Application Development for Canine Hearing Monitoring

R. S. Navarro[1], D. C. L. Martins[1], A. Baptista[1], L. A. M. Pereira[2], and S. C. Nunez[1(✉)]

[1] Universidade Brasil, Pós-Graduação Bioengenharia, São Paulo, Brazil
silvia.nunez@universidadebrasil.edu.br
[2] Universidade Brasil, Programa de Mestrado Em Produção Animal, Descalvado, Brazil

Abstract. Otitis is an inflammatory disease of the external auditory canal, being common in dogs. The treatment is complex, involves multiple antimicrobials and depends on the owner's involvement. Diagnosis in the initial stages are difficult to assess. With the increase in access to mobile App, this technology can help diagnose and monitor the evolution of canine hearing loss. The objective of the study was to develop an App for canine hearing monitoring aiming to introduce an innovative product in this sector. After evaluating available products, a software was designed in Java Script language for use on computers and cell phones with Android system, the device should reproduce sounds with a specific range to evaluate bass and treble sounds that can be affected differently in the hearing loss process. The developed application allows user and animal registration, on the test screen, it emits frequencies ranging from 20 Hz to 40,000 Hz with an intensity of about 45 dB in all bands, which represents an uncomfortable sound intensity, but not an irritating one, with 5 s of duration the frequencies correspond to the canine hearing range. The App's screens are intuitive and easy to manipulate and allow the storage of results with specific dates, which can permit the tutor or the veterinarian to follow the evolution of the animal's hearing degree. The App presented functionality and after registration at the National Institute of Industrial Property is available on the web page and it will be tested in clinical practice.

Keywords: Canine Otitis · Deafness · Mobile Application

1 Introduction

Otitis is an inflammation of the external auditory canal, which affects several species, being more common in dogs due to its anatomical features; long and pendulous ears, excess hair, narrow ear canals, and because it is a humid and hot region, become the favorite place for fungi, bacteria and mites. Some breeds develop this disease more easily such as Golden Retriever, Basset Hond, Cocker Spaniel, Labrador, German Shepherd, Beagle [1].

The most frequent symptoms and signs are intensive itching, excess wax, odor, edema, shaking the head several times from side to side, crying when scratching, ear

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discharge, lack of appetite generated by the pain. [1, 2]. This disease does not have a single cause, several factors can cause infections [1].

Hearing loss in animals doesn't just occur in elderly pets. Hearing impairment can be permanent, temporary or occur gradually and the diagnosis of hearing loss in its first stages is very difficult. Audiometry tests in dogs' use a stimulus elicited into the animal's canal, and a brainstem auditory evoked response waveform is analyzed to determine a pass or fail hearing screening result [3].

The softest sound an animal can hear at a specific frequency is called the threshold of hearing. The animal can hear sounds that are above its threshold without impairment until a certain combination of intensity and duration is reached. Above this threshold, the animal's hearing threshold may be temporarily or permanently worsened. When this happens, the sounds must be louder to be detected. If the threshold returns to near-normal levels after some time, this condition is called a temporary threshold shift or TTS. If the threshold does not return to near-normal levels, the effect is called a permanent threshold shift or PTS. PTS can occur because of repeated occurrences of TTS, or it can occur as a result of a single exposure to very loud sound [4]. Thus, it is important that the sound emitted remains within the animal's hearing threshold with adequate intensity and duration for the safety of the test [5].

During the treatment of canine otitis, the effectiveness of the procedure can be measured by the hearing threshold. Eger and Lindsay (1997) [4] carried out a study where the auditory function was measured in normal dogs and in dogs with otitis through auditory brainstem evoked response tests. Data were obtained from 86 normal ears and 105 ears with otitis, categorized into four degrees of severity. Data were analyzed to illustrate the differences between auditory function in normal and abnormal ears and to estimate the degree of impairment associated with different degrees of pathology.

While severe hearing loss appeared to be present in dogs with more severe otitis, only two individuals were identified as being totally deaf in the affected ears and no dogs were identified in which the cleaning and examination processes had caused damage to hearing function. Cleaning the ear canal produced measurable improvements in hearing in several dogs, indicating the profound effect of physical obstruction of the external ear canal by debris. The authors concluded that most dogs with chronic otitis external are not completely deaf and that the hearing impairment that occurs has characteristics of conductive hearing loss.

The home treatment of external otitis is time consuming for the tutors and if the animal does not present typical signs of otitis (i.e., bad smell, pain, scratching the ear) the tutors may not perceive the diseases and abandon the treatment [6].

Audiometry test in veterinary practice is expensive and difficult to find. Nowadays the test a medical procedure performed under anesthesia [7].

Some home methods are recommended for canine hearing testing, and these include making sounds without causing vibration on the floor and observing the animal's reactions that can be as small as ears lifting, looking in the direction of the noise, standing up or wagging the tail. However, these tests are performed only within the audible range of the sound frequency spectrum for humans and do not demonstrate the frequencies that are affect by the disease [3].

Faced with the lack of an alternative method for evaluating the canine auditory response, we propose an innovative project in the sector, where, through specialized software that emits frequencies between 20 Hz and 40,000 Hz, with the intention of being used by veterinarians and animal tutors to follow-up treatment of canine otitis in order of to prevent hearing loss due to a common infection.

With the increased access to applications for mobile devices, the use of this technology as an aid in the diagnosis and monitoring of the evolution of canine otitis can be useful for both caregivers and professionals. Based on the search that we carried out evaluating products available in the application market, we verified that there is a gap in analysis segmented by sound frequency. Apps for dog training are available with behavior control purposes emitting different sound frequencies. We did not find any device that had the proposed of audiometric analysis.

Therefore, the development of an application in this area can present an innovation in the animal health care sector. The objective of this study was to develop an App for auditory monitoring of dogs emitting sound frequency starting at 20 Hz and intensifying until close to ultrasounds of the order of 40,000 Hz, with an intensity of about 45 dB in all bands and approximate duration of 5 s, so no temporary threshold shift would occur affecting the test results.

2 Methods

2.1 Development of App

Surveys were carried out by active search of software specialized in sounds for dogs, software related to hearing in general and software that could emit sound frequencies from 100 Hz to 100,000 Hz. The search was carried out in applications for IOS and Android, in addition to searches for computer software open to the public. The keywords used in the search were “Canine audiometry”, Sounds for dogs, Sound frequency generators, hearing. Several software’s were found with the purpose of training and dressage, the available software’s generate sounds with a frequency of 100 Hz to 50000 Hz. Applications were found with the purpose of generating sounds to provide behavioral changes in the animal.

3 App AudioPet

Before starting to program the application, we studied the best way to create an efficient, easy-to-use application that can monitor the animal’s hearing loss as it ages. In this context, it was understood that the application should be divided into three modules:

- Access to the application and user registration.
- Hearing test and test result.
- History of tests performed.

As proposed, initially the application user needs to register and then log in for access. The main advantage of controlling access to the application is that the access to history of animal tests is possible. In order to ensure wide use of the application, the idea is

that the registration is carried out with little information, just to guarantee the possibility access the recorded data.

Bearing in mind that the user field is the key to access the system, the application will check if the registered user already exists in the database, if so, it will warn you for a new choice, avoiding errors in the history of the exams performed.

In the hearing and result test module, an application was designed that, after requesting the animal's data, to record the history, shows the choice of frequencies from 20 to 40,000Hz on the screen, each of these will have a button to turn the sound on and off, followed by a field for recording whether the animal heard the emitted sound.

At the end of the exam, the application will calculate the percentage of the animal's hearing responses and will issue some considerations according to the responses obtained. In the last module foreseen, the tests performed will be stored, in this way, it is possible to monitor the animal's hearing loss.

It should be noted that there are no test limits. The structure of the idealized database tables is shown in Fig. 1. In one database are stored the application user data and in the other the information about the animal and the tests performed. The interconnection between the tables is done through the user field, present in both tables.

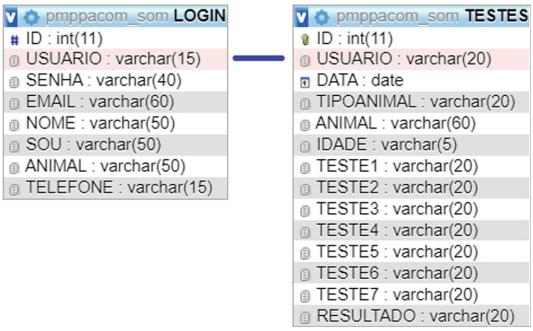

Fig. 1. Structure of the idealized database tables

4 Results and Discussion

The developed application can be accessed from any smartphone, tablet, or computer, as long as it has internet access. Its layout is responsive, that is, it adjusts according to the screen size of the device.

To use the application, the user just needs to access the link <www.pmppa.com.br/som>, the initial screen is shown in Fig. 2 in 1 in the version for computers and notebooks and in 2 the version for smartphones.

To access the application, the user must click on Enter in the desktop version and, in the case of a smartphone, he must first access the menu located on the upper left-hand tab, represented by three small dashes, where he will find the option: Enter. Two options will be displayed: login and register user. If it is the first time that the user accesses the

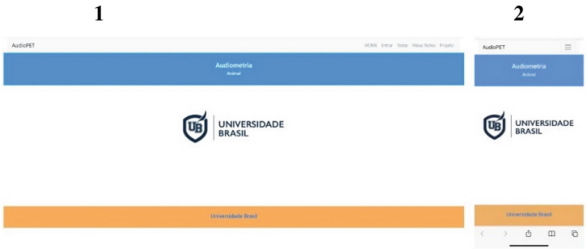

Fig. 2. In 1initial screen of the developed application viewed on a desktop computer and at 2 the screen of the developed application viewed in a smartphone

system, he must necessarily choose the second option. Once registered, the user must log in to access the application's functions. Figure 3 1 and 2 show the screen described for desktop and smartphone respectively.

Fig. 3. In 1 the access screen of the software viewed on a desktop computer and at 2 the access screen for smartphone

Once the option "register user" is chosen, the system will open a screen superimposed on the previous screen that will ask the user to fill in the fields: user, password, name, I am (veterinary doctor, zoo technician, student, pet tutor, entrepreneur, and others), telephone and email.

The username and password fields are responsible for giving the user access to the application. Figure 4 1 and 2 presents the screen described the first image for desktop and the second is the smartphone version.

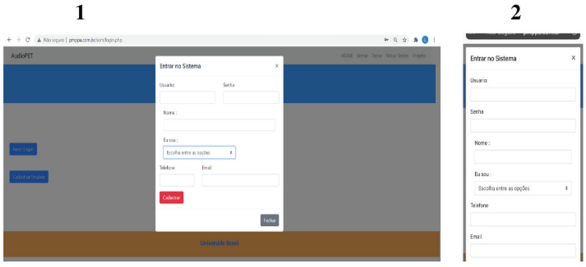

Fig. 4. In 1 the desktop screen of the software is presented and in 2 the smartphone version

With the registered user, it will be possible to log in to the application, in this case, a window superimposed on the previous screen will open, where the user must enter their username and password, if the data are correct, access to the application is released. Figure 5 in 1 and 2 shows the screen described the first image in the desktop version and the second in the smartphone version.

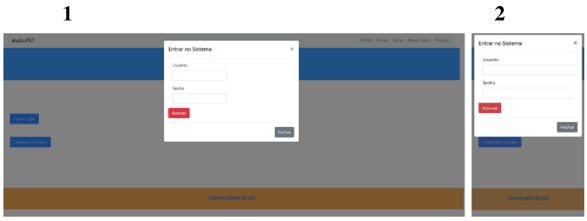

Fig. 5. In 1 the user login screen viewed on desktop computer and in 2 the same screen on a smartphone

Once the application is accessed, the user can choose from the menu the options: test, my tests and project. In the first option, the user is led to fill in the data of the animal to be tested, where it is requested: date, type of animal (canine and feline), name of the animal and age. After completing the form, the user must click on start test.

On the test screen, the user will find eight test options, in each of the options the frequency to be tested is displayed, a button to start the test, a button to turn off and a field to inform if the animal heard the sound tested or did not hear. The eight frequencies tested are: 20 Hz, 1000 Hz, 5000 Hz, 10000 Hz, 20000 Hz, 30000 Hz and 40000 Hz. Figure 6 in 1 and 2 presents the screens for desktop and smartphone respectively.

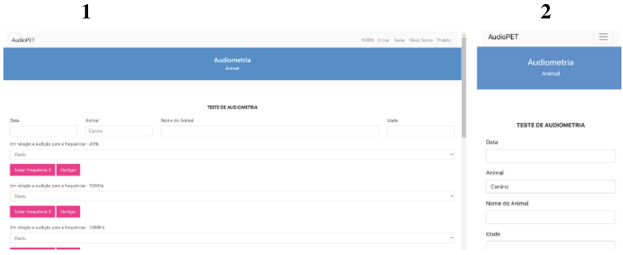

Fig. 6. In 1 audiometry test screen viewed on desktop computer and the same screen visualized on the smartphone

At the end of the test, the application will issue the result in percentage, accompanied by a comment according to the measured hearing. Figure 7 1 and 2 presents the screen describing the desktop version and the smartphone version.

In the option “my tests”, the user of the application finds the history of the tests carried out, if he understands that any test should be disregarded, the user simply clicks on the trash can icon to delete the record. It should be noted that for better visualization, if there are more than 8 records, they will be divided into pages that can be accessed

Fig. 7. Audiometry test result screen viewed on desktop computer and in 2 the smartphone version

by page advance and retreat icons. Figure 8 1 and 2 shows the screen described the first image in the desktop version and the second in the smartphone version.

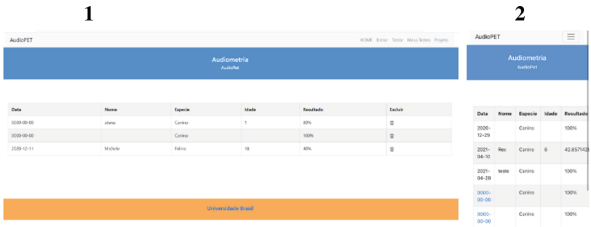

Fig. 8. In 1 the screen of history of audiometry tests performed by the user viewed on desktop computer and in 2 smartphone version

Finally, in the project menu item, the application user will find an explanation of the developed project, according to Fig. 9 for desktop and smartphone in 1 and 2.

Fig. 9. Screen of the menu project item viewed on a desktop (1) and smartphone (2)

In the software for veterinary medical purposes or for assessing, the degree of canine hearing was found in the searches and the available frequencies emitted by some dog training Apps do not include the canine auditory spectrum (100 Hz to 100,000 Hz). Some applications aiming human hearing testing are available, but they cover a small frequency range, usually from 100 Hz to 15000 Hz. This fact motivated the authors to develop the App for auditory monitoring of dogs, emitting sound frequencies starting at 20 Hz and intensifying until close to ultrasounds of the order of 40,000 Hz, with an intensity of about 45 dB in all bands and approximate duration of 5 s.

As pointed out by Sidiras et al. (2021) [8], even regarding human hearing loss control, efforts should be made to develop a strategy and implementation of user-operated audiometry tests since the control can be pivotal to prevent permanent deafness.

It will be important as future steps that the App developed in this study start tests with tutors, veterinarians and zootechnicians, therefore we provide easy access to the software so it could be tested and further improved, if necessary, after evaluation by veterinarians. The clinical use of a technology as an aid in the diagnosis and monitoring of the evolution of canine otitis treatment can be useful to implement a more accurate and efficient treatments.

5 Conclusions

The present study developed an App that is easy to use and could be a useful tool for monitoring the hearing health of domestic animals.

Conflict of Interest. The authors declare that there are no conflicts of interest in carrying out this study.

Statement of Animal Rights. The study was not performed directly or indirectly on animals, not requiring submission to the Ethics Committee for the Use of Animals.

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