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3D Tune-In - 3D-games for TUNing and lEarnINg about hearing aids

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1. Introduction

Hearing aid (HA) technology has dramatically advanced in the last 25 years since the commercialization of the first digital HA. However, the majority of individuals with digital HAs use these devices as if they are a standard analogue HA, i.e., only for their amplification and equalisation features; new algorithms are under-used or not exploited to their full potential (see figure 1). This could be due to inefficient training in how to use these features.

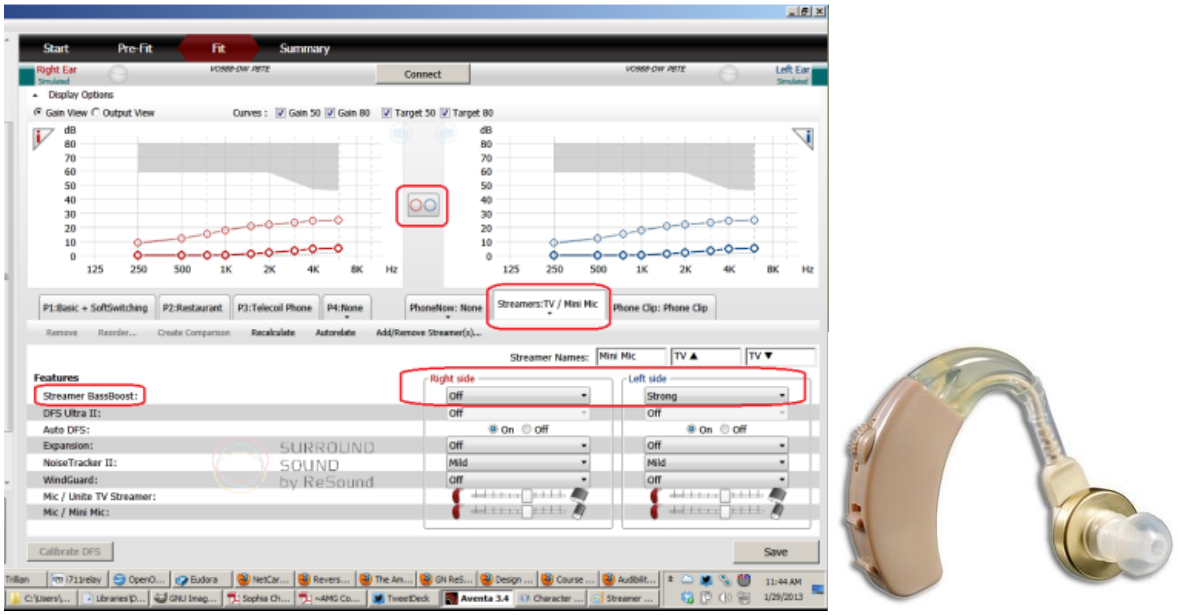

Figure 1. GN ReSound Aventa software for programming HAs (left). Note the complexity of the programming environment and of the various calibration options, as opposed to the two simple controls/settings on a basic analogue HA (right).

Traditional gaming technologies have been successfully employed in non-leisure scenarios for learning and skill acquisition, empowerment and social inclusion [1][2]. Studies have shown that games have benefits for enabling familiarisation of products specifically for older users [3]. Dryburgh [4] notes that the use of technology is self-taught by either watching others, asking advice from others, trial and error, or reading the manual. For many people none of these methods are satisfactory, especially when it is hard to develop a mental model of how a particular device works. Darzentas et al. [5] describe how a game-based approach can be applied to the process of device familiarisation to provide motivation and reduce anxiety and uncertainty associated with the use of technology. Further, digital games have largely done away with manuals, with the familiarisation process now built into the gameplay [6].

3D Tune-In (3DTI) is an EU Horizon 2020 funded project (2015-2018) that brings together the relevant stakeholders from traditional gaming industries, academic institutions, a large HA manufacturer, and hearing communities, to produce digital games in the field of HA technologies and hearing loss in children and older adults. Five games aimed at children or adults will provide accurate 3D sound simulations to demonstrate and provide training on the different features of digital HAs in everyday contexts.

2. Aims and objectives of 3DTI

3DTI will adopt a participatory-design process involving relevant stakeholders (human factors experts, technology developers, hearing communities, end-users) to create a Toolkit incorporating binaural audio and 3D visual rendering (see figure 2), and a series of game applications that can work on different target platforms (Windows, Mac, Android, iOs, Xbox, Play Station, etc.) to enable

- end users to explore, review and customize HA devices in different simulated everyday contexts
- HA providers to evaluate and demonstrate the functionalities of their products to improve their services and increase sales
- individuals with no hearing impairment to understand how hearing loss can compromise everyday activities, and how a HA can improve this situation
- gaming Small-Medium Enterprises (SMEs) to explore new non-leisure applications in the area of hearing loss and HA technology with support from the scientific community

Figure 2. Examples of possible visual rendering for 3D-Tune-In scenarios and applications.

3. Innovations and Challenges

The proposed work is particularly ambitious because it aims to redefine the way HA devices are used by the hearing impaired population. The use of virtual reality and a gaming approach to calibration issues/tasks, will transform the approach towards learning how to use HA technologies and the sale of these technologies, and will allow SMEs to move into a novel non-leisure gaming market. The principal advancements of 3DTI can be summarized in two areas: the creation and implementation of 3D interactive multimodal simulations and the integration of a gaming approach to the demonstration and calibration of HAs.

3.1. Creation and implementation of 3D interactive multimodal simulations

Currently, assessment of a specific impairment and the calibration of a given assistive technology are performed under highly controlled laboratory conditions. For example, the effectiveness of a HA is usually assessed on the patient in an anechoic environment with a single frontal loudspeaker. These conditions are far from realistic (e.g. a single speaker is very different from a complex auditory scene). However, real-life conditions are difficult to control, and evaluations performed in the real world would not deliver consistent results. 3DTI can be considered as a median point between these two extremes, delivering realistic conditions in controllable and practicable environments, facilitating the achievement of consistent and more reliable results in the calibration and demonstration of HA devices.

3DTI will create an innovative toolkit based on 3D sound, visuals and gamification techniques to transform the approach towards HA technologies from both the end-users' and manufacturers/sellers' perspective. A custom binaural 3D audio engine will be developed and implemented, including functionalities such as binaural reverberation, hearing loss and hearing aid simulations.

3.2. Integration of a gaming approach to the demonstration and calibration of HAs

Several studies have shown the benefits of adopting gamification strategies in non-leisure environments [7][8][9]. 3DTI will apply traditional gaming techniques and technologies to non-leisure use for the demonstration and calibration of HA devices. These will be based on game logic and gameplay drawing on best practices from leisure and non-leisure market segments. The key elements will be clearly defined goals for the players, an effective reward system, an engaging storyline and mechanisms to ensure an adequate level of competition. Appropriate design will ensure that the user interface and the controls are easy-to-use and that text, audio, graphic and visual design elements create a playful, immersive environment.

4. Methodologies

4.1. Participatory design process

A participatory design (PD) process will be adopted as it has been shown that the involvement of end-users in the design process generates information about how the end product will actually be used and puts it in a real world context [10]. There is an increased need for user involvement when there is a distinct user population, with characteristics far removed from the designers of the product such as children and older adults. Neale et al. [11] proposed using a 'toolbox' of methods that can inform different aspects of design for stakeholders who may have different requirements for assistive technologies. These include different types of PD activities (e.g. prototype testing activities, workshops, evaluation questionnaires), with different combinations of stakeholder groups taking different roles (e.g. user, tester, informant and design partner) at different stages of the design-development process.

4.2. The 3DTI evaluation

The 3DTI technologies and applications will be evaluated to provide scientific evidence of their effectiveness. The formative evaluation phase will test early concepts and prototypes with the end-

users using questionnaires, interviews, focus groups, observation and diary methods. This phase will include assessing the accuracy and robustness of audio simulations of different contexts, the effectiveness of the games, users' engagement, usability, user interaction and attitudes towards the technology. The results will feed into re-design and development of the applications. The final, summative evaluation phase will assess the 3DTI applications against desired outcomes to test for usefulness in the real world (e.g. ability to calibrate hearing aids, transfer of learning, increasing quality of life and social inclusion etc.).

5. The 3D-Tune-In consortium's expertise

The 3D-Tune-In partners are grouped by academic institutions (Imperial College London, De Montfort University, University of Nottingham and University of Malaga), SMEs (Reactify, Vianet, XTeam and Nerlaska) and a HA manufacturer (GN Hearing).

All partners will work towards the creation of a 3D-Tune-In Toolkit, which will comprise 3D audio and video engines, a haptic engine, HA emulators, evaluation tools, human-computer interfaces and game scenarios. The project's multi-disciplinary technical team has expertise in the fields of 3D audio and video technologies, audio and haptics interaction design, audiology and audiometric techniques, software and video game development, interactive virtual and augmented reality applications, next-generation music and sound formats, and human-machine interaction.

The human factors team will use their expertise in user-centred and participatory design methods to involve all stakeholders throughout the design, development and evaluation of the 3DTI technologies to ensure they support learning and skill acquisition.

In order to maximise the impact of the project outcomes, the hearing aid and hearing impaired communities will be deeply involved in the project. GN Hearing is one of the world's largest manufacturers of HAs, and has expertise in HA technology, audiology, audiometric techniques, and hearing loss measurement and evaluation. In addition, five hearing and care associations are external collaborators to the consortium: Extra Care (*www.extracare.org.uk*), Hearing Link (*www.hearinglink.org*), Accesibilidad y Personas Sordas (www.*fundacionaccesible.org/*), Ente Nazionale Sordi (*www.ens.it*) and Action Deafness (*www.actiondeafness.org.uk*). They have an active interest in supporting end-user activities in the project, such as design and evaluation.

6. Conclusions

3DTI will link the traditional gaming industry with the fast-growing game-based learning market and hearing device market; together with academic institutions, the project will generate a set of non-leisure applications to benefit European citizens. 3DTI aims to increase the quality of life and facilitate social inclusion of those living with a hearing impairment by improving their understanding of the different functionalities of their HAs and training them on how to use these in everyday contexts. The project will also increase awareness about hearing loss among the general public.

3DTI aims to help virtual reality and gaming communities to break into new non-leisure markets. For more information about the project, please visit www.3D-Tune-In.EU .

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