An introduction to how dogs hear

What is this note about?

This note provides an introduction to how dogs hear in comparison to humans.

Who is this note relevant for?

All dog handlers, trainers, care staff and personnel involved with working dogs.

Introduction

Hearing is used to detect, find and identify sounds. Dogs have better hearing than humans in many ways, and this is important for communication between dogs and their handlers.

Hearing development

Human babies can hear from birth, although it takes around a year to fully develop. Puppies, on the other hand, are born with their ear channels closed, so are largely deaf. The ears open at around day 12-14, and after that hearing quickly develops to adult levels by day 20 (Figure 1).

Figure 1: Puppies' ears open at around day 12-14.

Physical differences

The most noticeable physical difference in hearing between dogs and humans is that dogs have large outer ears called 'pinnae'.

The pinna acts like a funnel, amplifying sound into the ear. The size and shape of the pinnae differ depending on the breed – funnelling more or less sound or even acting like a sound barrier if folded down.

Inside the ear, the ear canal is longer, wider and more flexible in dogs than in humans. It also has a vertical section, which makes dogs more prone to foreign objects entering the ear (Figure 2).

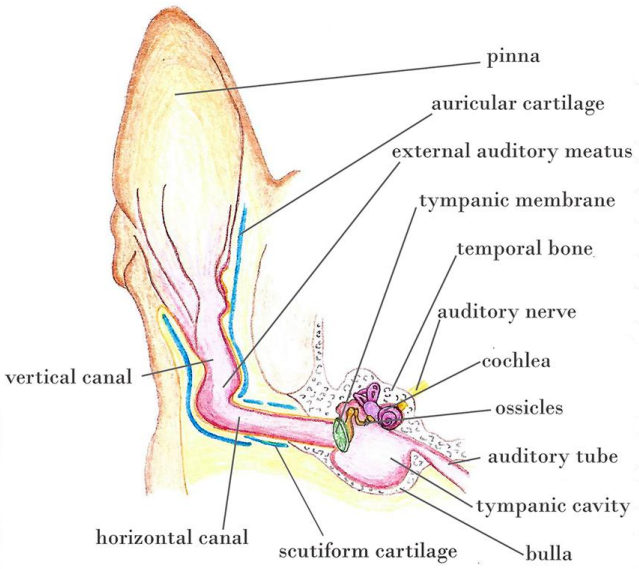

Figure 2: Structure of a dog's ear.

How hearing works

After being funnelled into the ear by the pinna, sound waves travel through the ear canal and vibrate through the eardrum. The vibrations are then amplified by tiny bones through to the inner ear. In dogs, these bones are shaped to amplify sounds better than in humans, giving dogs greater sound sensitivity. Therefore, dogs will perceive some sounds to be louder than humans. Sound vibrations then travel through the inner ear, to a spiral bony chamber called the cochlea. Here sound vibrations are converted into electrical signals that the brain can interpret (Figure 2).

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Sound perception

The ability to hear a sound depends on three things:

- How high or low the pitch is (frequency);
- How loud or quiet the sound is (amplitude);
- How long the sound lasts (duration).

The human hearing range is between 20-20,000 Hz, while the dog's hearing range is 65-45,000 Hz. This means that dogs are able to hear sounds that are higher in pitch than humans, including ultrasounds (>20,000 Hz) produced by some rodents and insects. Therefore, dogs may respond to sounds that their handler cannot hear. However, dogs' sensitivity to low pitch sounds does not differ much from humans' (Figure 3).

Humans find it easiest to hear frequencies between 128-4,000 Hz, while dogs are most sensitive to higher frequencies between 200-15,000 Hz. This could partly explain why dogs may respond more to high pitched voices.

Small dogs are more sensitive to higher frequency sounds because of their smaller heads with proportionally bigger outer ears, and greater amplification abilities of the small bones in the middle ear. This means that they can hear quieter sound levels than humans can.

Sounds also need to last at least 100-200 ms to be heard by a dog or a human. More detailed information about sound perception by dogs can be found in a recent review of canine hearing [1].

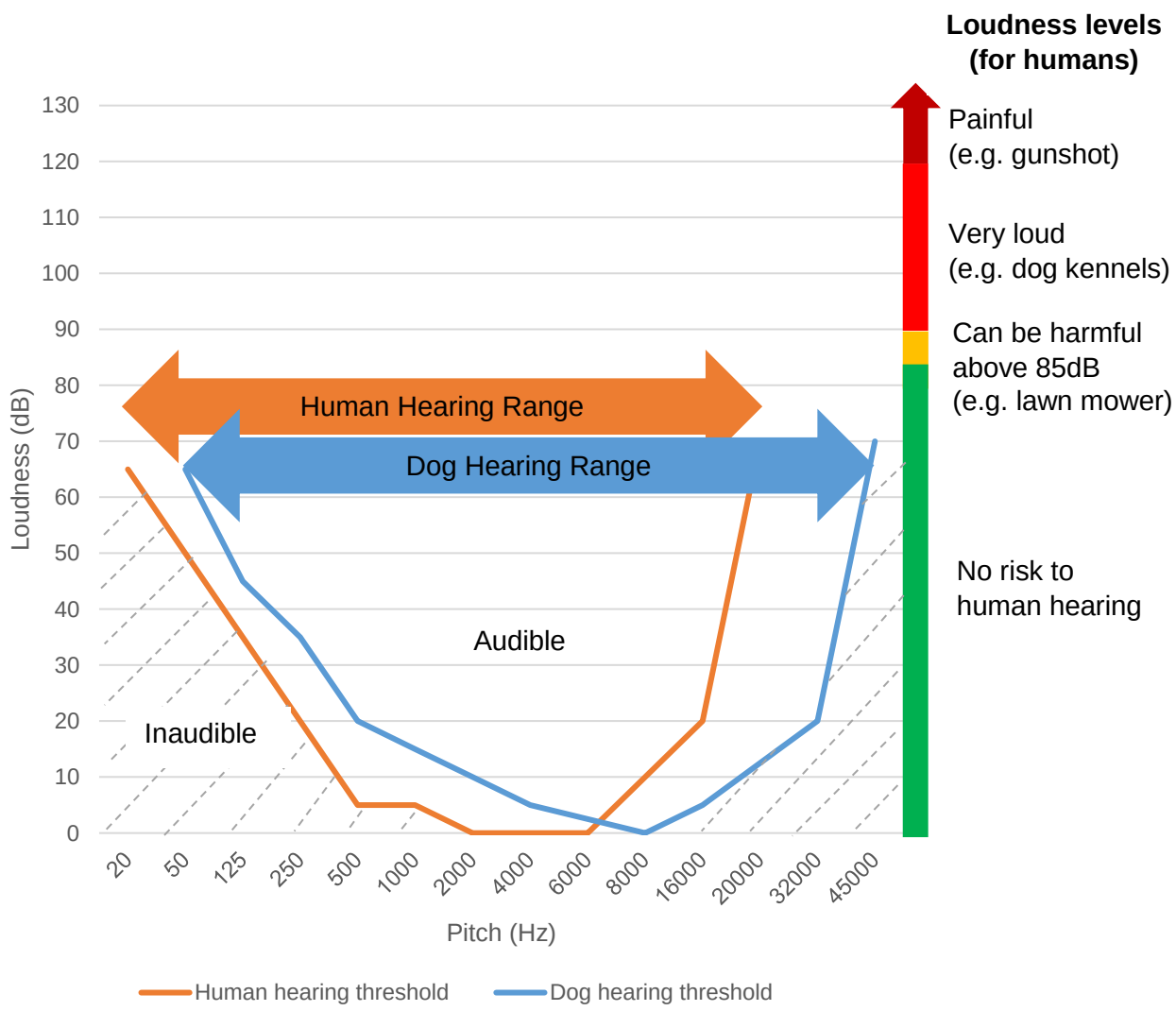

Figure 3: Sounds that can be heard by humans (area above the orange line) and dogs (area above the blue line) depending on their loudness (amplitude) and pitch (frequency). The green/red indicator arrow on the right shows human loudness levels (dog loudness levels are not known).

Direction

To find out where a sound is coming from in the environment, the brain compares the arrival time of the sound at each ear. There will also be slight differences in the loudness of the sound between the two ears, as the loudness drops the further the sound travels (Figure 4).

Figure 4: Dogs can detect where a sound is coming from by comparing the difference in loudness and arrival time at each ear.

The outer ears play a key role in locating where a sound is coming from, due to their funnelling. For this reason, dogs with large erect ears are especially good at locating where distant noises are coming from. Although, when making fine differentiations, dogs can only localise the precise position of a sound source with an accuracy of 4º compared to humans' 1-2º.

Distance

Sound provides animals with important information about how far away the source is. This is because the loudness of a sound decreases by 6 dB every time the distance doubles. It is thought that dogs can hear some sounds that are up to 4 times quieter than humans can hear, so in some situations handlers might not be able to hear what their dog can.

Dog hearing vs. human hearing

Compared to humans, dogs have:

- Better detection of some quieter sounds from further away;
- Better high frequency hearing;
- Similar low frequency hearing;
- Better sense of which direction a sound has come from;
- Similar hearing injuries, but are more susceptible at lower loudness levels.

Hearing damage

Like humans, dog hearing injury and loss can be caused by very loud noises and can be temporary or permanent, partial or complete. The louder the sound, the shorter the amount of exposure it takes to damage hearing.

The loudness at which human hearing is immediately damaged is above 120 dB, and for every 3 dB increase in loudness over 85 dB, the allowable exposure time reduces by half to prevent hearing damage. Dog noise exposure limits are not currently known, but because their hearing is more sensitive, it is possible that dogs' hearing could be damaged at lower levels than humans, especially for high pitch sounds. For this reason, it is important to consider providing dogs with hearing protection when working in very noisy environments. It is recommended that dogs' hearing is protected to at least the same levels as their handlers' wherever possible. Consult a qualified veterinarian for further advice about working dogs in noisy environments.

A single very loud burst of sound, such as an explosion, can damage hearing immediately by rupturing the eardrum or damaging the tiny bones. However, more often hearing is damaged as the result of repeated exposure to loud sounds, such as a noisy kennel environment. Listening to loud sounds, such as other dogs barking in their kennels, can overwork hair cells inside the cochlea which causes them to die – this particularly affects the high pitch area of the cochlea, so the ability to hear high pitch sounds is most often affected. Exposure to loud noises can also cause tinnitus, which is hearing a ringing or roaring sound that can be temporary or permanent.

Taking steps to ensure that dogs' hearing is not damaged by a noisy kennel environment is required to meet three of the 'Five Needs' under the Animal Welfare Act (2006), by:

- Protecting dogs from pain, suffering and injury caused by hearing damage;
- Providing a suitable environment with comfortable noise levels;
- Allowing dogs to exhibit normal behaviour patterns, such as resting in a quiet area.

Further information can be found in the 'working dog welfare during kennelling' guidance note [2].

Deafness

Deafness can affect one ear or both ears. It also varies in severity from slight hearing loss (16-24 dB worse than normal) to profound (>91 dB worse) and can be temporary or permanent. Causes of deafness include exposure to loud noises, congenital or caused by disease. Deafness is more common in some dog breeds (e.g. Dalmation) and is also linked to the Merle colour.

Top tips for considering dogs' hearing

- ✓ Dogs may respond to quieter or high-pitched sounds that handlers cannot hear.
- ✓ Dogs' hearing may be more susceptible to damage by loud sounds than humans' hearing. It is recommended that dogs' hearing is protected from exposure to loud noises at least to the same level as people wherever possible.
- ✓ Very loud sounds like gunshots and explosions may immediately damage dogs' hearing, while longer exposure to loud sounds such as noisy kennels can also be harmful to dogs' hearing over time. Hearing health should be considered to ensure that there is good provision for dog welfare.
- ✓ If dogs' hearing is damaged by noise exposure, they may not be able to effectively hear their handler or other environmental sounds. This may be specific to certain sounds that they cannot hear (depending on the sound's pitch and loudness), and the effects can be either temporary or permanent depending on the level of damage.
- ✓ If you have any concerns about your dogs' hearing, consult a qualified veterinarian.

Associated guides and information

[1] Barber, A.L.A., Wilkinson, A., Montealegre-Z, F., Ratcliffe, V.F., Guo, K., Mills, D.S. (2020). A Comparison of Hearing and Auditory Functioning Between Dogs and Humans. Comparative Cognition & Behavior Reviews, 15. DOI:10.3819/CCBR.2020.150005E

[2] Working Dog welfare during kennelling DSTL/PUB104181 www.cpni.gov.uk/canine-detection-guidancenotes

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