is practically overhead. However, whenever I attempt to do live broadcasts from among my friendly neighbourhood cows, we are constantly frustrated by helicopter noise that I don’t notice but the microphones can’t avoid.

Conscious process of listening involves focussing on sounds that are important and filtering out the rest (so far as possible). The evidence would suggest that the capacity of animals to focus only on the sounds that matter is at least as great, and probably far greater than ours.

Illustrate with two cat observations: one anecdote and one piece of hard science.

**Anecdote.**

Our late cat Sophie displayed totally normal cat behaviour: i.e. lie apparently fast asleep on the sofa and totally indifferent to the sound of the television. However, on more than one occasion, while watching a nature programme, the TV has broadcast the distress call of a bird. The cat is awake at once and has actually gone round to the back of the TV to check whether the source was real.

The piece of hard science goes back to a paper I read in the 1970s. Physiologists recorded impulses from the auditory nerve of a resting cat triggered by the regular ticking of a clock. When they alerted the cat by introducing a mouse into the room, the impulses travelling up the sensory nerve from the sound of the clock were switched off. It is difficult to understand how the brain managed to do this but the implication is that the cat had the ability to switch off altogether signals that it deemed were unimportant.

This brings me to my main theme. Which of the multiplicity of sounds that fall on an animal’s ears do they actually listen to; i.e. what sounds are important and why?

**Darwinian fitness:** Animal species evolve over generations physical and mental abilities best suited to their “fitness” – *survival and successful reproduction.* The way that individuals and social groups promote their survival and social needs is through behaviour appropriate to their phenotype. If you are a house mouse threatened by a cat, you hide, if you are a herd of muskox in the Arctic threatened by wolves you form a defensive circle.

The motivation to such behaviour is partly instinctive (i.e. built into the genes) but more often determined (or at least modified) by information from the environment as perceived and interpreted by the special senses, sight, smell, touch and taste. The relative importance of these special senses obviously varies between species, according to the message and according to the environment (e.g. sound and hearing are particularly valuable in the dark, under water or when the recipient of the communication is out of sight). Today I shall only consider those messages where hearing is of critical importance.

**Communication by sound**

The critical elements of communication by sound are:

* To identify a specific individual or location
* to locate the specific individual or individuals to whom a message is to be conveyed
* to convey a specific message
* to avoid, where possible, alerting predators

Human skills associated with education enormously helped by the evolution of language. Self-evident that language has been a boon to humankind and that speech, as we understand it, is uniquely a human trait. I do not intend to consider experiments where we have attempted to communicate with primates and parrots using human speech. In some of these trials the performance of the animals has been quite impressive, which shows how clever they are at learning this uniquely human form of communication. The fact remains that for them it is an alien mode of communication and one that they can do perfectly well without.

 I have a fundamental objection to scientists who devise behaviour experiments with non-human animals designed to demonstrate how human-like they are – these founded on the horribly anthropocentric view that the more alike other species are to us in appearance and behaviour the cleverer they are likely to be and the more they should be worthy of our respect. All sentient animals have developed senses and behaviours most appropriate to their phenotype. Pigs are good at being pigs, sheep are good at being sheep. Most dogs are not very good at being dogs because they spend too much time with humans. In regard to the special skills involved in problem solving, crows on the whole display more talents than chimpanzees.

**Priorities for fitness**

Post Darwinian definition; not just reproductive success but quality of life: appropriate behaviour resulting from motivation to take right action’

**Outcome** (long term) is improved security, survival and reproductive success,

**Motivation:** (short term) **satisfaction:** physical and mental wellbeing, avoidance of pain and stress, pleasure when there is time for such a luxury.

**Survival and security: *“eat and be not eaten”***

**Security.** All sentient animals are highly motivated to seek security from real or perceived danger. This is obviously most marked in the prey species, but all species that care for their young will seek to protect them from risk until they are able to look after themselves.

**Predators.** Most owls hunting at night use hearing to locate their prey. Asymmetrically placed ears enable them to calculate the vertical and horizontal angles to their prey.Some owl species with symmetrically placed ears cannot hunt in the pitch dark e.g. Great horned owl.

Bats (which have excellent sight) first locate prey by echolocation –sight in the final attack.

Parallel evolution in prey species. Great hawk moth, on picking up radar signals from bat can send out jamming sound signals – by scraping its genitals against its abdomen. How this deters the bat not really understood – maybe it just considers the whole process too grotesque.

Whales and dolphinsnavigate and huntusingSonar: clicks in the human audio frequency for prey location, navigation, Holes in ice.

**Prey behaviour**

**Alarm calls:** Screaming in presence of/or attack by predator.

Fear or warning? Probably the latter. Why warn others at possible increased risk to oneself? True altruism difficult to detect in animals. Mostly driven by selfish gene best expressed by Haldane. “I would lay down my life for two of my brothers or eight of my second cousins”. In my experience, biggest screamers are rabbits and piglets – animals from large litters.

Well known that primates, e.g. chimpanzees, vervet monkeys definitely have different warning calls. Distinct differences between leopard, snake and eagle. Eagle – others look up, snake, others look down. Calls extend beyond immediate family to extended social group – obvious survival advantage. These have been described as a primitive form of language. Less well known that hens have distinct “look up” and “look down” calls.

**“Secret messaging”** Rodents communicate high frequency alarm calls, inaudible to most predators. Cats may be catching up but Darwinian principles of parallel evolution would favour selection of rodents communicating at highest frequencies – so trend upwards in audio-frequency thresholds.

 **Reproductive success: mating, bonding and child rearing.**

**Mating**

Darwinian fitness depends not only on personal security but also the ability to find a mate and reproduce. In this regard, males generally make the most noise, which exposes them to more danger both from predators and other males of the same species, but then males are more expendable and the most noise tends to be made by males that contribute least to the care of their offspring. Bird song is perhaps the best illustration of the role of sound and hearing in sex and social life. This is involved in:

**Mating:** mostly males in temperate latitudes with predictable breeding season. Both sexes sing in some tropical and desert zones, (greater pressure to find *any* mate)

**Bonding;** Duetting –quail, some owls

**Child rearing:** fathers teach their chicks to sing \_ regional accents.

Other mating calls include

* Rutting calls and lecking by stags
* Singing whales
* “Bulling” calls by cows.

**Child rearing**

*“Keep safe and don’t get lost”*

* Ewes and lambs can recognise each others’ individual voices within a large flock.
* Dolphins have signature whistles
* Parent birds begin to teach their chicks to recognise a warning signal while still in the egg.
* Cows calling for their calves after weaning will go into a shed to amplify the sound of their call.

**Social communication**

Security: alarm calls in primates (extended families)

Companionship: wolf calls (extended families)

Pleasure: cello and the nightingale (Beatrice Harrison)

Why do cats purr?

**Slide: Summary**

Sentient animals selectively listen to the sounds that they identify as important because they convey information relevant to their need to achieve security, satisfaction and reproductive success.

Clear evidence that satisfaction includes expressions of pleasure.

But do animals like music?

* Long distance communication by whales
* Group bonding calls by wolves.