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Research

Behavior of hearing or vision impaired and normal hearing and vision dogs (*Canis lupis familiaris*): Not the same, but not that different

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ABSTRACT

The article compared behavioral characteristics of dogs (*Canis lupis familiaris*) labeled as hearing and/or vision impaired by their owners with cohort dogs labeled as having normal hearing and vision (NHV) by their owners. The Canine Behavioral Assessment and Research Questionnaire, developed by Hsu and Serpell (2003), was used to survey owners. Four hundred sixty-one dog owners completed the online survey, with 183 of these being owners of hearing and/or vision impaired (HVI) dogs. Data analysis revealed that HVI dogs were reported by owners to show less aggression, less excitement, and were less likely to engage in behaviors, such as chasing of rabbits and rolling in feces than their normally hearing/seeing (NHV) cohorts. HVI dogs, however, were reported to be more likely to chew inappropriate objects, consume feces, bark excessively, and engage in greater licking behavior. When owners were surveyed about the type of training method used, owners of HVI dogs were found to be more likely to use hand signs, physical prompts, or combination of these training methods. Owners of NHV dogs reported being more likely than owners of HVI dogs to use gestures or report no formal training with their dogs. The data provide evidence that HVI dogs are as trainable as NHV dogs, can make excellent pets, and show behavior that is well within the parameters of NHV dog behavior. Still, because of their sensory limitations, specialized training methods and adaptations should be implemented with these dogs. This may limit HVI dogs to owners who are motivated, understand the sensory deficits, and are willing to engage in the modified training.

Introduction

Population of dogs with disabilities is increasing, at least in part because of greater awareness and attention to these canines (Asher et al., 2009). More specifically, hearing or vision impaired (HVI) dogs appear to be an increasing population in American animal shelters, foster programs, and rescue organizations (Deaf Dogs Forever, 2010). There are a variety of discussion groups and Web sites (for a list contacted in the present study, see Table 1) devoted to these dogs and their training, and it is not unusual to see media reports of adaptations made by pet owners and stories of successful adoptions of these animals (e.g., Mayor's Alliance for NYC's Animals, 2010; Pantagraph, 2013; Huffington Post, 2014; KXAN News, 2014). However, little empirical data exist that describe how dogs with disabilities behave or how their owners train them, particularly dogs that are deaf and/or blind. Are these dogs successfully placed into homes? What behavioral and/or temperament issues might arise in these dogs? Finally, how do owners adapt to and train dogs that are unable to hear and/or see? This, then, is the focus of the present article.

Causes of deafness and blindness

There are very little reliable data regarding the numbers of blind dogs. At least 2 reasons potentially explain this lack of data. First, it is difficult to get an overall estimate of the number of blind or visually impaired dogs given the wide range of eye disorders and the range in ages at which the dogs are affected. Tamilmahan et al., (2013) found that 54% of dogs in their sample of veterinarian

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Table 1
List of listserve and Web site sources used for participant recruitment

www.deafdogsneedavoice.com/
http://www.kwic.net~cairo/deaf.html
www.deafdogs.org
http://www.bordercollie.org/boards/index.php?showtopic=32886
http://handicappedpet.net/helppets/viewtopic.php?f=39&t=13295
http://www.dfordog.co.uk/deafdogs_stories.htm
http://www.astraean.com/borderwars/2011/07/something-is-rotten-in-harlequin-danes.html
http://www.faqs.org/faqs/dogs-faq/breeds/austshepherds/
http://disabledanimalsclub.wordpress.com/dogs/
http://blinddog.info/blinddogmap.shtml
http://www.chazhound.com/forums/index.php
http://sheltieforums.com/index.php
http://www.terrificpets.com/forum/
http://www.allbordercollies.com/forums/archive/index.php/thread-7987.html
http://www.dogster.com/dog-community/
http://www.aussierescue.org/
http://www.amazingaussies.com/
http://midwestaussierescue.org/
http://www.aussierescueil.com/
http://www.aussielads.com/
http://www.gis.net/~shepdog/Other_BCR_Web_Sites.html
http://www.blinddogs.net/adoption1.html
http://www.tailsinc.com/tag/lethal-white/
http://www.petfinder.com/shelters/NY935.html
http://www.lethalwhites.com/

practices showed some kind of eye anomaly affecting vision over the dog's life span. However, when age was factored in, only 7.88% of dogs younger than 1 year had a significant eye anomaly, suggesting a much smaller rate for congenital vision impairments. Second, the effects of some eye disorders may onset slowly, thus a dog may lose its vision gradually across its life span (Tamilmahan et al., 2013). One owner-moderated Web site, Deaf Dogs Forever (2010), estimates the number of blind dogs in the United States at around 300,000, but there are no published data that currently support this estimate.

Estimates of the number of hearing-impaired dogs are much more reliable. Data from 2010 suggest that approximately 5%-10% of canine pets in the United States are deaf or low hearing, but these estimates do not distinguish between congenital deafness and late-onset deafness (Strain, 2013). Hayes et al., (1981), in a retrospective study of 14 US veterinary teaching hospitals, reported an incidence of 1.1 per 10,000 dogs. This, however, may be a low estimate, as most owners do not take their dog to a veterinary teaching hospital exclusively for hearing loss. Still, given the canine population in the United States of approximately 77 million (National Pet Owners Survey, 2009), this suggests a range of 8,700 to 3.5 million hearing-impaired dogs in the United States today (Hayes et al., 1981; Strain, 2013).

Disorders affecting hearing and vision

One reason for the large population of HVI dogs is the large number of genetic anomalies that produce deafness and blindness across many purebred dog breeds and among mixed breeds (Strain 1996, 2013; Tamilmahan et al., 2013). For example, although eye abnormalities can develop spontaneously (e.g., colobomas can occur *in utero*), most are genetically inherited (Tamilmahan et al., 2013). Furthermore, particular eye disorders are more frequent among certain breeds. According to a recent report, persistent pupillary membrane, multifocal retinal dysplasia, persistent hyperplastic tunica vasculosa lentis, and persistent hyperplastic primary vitreous disorders are among the more common inherited eye disorders (The British Veterinary Association and The Kennel Club, 2010). The most common, however, is photoreceptor *dysplasia*, or Collie eye anomaly/collie eye defect, found in as many as 70%-97% of rough and smooth collies in the United States and Great Britain (Bedford, 2006). According to Bedford (2006), Border collies, Australian shepherds, Shetland sheepdogs, and other herding dogs are also quite prone to this eye disorder. This eye disorder, in particular, is often found in dogs that carry a double merle or piebald gene. Furthermore, the double merle or piebald gene is also linked to deficits in hearing, as described later.

The genetics of inherited deafness has also been investigated. Strain (1996, 2013) has found 92 different breeds of dogs with congenital deafness. Breed-specific deafness ranges from a high of 30% in Dalmatians and 18% in Australian shepherds, to a relatively low 1.3% in colored bull terriers. The commonality across these breeds is pigment-associated deafness; in particular, deafness carried by recessive piebald or merle genotypes. However, distinguishing the genotype versus visible phenotypes is not always easy for breeders. Some dogs possess a hidden merle or piebald trait that is only evident when it is bred to a dog that also carries that recessive trait. Thus, hearing disorders may occur unexpectedly in a litter (Strain, 1996; Dalmatian Club of America, 2011).

Breeding practices and deafness/blindness

Many breed and veterinary organizations have policies regarding and/or monitoring the breeding of animals prone to congenital deafness and blindness. These organizations have attempted to limit the number of HVI dogs by promoting, at the most extreme, euthanization of HVI pups (Strain, 1996; Dalmatian Club of America, 2011), and at minimum, the elimination of affected dogs from further breeding. For example, a publication by the combined British Veterinary Association/Kennel Club/International Sheep Dog Society (BVA/KC/ISDS) outlines both the genetics involved and the risks inherent in breeding dogs with tendencies toward particular eye conditions. The BVA/KC/ISDS notes that breeding practices that produce HVI dogs become a special concern when desired genetic traits, such as coat color, become linked with deafness or blindness.

One example of desirable genetic traits linked to HVI occurs in Dalmatians and Australian shepherds. Unfortunately, the specific genetic link for hearing loss is directly tied to these breeds' desired color phenotype. This confluence brings up potential ethical implications when intentionally breeding dogs for select coloration patterns that also results in a high number of deaf animals. To further complicate this issue, there are few data supporting or refuting the development of problem behavior as a direct result of hearing and/or vision impairments. What is lacking, then, is an actual sampling of the behavior of HVI dogs compared with normal hearing and vision (NHV) dogs. As it is likely that a behaviorist or veterinarian may treat 1 or more HVI dogs across their practice, there is a need for research investigating how having limited hearing or vision affects behavior and training in the pet dog.

Behavioral assessment in dogs

Behavioral assessment in dogs may be conducted in 2 ways: direct observation and owner survey. Several barriers may limit direct observation of a large sample of HVI dogs. First, unlike breed directories or club directories, there are no lists of HVI dogs. Second, given that HVI dogs make up only about 10% of pet dogs, owners of HVI dogs are spread out not only nationally but also internationally. Thus, it is difficult to access a substantial sample of these dogs within a particular geographic area.

Owner surveys are one alternative for obtaining a relatively large sample regarding behavioral issues of dogs. Perhaps the most comprehensive and scientifically validated owner assessment is the

Canine Behavioral Assessment and Research Questionnaire (C-BARQ; Hsu and Serpell, 2003; Serpell and Hsu, 2005). This behavioral assessment instrument has undergone extensive testing to establish both its reliability and validity using many large samples of many dog breeds (Hsu and Serpell, 2003), yielding data on behavioral traits, aggression, and general temperament of the dogs. However, to date, the C-BARQ has not been used to examine behavioral differences that may exist between HVI and NHV dogs.

Specific aims

This article compares C-BARQ survey responses provided by owners of HVI and NHV dogs. Owners were also surveyed about their training methods, the breed of their dog, and the role the dog played in the owner's home. The sample was fairly large: 461 dog owners completed the survey online, with 183 of these being owners of HVI dogs. The data emerging from this project represent some of the first data examining differences in behavior between NVH and HVI dogs.

Materials and methods

Participants

Owners of 183 HVI dogs (identified by their owners as 98 deaf/hearing impaired, 32 blind/low vision dogs, and 53 deaf and blind dogs) and 278 NVH dogs completed a modified C-BARQ online survey (Hsu and Serpell, 2003).

Table 2 shows the age ranges and household role for the HVI and NHV dogs included in the study. Ninety-seven percent of dogs, regardless of disability, were family or household pets. Owner responses to the C-BARQ were categorized by disability (HVI or NHV), age, breed, and sex. Differences in C-BARQ scores were then used to determine if differences existed between HVI or NHV dogs, as well as by age, breed, and sex.

The C-BARQ survey

The C-BARQ is designed to assess the prevalence and severity of behavior problems in dogs using owner report. The C-BARQ (Hsu and Serpell, 2003) contains 101 questions, with 68 of these items condensed by factor analysis into 11 distinct subscales, of which 5 are primary: aggression, fear and anxiety, excitability, separation-related behavior, and attachment. Other subscales include stranger-directed behavior, owner-directed behavior, and object-directed behavior. Additional items on the questionnaire evaluate trainability and a subset of 21 items that appear to predict canine behavior but do not load on the main 5 subscales.

The C-BARQ uses 0-4 Likert scales to evaluate owners assessments of their dog's behavior "in the recent past" to a variety of environmental events and stimuli. The wording of individual scales differs depending on the questions. For example, owners may be asked to note the frequency of a behavior (0 = never, 1 = seldom, 2 = sometimes, 3 = usually, and 4 = always) or the quality of the behavior (0 = no signs of the behavior, 1-3 = mild to moderate signs of the behavior, and 4 = severe signs of the behavior). A brief explanation is included for the qualitative items (e.g., "Typical signs of moderate aggression in dogs include barking, growling, and baring teeth. More serious aggression generally involves snapping, lunging, biting, or attempting to bite.").

We included several items in addition to the original C-BARQ items. These additions included demographic questions (age of dog, breed of dog, type of disability, role dog plays in home), and the type of training, if any, provided by the owner for their dog. Owners were asked to designate the breed of their dog or what they considered the primary breed if their dog was a mixed breed. Training methods were also defined. Hand signs were defined as consistent hand motions or positions used as a cue for a behavior; physical prompts were defined as physical contact with the dog, such as touching, leash tugs, and others. Gestures were defined as motions such as pointing toward an object or direction. Verbal cues were defined as words or sound used as a consistent cue for a behavior. Combination training was defined as any combination of verbal and nonverbal cueing. The "None" category was defined as providing no formal training (individual or group class) for their dog.

Disability category definitions

Owners were asked to indicate if the disability was a congenital anomaly or developed later in life. Disability categories that the owners could choose included the following: deaf in both ears, deaf in 1 ear, hearing loss in both ears, hearing loss in 1 ear, blind in both eyes, blind in 1 eye, low vision in both eyes, low vision in 1 eye, missing a front leg, missing both front legs, missing 1 rear leg, missing both rear legs, missing a combination of front and rear legs, seizures or epilepsy, thyroid condition, diabetes or no disability. Deafness was defined as no hearing in 1 (unilateral) or both (bilateral) ears. Blindness was defined as having no vision in 1 (unilateral) or both (bilateral) eyes. Low hearing or low vision was defined as less than normal vision or hearing but not blind or deaf. Disability categories other than blind/low vision and deaf/low hearing were included to account for behavioral differences that may have been because of other health or disability conditions. However, only a total of 11 owners (8 NVI owners and 3 HVI owners) reported that their dogs had a disability or health concern other than deaf/low hearing or blind/low vision. Given the very low incidence of dogs with a disability other than HVI, and because other disabilities were not the focus of the present investigation, these dogs were excluded from further analysis, so as to prevent confounding the data comparing HVI and NVI dogs.

To determine if differences existed between dogs with hearing loss versus vision loss within the HVI group, an analysis of variance (ANOVA) was conducted on the data from each C-BARQ subscale. No significant difference between the vision and hearing-impaired dogs in the HVI group were found for any of these subscales ($P > 0.05$ for all). As such, the data for dogs with vision or hearing impairments were combined into single HVI category.

Table 2
Demographic data from survey

Age and role in household	HVI* (N/%)	NHV* (N/%)
Age		
6 months-1 year	12/0.08	7/0.02
1-3 years	47/0.25	40/0.14
3-5 years	35/0.19	58/0.21
5-7 years	28/0.15	41/0.15
7-9 years	24/0.13	43/0.16
9-11 years	18/0.10	30/0.11
Older than 11 years	19/0.11	59/0.21
Dog's role in home		
Family pet	174/0.97	270/0.97
Working dog	2/0.01	2/0.01
Therapy dog	3/0.02	5/0.02

HVI, hearing and/or vision impaired; NHV, normal hearing and vision.
Data represent the percentage of respondents' each category of age and the dog's role in the home.
* Not all numbers add to 183 (HVI) or 278 (NHV as 4 respondent with HVI dogs and 1 respondent with a NHV dog did not report their dog's role in the home. However, these respondents did complete the entire C-BARQ and related questions.

Table 3
Breeds of dogs as labeled by owners categorized into each of the 5 general breed categories

	HVI	NHV
Asian/ancient		
Akita	0	1
Basenji	0	4
Chinese crested	0	1
Chinese shar-pei	0	1
Chow chow	1	3
Hairless chinese crested	0	1
Husky	0	1
Lhasa apso	2	2
Maltese	2	4
Pekinese	1	2
Samoyed	1	0
Shiba Inu	1	1
Shih tzu	1	4
Siberian husky	1	5
Xolo/Chihuahua	0	1
Total	*10*	*31*
Herding		
Borzoi	0	2
Collie	5	4
Icelandic sheepdog	0	1
Old English sheepdog	2	0
Sheltie	1	1
Shetland sheepdog	5	7
Swedish Vallhund	0	1
Total	*13*	*16*
Hunting		
American cocker spaniel	0	1
Australian cattle dog	7	4
Australian kelpie	1	0
Australian koolie	1	0
Australian shepherd	29	11
Basset hound	0	4
Beagle	0	6
Bichon friese	3	2
Black mouth cur	1	0
Border collie	12	27
Border terrier	1	5
Boykin Spaniel	0	1
Cairn terrier	0	2
Catahoula	2	1
Cattle dog	3	0
Cavalier King Charles spaniel	0	2
Chihuahua	2	5
Cocker spaniel	3	4
Coonhound	0	1
Corgi	2	0
Coton	1	0
Dachshund	3	4
Dalmatian	6	2
Doberman	2	2
English cocker spaniel	1	3
English pointer	0	1
English setter	1	0
English shepherd	0	2
English springer spaniel	0	4
Foxhound	0	1
German koolie	2	0
German shorthaired pointer	0	1
Golden retriever	2	11
Great Dane	6	1
Greyhound	0	1
Havanese	1	0
Hound mix	1	0
Hungarian vizsla	0	1
Irish setter	0	1
Irish terrier	0	1
Italian greyhound	0	1
Jack Russell terrier	4	5
Koolie	1	1
Labrador retriever	8	23
Miniature doberman pinscher	0	4
Papillon	0	1
Pembroke Welsh corgi	0	3
Pomeranian	0	2
Poodle	2	2
Portuguese water dog	0	2
Pug	1	4
Pumi	0	2
Rat terrier	3	1
Rhodesian ridgeback	0	1
Schipperke	0	1
Schnauzer	0	4
Standard Manchester terrier	0	1
Terrier	2	3
Treeing walker coonhound	1	0
Weimaraner	0	1
Welsh terrier	1	0
West Highland white terrier	1	0
Whippet	0	1
Wire fox terrier	0	2
Wirehaired pointing griffon mix	0	1
Yorkshire Terrier	0	3
Total	*117*	*181*
Mastiff		
English bull terrier	0	1
American bulldog	5	0
American pit bull terrier	10	7
American staffordshire terrier	3	3
Bernese mountain dog	1	10
Blue nosed pit bull terrier	1	0
Boxer	14	5
English bulldog	2	0
English mastiff	1	1
French bulldog	1	1
German shepherd	1	9
Great Pyrenees	1	2
Rottweiler	0	9
Total	*40*	*48*
No breed listed	0	3

HVI, hearing and/or vision impaired; NHV, normally hearing and vision.
The number of respondents for each breed and breed category for congenitally hearing or vision impaired (CHVI) or NHV dogs are also displayed.

Role of dog in household

Owners were asked to categorize the role their dog played in their household. Dogs were categorized as a family pet, a working dog (herding, farmwork, etc.), a guide dog or an assistance dog (works with 1 individual), or a therapy dog (works with many individuals).

The sample

The C-BARQ data and answers to the additional questions were collected using an online survey system (*SurveySELECT*) that was available through Illinois State University. To recruit dog owners, several listserves and organizations (see Table 1) were contacted, and the webmaster or site manager was asked to include an invitation to participate and a link to the survey on their Web site or in a listserve announcement. When potential participants accessed the survey Web site, they were given a brief description of the study and informed that their participation was voluntary and anonymous. Furthermore, the participants were informed that the project was approved by the Institutional Review Board at Illinois State University. The participants clicked on a tab signifying their agreement to participate in the study and were then taken to the survey items themselves.

The survey was made available for 14 weeks from the notification of the survey availability to the various groups. Only the responses from individuals who completed the entire survey were included in the survey: 623 individuals opened or started the survey, with 163 individuals exiting before completing the survey, resulting in a completion rate of 74%. No reward or penalty was given for completion or noncompletion of the survey. Individual

participants could provide their e-mail address to the researchers, regardless of whether they completed the survey.

Breed groupings

Ostrander and Wayne (2005) have determined that dog breeds may be collapsed into 4 hierarchical grouping defined by distinct genetic units: (1) ancient/Asian, (2) herding, (3) hunting, and (4) mastiff. These groupings are based on their finding that dog breeds express specific phenotypic traits and vary in behavior and the incidence of genetic disease that may be categorized based on genomic-wide scans linking breeds within a group. Their analysis demonstrates that these groupings may be used as to understand the genetic underpinning of both behavioral and physical traits. These categories were used as the basis for classifying dogs included in the data set according to potential behavioral traits.

Table 3 lists the 4 breed categories, individual breeds as labeled by owner included in each category, and number of HVI and NVH dogs within each category. If a respondent gave multiple breeds for their dog, the first listed breed (primary breed) was used to categorize that dog. A breed that was included on a respondent's answers but was not listed in the article by Ostrander and Wayne (2005) was placed into a grouping based on the history of that breed. For example, pit bulls are most typically pit bull terriers and thus were placed into the mastiff group with other bull terriers. Only 3 respondents failed to list the breed of their dog.

Statistical analyses

Responses from the survey were grouped by HVI or NHV categories. As noted previously, only 5 respondents reported having a dog with a disability involving a limb, and only a very limited number reported a congenital health problem (by 6 owners in the present data set). Thus, responses from these owners were excluded from the analysis. To determine if differences existed between dogs with hearing loss versus vision loss, an ANOVA was conducted on the data from each C-BARQ subscale. No significant difference between the vision and hearing-impaired dogs were found for any of these subscales ($P > 0.05$ for all). As such, the data for dogs with vision or hearing impairments were combined into single HVI category.

MANOVA analyses

A multiple analysis of variance (MANOVA) was conducted on the data to determine differences between HVI and NHV dogs and across the 4 breed categories. Thus, the breed category (ancient, herding, hunting, and mastiff) and the disability category (HVI or NHV) were used as independent variables. The dependent variables included age, the 5 scales of the C-BARQ (aggression, anxiety, separation anxiety, excitement, and attachment), and the 20 miscellaneous subscales (e.g., chases cats, stares at invisible objects) that do not load on the 5 major factors but do appear to be related to behavioral differences. As no differences were found across breed categories, post hoc analyses were only conducted on the disability categories.

Results

The MANOVA analysis conducted on the data set revealed a significant effect for *disability*, $F(29,380) = 2.15$, $P < 0.001$, but not for *breed* category, $F(116,1532) = 1.18$, not significant (NS). The *interaction* of breed and disability was also not significant, $F(87,1146) = 0.96$, NS. Post hoc analyses were conducted using only the 2 disability categories: HVI and NHV. ANOVA was conducted on each of the 5 C-BARQ subscales and the 20 miscellaneous measures, as well as training methods. Results for each of these are described in the following section.

C-BARQ results

Results of these ANOVAs yielded significant differences across 2 of the 5 C-BARQ subscales as well as across 6 of the 20 miscellaneous subscales. A significant difference was found for *aggression*, $F(1,408) = 5.83$, $P = 0.02$, with NHV dogs reported to be more aggressive than HVI dogs. Similarly, there was a significant difference for the *excitement* subscale, $F(1,408) = 4.09$, $P = 0.04$, again with NHV dogs being reported as more excitable. Significant differences were found for neither the *separation* subscale, $F(1,408) = 0.01$, NS, nor the *anxiety* subscale, $F(1,408) = 0.89$, NS. The *attachment* subscale $F(1,408) = 2.66$, $P = 0.10$, showed no differences bewteen groups. Results for each of these 5 subscales are shown in Figures 1–5.

As shown in Table 4, significant differences across the C-BARQ miscellaneous subscales were found: NHV dogs were reported as *more* likely to chase rabbits, roll in feces, and consume feces than HVI dogs. In contrast, HVI dogs were more likely to show excessive barking, chew inappropriate objects, and engage in inappropriate licking ($P < 0.05$ for all). No other significant differences were found between HVI and NHV dogs across these miscellaneous items or for age ($P > 0.05$ for all).

Differences in training approaches were reported between the owners of the disabled and typical dogs. As shown in Figure 6, owners of HVI dogs were more likely to report using hand signs, $t(459) = -1.97$, $P < 0.01$, physical prompts, $t(459) = -1.72$, $P < 0.01$, and combinations of these cues, $t(457) = -1.96$, $P < 0.01$, than owners of NHV dogs. In contrast, owners of NHV dogs were more likely to report the use of gestures (separate from signs), $t(459) = 3.23$, $P < 0.01$, verbal cues, $t(457) = 2.77$, $P < 0.01$, or reported engaging in no formal training at all, $t(459) = 2.21$, $P < 0.01$.

Summarizing the results, the present investigation showed, for this sample of owners, that NHV dogs were reported to show significantly more aggression and excitability than HVI dogs as well as were more likely to roll in or ingest feces and engage in chasing of rabbits. In contrast, HVI dogs were reported as more likely to chew inappropriate objects, engage in inappropriate licking, and bark excessively. There was a trend toward greater attachment reported by owners of HVI dogs. Finally, owners of HVI dogs were more likely to report using hand signs, physical prompts, or combination of these training methods but were less likely to use gestures, verbal cues, or no training methods at all.

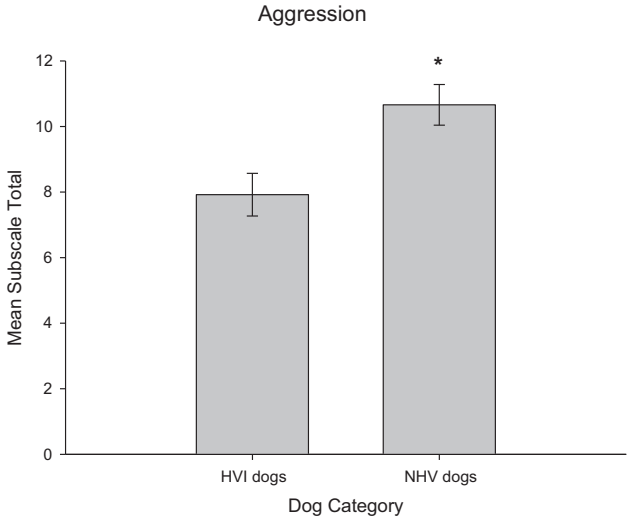

Figure 1. Mean aggression subscale total score for CHVI and NHV dogs. NHV dogs were reported to show more aggression than CHVI dogs ($P = 0.02$). CHVI, congenitally hearing and vision impaired; NHV, normal hearing and vision.

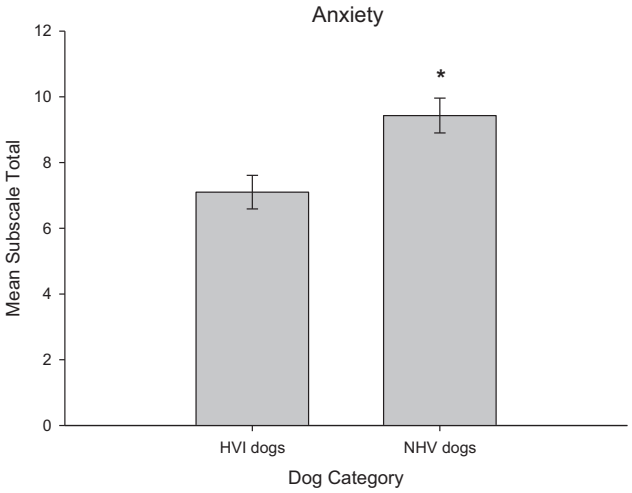

Figure 2. Mean anxiety subscale total score for CHVI and NHV dogs. NHV dogs showed a strong tendency toward more anxiety than CHVI dogs ($P = 0.09$). CHVI, congenitally hearing and vision impaired; NHV, normal hearing and vision.

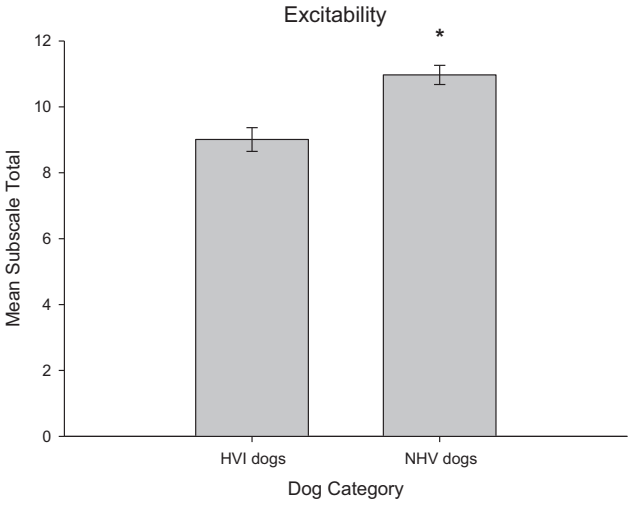

Figure 4. Mean excitability subscale score for CHVI and NHV dogs. NHV dogs showed significantly higher excitability scores than CHVI dogs ($P = 0.04$). CHVI, congenitally hearing and vision impaired; NHV, normal hearing and vision.

Discussion

The current investigation provides evidence that owners of HVI dogs report that behavior of HVI dogs is within the limits measured for NVH dogs on most scales of the C-BARQ. Based on owner responses, it appears that HVI dogs are likely to assimilate into family homes at least as successfully as NVH dogs and that HVI dogs have the same likelihood of showing behavioral problem as NVH dogs. However, the types of problems reported by owners differed between the HVI and NVH categories. As indicated by the results from the attachment subscales on the C-BARQ, owners of HVI dogs reported similar attachment to their dogs as owners of NVH dogs. The data suggest that HVI dogs show no increased likelihood of aggression or excitability than NVH dogs. The data did suggest that HVI dogs may be significantly more prone to perseverative behaviors, such as chewing, licking, and barking, but were less likely to interact with feces or chase prey. Finally, owners of HVI dogs reported that they adapted their training methods to fit differences in sensory abilities.

No breed differences were found to explain differences in the behavior of HVI or NHV dogs. It should be noted that a large proportion of the dogs in the study were of the herding category, with far fewer dogs in the other 3 breed categories. However, there were similar numbers of HVI and NHV dogs represented in the herding breed category. Any behavioral differences between HVI and NHV dogs did not appear to be because of differences in specific breed and were most likely because of differences in sensory ability. Furthermore, owners completing the survey reported residing in the United States, Canada, Western Europe, Australia, and New Zealand. It is possible that differences in the genetic dispositions of dogs from the various continents masked breed category differences.

The increased chewing, excessive barking, and increased self-licking reported in the HVI dogs may be because of differences in sensory input compared with NHV dogs. Indeed, all the excesses in behavior may be self-stimulatory in nature. It is also possible that behavior such as licking could be because of medical causes. Although the owners were not explicitly asked if their dog had a coexisting health issue, only 6 respondents reported a disability or

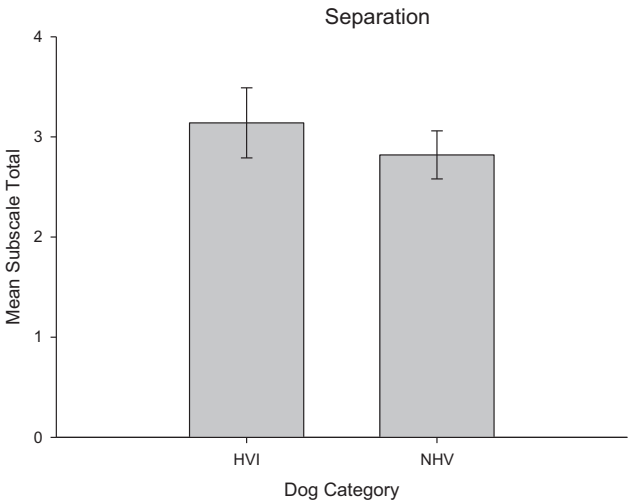

Figure 3. Mean separation subscale total score for CHVI and NHV dogs. There were no significant differences in separation anxiety between disabled and normal dogs ($P > 0.05$). CHVI, congenitally hearing and vision impaired; NHV, normal hearing and vision.

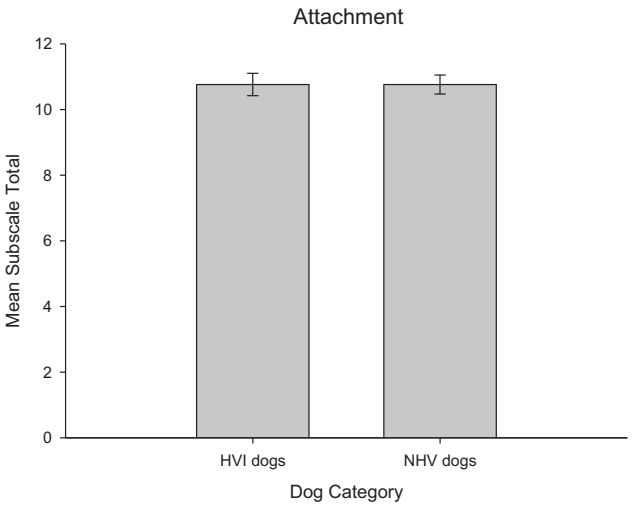

Figure 5. Mean attachment subscale total score for CHVI and NHV dogs. There were no significant differences in owner reports of separation anxiety shown by NHV versus CHVI dogs ($P > 0.05$). CHVI, congenitally hearing and vision impaired; NHV, normal hearing and vision.

Table 4
Means and standard errors for CHVI or NHV dogs for each of the 20 miscellaneous categories

Behavior category	HVI dogs		NHV dogs		
	Mean	SE	Mean	SE	*P*
Chases cats	1.31	0.11	1.70	0.09	<0.072
Chases birds	1.15	0.10	1.38	0.08	<0.230
Chases rabbits	**1.49**	**0.12**	**2.23**	**0.09**	**<0.000**
Rolls in feces	**0.68**	**0.08**	**1.08**	**0.07**	**<0.003**
Eats feces	**0.76**	**0.08**	**0.92**	**0.07**	**<0.012**
Chews inappropriate objects	**1.02**	**0.09**	**0.60**	**0.05**	**<0.006**
Inappropriate mounting	0.14	0.04	0.19	0.03	<0.461
Inappropriate begging	1.04	0.09	1.28	0.07	<0.425
Stealing	0.75	0.08	0.89	0.07	<0.909
Refuses stairs	0.49	0.08	0.51	0.07	<0.957
Pulls hard on leash	0.96	0.08	1.16	0.07	<0.932
Urinates on objects	0.19	0.05	0.15	0.03	<0.144
Urinates when approached	0.03	0.02	0.06	0.02	<0.763
Urinates when left alone	0.27	0.05	0.24	0.04	<0.635
Defecates when left alone	0.23	0.05	0.19	0.04	<0.828
Highly active	0.73	0.07	0.49	0.05	<0.334
Stares at invisible objects	1.80	0.09	1.52	0.07	<0.281
Snaps at invisible objects	1.82	0.09	1.54	0.08	<0.083
Chases own tail	0.71	0.08	0.38	0.05	<0.122
Chases shadows	0.28	0.06	0.15	0.03	<0.120
Barks excessively	**0.32**	**0.06**	**0.17**	**0.03**	**<0.046**
Excessive licking of self	**0.42**	**0.07**	**0.10**	**0.03**	**<0.003**
Excessive licking of people	0.70	0.07	0.63	0.06	<0.586
Other repetitive behavior	0.51	0.07	0.56	0.06	<0.911

CHVI, congenitally hearing or vision impaired; NHV, normal hearing and vision; HVI, hearing and/or vision impaired; SE, standard error.
Categories with significant differences are highlighted in bold.

health issue according to the original disability categories, and the data from these respondents were excluded from the analysis. Specific potential medical associations were not explored here.

It has been our experience that many HVI dogs appear to engage in barking in contrast to barking at perceived predators or clearly definable stimuli. Similarly, these dogs appear to engage in oral stimulation such as chewing and licking. This may be because of HVI dogs having fewer environmental cues regarding events going on around them. NVH dogs receive auditory and visual feedback that accompanies a moving object. In contrast, a HVI dog must rely on visual or auditory information alone or no visual or auditory information at all. To increase sensory awareness, self-stimulatory behaviors using gustation, olfaction, or tactile stimulation are likely to occur more frequently and may even provide increased information about the environment. Interestingly, the sensory-seeking behavior observed in HVI dogs parallels what is observed in children with vision and hearing loss. Children with visual or hearing impairments often engage in self-stimulatory behaviors such as rocking or self-soothing behaviors, higher degrees of oral stimulation, and a tendency to seek tactile stimulation (Wright, 2008).

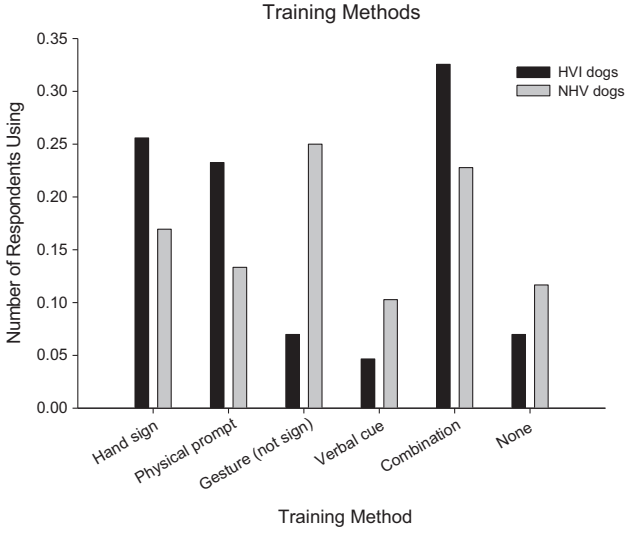

Figure 6. Differences in training prompts used for CHVI and NHV dogs. Data in the figure represent percentages of owners reporting using each method. Hand signs were defined as consistent hand motions or positions used as a cue for a behavior; physical prompts included touching, leash tugs, and others. Gestures were defined as motions such as pointing toward an object or direction. Verbal cues were defined as words or sound used as a consistent cue for a behavior. Combination training was defined as any combination of verbal and nonverbal cueing. None was defined as providing no formal training (individual or group class) for their dog. Note that owners could report using more than 1 method to train their dog. All differences between CHVI and NHV are significant ($P < 0.05$). CHVI, congenitally hearing and vision impaired; NHV, normal hearing and vision.

Sensory deficits exhibited by HVI dogs may present a challenge for some owners. Behaviors such as chewing, excessive licking, and barking are among the common behavioral problems reported by veterinary behaviorists (Beaver et al., 2001). Although perhaps not considered as severe a behavioral issue as aggression, these behaviors can be quite problematic for pet owners. However, there exist many ways to remediate or reduce these behaviors. For example, enrichment toys may be used to provide HVI dogs with sufficient sensory stimulation, including Kong, vibrating toys, or specialized chew toys. Active training can provide cognitive stimulation, particularly if it is adapted for the dog's sensory needs. Activities such as agility and fly ball are easily accessible to dogs with deafness/limited hearing and even some low-vision dogs. A quick reading of posts from HVI dog owners who contribute to the various listserves and Web sites regarding HVI dogs (see Table 1) show that many of these owners report entering obedience, rally obedience, or even dog dance events with their deaf, low vision, and hearing, and even some blind dogs. Providing alternative sources of stimulation other than or in addition to the typical auditory and visual stimulation may be one way to offset or prevent the behavioral difficulties that are observed in HVI dogs.

Sensory deficits may not only elicit perseverative behaviors but also social differences may appear in HVI dogs as a result of sensory deficits. Certainly, HVI dogs do not have the same social experiences as NVH dogs. Deaf dogs will be unable to learn the meaning of warning growls and other vocalizations. Blind dogs will be unable to use body signals, such as posture, tail position, or eye, head and mouth cues. How these dogs adapt, and the resulting potential deficits in their social development, has not yet been investigated. The present data set suggests that most HVI dogs assimilate into families as successfully as NHV dogs, suggesting that they do not experience severe difficulties in social interactions, at least with humans. Further research should investigate how the sensory deficits experienced by HVI dogs affect social interactions with both humans and NHV dogs.

There is no doubt that HVI dogs require a different approach to training than NHV dogs. Obviously, deaf dogs cannot hear verbal commands, blind dogs cannot see visual commands, and deaf/blind dogs cannot see or hear many typical training commands. Owners of HVI dogs were significantly more likely to use hand signs (for deaf/low hearing dogs) and physical prompts (for deaf/blind or blind dogs), or a combination of these prompts than owners of NHV dogs, and not surprisingly, owners of HVI dogs were less likely to use gestures (for blind dogs) or verbal cues (for deaf dogs). What was surprising was that owners of HVI dogs were more likely to engage in formal training than owners of NHV dogs. This could reflect either a need for owners of HVI dogs to seek formal training to help them learn how to manage and train their dogs or perhaps reflects a higher level of knowledge regarding training and behavior management among owners of HVI dogs. This distinction should be

investigated in future research examining the type of dog owner who is willing to adopt an HVI dog.

Of course, it would be neglectful to not point out that the present data set relies on owner reports of their own dogs. It is possible that owners of HVI dogs are more positive, more motivated, and potentially more likely to overlook behavior problems. To reduce this potential for bias, the present investigation also recruited from breed-specific listserves and Internet groups (see Table 2). It is just as likely that owners who are members of a breed-specific group are equally as positive, motivated, and dedicated to their dogs. However, the data are still based on owner report. Future research should be undertaken that directly evaluates the behavior of HVI and NHV dogs using direct behavioral assessments.

Conclusions

In conclusion, the present investigation provides evidence that HVI dogs do not show increased risk of significant behavior problems when compared with NHV dogs. The investigation did find a higher rate of sensory behaviors, such as chewing, barking, and licking. In contrast to unsubstantiated reports that HVI dogs exhibit greater aggression, it appears that owner reports of behavioral issues such as aggression and excitability are within or below the rate of those exhibited by NHV dogs.

The finding that HVI and NHV dogs exhibit only a few sensory-related behavioral differences is important for not only veterinarians, veterinary behaviorists, and other professionals who may work with these dogs but also the general pet owner community. Currently, there are limited opportunities for owners of HVI dogs to participate in obedience, agility, or other training competitions. For example, current American Kennel Club (AKC) policy (American Kennel Club, 2011) allows the participation of mixed breed dogs in agility, obedience, rally obedience, and other nonconformation events in the AKC but explicitly excludes HVI dogs. The reasoning behind the exclusion of HVI dogs is apparently because of their unpredictable nature of their behavior and the supposed increased potential for aggression. In contrast, the *World Cynosport Rally* group (World Cynosport Rally, 2013), formally overseen by the Association for Professional Dog Trainers, has allowed participation by HVI dogs in all their events for several years.

The present data suggest that an argument can be made for the opening of opportunities for HVI dogs and their owners to participate in AKC obedience, rally, and agility events as well. Given that no evidence was found for increased aggression, it seems that HVI dogs could successfully participate in these additional socialization opportunities. Opening up these opportunities would increase the available activities for HVI dogs. Increased opportunities for training and competition increase the general health and well-being of all dogs.

HVI dogs, however, are not for everyone. These dogs do require modified training approaches and an understanding of and adaption to their sensory differences. It is important for veterinarians, veterinary behaviorists, and animal behaviorists to recognize the positive behavioral abilities of these dogs to gain an understanding of how differences in sensory abilities may affect behavior and to provide appropriate assistance and guidance for those owners willing to take an HVI dog as a pet. Through cooperative partnerships between veterinarians, behaviorists, and owners, HVI dogs can, indeed, be excellent and well-loved companion dogs.

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Ethical considerations

None to report.

Conflict of interest

The authors declare no conflict of interest. The idea for the article was conceived by Valeri Farmer-Dougan, PhD. The experiments (survey) were designed by Valeri Farmer-Dougan, PhD, using established instruments, as noted. The experiments (survey data collection) were performed by Valeri Farmer-Dougan, Amanda Quick, and Kelsey Harper. The data were analyzed by Valeri Farmer-Dougan, Amanda Quick, Kelsey Harper, Kirsten Schmidt, and Daniel Campbell. The article was written by Valeri Farmer-Dougan. No funding was provided for this project. This study was approved by the Institutional Animal Care and Use Committee of Illinois State University.

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