FETCH/LAB

Facility for Education and Testing of Canine Hearing § Laboratory for Animal Bioacoustics

Canine Hearing Threshold Shifts Due to Noise Exposure (And Specifically Transportation Noise) and General Outline of the Audiological and Acoustical Testing of the CAPS Snood Device

1. *Hearing loss and threshold shifts in canines*

Deafness and hearing loss in dogs for a variety of reasons, is well known and has been the subject of research in the past. (1, 2, 3, 4, 5, 6) Causes include: congenital deafness, hearing loss due to presbycusis (age-related), otoxicity, and noise. Whether constant noise can affect dogs, particularly working dogs that are relied upon for their enhanced sensory capabilities (e.g. those used in police, military operations or search and rescue), is important to determine the conditions or environments that can impair these sensory capabilities and to adequately understand their impact on canine hearing. The most important frequencies for canines to hear are in the human audible range of 20Hz to 20 kHz (even though dogs are very sensitive to higher frequencies – 30Hz to 57 kHz) due to the fact that operationally, it is paramount for the dogs to be able to take vocal commands from the handler and that higher frequencies attenuate rapidly (7).

Outside of congenital deafness, noise-induced hearing loss (NIHL) occurs in military working dogs during transport in trucks and helicopters, when exposed to gunfire and explosives and most commonly in working dog kennels. (data from samples taken on military bases – unpublished). The susceptibility and probability of a dog incurring a noise-induced hearing loss (NIHL) may be witnessed by elevated temporary hearing threshold shifts (TTS) as shown by an electrophysiological auditory test known as a Brainstem Auditory Evoked Response (BAER). The BAER test is the only accepted method of diagnosis as per the Orthopedic Foundation for animals (8).

Although anatomically the canine ear canal differs from humans and the canine cochlea differs anatomically (where dogs have a higher range of frequencies of hearing than humans) fMRI studies have shown analogies between human and canine auditory cortices and central auditory systems. (9, 10, 11, 12).

2. *Hearing threshold audiological and acoustic testing*

Initially, four (4) types of acoustic foam were bench-tested in the sound booth for absorption properties.

We used BAER testing for threshold estimation as a baseline for establishing current hearing threshold in dogs and again after use of the CAPS snood-style hearing protection device (HPD) in the current protocol. We also tested the CAPS using the "real-ear" measurement protocol. During the real-ear protocol a small microphone is placed in the ear canal under the snood to take an accurate measurement of mow much sound is attenuated by the CAPS. Using this technology is considered a "best practice" in audiology, because it is the only way to ensure that the HPD is fit and functions appropriately for each animal. The testing for real-ear measurements was conducted in an audiological booth and the white noise level played was 95 dBA. Figures 1 and 2 show dogs being tested with an earmuff type HPD and CAPS respectively.

The BAER test tells us the threshold of the dog's hearing before and after the use or non-use of the CAPS. In other words, was there a temporary threshold shift (TTS) in the dog's audiology and if so, how great of a TTS was there? The real-ear attenuation testing tells us how much of the 95-dBA noise was attenuated (lost) by the snood. Figure 3 shows early attenuation curves.

A Noise Reduction Rating (NRR) is a system used to measure the amount a hearing protection device can reduce sound exposure in decibels. The higher the NRR of a hearing protector, the more effective it will be at reducing noise. The EPA labeling standard is defined in Code of Federal Regulations (CFR) 40, Part 211, Subpart B – Hearing Protective Devices.

CAPS were tested in the audiology sound booth across a range of test frequencies to determine their hearing thresholds with ears open (no hearing protectors) and occluded (with hearing protectors) to simulate a typical noise setting. The difference between those measurements is the noise reduction of the hearing protection device (HPD). A 3-dBA correction is built into the NRR calculation to account for the fact that not all noise spectrums are the same. Mean attenuations based on tests on a subject animal and standard deviations are calculated in accordance with the ANSI standard. The NRR is then computed from the mean attenuations and standard deviations according to the following equation:

$$NRR = 107.9\ dBC - 10 \log \sum_{f=125}^{8000} 10^{0.1(L_{Af}-APV_{f98})} - 3\ dB.$$

where L_{Af} is the A-weighted octave band level at frequency f of a pink noise spectrum with an overall level of 107.9 dBC, and APV_{f98} is the mean attenuation value minus 2 standard deviations at frequency f (2 standard deviations accounts for 98% of the variance in a normal distribution).
(Method 2 of the NIOSH Compendia, 1975)

The calculated NRR for the Zeteo/UC snood model is 12.5
The preferred method for use based on an 8-hour use considers and adjusts for the de-emphasis of low-frequency acoustic energy that is characteristic of an A-weighted measurement. This is the 7 dB correction in the equation for use below.

protected dBA = unprotected dBA - [NRR - 7]

NOTE: NIOSH recommends de-rating the NRR by a multiplicative factor of 75%, 50% and 30% for earmuffs, slow-recovery formable earplugs and all other earplugs, respectively. This variable de-rating scheme considers the real-world performance of most different types of hearing protectors (NIOSH, 1998).

Figure 4 shows one of a few tests of CAPS versus no CAPs hearing thresholds from a 30-minute helicopter flight.

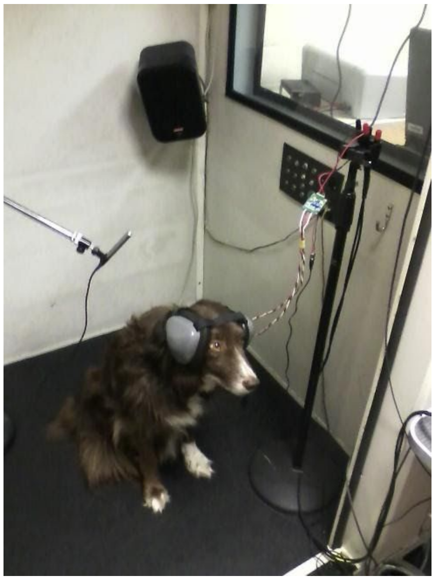

Figure 1. Dog undergoing attenuation testing of earmuffs at UC FETCHLAB™

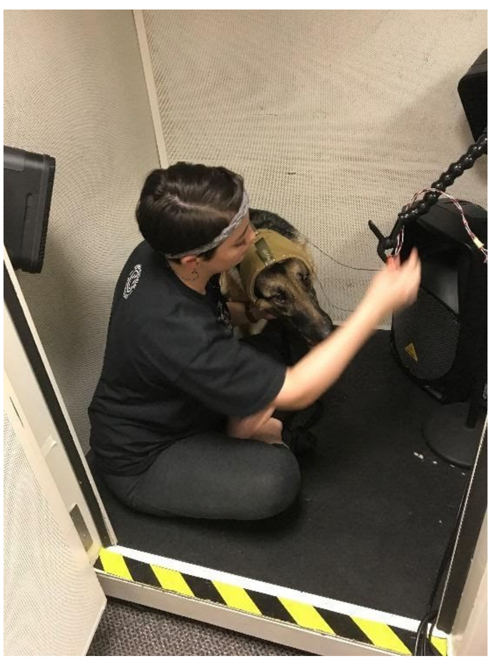

Figure 2. Dog undergoing snood type (CAPS) attenuation test at UC FETCHLAB™

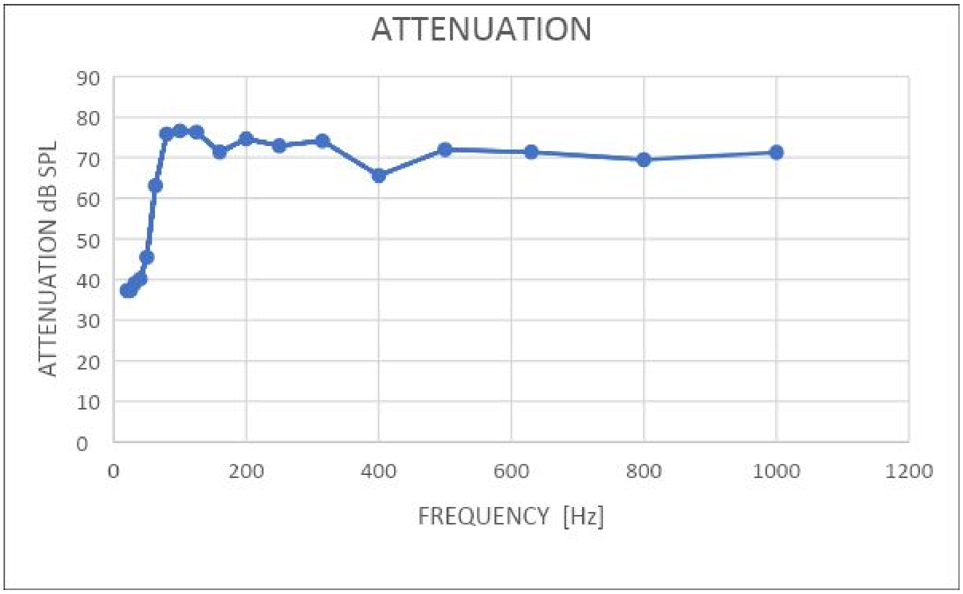

Figure 3. Attenuation curve for CAPS

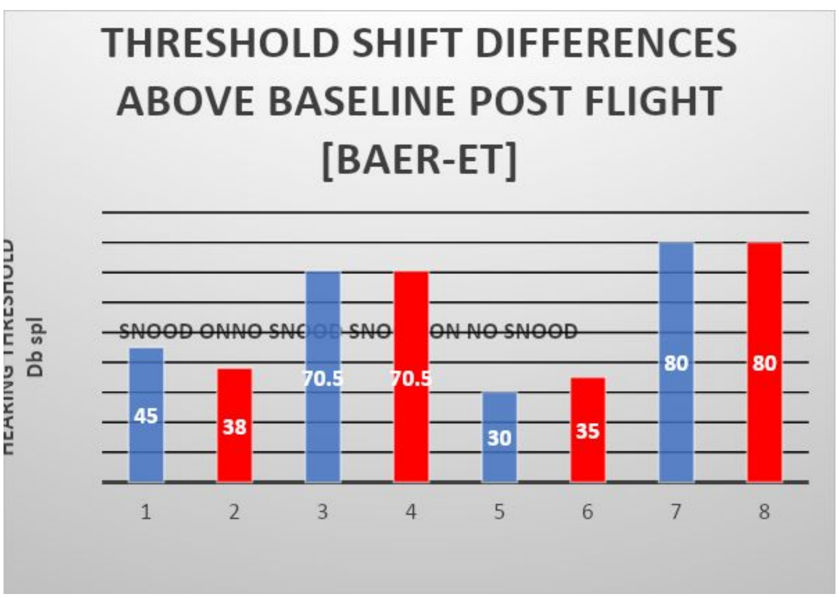

Figure 4. CAPS versus no CAPs hearing thresholds from a 30-minute helicopter flight.

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Our goal is to help support the working canine. If we can understand the study the hazards military, police and other working dogs are exposed to then we can help mitigate and solve some problems that result from them. We want not only to protect the dog, but maybe even find a way to extend its longevity in service. We also hope to find ways to enhance the dog and handler capabilities. This can benefit the dog, Department of Defense, and law enforcement. Additionally, these dogs will eventually retire, and we want to ensure we did everything we could to make their life after service good.

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