Play&Tune: user-feedback in the development of a serious game for optimising hearing aid orientation.

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ABSTRACT

Many hearing aid (HA) users are dissatisfied with HA performance in social situations. One way to improve HA outcomes is training users to understand how HAs work. Play&Tune was designed to provide this training, and to foster autonomy in hearing rehabilitation. We carried out two prototype evaluations and a pre-release evaluation of Play&Tune with 71 HA users, using an interview or online survey. Users gave detailed feedback on their experiences with the app. Most participants enjoyed learning about HAs and expressed a desire for autonomy over their HA settings. Our case study reinforces the importance of user-feedback during app development.

1 The problem with hearing aid fittings

Hearing aid (HA) use by adults with hearing loss (HL) is typically at a less than optimal level. EuroTrak, a large scale survey (11,867 adults with hearing impairment), found that less than half (37%) of adults with HL in the UK, Germany and France actually use HAs (Bisgaard & Ruf, 2017), perhaps owing to forgetfulness, discomfort or stigma associated with wearing HAs. Among the reasons for low usage is the perception that HAs do not provide enough benefit, i.e. those with HL do not think that a HA makes a vast difference to their hearing ability (Kochkin, 2000).

One explanation for dissatisfaction with HAs is that they are being used incorrectly (Desjardins & Doherty, 2009). Correct usage and user satisfaction rely heavily on the calibrations made by the audiologist (or HA fitter), who needs to configure the optimal calibration for the patient (Dillon et al., 2006). Yet audiologist's calibrations are based predominantly on average fitting rationales, which may not be preferable or acceptable for each unique patient (Keidser & Dillon, 2006). Additionally, any modifications that they might make during fittings are based on the client's self-report of their hearing level in response to artificial sounds produced in a sound-controlled environment. The differences between hearing sounds in a clinic (sound-controlled) and hearing sounds in everyday life (unpredictable) result in a lack of ecological validity of HA calibrations (Dahl & Hanssen, 2017). Consequently, HA users often report issues relating to their audiologist's calibrations (Keidser & Dillon, 2006) which necessitate a laborious and continuous process of perfecting a HA fitting. For example a HA user might return to the clinic to adjust their HA to fix a particular problem, but finds that this change causes new problems in other situations (Bennett, Laplante-Lévesque, Meyer, & Eikelboom, 2017). HA users are not (currently) encouraged to alter the calibrations of their HA themselves, indeed in many cases this is not possible unless they possess certain expensive software, equipment (i.e. Bluetooth enabled HAs) and expertise. Efforts have been made to produce smartphone technology to help HA users to train their HA through personalising their settings in different environments. Emerging techniques using smartphone apps connected to Bluetooth enabled HAs have been recently described (Aldaz, Puria, & Leifer, 2016; Pasta, Petersen, Jensen, & Larsen, 2019; Søgaard Jensen, Hau, Bagger Nielsen, Bundgaard Nielsen, & Vase Legarth, 2019), in which user-preference is incorporated into an ongoing calibration process. These studies reported positive findings relating to different aspects of the hearing experience for conditions in which HAs had been optimized by the user. However, in these studies, participants were fitted with specific Bluetooth enabled HAs for the trials, whilst the general population of HA users use a wide variety of types of HA, many operating without smartphone connectivity. Until the universal baseline functionalities of HAs include connectivity to smartphone apps, it makes sense to examine alternative means of involving users in the ongoing optimization of their HA fittings.

2 Intervention: 3D Tune-In

The 3D Tune-In (3DTI) project (http://3d-tune-in.eu/) sought to address the gap in services for HA education and autonomy by developing game applications which could improve the everyday experiences of HA users (see D'Cruz et al., 2017; Eastgate, Picinali, Patel, & D'Cruz, 2016; Patel et al., 2016). Through developing serious and leisure games, the project aimed to; educate HA users about the functionalities of their HAs; train HA users in the optimal use of their HAs in different environments; and provide an enjoyable leisure activity for HA users. The initial objective was to produce services which could be used with the audiologist at the clinic, but could also bridge the gap between audiology appointments in which the user must assess their hearing ability in different contexts.

The games make use of a Virtual HA (VHA), which can be calibrated using the HA user's audiogram entered manually, or users can take an in-built hearing assessment to set the VHA to mimic the amplification of a real HA, such that users can remove their HA and use headphones to play. The VHA calibration process is designed to be simple to use, allowing users to quickly enter details relating to their hearing. A large number of parameters can be adjusted and personalised within digital HAs. A subset of these was selected for the current project, namely tone control (low, mid and high frequencies), microphone directivity, overall dynamic range compression and overall amplification level, all independently controlled for each ear. Since the games are designed to help users to understand how their hearing can be improved through adjustments to these parameters, it was not a requirement for the VHA to be calibrated to the exact specifications of the user's existing HA. Rather, the VHA is simply calibrated to the extent that the user can hear an audio source before starting the games in which calibrations are refined.

The games employ the 3DTI Toolkit to produce realistic sounds in 3D space to mimic the demands of binaural hearing in different real-life environments (Cuevas-Rodríguez et al., 2019; Levtov, Picinali, D'Cruz, & Simeone, 2016). Through gamification, HA users are provided with a risk-free environment in which to test the VHA in different sound environments, and are provided with an engaging means to learn more about the terms that their audiologist uses to describe the HA calibration process in the clinic. HA users can explore the affordances and limitations of different HA calibrations and examine the effects of making changes to the VHA to hear better within the games; for instance, what happens if they increase compression in a restaurant situation?

Play&Tune, developed by Vianet, includes a number of engaging games, each simulating a series of virtual scenarios with realistic sounds where players face different challenges and learn how to calibrate a HA: tone control, overall amplification level, overall compression, microphone directivity , etc. (Simeone, Picinali, & Atvur, 2018). Since the development team had not developed services for HA users before, a bespoke evaluation protocol was employed to provide the development team with crucial user feedback on their designs, in the hope of ensuring the final design met the needs of the target user group. The aim of this paper is to describe the process of iterative prototype evaluation, as a case study of the development of an app for a unique target audience with multiple, often-complex needs.

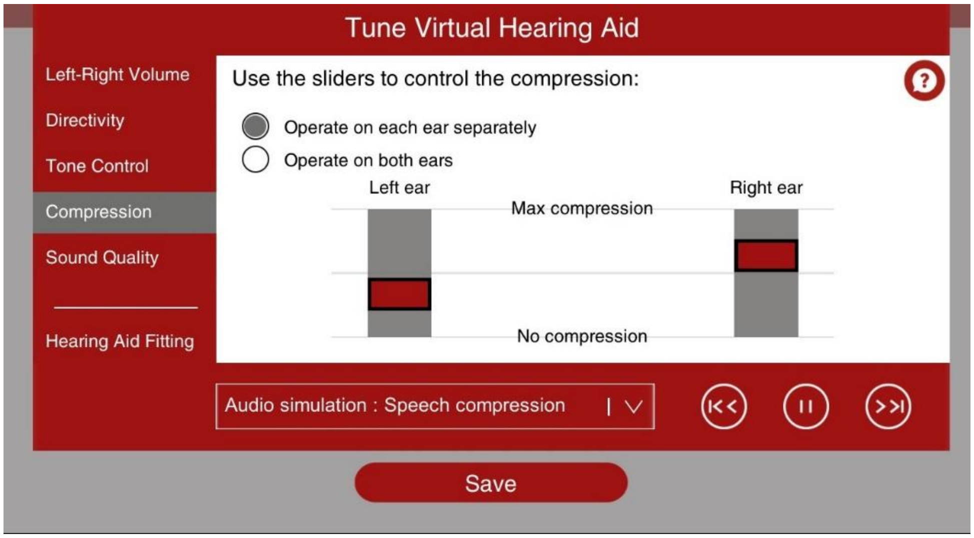

Figure 1: Screenshot from the VHA

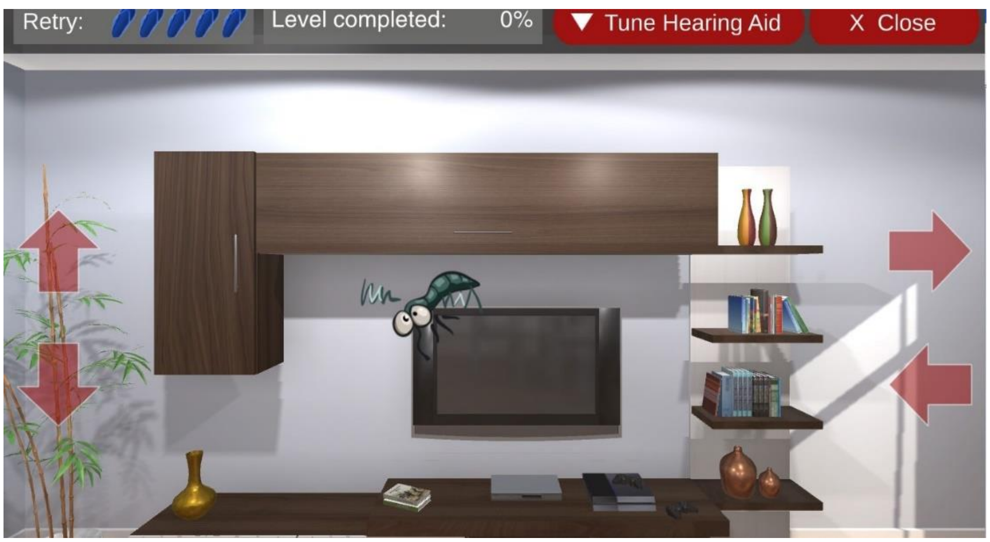

Figure 2: Screenshot from the game "Mosquito Catch"

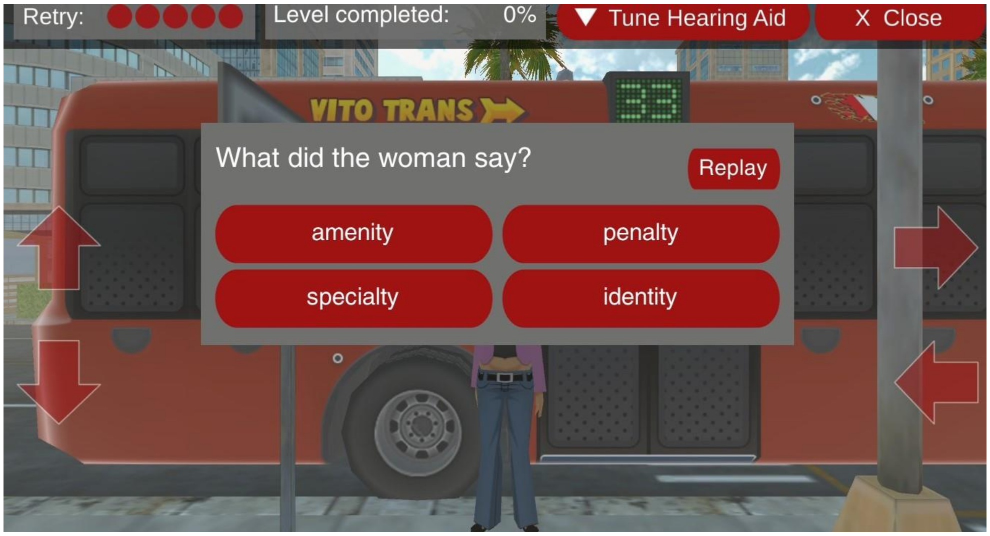

Figure 3: Screenshot from the game "Noisy Street"

When choosing the specific hearing challenges to be implemented in the game, attention was put on two main tasks, namely sound sources localization and speech understanding. These typically require different calibration of certain the HA controls. For example, when trying to localise a sound source located in the surrounding space, the HA microphones should be set to an omnidirectional pattern, therefore not attenuating sources when these are behind or on the side of the listener. When trying to understand speech in noise, considering that the target speech source is generally located in front of the listener, while the noise comes from the surrounding environment, the setting of the microphones to a directional pattern can prove to be very useful for improving intelligibility.

3 Timetable of evaluations

After a period of user-requirements generation (reported in Patel et al., 2016), initial idea development, and a low-fidelity prototype evaluation (in which paper based descriptions were evaluated for acceptability with end-users) there were two prototype evaluation stages and a final evaluation throughout the 36-month project. **Error! Reference source not found.**Table 1 details these different stages.

Participants were adult HA users from the UK, Italy and worldwide with mild to moderate HL over the age of 18 who were users of behind-the-ear, in-the-ear or completely-in-the-canal HAs, i.e. devices that did not require surgery.

Table 1: Participant and prototype details for each stage of evaluation

Evaluation stage	**Description of the prototype**	**Participants and procedure**
Formative Evaluation 1: Month 22	At this stage the prototype was an Android-only app. Play began with a calibration of the VHA, then players had three hearing tasks to assess; 'Mosquito Catch'(sound-localization task); 'Magic Garden' (speech understanding task); and a 'Hearing Aid Diary' (a record of hearing experiences). Mosquito Catch depicted a virtual living room in which the user could hear the sound of a mosquito buzzing. The aim of the game was to locate the sound of the mosquito in the room and use one or more of the five flip-flops shown on the interface to kill the mosquito. Arrows on the screen enabled users to navigate around the room. The Magic Garden game involved a magician who flew around the user whispering sentences. The user recorded (by typing) what the magician said and the app checked whether this was correct. If they could not hear the stimulus sounds clearly and/or failed the tasks, they were encouraged to change the settings of the VHA until they could proceed in the hearing tasks (see figure 1). The Hearing Aid Diary allowed users to record (by typing input) everyday instances or situations in which they have found hearing to be difficult or easy.	• Participants attended workshops to use Play&Tune for 30 minutes and then participated in single or paired interviews about their experience. • Number of participants: 17 (14 from UK, 3 from Italy) • Mean age: 69.5 • 7 female, 10 male
Formative Evaluation 2: Month 30	The prototype was now an Android and PC/Mac-based game. It had six tasks to assess: the sound-localization tasks Locate the Phone, Mosquito Catch and Invisible Mosquito Catch; and the speech understanding tasks Magic Garden, Noisy Street and At the Restaurant. The first three tasks had a similar premise, that is, locating an object (mosquito, phone or invisible mosquito) in varying levels of background noise in a room using arrows to navigate around the room. The last three tasks involved identifying a word/phrase spoken in varying levels of background noise by selecting the correct option from a selection. All tasks requiring keyboard interaction had been removed from the app.	• Participants attended workshops to use Play&Tune for 30 minutes and then participated in single or paired interviews about their experience. • Number of participants: 13 (10 from UK, 3 from Italy) • Mean age: 59 • 4 female, 9 male
Final Evaluation: Month 33-34	For the final version of the prototype, the developers decided to narrow their focus on the desktop/laptop version (PC/Mac-based game) for various reasons, including the fact that users complained about the difficulty of using the app on small devices, which posed some challenges in relation to both the limited dimension of the display and the touch-based user interface. In the final desktop/laptop version of Play&Tune, the overall user interface was streamlined and simplified, incorporating new and higher-quality sounds. At this stage of evaluation, Play&Tune contained the sound-localization tasks "Mosquito Catch" (see Figure 2), "Locate the Phone" and "Invisible Mosquito Catch", and the speech understanding tasks "At the Restaurant", "Magic Garden"	• Participants either attended workshops or downloaded Play&Tune to play at home. Participants completed an online survey following at least 30 minutes play. • Number of participants: 41 (from worldwide) • Mode age range: 61-80

	and “Noisy Street” (see Figure 3). Some more help and information features were added, such as game tutorial videos and further information about VHA settings/features, as requested by participants and detailed in table 2.	• 17 female, 24 male

4 Formative evaluations: shaping the app development process

For both stages of evaluation, participants first completed a demographics questionnaire, then used Play&Tune for 30 minutes on an Android tablet device (month 22 prototype) or Windows PC (month 30 prototype) and good quality over-the-ear headphones, which they wore instead of their HA. We gave participants minimal instructions about the game in order to evaluate the ease at which they could ‘pick-up-and-play’, however researchers assisted participants if requested. Following the game play session, we interviewed participants about their experience of the game using a semi-structured interview covering the following areas;

- Month 22 prototype: audiological aspects; game play and game story; game mechanics; accessibility; and usability.
- Month 30 prototype: the extent to which the game met the overarching objectives of the project; learning opportunities; relevance to project aims; usability; and acceptability. We also asked users to assess the VHA functionalities.

We recorded interview responses using a digital voice recorder, then transcribed these recordings. In order to extract clear user-requirements to feed back to the developers, a document was created outlining positive feedback (aspects of the app that participants liked and reasons for this), negative feedback (aspects that participants disliked and reasons for this) and suggestions from participants. These points were then rephrased into actionable changes, consisting of suggestions made by the participants, and recommendations made by researchers for additions to or deletions from the game or refinements to be made. In this way, each of the actionable changes was supported by an identified user-requirement and exemplar quotes taken directly from the interviews to provide context. Owing to the significant overlap of areas of questioning for the two stages of evaluation, the results are combined and summarized below in table 2. This table also summarises some examples of solutions implemented by the developers based on the recommendations made during the formative evaluation process.

Table 2: summary of feedback and design implications.

AREA OF EVALUATION	SUMMARY OF FEEDBACK	ACTIONABLE CHANGES	EXAMPLES OF CHANGES MADE BASED ON END-USER FEEDBACK
GAME PLAY AND GAME STORY	Participants found the game interactive and fun to play, they liked the characters, found it could be useful for troubleshooting their HA, and thought it worked quickly. However, some participants found there were not enough challenges, said they needed more rewards and that they could get bored quickly; in contrast, some tasks were too difficult. Some people did not understand the purpose of the game.	Make some tasks more challenging. Make some of the hearing tasks, sounds and scenes more realistic and relevant to those with HL.	More realistic sound environments were added in various games. Developers also re-spatialized foreground and background sounds and worked on the volumes to make the gameplay more challenging.
GAME MECHANICS	Participants thought that most of the controls were clear and the game would provide a useful audiological experience. However, some participants could not hear aspects of the hearing tasks at all even after altering the VHA settings; some were concerned about volume compatibility with certain devices and were unsure about how to use the VHA. Participants reported there was no continuity of sound quality, not enough feedback and some of the controls were difficult to use (i.e. the keyboard in the first prototype).	Change the input mechanisms to avoid typing. Address compatibility issues with different types of devices. VHA controls should be incorporated into the hearing tasks to enable participants to directly make changes to the stimulus sound and background sounds.	Games requiring keyboard input were changed to enable players to choose from a selection of similar sounding words. Developers also avoided using words that can be spelled in different ways. Additional contextual menu items were added to allow end-users to have a broader control of the interaction.

ACCESSIBILITY	Most participants understood the instructions, and thought that the game would be suitable for all age groups. However, suitability was thought to depend on familiarity with the device, and some tasks were not appropriate for those with dexterity issues (e.g. keyboard typing in the first prototype). Many participants reported that it would not be useful to learn about HA functionalities if they cannot make changes to their real HA.	Consider the degree of experience that a participant has with different devices and change the controls or input method for certain hearing tasks accordingly (e.g. word selection rather than keyboard typing). Avoid tasks that make use of memory or fine dexterity to enable older participants to comfortably play the game. Ensure that visual aspects of the app were suitable for those with vision difficulties.	In addition to the removal of keyboard interaction methods, developers implemented specific measures to further the accessibility of the user interface, for example bigger and more differentiated buttons.
AUDIOLOGICAL ASPECTS	Participants found most tasks were relevant to daily life, the contexts and sounds were realistic, and they thought that the app was a realistic tool for calibrating HAs or even testing hearing at home. Using the app would encourage participants to see their audiologist to change their HA, and many wished that they could make the same changes to their real HA. However, some participants thought that some of the scenery/sounds were not realistic and that some of the hearing tasks were too hard or not relevant to daily life (e.g. locating a mosquito). Some of the tasks were thought to be memory (rather than hearing related) tasks, and some struggled to hear some stimulus sounds despite adjusting the VHA.	Certain hearing tasks should be more realistic and varied. Ensure hearing tasks were testing hearing ability rather than memory. Provide more guidance about which settings to change if participants struggle to complete the games.	Developers reworked the sound environments and the related volumes to achieve more realistic representations of typical sound ecologies experienced by end-users. Developers also added a fine-grained contextual help mechanism to support those users who are struggling to complete the games. Finally, the number of questions was increased to avoid users memorizing the responses.

LEARNING	Participants learnt about how their HAs could be adjusted to improve their hearing. They thought that the app could help them to learn about their HAs different settings and empower them to discuss these with their audiologist. Some said they would prefer using the app to using traditional learning tools, and reported discovering that changing HA settings made a real difference to their hearing. Some learned that their existing settings were not right for them and were prompted to speak to their audiologist about changing them. However, there were some participants who did not understand why they were making changes to the VHA; they did not understand what the different functionalities did, found that they needed more guidance about what changes to make and thought there was not enough variation in the hearing tasks.	Provide more instructions and explanations for the hearing tasks and VHA. Provide an explanation of the purpose of the individual hearing tasks and the VHA. Hearing tasks should provide suggestions to participants based on their performance. Provide more instruction and guidance about why participants need to change the VHA settings and why certain settings might work in different situations.	Developers included tutorials and videos to explain how to use Play&Tune. The tutorials also try to highlight the benefits that the users might get by playing with Play&Tune.
USABILITY	Participants enjoyed the simplicity of the app, and found it was easy to interact with the hearing tasks. The different levels of challenges were appreciated. Many participants would welcome using it under the instruction of their audiologist. However, some commented that the instructions were not clear, that certain hearing tasks were too difficult, and that there were problems with playing certain hearing tasks (e.g. the screen would freeze when searching for the waiter in "At the restaurant"). Some participants thought that the visual aspects of the game needed simplifying in order to improve accessibility.	Some participants would like clearer instructions for the app and individual hearing tasks. The VHA should be visually simplified for those with visual problems.	In addition to the already described fine-grained contextual guidance, developers also implemented a new dedicated "Help" section. The visual design of the VHA was further streamlined.

ACCEPTABILITY	Participants thought that the app would make a welcome addition to their audiology service, and thought it would be useful for exploring their hearing. They thought that the hearing tasks would be fun for all ages, and they would like to use it on all kinds of devices. Participants thought it would provide a useful innovation for audiology practice. However, it was noted that Play&tune's success requires input from the audiologist, and/or the ability to make changes to their own HA, which might be impossible. Others argued that their audiologist should be able to get a perfect setting for their HA without using the app, and the need for gamification was questioned.	More explanation was needed for why the app is useful for end-users and audiologists.	Better introductory texts were developed for the whole app, explaining the benefits of learning via a game.

5 Final evaluation: meeting to project aims

For the final evaluation, HA users used Play&Tune for a minimum of 30 minutes, and then completed an online survey. Participants were asked to select their age group- the numbers of participants in each age group were as follows (mode age range in bold): 19-40 = 8, 41-60 = 9**, 61-80 = 19**, 81+ = 5.

Participants who opted to attend workshops used a Windows PC or Mac laptop with good quality over-the-ear headphones, which they wore instead of their HA. Again, we gave participants minimal instructions about the game, although one-two researchers were present to assist participants if requested. Participants who opted to download Play&Tune at home were sent an email including a short description of the game, a web-link to download it, and instructions for installation and for completing the survey. Researchers and the game developers were available via email or phone if participants had any difficulties downloading or using the app.

The online survey included some demographic questions; open questions about what they liked and disliked about the app and what they thought should be changed, and a series of Likert-scale questions which asked participants to rate the game on a number of descriptors (figure 4). Participants were then asked to judge the extent to which Play&Tune met the project aims and whether they would consider buying/recommending Play&Tune in the future.

Generally, participants had positive opinions about Play&Tune: the majority of participants selected positive ratings to describe the app. Figure 4 shows the responses to each of the Likert questions which asked participants to rate the app on a number of descriptors, with the lowest numbers relating to negative dimensions of the descriptors and the highest numbers relating to positive dimensions of the descriptors. For example, for the descriptor "complexity", the negative dimension was "complicated" scoring 1, and the positive dimension was "simple" scoring 5. 61.84% of total ratings were on the positive end of the scale, scoring 4 and 5, 14.35% of ratings were on the negative end of the scale, scoring 1 and 2.

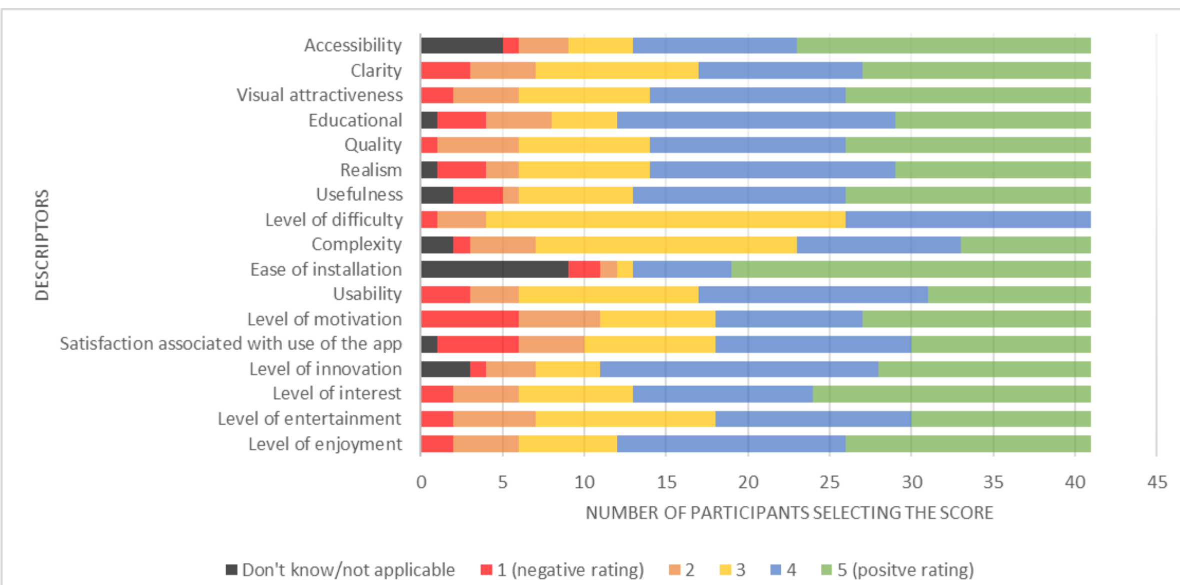

Figure 4: Responses to Likert questions regarding descriptors of the apps

In response to open questions regarding what they liked/disliked about Play&Tune, participants particularly liked the variety of games; tuning the VHA; ease of use of the controls; the interesting nature of the games;

the idea behind the app; that it was engaging, fun, realistic, a challenge, and enabled users to better understand HA settings. Some participants did not like the difficulty of all or some of the games; they sometimes did not understand what to do; the controls were too slow to respond; some did not have an interest in these types of games; some found the games were stressful; and some found that they got no benefit from playing. Suggested improvements included more and clearer instructions; a reset option; more accuracy of the controls; more play options (increase the difficulty levels); new scenarios; the ability to change the settings of the VHA within the individual game rather than separately; and adding more communication options, for example, asking a character to speak more loudly.

Most of the participants agreed or strongly agreed that Play&Tune has achieved the aims proposed, as shown in figure 5 below.

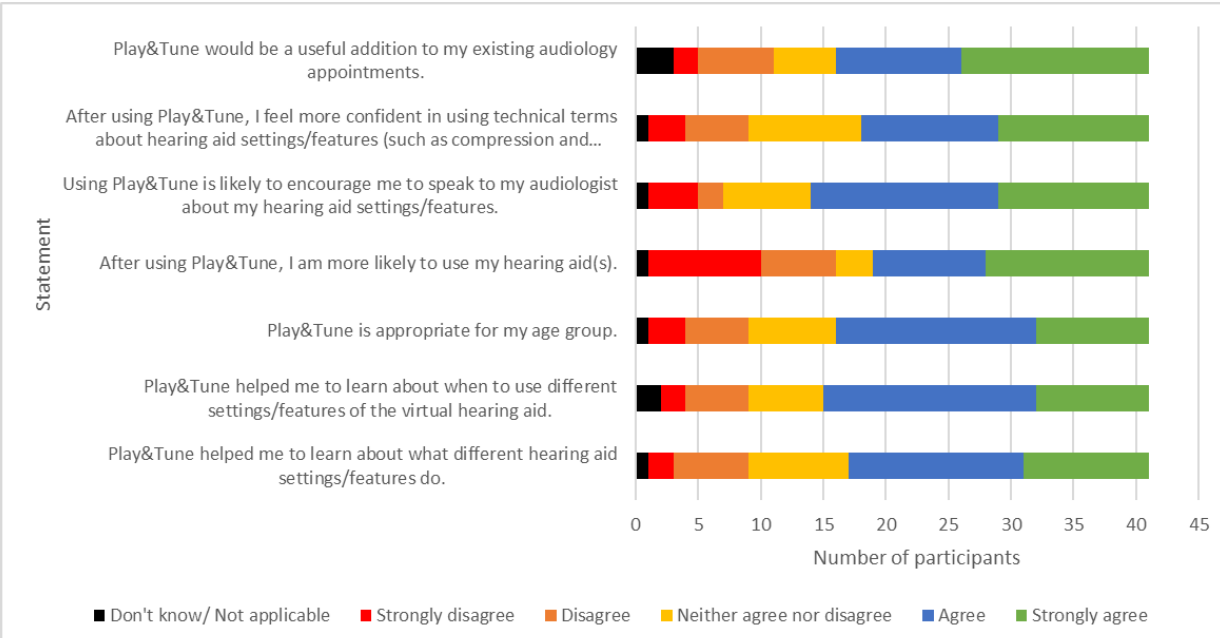

Figure 5: Responses to questions regarding the extent to which Play&Tune meets the 3DTI project aims

The project aims with highest level of agreement (indicating that participants agreed that the game has met those aims) were that it helped participants to learn about when to use the different settings/features of the VHA, and that using Play&Tune is likely to encourage users to speak to their audiologist about their HA. For the remaining project aims, more participants agreed that Play&Tune had met the aim than disagreed or gave neutral responses.

We asked whether participants would buy Play&Tune and whether they would recommend it to others. The majority of participants would recommend Play&Tune to others: 56.10% selected either "probably would" or "definitely would", whilst 39.02% selected either "probably would not" or "definitely would not" and 21.95% selected "unsure" or "don't know". However, when asked if they would buy Play&Tune, 39.02% either "probably would not" or "definitely would not" buy the app, whilst 41.46% either probably would or definitely would buy it, and 19.51% selected "unsure" or "don't know".

6 Discussion

We evaluated two prototypes of one of the 3DTI applications in order to provide feedback for developers to incorporate into their designs, and then perform a final evaluation on the pre-release game. Participants provided feedback on the practical aspects of the app along with the higher level consideration of the extent to which the app met the 3DTI project's wider aims. From carrying out single and paired interviews with 30 adult HA users and a final evaluation survey with 41 participants, we found that the pre-release version of Play&Tune could help HA users feel more confident in using technical terms such as compression and directivity, encourage HA users to discuss their HA settings with their audiologist, help HA users to learn about what the different settings and features of HAs do and when to use them. Most participants saw the benefits of Play&Tune and thought that it would provide an engaging way to explore different features, although some would probably need a greater incentive to buy the app. This incentive could be a clearer description of the app and its aims. Furthermore, people with HL/HA would benefit from more instructions about what to do in the games, and general technical support is needed for those who are less confident with computers.

The iterative evaluation process resulted in many key decisions and changes which helped the developers to better design the app for its target users. For instance, it was noted that the hearing tasks which required typing using a tablet's keyboard were too difficult in the first prototype, especially for those with visual or dexterity problems. For this reason, developers replaced the keyboard input mechanism with an on-screen selection of similar sounding words. Additionally, the developers focused on a desktop version rather than a tablet version owing to the end-users' difficulties in using small devices. The positive response of participants during the final evaluation is evidence of the value of the iterative evaluation process, however there is still some work required to improve the app's usability. Some specific changes were suggested to improve the games further.

Participants felt that Play&Tune could help them to learn more about HA features and settings and when to use them, as well as feeling more confident in using technical terms. A crucial element of the provision of services to HA users is the shared understanding of the client's experience of HL, as well as a shared understanding of the nature of the problem and treatment options (Dahl & Hanssen, 2017). One major implication of our findings is that HA users are open to, and enthusiastic about learning to make changes to their HA independently of their audiologist. The current audiology paradigm is resistant to allowing HA users to make any adjustments, and indeed most UK National Health Service HAs are configured to prevent any changes by the HA user. However, most of our participants would welcome learning about their HA functionalities and settings as part of their audiology service, and participants noted that they would find the app more useful if they were able to make changes to their real HA. Although there are questions over the extent to which HA users' subjective preferences for HA settings are actually beneficial for them, it has been found that subjective input from participants to a 'genetic algorithm' style HA fitting system produced solutions with good intelligibility (Baskent, Eiler, & Edwards, 2007).

Advances are being made in provisions of technologies to assist HA users with calibrating their own HA, for example via smartphones i.e. Pasta et al. (2019) and Søgaard Jensen et al. (2019), and indeed many modern HAs are sold along with proprietary smartphone apps which enable some extent of personalisation. These services enable HA users to change their HA calibrations whilst in a "live" situation, so as to correct their hearing as they go about different everyday activities. Play&Tune on the other hand could help HA users to understand what those changes could do for their hearing *before* they enter these environments, thus shortening the trial and error process that is necessary as they attempt to compare different settings in a live context. The service provided by Play&Tune then could influence the experience of making calibrations to a HA as the user could learn exactly which settings to target to alleviate particular difficulties in a live situation.

7 Conclusion

Current audiological practices along with a relative sparseness of technological interventions pose a significant barrier to the training of HA users in relation to the functionalities of their HA. Digital games like Play&Tune could be a practical approach to addressing this gap in services for HA users. We examined HA users' experiences in response to prototypes of a game designed to train them to understand the full range of functionalities of their HA and provided this feedback from the target audience to the game developers, which informed their re-design and further development processes. Game designers were given the opportunity to reflect on their preliminary designs to consider the extent to which Play&Tune will be acceptable to the target audience. The app benefitted from the iterative design and evaluation, as evidenced by the changes made between the first and second prototypes, and the positive results of the final evaluation. A user-centered design and evaluation process, in which extensive qualitative and quantitative feedback is sought from the target audience is strongly recommended when developing a new service for a target audience with many differing needs, such as HA users.

The market for digital services for the considerable population of people with HL is growing. Play&Tune could offer an important service for those who wish to educate themselves about the functions of HAs with the end goal of being able to hear better in different sound environments. However, a key step-change in the rehabilitation of HA users is required, that is enabling HA users more control over the calibration of their HA. Thus we would advocate the opening up of technologies and education interventions that would facilitate greater autonomy for HA users regarding how their HA is calibrated and which functionalities are made available to them. Furthermore, we would urge audiologists to encourage and promote this autonomy among their clients.

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Conflict of Interest

Luca Simeone and Mauro Simeone are co-inventors of intellectual property licensed by Vianet and are entitled to royalties received in relation to the sale of Play&Tune.

Ethical Approval

Ethical approval for the collection of data during the evaluations was granted by the ethics boards of the University of Nottingham's Faculty of Engineering, Imperial College London and the University of Malaga. Following local practices, no ethics permissions were sought for conducting the research in Italy, although researchers followed the ethics procedures outlined by UK partners.

Informed Consent

All participants provided written informed consent before participating in any research activities.

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