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Development of a Journaling Application to Track Progress of Adaptation to Amplification for Adult Patients: DEarDiary

Nicole C. Snider

The Graduate Center, City University of New York

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DEVELOPMENT OF A JOURNALING APPLICATION TO TRACK PROGRESS OF
ADAPTATION TO AMPLIFICATION FOR ADULT PATIENTS: DEarDiary

By

Nicole Snider

A capstone research project submitted to the Graduate Faculty in Audiology in partial fulfillment of the requirements for the degree of Doctor of Audiology, The City University of New York

2018

This manuscript has been read and accepted for the
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Barbara Weinstien Ph.D.

Date

Faculty Mentor

John Preece, Ph.D.

Date

Executive Officer

THE CITY UNIVERSITY OF NEW YORK

Abstract

DEVELOPMENT OF A JOURNALING APPLICATION TO TRACK PROGRESS OF ADAPTATION TO AMPLIFICATION FOR ADULT PATIENTS: DEarDiary

By

Nicole Snider

Advisor: Barbara E. Weinstein, PhD

The DEar Diary application is an illustration of concept of an Apple iOS (operating system) application designed as a tool for supporting compliance and satisfaction with the use of amplification. The audiologist's main purpose is to counsel, support and to provide rehabilitative counseling to their patients. Helping a patient succeed while using hearing devices for the first time is a complicated task which can be accomplished with the proper counseling and helpful tools in place.

The use of a journal to write down experiences and providing written support material the patient can refer to once they are out of the office may help patients succeed. With the rising use of technology among the incoming audiological populations, a phone application may be a better suited to equip these hearing aid candidates as this resource would be at their fingertips at all times.

DEar Diary was developed as a modern version of a journal with additional tools to best support the new hearing device user. The focus of the DEar Diary application is to promote setting hearing goals which the patient can strive to reach, tracking progress with amplification to demonstrate benefits of amplification, to provide a reference for care and maintenance of hearing devices and to provide communication strategies for overcoming difficult listening environments.

Acknowledgements

I would like to thank my father, my grandmother and my advisor Barbara E. Weinstein for their kindness, patience, and expertise.

To Daddy, you were the one who inspired me to dive into the complex world of application development. Your relearning the updated coding languages and development software demonstrated where there is a will, there is a way to find and fix the errors in the code. If it was not for your assistance, this project would have just been talking about possibilities with no additional example application. Thank you for all your support when all seemed at a loss and helping troubleshoot until we got a working illustration of concept application.

To Grandma, your constant attempts to use the iPad proves age does not limit your use of technology. I will always be willing to be your information technology hotline and I am just a call away for you. As always Grandma, I love you.

To Dr. Weinstein, thank you for your patience with my schedule and for all of your expertise in the development of this application. It was through all your class discussions about ensuring the patient has the best tools for success available and the extreme focus on patient centered care which inspired this project.

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Introduction

The proposed 'DEarDiary' application is a technological update to the use of a journal and additional tools to increase use of amplification for new hearing aid users and by association optimize satisfaction. While a patient is first adjusting to amplification, it can be difficult to give an accurate report on the types of experiences they had in their environment when they are in the office (Skagerstrand et al, 2014). Keeping a hearing journal, promotes active participation in the user experience which may help patients recognize the benefits of amplification. With the incoming patient base of the baby boomer generation and Generation X, many of these individuals are accustomed to using technology and are active on the go (Ipsos-MORI Generations, 2018.). A journaling application would better suit this future population base as the journal would be on their smart phones instead of requiring them to carry a separate book.

This journaling application, Dear Diary, include items such as reference materials for the care and maintenance of the hearing devices, communication strategies, and ways the patient can advocate for their hearing needs. The journaling section is a place the patient could save notes about their hearing experience with either short answer questions or a long answer free response. A questionnaire section which assesses hearing handicap and satisfaction provides objective measures of progress with amplification. All these elements of the journaling application, along with the proper counseling from an audiologist, provide a support to the patient to allow greater success with hearing devices.

First Fit for Amplification

When a patient is first fit, the patient could reject the appropriate prescribed gain levels when fit to full targets. Many times, the initial gain is reduced to accustom the patient to the new sound and gradually increased to prescription over several weeks or months according to an adaptation schedule (Pumford, Hayes, Cornelisse, 2012). If the patient is given the full prescription of amplification, she will be told to wear the devices for an increasing number of hours over the first few weeks. These methods are attempting to adjust the amplification so the patient will continue wearing the devices and not reject the amplification. Once these adjustments are made, they do effect the audibility of speech so it is a balancing act between making the amplification acceptable for the patient to wear while providing the maximum audibility as demonstrated in *Figure 1* (Pumford, Hayes, Cornelisse, 2012).

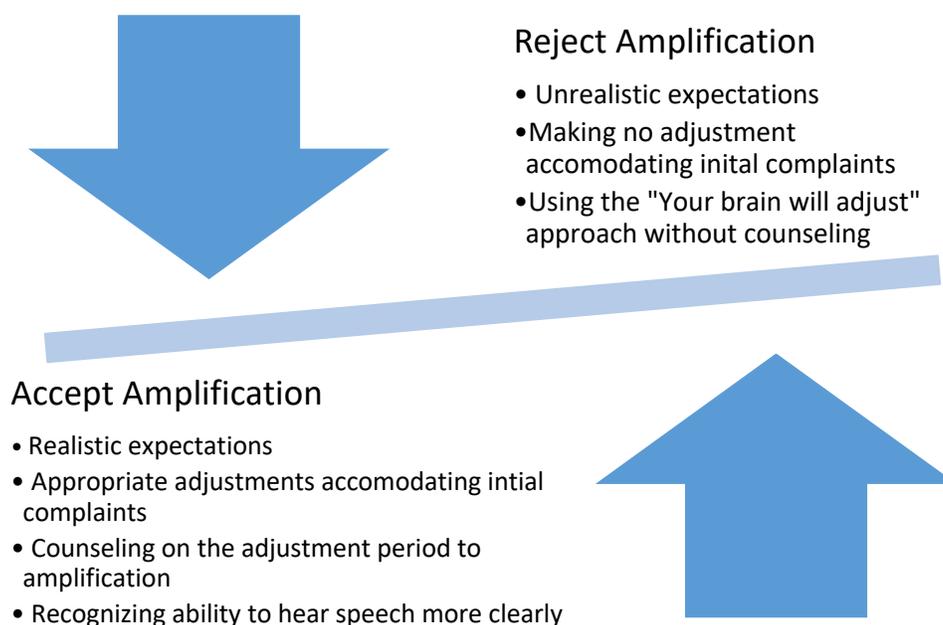


Figure 1 Factors that cause patient to accept or reject amplification (Pumford, Hayes, Cornelisse, 2012).

Audiologists know how to interpret complaints to increase comfort and compliance over the adjustment period. “It sounds tinny” means the high frequencies may be too high for the patient to adjust to at first. “There is an echo from my own voice” means there may be a large occlusion effect so lower the low frequencies or lower the gain for only high intensity low frequencies. These adjustments are simple enough to make in the office, but what happens when a patient comes in with a complaint that there are sounds they cannot stand, but they cannot recall a specific example? This is where journaling may help the patient recall the difficulties and benefits they have been experiencing at the time of follow up appointments to increase the overall satisfaction with hearing devices (Bennett et al, 2018)

Changes in Patient Technology Usage

While hearing loss occurs across all age groups it reaches a higher prevalence as age increases (National Institute on Deafness and Other Communication Disorders, 2017). While there is a stereotype of older patients having difficulty with technology, there are other influencers that may have greater impact than age. Level of education, attitudes towards technology, cognitive abilities, and levels of computer anxiety all had effects on an individual’s ability to use technology independent of the age of the individuals (Czaja et al, 2006). As every audiologist has seen, there are 90-year-old patients with the latest smart phone who could teach a thing or two about how to use them and then there are the 40-year-old individuals who can barely use a simple cell phone. A report by Anderson and Perrin in 2017 found smartphone usage to be 59% among those 65 to 69 years of age, 49% for those 70-74 years of age, 31% for those 75-79 years and older than 80 years the usage is reportedly only 18%. While the elderly

did not use technology the majority of their lives, 49% of the baby boomer generation, 68% of Generation X and 70% of Generation Y accesses the internet several times a day (Ipsos-MORI Generations, n.d.). These generations with overall increased use of technology will be the incoming patients for audiologists in the not so distant future. With this in mind, audiologists must adapt their methods to best support their patient base.

Audiologists Work with Technology and Counseling

The American Speech-Language and Hearing Association's Scope of Practice in Audiology (2004) has a definition of rehabilitative management which is summarized below in *Figure 2*. With the focus on rehabilitation, a large emphasis is placed on increasing the patient's receptive and expressive communication.

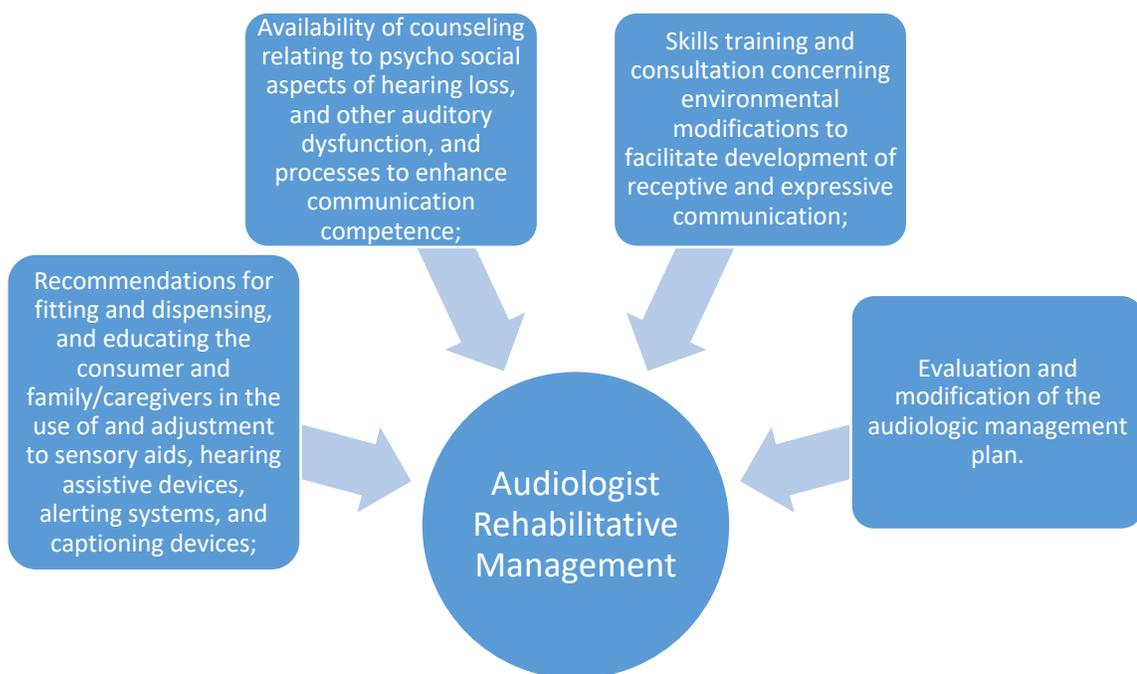


Figure 2 Scope of practice in audiology in regard to rehabilitative management.

(American Speech-Language-Hearing Association, 2004).

With the soon to be introduction of Over the Counter (OTC) devices, the field of audiology must focus on the services and counseling which sets itself apart from these

options (Kirkwood, 2004). A 2004 survey by Kirkwood of 753 audiologist and hearing dispenser participants, prior to legislator passing approving the sale of OTC devices showed some reactions to the then proposed OTC method of hearing aid distribution. 63% of the participants said the availability of OTC hearing aids would not be beneficial as those potential patients would not receive thorough counseling or other professional guidance (Kirkwood, 2004). A study completed by Humes (2017)) revealed that there was benefit to the use of OTC devices, though there was an increase in their benefit after receiving thorough counseling and an orientation to the devices. The lack of counseling with OTC devices could cause issues with patients only using the devices when they feel they need them when going out of the house. There is also a great concern with OTC devices that patients will be under or over fit with amplification which could cause individuals to not realize the full potential of properly fit amplification or even more devastating is damaging the remaining hearing sensitivity they do have (Kirkwood, 2004). In the Humes (2017) study patients who self-selected their devices did have a preference for being under fit which could have limited their success with these devices.

Walden, Walden, Summers, and Grant (2009) in their development of the Everyday Listening Assessment (ELA) identified problematic listening environments deemed most commonly reported for hearing impaired patients when they begin to use amplification (*Figure 3*). At times, patients will use these difficult listening situations as a way to judge how their amplification is able to help them hear more clearly. If they only do this while they are first adjusting to the amplification, and they do not track their progress as they relearn how to hear, then it may seem as though the devices are not

helping as they should. By having the patient keep track of how they are hearing in situations like these over time, they can see the progress they are making with amplification and understand the benefits it provides.

| | | | |
|-------------------------------------|---|--|---|
| Conversation with TV in background | - At the movies - Listening to child | Listening in large theater or sanctuary | Listening in conference room or classroom |
| Talking in a restaurant | Conversation at cocktail party | Conversation in car with radio playing in background | Dinner conversation |
| Listening to child at play outdoors | Conversation with someone in another room | Listening to vocal music | Listening to instrumental music |

Figure 3 Everyday Listening Situations That Are Most Frequently Reported to Be Problematic by Patients (Walden et al, 2011).

Purpose of DEar Diary

DEar Diary is a proposed Apple iOS application which would be a tool for audiologists to use in their fitting process with new users of amplification. It is an application that is not limited to a specific manufacture which allows it to be used as generic hearing aid fitting support. DEar Diary will have implements pertaining to goal setting, progress tracking, and it will be an information guide to help support patient's adjustment to amplification.

Methods of the Development for DEar Diary

Why iOS and Not Other Platforms?

An operating system (OS) is the software that controls the operation of a computer and directs the processing of programs (as by assigning storage space in memory and controlling input and output functions) (Operating system, n.d.). The android operating systems are usually sold programmed into the device and there is limited access to upgrading to newer versions as they become available. As of April 16, 2018 the Anrdoid developer website shows only 4.6% of users are using the current Oreo 8.0 platform with only 0.5% using the latest updated Oreo 8.1. (Android developers, 2018). iOS allows all supported devices to upgrade to the newest platform until it becomes unsupported several years after the device was released. This allows for 86.6% of Apple users as of April 20, 2018 to be on the most up to date version of iOS since it's release in September 2017 meaning developers only need to focus on compatibility between a limited number of versions (Mixpanel, 2018). Due to this ease of compatibility among users of Apple iOS, the implementation of this DEarDiary application is utilizing the iOS platform.

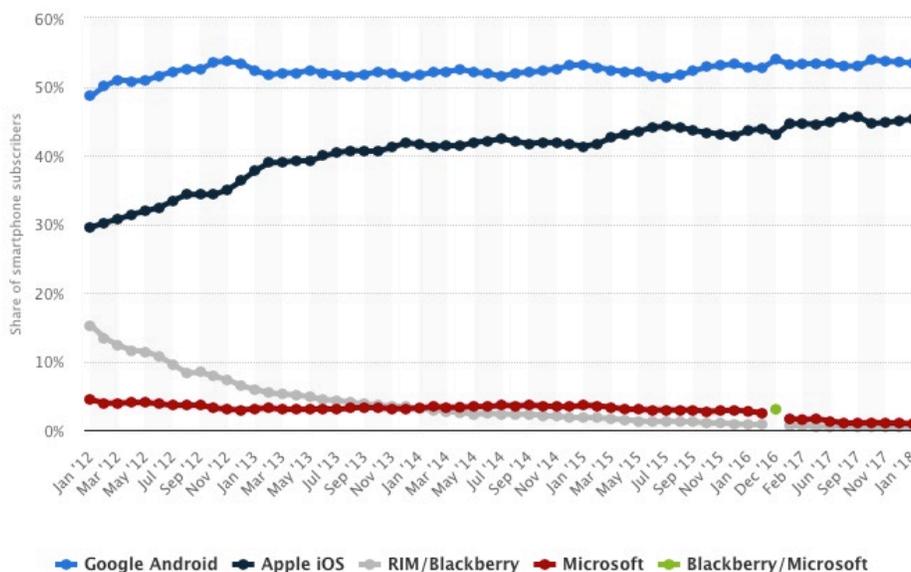


Figure 4 Operating system distribution use in the US by share of smart phone subscribers. In January 2018 45.3% of cellphone subscribers used phones running Apple iOS and 53% used Google Android (Statista, n.d.).

OS and Direct to Smart Phone Hearing Aids

As of the writing of this paper, there is only one direct to any Bluetooth technology hearing aid by Phonak The Phonak Audèò-B Direct can stream monaurally only for phone calls from a phone on either the Android or Apple iOS platforms. Even though most of these Android devices cannot stream to the devices directly, many can use an application as a remote control of some kind. This is lack of connectivity for Android is mainly due to the wide variety of differences is the way each model, manufacturer, and software version work the Android operating system. This causes challenges in the way programs must be written since there are many chances for breakdowns in the coding and coding languages based off the behavior of each specific Android device.

Apple with their iOS has this more standardized. The main difference between their different generations and style of devices are the screen size while they all functionally work exactly the same. If a developer knows how to create proper universal constraints, she can create an application that would work and be formatted properly on an iPad through to the smaller iPhone. Currently, many of the major hearing aid manufacturers have direct to iPhone compatibility with streaming, direct phone calls, and full connectivity because of the ease of developing universal applications.

Developing the Application

The development of this application was started in the coding language Swift 3 using the Xcode 8 development software. During the early stages of development, Apple released the fourth version of the Swift language and the new version of Xcode 9 so the application was restarted using this new software and language. The final version as of the submission of this paper was written in the Swift 4 language using version 9.2 of Xcode. Due to the complex nature of the universal constrain system and only a basic knowledge of coding, this current application was designed specifically for a standard iPhone 7 which was the device available for testing purposes. DEarDiary was created mainly using Storyboard and using click through navigation style. This version is not a completed application, but an illustration of concept to show the type of application which would best suit the patient needs and support them through their success with amplification.

Note for future development: All results from questionnaires and other entries should be stored internally so the audiologist can track and monitor these changes over time.

Main Goals Of 'DEarDiary' a Communication Journal Application

The first goal for DEarDiary is to provide efficient ways for the patient to keep notes of their experience with the use of amplification for their audiologist. Another goal would be to administer questionnaires about their experience with amplification for the day or week depending on the needs of the patient. The final goal is to provide information resources such as instructional videos, communication strategies for the listener and speaker, along with ways to advocate for the patient's hearing needs. An additional consideration is implementing a reminder system for when to change batteries, clean the device, when to schedule hearing tests, etc to promote proper care of the devices.

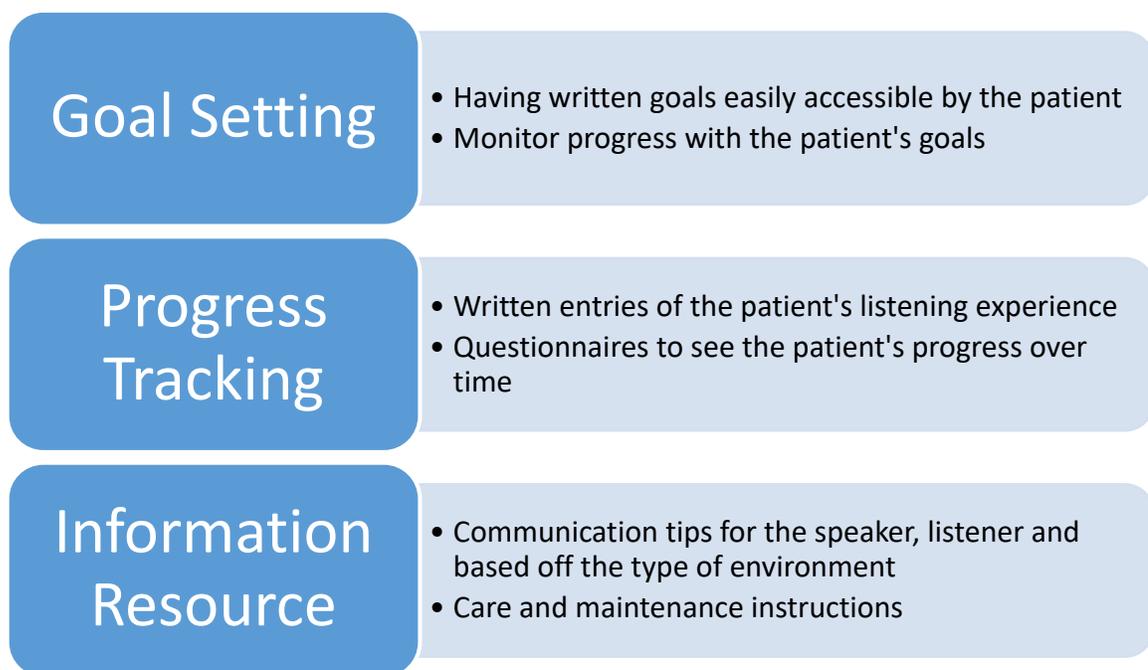


Figure 5. Main goals for Dear Diary



Figure .6 Main screen of the Dear Diary application

Goal Setting

My Hearing Goals

This section is where the goals can be entered by the patient and they can be edited and changed at any time. Goals such as hearing/understanding better over the phone, being able to carry a conversation at dinner, hearing the doorbell, or hearing their name when called from another room. These goals would be looked at during the first follow up and a list of steps or strategies to accomplish these goals should be discussed. Potentially, there could be a goal set by the audiologist as a homework if needed such as, "Wear the devices 8 hours a day by the next appointment." Once a goal is achieved, it could be changed to accommodate a new goal.

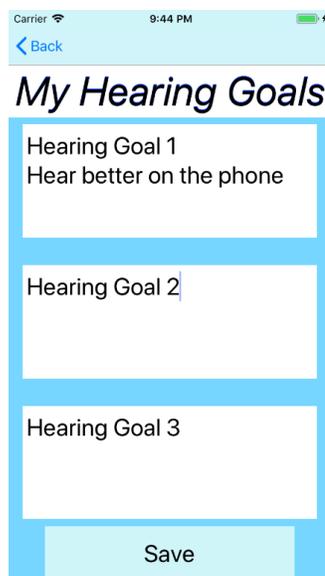


Figure 7. Screenshot of the goals section

A note for the future development: *Once a goal has been accomplished, moving it to a new section listed as an accomplishment would help the patient keep track of the progress they have made.*

Tracking Progress

Daily Journal

As mentioned before, writing down the sounds a patient deems annoying, overall comments about sound quality, and any questions they have may allow for a more productive appointment with the audiologist. This allows the patient to effectively remember situations they were concerned about hearing which in turn helps the audiologist make more precise adjustments to the amplification (Skagerstrand et al, 2014). These questions and journal entries would be a way to track patient satisfaction with the amplification and the hearing handicap. There is a quick response journal where it asks if the patient had difficulty hearing that day. Following, a slider comes through for the patient to rate their overall hearing experience for the day. If they stated

they had difficulty, then it will next come to a section asking what type of environment they had difficulty in which would take them to a tips section to help them hear better in that environment. In the short answer, it utilized the questions from Skagerstrand et al's research in 2014, "What sound or sound source was annoying? What characteristic of the sound was annoying? In what situation was the sound annoying, and how were you occupied in that situation? What did you do to reduce the annoyance?" Under each of the questions it has a fillable text field for the patient to store their answers. Lastly, there is a general freeform answer format where the patient can write notes and experiences for their day for their hearing.

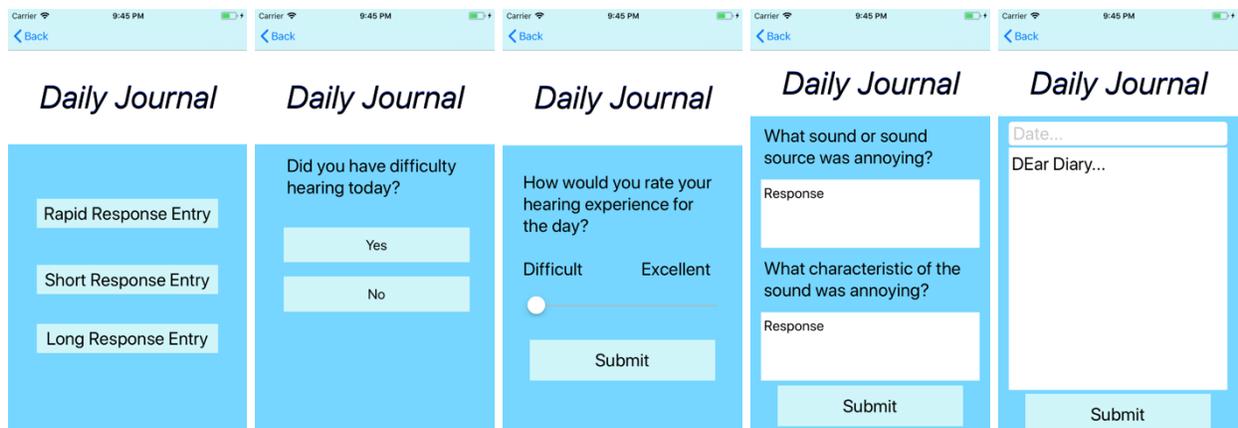


Figure 8. Screenshot of the various journal types

A note for the future development: Once the core data (the ability to save data within the application) is in place, then there should be a section to access previous journal entries and responses.

Check Up

This section is where the patient can complete score-based questionnaires to monitor their progress with amplification. There is evidence that these types of questionnaires should only be administered after 30 days of consistent use due to the

acclimatization period which exists for the first month (Taylor, 2007). With this in mind, there should be instructions to the patient to leave this section alone for the first few weeks of the fitting. The currently included questionnaire is the Hearing Handicap Inventory in the Elderly Screening (HHIE-S) which was adapted from the original Hearing Handicap Inventory for the Elderly by Ventry and Weinstein (1982) (Hearing Handicap Inventory in the Elderly – Screening Questionnaire, n.d.). The Satisfaction with Amplification in Daily Life (SADL) questionnaire by Cox and Alexander (1999). These are both questionnaires which have good test retest reliability and thus can be used to track changes in the patient's performance and satisfaction with the devices. Their limited answer format makes them well suited for an assessment given through a mobile device. Currently, the assessments are not functional and are only examples of what it could look like once the coding required is completed.

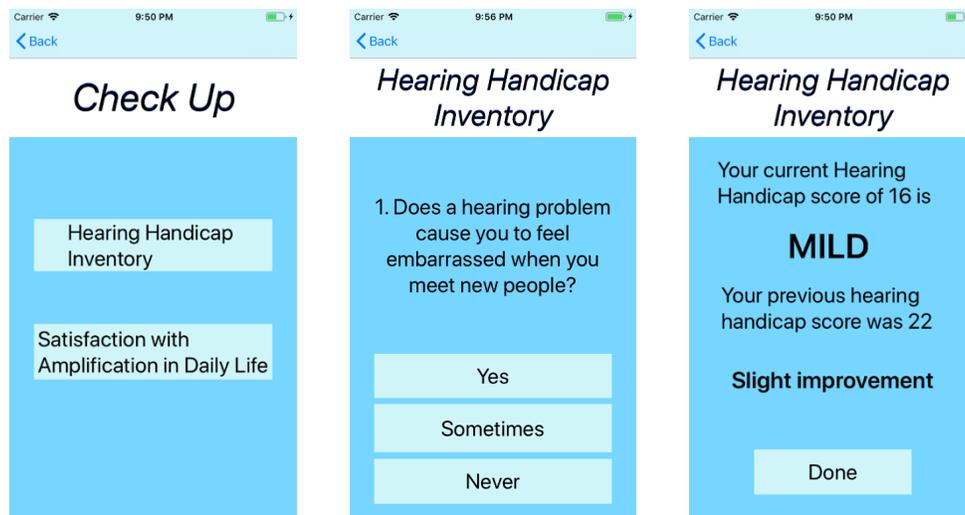


Figure 9. Screenshots showing the proposed format of the Hearing Handicap Inventory

Note for future development: The addition of several other versions of questionnaires so the patient has multiple measures of progress. Also, potentially having a graph of the progress the patient has made.

Information Resources

Communication Tips

When a patient is in a difficult situation, it may be helpful to have a pocket resource for improving their communication. *Figure 10* demonstrates the possible way to lay out the types of situations a person may encounter. The part, “For the Speaker” is especially useful as a way for the patient with hearing loss to promote communication education. In the moment of a communication breakdown due to someone speaking from another room or from shouting to be heard, both the person speaking, and the listener can become tense and agitated. By having a list of communication strategies available to use right away without searching the internet, it can help in the moment to provide solutions to resolve where the communication breakdown occurred.

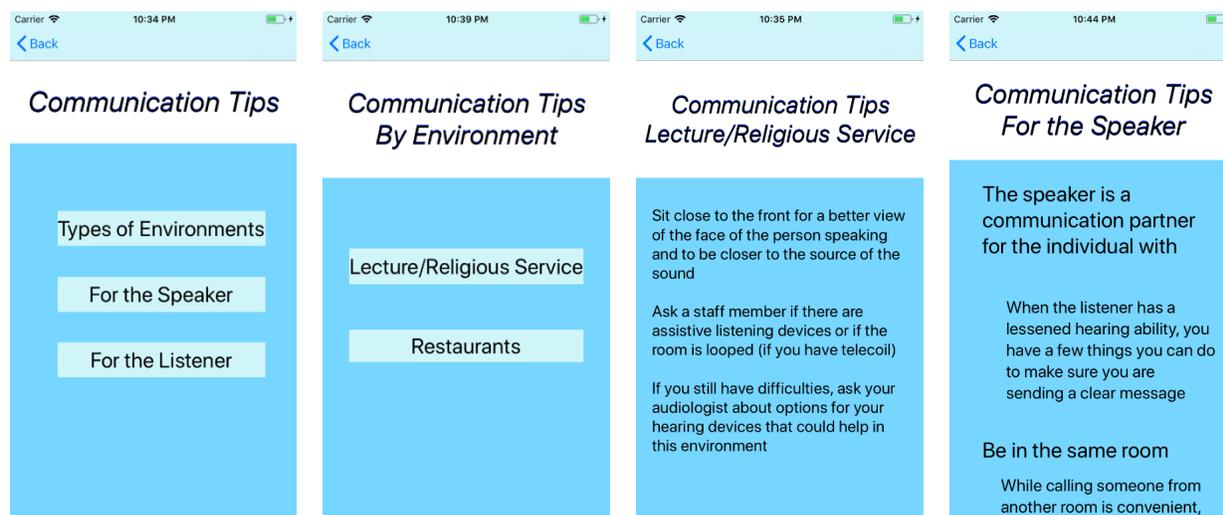


Figure 10. Screenshots demonstrating layout and content for Communication Tips

Note for future development: *The addition of more communication materials is needed for a complete resource.*

Instructions

Any audiologist has experienced when they fit a patient with devices and they have gone over how to change batteries several times, and yet the patient comes in for first follow up with a dead battery. Worse yet, they attempted changing the battery and left the air barrier sticker on so the battery was not activated or the battery was placed upside-down and forced closed which damaged the device. These are examples of a breakdown in the orientation process from a lack of supplemental materials that could have reinforced what was taught (Bennett, 2017)

During the initial counseling on care, maintenance and use of the devices there is a wealth of information provided to the patient where they may not have had a prior knowledge to build upon. This information is generally given verbally with little to no written information provided to support the learning once the patient has left the clinic. Having a reference application with information on care, maintenance, communication tips, and quick references for the patient to access at any time could help increase the amount of compliance with hearing aid usage following the first fitting and the follow up appointments (Bennett et al, 2018). This instructions section of DEar Diary is to be used for a reference of care and maintenance tasks involved with using the hearing devices including:

- Battery changing
- Checking battery
- Changing wax filters
- What to do if there is feedback
- Insertion and removal of the devices
- Left and right indicators
- Cleaning devices

Note for future development: Instructional videos would be the most helpful for this section. Potentially even allowing the patient to choose if their device is a custom product, a standard behind the ear device, or a receiver in the canal device.

The Future of DEar Diary

As previously mentioned, this current version of the application is an illustration of concept and not yet a ready for the user application. This product needs to be fully developed into an application that will be able to locally store information so progress can be tracked. There also are further user interaction pieces by making scoring available for the questionnaires and the ability to see the improvement over time. Some additional materials that would be useful include a section where the patient can put in their hearing aid information including battery size, make, manufacturer, serial numbers, warranty information, and previous repairs completed on the devices. Potentially having notification reminders to change the batteries of the devices, clean the devices, check your current hearing goals, etc would be helpful for patients who have difficulty remembering to do so on their own.

SUMMARY

While DEar Diary is not yet a fully functioning application, it shows an example of what a patient would need to help support their transition from someone with hearing loss to someone in charge of their hearing health and communication.

The goal setting is able to help them determine where they want to accomplish and ensure they remember to strive towards that mark. The progress tracking is able to show how far they have come and see their success through validated questionnaires. Lastly, the information section is available to provide resources for communication tips

they can use to take charge of difficulty listening situations, care properly for their devices and to help advocate for their hearing needs.

The rising technology use in the population of those in the audiological patient base may be better served by switching from paper methods to digital tools. This way those tech savvy patients will not need to carry a booklet or materials, but they could record a note for their audiologist no matter where they are. With changes in technology, come opportunities for growth and to adapt to whatever challenges are ahead.

RESEARCH APPLICATIONS

The future development of the DEar Diary application should focus on creating a prototype to be implemented with patients. Once this is accomplished, conducting a study comparing hearing aid adaptation success and overall satisfaction with and without the use of the application would show if an application like this one could provide benefits over standard paper methods with those who already utilize smartphones.

Potentially, conducting a survey to see how many audiologists have patients with smart phones would also serve the development of the DEar Diary application. It would serve as a study to see the potential reach of patients who may be able to utilize the application. In addition, obtaining the prevalence of the use of direct to smartphone hearing aids would show the demand for the advanced technology this application would be able to offer in the future.

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