

Canine Hearing Loss Management

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- Hearing loss management • Canine hearing loss • Sign language • Vibrotactile
- Hearing loss prevention • Hearing aid amplification

KEY POINTS

- Consider whether canine hearing loss has social and emotional parallels to human hearing loss.

Regardless of whether these parallels exist, we must also consider the following:

- If hearing loss has a direct impact on owner's interactions with the hearing-impaired dog and how communication can be enhanced.
- Whether any safety concerns might arise for the animal or its humans because of diminished hearing.
- And whether there are any recommendations that the veterinarian might share with the dog owner or handler to help mitigate the impact of any existing hearing loss.

INTRODUCTION

Is it possible that dog owners project their fears of personal hearing loss onto their pets? The thought of developing a hearing loss is indeed frightening for many people. Helen Keller, who was both deaf and blind, once noted that her loss of hearing was far more disconcerting than her loss of sight. As she stated, her blindness separated her from the things in her life that she enjoyed, but it was her hearing loss that separated her from the people in her life that she loved.

Very quickly after a dog enters one's home, either as a family pet (or dare we say family member) or as a working partner, a close bond develops in which the owner/handler wishes only the best for his or her companion. When this loved animal develops a hearing loss, or is suspected to have and subsequently confirmed to have a congenital deafness, it is only natural for owners to project onto their canine companion their

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own fears of hearing loss and the perceived impact such loss would have on the life of the dog.

Importance of the Sense of Hearing versus the Sense of Smell

As we discuss the impact of hearing loss on dogs, we need to keep in mind that dogs rely on their sense of smell more heavily than their sense of hearing. Humans have about 6 million receptors for scent, whereas dogs, depending on breed, can have up to 300 million!¹

Whereas humans often judge on appearance, dogs assess by scent.² Not only can they identify a stranger by scent, but they can smell if a new dog acquaintance is male or female, mature or not, if a female is ready to breed, if she is nursing pups, if there is a health problem, and some of the animal's mood. From a human perspective it might be somewhat disconcerting if everyone met on the street could tell that much about us by just being nearby.

A dog's daily life would be affected much more by the loss of smell than by the loss of hearing. Dogs follow scent trails to find potential prey (as anyone who has had to chase a beagle through dark woods is sorely aware), find their toys, and navigate the house (as blind dogs quickly learn how to do). Using an olfactory sense that is a million more times acute than a human's,³ they learn about other dogs' states of being by sniffing where they urinated, and then add their own scent to the mix creating a type of newspaper for the next dog that comes along. They can smell when a door in the house has opened, alerting to the new scents from outdoors, to arrive in time to go for a run, and they can smell out sources of food from great distances. They have even been trained to detect fingerprints on glass six weeks after the glass was touched.²

Dogs are so adept at using their sense of smell, that they have been trained as sensors to detect bladder cancer in humans by smelling urine samples, detecting the cancer before any current noninvasive laboratory test is able.⁴ They can find microscopic traces of drugs left behind on money, and recently have been trained to find single bed bugs in a building. They are commonly used in searches for missing people and in combat to sniff out explosives and insurgents. Their sense of hearing takes a back seat to the value of the sense of smell in their lives.

Keeping this in mind, owners should not project their own despair at their dog's hearing loss and remind themselves that their dog has other ways to compensate. It is the communication with the owner that suffers most, and that is where owners should concentrate their efforts. For most dogs, a hearing loss can be taken somewhat in stride. On the other hand, for some highly trained dogs who are accustomed to a variety of vocal commands, a hearing loss can be frustrating or cause them to retire early from a career they enjoy.

HEARING LOSS IN CANINES: ARE THERE IMPACT PARALLELS WITH HUMANS?

Before looking at the types of hearing loss, one must question if canine hearing loss has social and emotional parallels to those of humans. Significant permanent hearing loss in humans has a direct impact on academic achievement, vocational success, earned income, social interactions, and family dynamics.^{5,6} Studies have further shown that untreated adult human hearing loss is associated with overall poorer health, decreased physical activity, psychosocial dysfunction, and depression.^{7,8}

Given the substantial negative impact that hearing loss has within our species, it is understandable that many dog owners become quite concerned when their beloved pet shows signs of diminished hearing. But a legitimate question might be: Does

a dog's loss of hearing have the same deleterious effects on quality of life as it does for humans?

As a follow-up, one might further question: Can a dog give and receive the same affections without a sense of hearing? Can a dog harmoniously coexist with its human companions in the presence of hearing loss (in either species)? Can a dog interact joyously with members of its own species when hearing is diminished? The answer to all of these is a reassuring "yes." The greater question is how do we maximize the experience of living with a hearing-impaired or deaf dog? A large answer to this question lies in ensuring adequate communication and safety.

TYPES OF HEARING LOSS

The types of hearing loss in canines parallel the types of hearing loss seen in most other mammals including humans. As discussed elsewhere in this issue, a variety of etiologies can underlie hearing loss, and depending on the pathology, the loss may be amenable to medical intervention. Although the purpose of this article is to provide discussion of management of permanent hearing loss in canines, let us first briefly summarize the types of hearing loss.

Conductive Hearing Loss

Disorders that disrupt the normal sound propagation (or *conduction*) of sound energy from the environment to the cochlea of the inner ear present a conductive hearing loss. Some of these disorders, such as cerumen accumulation in the outer ear canal, otitis externa, and otitis media, are clearly amenable to medical intervention. The sequela of longer-standing, untreated middle ear effusion can result in more permanent hearing deficits. Conductive hearing loss can also arise from disruption or fracture of the middle ear ossicles (the bones that transmit sound vibration from the tympanic membrane to the cochlea) or reduction of ossicle vibration (the stapes in particular) caused by otosclerosis. These latter conditions, although correctable, are difficult to diagnose accurately in canines and are rarely addressed medically. The management discussions in this article, however, can apply to any nonremediated conductive hearing loss.

Sensory Hearing Loss

More permanent hearing loss that affects the cochlear structures (primarily the inner and outer hair cells) can be congenital (present at birth or with delayed onset) or can be adventitious secondary to ototoxic agents, noise exposure, or presbycusis (aging process). Although both sensory and conductive hearing loss create an attenuation of incoming sound intensities, sensory hearing loss creates greater hearing difficulty owing to cochlear distortions even when hearing loss levels (degree of attenuation) are held constant. The effects of sensory hearing loss listed in **Box 1** greatly exacerbate communication difficulties in humans. Given that successful canine

Box 1

Effects of sensory hearing loss in humans

- Reduced intensity of speech and environmental sounds
- Reduced frequency resolution of speech sounds
- Reduced temporal resolution of speech sounds
- Reduced tolerance for intense sounds

auditory comprehension of human speech is reliant on the accurate reception of a more limited number of brief commands that can partially be deciphered by context and vocal tone, the adverse effects of sensory hearing loss affect canines less.

Mixed Hearing Loss

Mixed hearing loss typically refers to the coexistence of conductive hearing loss and sensory hearing loss. Management is most effective when any treatable conductive component is addressed medically in combination with hearing loss management suggestions presented in this article.

Neural Hearing Loss

Hearing loss that arises from lesions along the cochlear nerve between the cochlea and the brainstem (eg, acoustic neuroma, acoustic neuritis, multiple sclerosis) can produce a neural hearing loss. These hearing losses used to be lumped within the larger term "sensorineural hearing loss"; however, today's diagnostic tools, including measures of auditory brainstem response, recordings of otoacoustic emissions, and imaging through computed tomography scan and magnetic resonance imaging, can differentiate sensory and neural hearing losses, permitting separate classification in humans. In animal audiology, the management of sensory and neural hearing loss is essentially the same, and the 2 types of losses are still routinely classified within the more generic term of sensorineural. Although neural hearing losses are frequently specified as "retrocochlear," it should be noted that by definition this term includes any hearing loss beyond the cochlea; yet, a central hearing loss, which is also beyond the cochlea, is a categorical hearing loss in its own right.

Central (or Cortical) Hearing Loss

A decrease in auditory comprehension in the absence of a concomitant loss of hearing sensitivity is known as a central auditory disorder or auditory processing disorder. The resultant listening difficulties that arise in humans (often resulting in a variety of learning disabilities in schoolchildren) are still frequently undiagnosed or misdiagnosed. Given the vast similarities among animal species' auditory systems, it is likely that some dogs suffer with a central hearing loss; however, the clinical documentation of this disorder within canines would be difficult at best. Although not identified as a disorder, owners of dogs who may have an auditory processing deficit likely recognize that their dogs are easily distracted and side-lined and find means to compensate in their instruction and interactions.

WHAT MIGHT WE EXPECT WITH CANINE HEARING LOSS?

The dog with a congenital hearing loss grows up visually alert and is not truly aware that he is different from other dogs. As discussed earlier, dogs rely on their sense of smell more heavily than their sense of hearing; and for dogs who have hearing loss from birth, there is little we need to do other than to find a mutually satisfactory means to communicate with the animal and ensure its safety and the safety of others.

Dogs who lose their hearing later in life, whether from presbycusis, disease, ototoxic agents, long-term noise exposure, or sudden-impact acoustic trauma, may indeed know that they are different from their compatriots and may sense the loss of hearing more acutely than dogs with congenital hearing loss. It is mostly for these dogs that owners will seek advice from their veterinarian.

The most common questions that the veterinarian may hear from their patient's owners pertain to the warning signs of hearing loss (ie, *What should we be watching*

for? How do we know there is a loss?), if the hearing can be tested, and what should be done if a hearing loss is verified.

WHAT ARE THE WARNING SIGNS OF CANINE HEARING LOSS?

In the absence of brain stem auditory evoked response screening (BAER), it is nearly impossible to identify a deaf puppy until after it is weaned. A normally hearing pup will generally begin responding to environmental sounds and voices by about 10 days of age; however, a deaf puppy within a litter of pups lives its early life within the “pack” and will blend with the movements and “group responses” of its littermates. Although a congenitally deaf pup may appear behaviorally more aggressive with its littermates, it is generally only on later separation from the litter that behavioral observations raise suspicion of deafness.

A dog born with a unilateral deafness, or who later acquires a unilateral hearing loss, is more difficult to identify; however, close observation will reveal difficulty localizing the source of sounds and what may appear as a greater disorientation than other dogs. Suspicion of unilateral deafness can only be fully confirmed through BAER testing.

As with humans, as dogs age, their hearing diminishes. This most often is of a gradual onset discovered by owners through observation of changes in the dog’s awareness of or responses to environmental sounds or verbal commands.

COMMON SCENARIOS LEADING TO SUSPICION OF ADULT-ONSET BILATERAL HEARING LOSS

Alice arrives home to find her 8-year-old golden retriever, Dixie, happily sleeping on the couch. This would be fine if the dog did not shed all over the couch, she thinks. But her larger concern is that Dixie is usually jumping up and down at the door in happy anticipation before she has even pulled fully into the driveway. As Alice approaches her dreaming dog, her winter boots clomping on the floor, Dixie does not even crack an eye. She reaches down curiously to pet the dog thinking, “Why wasn’t she at the door?” As Alice’s fingers barely touch fur, Dixie gives a startled yelp and almost bounces off the ceiling. The dog then looks at her with confusion and a sheepish reaction. Dixie does not understand how or why her owner snuck up on her.

Bill is throwing a ball for his border collie, who loses interest for a moment and heads off to sniff a distant tree. Although usually responsive, this time the dog ignores Bill’s recall. Finally, in frustration, Bill marches over to the collie and disciplines her for not coming when called. The dog cowers and does not understand what she did wrong or why the playful owner is now angry. She would have come right away if the owner had called!

Max, an 11-year-old show dog and agility champion is in a training session. He knows more than 50 behaviors well, many of them on verbal command. His trainer has noticed that over the past few months some behaviors have become sloppy, or seem to have false starts. In working to tone up these vocally cued behaviors, the dog appears anxious and not as responsive as usual. In later weeks, the dog finally walks away when the trainer gives a series of vocal commands. The dog is willing to work, happy to be trained, and responds well to hand cues, but seems less interested in responding to vocal commands.

These scenarios are often first glimpses into changes in a dog’s hearing. Dogs cannot come up to their owners and report that their hearing seems to be failing. It is up to owners to be aware of the changes in their pet’s behavior.

For many health problems, changes in behavior can be the first sign. A loss of hearing is no exception. If a dog starts to consistently have a different response than what has been established for years, the owner should consider what may be medically wrong rather than assuming that the dog is misbehaving or lazy.

Most frequently, when questions arise about hearing abilities at a veterinary clinic visit, it is inquiries about an adult dog with adventitious hearing loss, generally from presbycusis. In the absence of any history of otologic disease or excessive noise

exposure, such hearing losses are almost always bilateral in nature. Because of the gradual onset of presbycusis, recognizing the signs of bilateral hearing loss in the adult dog is much more difficult than recognizing the signs of bilateral deafness in a puppy. Although the pet owner may have felt that something was not right with their dog for some time, it is most often only after the loss has progressed to significant levels that hearing loss is suspected.

Warning signs of bilateral hearing loss may include the following:

- Sleeping through sounds or a lack of response to sounds for which one would expect a response, such as verbal commands, hand clapping, doorbells, knocks, can opener, car in the driveway (many times breeders suspect a puppy who continues to sleep when the rest of the litter wakes up and runs to greet a person)
- Startling at a touch
- Not responding when called
- Confusion when given previously trained vocal commands
- Startling at loud sounds that in the past were not an issue (eg, owner sneezing, blasts from the TV, a dropped pot) (Note: Some sensory hearing losses decrease sensitivity for soft or average intensity sounds while increasing sensitivity to loud sounds.)
- General decrease in activity level, sleeping more hours in the day than typical for a dog of similar breed and age
- Difficulty waking the dog when sleeping
- Tendency to startle or snap when woken or touched from outside of its field of vision
- Excessive barking or unusual vocal sounds compared with other dogs of comparable age and breed
- Disorientation, confusion, or agitation in familiar settings

Before the onset of universal hearing screening for newborn humans, suspicion of hearing loss was often delayed owing to apparent responses to auditory signals that were actually responses to visual cues accompanying the auditory signal or response to vibrations. These same confounding factors can affect clear identification of hearing loss in the adult dog with true confirmation only possible through BAER testing.

What Should be Done if Hearing Loss is Verified?

As when other maladies arise with one's pets, when canine hearing loss has been confirmed, pet owners/handlers want to know what they can do to improve or restore the dog's quality of life. As stated at the outset of this article, there is frequently considerable projection on the part of owners relative to what hearing loss must mean to their pet. It is likely that the hearing loss is far more disconcerting to the pet owner than it is to the dog; however, there is information that the veterinarian can share that may be beneficial to both the owner and the dog.

Once the owner has pursued any medically appropriate treatment, it is time to find ways to adapt the human/animal relationship to the hearing loss. Teaching the dog to look for eye contact with the owner, and then to pursue hand signals can offer a new and often fun pursuit for the human/dog team, while building communication skills. The owner should be made aware of dangers that accompany a hearing deficit, such as inability to hear cars and other hazards, nonresponsiveness to human speech, nonresponsiveness to expressions of pain and surprise for which a hearing dog may alter behavior, and changes in training to ensure the deafness is taken into consideration, especially involving disciplinary actions.

Considerations When Living with a Hearing-Impaired or Deaf Dog

Life with a hearing-impaired or deaf dog can be quite fulfilling for both the dog and owner; however, there are potential behaviors of which owners should be made aware. Although some of these can be viewed as humorous, others are more directly related to the safety of both family members and the pet.

NOT SO UNIQUE SCENARIOS FROM LIFE WITH A DEAF DOG

Linda, who had owned her congenitally deaf Australian Shepherd named Belle for about 6 months, relays a story of mistaken identity. Linda was in the shower with the window open on a beautiful summer morning when she heard a woman calling from the deck outside the kitchen. Sticking her head out of the curtain, she listened again, "Yoo Who!" Linda called out, "Crissy, is that you?" But there was no response. A moment later she heard a repeat call, "Yoooo Whoooooo!" This time Linda called "Crissy, come on in! I'll be out in a minute!" Still, no response. "Yoooooooooooo Whoooooooooo?" Feeling slightly perplexed that she could not make herself heard, Linda got out of the shower, dripping wet, wrapped herself in a large towel and went to the door to greet her friend. To her surprise her friend was not there. Instead she saw Belle through the kitchen window happily calling "Yoooooo Whoooooo!" Living with a deaf dog has many challenges...some are indeed comical, as in this scenario, which shows how unusual some of the sounds are that a congenitally deaf dog can make.

Sometimes those unusual sounds can cause owners embarrassment. Ted and Alice took their deaf golden retriever to their children's cross-country meet. Dixie was one of many dogs in attendance. They lined up with dozens of other parents and spectators along a lightly wooded path where all the runners would pass. As the first runners came through, Dixie became excited. By the time their own kids came through, she wanted to run along and showed her displeasure of the leash by SCREAMING. This was not a dog whine or howl, but rather nonstop blood-curdling, drawn out soprano SCREAMS right out of an old movie with the heroine tied on the railroad tracks. All eyes turned toward Ted and Alice with silent accusations of torture. There was just no way to explain what was going on to that many people, so they slunk away as quickly as they could.

Unfortunately, a deaf dog cannot hear our unexpected sounds. A dog with normal hearing takes notice when its human is displeased. For example, Rhonda was lying in bed reading a book when her 95-pound deaf shepherd, Mackenzie, jumped onto the bed, landing on the owners' stomach. Although a dog with normal hearing gets the picture not to do that again without much actual training, a deaf dog will never hear its owner's "OOF" and grunt and will remain completely oblivious to the discomfort caused by jumping up on the bed. Although Rhonda's dog may not learn from this, Rhonda surely will learn to expect another unexpected gut punch.

A deaf dog will not hear a person yelp if play gets too rough. If the dog has not been taught properly, and rough play is encouraged, a deaf dog may assume it can play as roughly with a human as with another dog. Human skin is not as pliable or resilient as canine skin, and injuries can happen. When playing with a child, the dog will not hear the discomfort of the child and may think the child's attempts to fend it off are just more play, increasing the risk. Even more than with a hearing dog, care must be taken from the start to teach good manners to a deaf dog.

Dogs pay attention to the sounds and behaviors of other dogs to determine attitude and whether an encounter will be friendly or aggressive. A growl is an aggressive sound, a whine is a plea, a yip is an invitation to play, and so forth. If a deaf dog gets into a fight with another dog, it will not hear when the other dog yelps, whines, or makes submissive "you win" sounds. Because submission is also usually shown by exposure of the throat and belly, a dog submitting in the fight is at risk if the deaf dog does not accept the submission, as it was not heard. Deaf dogs are not any more violent than hearing dogs, but a deaf dog is still biologically/instinctually wired, exactly the same as a hearing dog, to expect certain behaviors. The deaf dog lacks the self-awareness to realize it will never receive the full submission (sound and exposure).

Ryan's story exemplifies the inherent dangers of when a deaf dog fails to recognize submission. Ryan's border collie, "Q," was very hard on the family's deaf dog, Beethoven. Q felt she had to be in charge all the time, bullying Beethoven. Ryan and his wife, Lucy, intervened and maintained the peace for years, but one Sunday night Q snapped at Beethoven, slightly scratching Beethoven's nose. Beethoven responded with a full charge. Q immediately realized she was in trouble, whimpered and rolled onto her back, but Beethoven was on her, clamping down on multiple places and shaking for all he was worth. Q was crying out and submitting, but Beethoven was not responding and continued to bite and shake violently. The owners separated them as quickly as possible...the fight lasted just moments...but poor Q spent the night in the hospital, was very sore for days, and Ryan and Lucy were out more than \$1000 in veterinary bills.

Last year, Ryan and Lucy added a rescued 9-month-old beagle to their home. Beethoven had a difficult time comprehending the new hound's behaviors. The beagle, "Bones," would run up to Beethoven and bay. At first Beethoven thought the running at him, raising the head so high, and opening the mouth at him were signs of aggression from Bones. But as soon as Beethoven would start to react, Bones would go into a play bow, roll over or run off, completely confusing the deaf dog. It took a few months, but Bones taught Beethoven to play like a dog, which was a joy Beethoven could never share with Q.

Dog Owner/Handler Communication with the Hearing-Impaired or Deaf Dog

Deaf dogs learn quickly to watch faces and learn to associate their owner's moods with the corresponding facial expressions. Savvy owners can use this to their advantage. Because the dog understands the angry face, sometimes that is all that is needed to get a point across. Owners have to take care to send consistent messages. It can be hard to keep an angry face while scolding, when one just wants to laugh at all the feathers stuck onto the furry face that got into the school art project. But if the owner laughs and smiles, the deaf dog may pick up on that more than the scolding, and dive right back into the feathers for more fun.

Dogs have been bred by humans for tens of thousands of years for many specific traits: herding, guarding, body size, nose length, color, ear size, temperament, coat type, webbed feet, tail shape, amount of wrinkles in the skin.....the list goes on and on. One trait that is true across the board, regardless of breed, is that we want our dogs to be in tune with people. We want them to accept humans as their pack and to look to us for guidance. This quality is what makes the domestic dog such a good pet, and a wonderful companion and working partner. This is also the quality that allows us to create an interspecies communication system.

Deaf dogs are just as intelligent and willing as hearing dogs. Dogs are hardwired to communicate. They instinctually use facial expressions and body language, in addition to sounds. These expressions would be of no use to a dog if no other dog could "read" them. Dogs are able, willing, and actually very perceptive at reading human facial expressions and body language. They also have their hidden ace; that sense of smell that helps to cue them in on how we are feeling.

Dogs that are congenitally deaf learn quickly to watch for facial signs in the people around them to help them understand situations. This is a natural survival instinct. A deaf dog that is socialized properly with humans will watch faces and body language and learn to change its behavior based on what it reads in the people. Dogs that become deaf later in life already know the basics and have had the advantage of formerly heard sounds that have taught them what frame of mind may be paired with which human facial expression and body language. With their hearing not helping them, they naturally look for additional information by watching more.

This natural ability to read humans gives us a wonderful basis for communication. Deaf dogs can be taught a wide range of visual cues. These cues can be hand signs

(a form of dog sign language), owner body position, blinking lights, prop driven commands, and so forth. Many owners train their dogs to visual cues without even realizing it, such as when the owner puts on a coat and the dog begins dancing around the owner asking for a walk.

As with all training, consistency is the key. With deaf dogs, this includes consistency of body language and facial expression. As in the example with the feathers, training will be slowed or confused by mixed signals. Explicit training can commence once the deaf dog has an established, healthy relationship with the owner.

Owners can use food reward, toy reward, affection, or combinations to keep the dog interested in the training. Training should be performed in a positive atmosphere, with the goal being enjoyable, useful communication. A good start is to train a recall. Have the dog loose in an enclosed area. Have some treats available. When the dog looks up, show it a treat and make the gesture you want to use that means "come here." Any visual cue should be easy to remember, easy to perform, and easily distinguished from other cues. In the case of "come," a visual cue easily understood from a long distance is advisable. When the dog comes over for the treat, the owner should be aware to show a happy facial expression, make eye contact with the dog, and praise it with affection while giving the treat. Soon the dog will be watching for the visual hand cue, and excited to come when it sees it. This can easily be paired with a light cue, such as a flashlight turning on and off, or blinking outside lights, so that a deaf dog loose in a yard can be recalled at night even when not directly looking at the owner.

This same method is used to train a deaf dog to come to the vibration of a collar. The owner shows the dog a treat and as the dog comes to get it, the owner vibrates the collar. Once the dog is not surprised by the collar vibration, and the treat has made the vibration a positive experience, the owner vibrates the collar simultaneously with showing the treat. The dog learns to associate the vibration with the food reward. Eventually, the vibration alone will alert the dog to return to the owner for a reward.

The basic principle is the same for each trained visual cue. Pair visual cues with behaviors and communication, and reward when the dog responds appropriately. Dogs quickly pick up signs for supertime, time to go outside (bathroom break), back up, sit down, stay, look at me, look over there, put that down, give that to me, do you want to play? They can even be taught signs for individual toys. Just as importantly, dogs learn the sign for NO! This sign should be very clear, very distinct, easily and quickly made with one hand, and accompanied with an angry face. We use the classic, side to side, scolding index finger.

Disciplining deaf dogs can be more challenging than disciplining hearing dogs. For example, Dan is relaxing in the living room when he looks up and sees his young deaf dog, Suzie, stealing some meat off the kitchen counter. He yells and runs to the kitchen. A hearing dog would have heard the angry yell as it took the meat. In this case, Suzie has swallowed the free meat that her owner obviously was not guarding for himself, never heard the yelling, was very happy with her treat, and is now beginning to scratch an itch. All of a sudden she is being hit, and Dan is there with a very angry expression. She is surprised and scared and reacts by trying to twist away. She cannot get away, she hurts from where she was hit, her owner looks and smells scary. She is confused, and finally attempts a bite in her panic. This further infuriates Dan and the situation continues to go downhill. Suzie never does understand what went wrong...she was just scratching herself! Damage has been done to the relationship, and if Dan does not learn how to communicate better, Suzie is going to start biting to protect herself.

Owners of deaf dogs need to be proactive, especially while their dogs are young and learning the rules of living with humans. The best solution to Suzie's dilemma would be for the meat to not be accessible in the first place. Leaving it out invites Suzie to learn that the counter is a good place to find treats. Let's look at a different way for Dan to deal with Suzie.

Dan looks up in time to see Suzie stealing the meat off the counter. Understanding that he will not get there in time, and that this is a training situation, Dan keeps his temper under control but quickly makes it over to Suzie. He lays another piece of meat at the edge of the counter, stands back and waits. Suzie smells the meat, reaches for it, but is immediately intercepted by Dan, who puts on a very angry expression and gives her a strong visual cue for NO! If necessary, he can hold her muzzle gently but firmly while making her watch the NO cue. Then Dan makes her leave the room, removes any easily stolen food, and monitors Suzie for a while to make her stay near him in the living room, effectively giving her a time out by limiting her freedom. Suzie realizes she got in trouble while reaching for the meat, knows her owner is mad and why, and realizes that she has lost some freedom while her owner is angry. They have communicated, no damage was done to the relationship, and Suzie has taken a step in learning the rules.

There are other "tricks" that can be used as long-distance disciplines, or to get a deaf dog's attention. Some owners believe a squirt gun is best for getting attention. An Airzooka can also be used with good success. This drum-sized toy shoots a powerful slug of air about 30 ft, enough to startle a dog a room away and cause the dog to look over to the owner, who can redirect the dog away from the mischief.

KEEPING THE HEARING-IMPAIRED OR DEAF DOG SAFE

A deaf dog cannot hear a car racing down the street, and cannot hear a warning or recall issued by the owner. It is difficult to keep a loose deaf dog safe. An owner who wishes to take a deaf dog off leash may have success communicating a recall with a vibration collar. Vibration collars are available through distributors for hunting dog training aids. The collar can be set to vibrate when the owner pushes a button, alerting the dog that the owner is recalling. Care has to be taken that the dog does not get out of range where the collar will no longer respond to the handset. The owner must spend many hours training the deaf dog to respond to the collar consistently.

Because it is more difficult to get a deaf dog back if it gets loose, other precautions can increase the chances of keeping the dog safe. Always have owner information attached to the dog's collar so that if someone finds the deaf dog, the dog can be brought home. Micro-chipping is another good safety measure. Even if the dog loses its collar, a microchip can still bring it home.

Physical fencing is always a great option for keeping pets home and safely confined. In some subdivisions, physical fencing is prohibited and invisible fencing (electronic fencing, usually involving a shock collar) may offer a solution, but only when used in appropriate circumstances. Although the use of such "fencing" may be a convenience for dog owners, there are added risks over conventional fencing. Without appropriate supervision of the dog at all times, in conjunction with knowledgeable, proper training to the fence to keep shocking at an absolute minimum, dogs will sometimes run through the fence or be traumatized by the training. Furthermore, hearing dogs are able to listen for an audible beep, warning the dog that they are approaching the perimeter. When choosing an invisible fence company, owners of deaf dogs must be assured that the collar has a vibration setting to warn the dog of the perimeter and must train accordingly. If the owner is already using a vibration collar as a recall device, this can cause confusion. Unlike physical barriers, invisible fences keep

your pet in, but do not keep other dogs out. Owners must be diligent not to leave a pet “safely” in the yard, just to have it attacked by a loose dog.

Audiological Management of the Hearing-Impaired or Deaf Dog

In human audiology, audiologists are not only interested in determining the extent and impact of an existing hearing loss, an equally important test outcome is differentiating the site of lesion of the hearing difficulty (conductive, sensory, neural, or central). In canines, the primary evaluation concern is ascertaining the degree of hearing loss and the amount of residual hearing abilities.

If hearing aid amplification is being considered for a dog, we require specific testing to determine audiological “candidacy” of a dog. As with human amplification, dogs require a certain amount of residual hearing for amplification to be effective. To be considered for amplification, we require candidates to have BAER with insert earphone delivery no poorer than 102 dB peSPL (equivalent to 80 dB nHL) using an IHS testing unit (Intelligent Hearing Systems, Miami, FL). The waveforms must contain at least waves I, II, III, and V and must be replicated using 2000 sweeps at either 17.1 or 33.3 clicks per second using a condensation or alternating stimulus with filter settings of 100 Hz and 1500 Hz. If the candidate has a hearing loss no worse than our cutoff criteria, then the same test is run in a free-field (through speakers) in an audiological sound booth to attain unaided BAER responses that can be later compared with aided BAER responses.

Based on the set criteria, and if the dog and owners are good candidates with respect to commitment and behavior, silicone impressions of the ears are taken for laboratory fabrication into hearing aids. Once the hearing aids are received from the hearing aid laboratory, the dog is fitted with them and the free-field BAER testing is run again with hearing aids. This final testing process allows for “tuning” of the hearing aids to ensure improved audibility.

At the University of Cincinnati’s FETCH~LAB (www.fetchlab.org), we have been experimenting with canine amplification for the past several years with very mixed results. Otter, the first dog we fit with hearing aids, was our most successful. Not coincidentally, Otter was probably the most highly trained dog we have worked with. He had appeared on David Letterman’s Stupid Pet Tricks and several TV shows, performed regularly, and knew more than 100 behaviors.

BAER testing revealed Otter had a severe hearing loss bilaterally (approximately 70 dB nHL). Otter’s hearing loss was secondary to presbycusis and his animal trainer/owners sensed that he appeared stressed that he could no longer discern verbal commands. He was outfitted with digital postauricular human hearing aids attached to a cowl (**Fig. 1**). Fairly lengthy tubing extended from the hearing aids to custom-fabricated Lucite earmolds fitted to each ear.

As expected, Otter did not at first recognize hearing aid-amplified sound as something meaningful. It took considerable consistent behavioral conditioning for Otter to wear the hearing aids for increasing lengths of time. Eventually he became aware that he was missing something when the hearing aids were not worn and he began to re-recognize the verbal commands he had responded to when his hearing was normal.

The “ah HA!” moment for Otter came during a training session after weeks of wearing the aids. After performing several behaviors for hand cues, his trainer set him up for what used to be a favorite behavior in which Otter had to wait for a verbal command from a prone position. He had become increasingly frustrated with this behavior over the past few years as he lost his hearing. This time he heard the verbal command and was so surprised that at the first command, he jumped to his feet and spun toward the trainer. Setting the behavior up a second time, Otter exploded into the behavior, then ran excitedly to the trainer and happily repeated the behavior over and



Fig. 1. Following protracted and dedicated training, this highly skilled dog adapted to use of amplification and sought his hearing aids in the morning. Hearing aids provided by ReSound (Bloomington, MN). (Custom earmolds *courtesy of* Westone Laboratories, Colorado Springs, CO.) (*Courtesy of* University of Cincinnati FETCH~LAB, Cincinnati, OH.)

over. After that, he accepted the hearing aids easily and would wear them 10 hours or more each day, napping and running outside without removing them. He would even come looking for his cowl in the morning, tugging it off a table and standing stock still so that the hearing aids could be put on.

As stated, Otter was our most successful fitting. Yet even with his success, questions remain. Otter, unfortunately died of cancer, within 6 months after he received his hearing aids. It is unknown if he would have continued to wear his hearing aids or if he would have instead begun to rely more on visual cues and signs for communication with his owner/trainer. Dogs are very resilient, do not communicate primarily through audition, and most frequently do continue with their lives quite successfully in the presence of diminished hearing.

Subsequent hearing aid fittings were done with custom-molded completely in the concha hearing aids equipped with wireless microphone transmission to convey the owner's voice directly to the dog's ear at distances up to 50 ft (**Fig. 2**). In spite of the higher level of technology, the dogs fit with this device were not as successful as Otter, most likely as postfitting training was not as diligent.

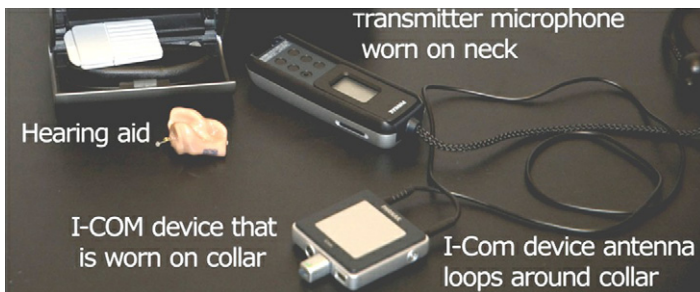


Fig. 2. Custom Phonak (Warrenville, IL) hearing aid (worn in the dog's ear) with wireless transmitter microphone (worn by dog owner) and I-COM receiver (worn on the dog's collar). Owner's voice can be transmitted up to 30 ft. (*Courtesy of* University of Cincinnati FETCH~LAB, Cincinnati, OH.)

What have we learned from our experiences? With hearing aid fittings on subsequent dogs, we have discovered the following:

- When canine hearing loss develops, it is the owner, not the dog, who is being “treated” when we fit hearing aids.
- The owner must either be a skilled trainer or work closely under the guidance of an animal behaviorist if the hearing aids are to be tolerated.
- A behaviorist can give owners training steps to take *before* hearing aids are pursued, both to assess the ability of the owner/dog team to successfully complete the training, and to pretrain the dog to accept a device.
- Training, as in all other areas, must be consistent and is expected to be long term.
- The dog must have a history of being easily trained and compliant.
- The owner must have the patience of Job.

Even with these factors all in place, success is a relative term in canine amplification and never guaranteed. We have learned that the first approach when owners want hearing aids for their dogs (and FETCH~LAB gets calls weekly) is serious counseling with the owners so that they know who they are getting hearing aids for (it is really more for the owner than for the dog), what will be expected from the owner, and that life with a hearing-impaired dog can be highly enjoyable and rewarding in spite of the hearing loss without hearing aids.

Other Amplification Options

Dog owners frequently inquire if implanted amplification may be more successful with dogs. The underlying thought is, given that much of the requisite training with the dog is geared toward acceptance of having something foreign in the ear canal, an implanted device may be more successful. There are caveats for each of the 3 implanted approaches.

- **Osseointegrated Auditory Implant (aka: Bone-Anchored Hearing Aids):** Bone-anchored hearing aids are used for conductive hearing losses or mixed hearing losses with a large conductive component. As such, they are not truly applicable for dogs with gradual-onset, presbycusis hearing loss, as the requisite bone conduction (neural reserve) is lacking. From an audiologic perspective alone, this style hearing aid could be considered for dogs with conductive hearing loss secondary to ear disease. However, other factors would still rule this out for canine implantation.

The actual processor is attached to a surgically implanted titanium post in the mastoid bone. The cost of bone-anchored hearing aids for humans is approximately \$3000 for the titanium implant itself. When one adds to this the cost of surgery and the surgical and audiological aftercare, cost alone is not a small consideration when considering this device for canines. The sound processors of these devices are more sensitive to damage from extreme weather conditions than are more traditional hearing devices. Of a greater concern are the reported incidents when a blow to the head during sports has broken the anchor from the bone in humans. This certainly makes the device inappropriate for canines.

- **Middle-Ear Implants:** Middle-ear implants have some advantages over traditional hearing aids but come at a considerable cost: as high as \$15,000 for the device and surgical procedure. Side effects reported in humans with middle-ear implants have included partial facial paralysis and loss of taste.
- **Cochlear Implantation:** A cochlear implant provides stimulation directly to the cochlear nerve, bypassing the damaged hair cells in the cochlea that no longer stimulate the cochlear nerve. The average cost for a cochlear implant for human

deafness, including preimplant evaluations, the implant itself, surgery, and post-operative aural rehabilitation, is more than \$40,000. Without being able to fine-tune the device with clear input from the canine, it is questionable how successful a cochlear implant might be.

HEARING LOSS PREVENTION

Up to this point, this article has been addressing existing hearing loss and its management. The prevention of avoidable hearing loss should be of equal importance to veterinarians and dog owners/handlers. Although hearing loss is inevitable with the aging process, hearing loss for younger canines is often preventable.

The adverse effects of noise exposure on human hearing are well documented and have culminated in legislation for the protection of workers' hearing. The Occupational Safety and Health Administration⁹ and the National Institute of Occupational Health¹⁰ have both set guidelines for hearing protection from noise exposure that permits a time-intensity trade-off in which a worker's permissible exposure level decreases as the length of exposure time increases.

Canines, too, can be at risk of hearing damage from excess sound levels, but their hearing is not protected through damage-risk legislation. Although FETCH~LAB research has documented that the intensity of driers commonly used during dog grooming is sufficiently loud to damage the groomer's hearing, the shorter duration of exposure for the dog being groomed renders the intensity safe for canines. In contrast, given the longer exposure times, FETCH~LAB has demonstrated that the noise levels in kennels can damage the hearing of dogs kenneled for longer periods of time.¹¹ Working dogs in the military are frequently exposed to noise levels for which their handlers are afforded hearing protection. The FETCH~LAB is currently working toward proposed solutions to help protect the hearing of these highly trained animals.

"Civilian" dogs are not routinely exposed to intense noise. All advocates for canine health and safety, however, should promote awareness of potential dangers to canine hearing. The FETCH~LAB successfully installed sound-absorbing panels in a local kennel to mitigate noise levels. Hunters who wear hearing protection should be cognizant of the proximity of their dogs to gunfire and consider protecting their dog's hearing as they should their own. Effective canine hearing protection is currently under development through the University of Cincinnati FETCH~LAB.

SUMMARY

Dog owners and handlers are naturally concerned when suspicion of hearing loss arises for their dogs. Questions frequently asked of the veterinarian center on warning signs of canine hearing loss and what can be done for the dog if hearing loss is confirmed. Communication training and safety awareness issues should be paramount for those living with a hearing-impaired or deaf dog. Some owners/handlers will ask about the feasibility of hearing aid use for their dog. Given the many obstacles to success in this arena, hearing aid use is generally not recommended. Although hearing loss is inevitable for dogs as they age, as it is for humans, owners should be aware of potential damaging noises their animals may be exposed to and possible means to prevent noise-induced hearing loss in canines.

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