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<th>The HEARing CRC</th>
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aTune is a game based on our clinical research designed to improve pitch perception in both normal hearing listeners and hearing-impaired users of a cochlear implant (bionic ear). The game is targeted toward children and adults who have problems hearing changes in pitch that are critical for music appreciation. These problems can arise from a hearing loss, or can occur in normal hearing listeners who have an auditory processing disorder, which makes it difficult to pick particular sounds out of the background. However normal-hearing listeners can also expect to improve their pitch perception skills by playing the game!

The game requires players to match tone patterns they hear to visual patterns on the screen. Training begins with simple sounds and as players progress through levels, more complex sounds and a variety of musical instruments are introduced so that improved outcomes in a variety of everyday listening environments are obtained.
1. Nerfs enter the screen through a pipe.....

2. ....and move along a path,

3. through vents to other paths.

4. Player selects Nerf that matches pitch position of the tone they hear.

5. Selection was correct, so Nerf is energised and leaves the sequence.....

6. ...to fly up and knock down a brick.

The process is repeated until enough Nerfs have been energised and a path has been cleared enabling the Nerfs to get to the next level.
Different Paths and Nerf abilities

Pitch and Instrument training

New player screen

Game help screen

Level selection screen
The game is designed to engage users in “play” rather than a repetitive training approach common to standard rehabilitation programs. Its story is set around musical-beings called Nerfs who are stranded on Earth and are climbing a building so that they can get high enough to boost themselves home. However, there are obstacles that they cannot get past without the players help.

Nerfs enter each level and move along paths singing one or more tones of different pitch as they go. The Nerfs vertical position on paths visually indicates their pitch (this concept and others are taught to players through in-game tutorials, see figures). By correctly matching the acoustic patterns to the visual patterns, players help the Nerfs transform their abilities, enabling them to get to the next level. The game features 4 stages with 10 floors each, 4 Nerf classes, 4 Nerf transformations, bonus rewards, and hidden jewels to find.
Hearing-impaired and normal-hearing listeners can experience problems with perception of pitch. For cochlear implant users, difficulties arise because the implant system only encodes weak cues to pitch. In addition, both hearing-impaired and normal-hearing listeners have problems judging pitch when there is a change in tone color (timbre) which arises when listening to different instruments.

Because real world sounds are complex, varying in many dimensions simultaneously, they do not provide the best initial training stimulus for improving pitch perception, especially for the hearing-impaired. The approach adopted in this game was thus to initially train listeners with simple tones presented as clearly as possible, without other distracting cues. Following this, listeners’ are trained to exclusively attend to changes in spectral timbre (instrument). After listeners learn to use those cues independently, more complex sounds are gradually introduced where both cues vary together, as occurs in music.
A prototype version of the training game has been clinical evaluated at the HEARing CRC with cochlear implant users and with normal hearing listeners [1, 2]. Outcomes demonstrated a two-fold improvement in pitch perception that was retained three months after completion of training.

The rationale underlying development of this program was based on well established evidence:

- Cochlear implant recipients exhibit poorer pitch [3-6], and melody perception [7-10] compared to normal-hearing listeners.
- Changes in spectral timbre can influence both normal hearing [11-14] and cochlear implant listeners’ [5, 6, 15] judgment of pitch.
- Provision of specific training can improve cochlear implant listeners’ ability to identify pitch [4,16], melody [15,17] and instruments [18].

List of references is provided on the next slide.
Our training-based game is based on rigorous proven research that has been externally reviewed in international journals. Each stimulus and challenge within the game is based on the current understanding of cognitive and auditory science and is designed to increase user benefit within minimal time and to promote benefits to real-life perception of music and pitch.

Hearing loss is a growing problem in Australia due to our ageing population. Currently, 20% of Australians have some degree of hearing loss, but for those over 70, this climbs towards 80%. Treatment strategies currently focus on provision of hearing aids and/or cochlear implants. Our training-based approach is not intended to replace existing treatments, but to complement them. This may be particularly important for the elderly, as there is increasing evidence that the use of hearing prostheses, coupled with cognitive training, can delay or slow the onset of cognitive decline.
There are currently no apps available that offer the type of training provided by aTune. Our research has found that most apps are relatively routine, focusing primarily on the task of training listeners to discriminate pitch using a piano-keyboard interface or musical-score. While apps such as “Listen and Sing” and “VocalizeU” do provide some engaging game play by getting players to sing along to melodies, they do not systematically train listeners to discriminate between pitch and timbre.

We are in a unique position of having developed and clinically tested this concept on a PC-based platform. While this has been effective for users enrolled in our research, a mobile-based app would lend itself to use by a much broader community. Ultimately, this will assist us to achieve our goal of improving music perception in hearing-impaired and normal-hearing people in an enjoyable and engaging way that encourages ongoing use and play.
The game interface includes a number of help screens and in-game tutorials to teach players how to proceed through the game/training experience.

It was designed for use by children and adults alike and has a number of difficulty scaling algorithms and controls to cater for players of different age, previous musical experience, and modality of hearing (see the new player and options screens).

The app is well suited for use in situations where the user is seated and free from doing other tasks. These situations include travelling as a passenger on public transport, in a car, or on a plane, sitting at home, at school, in the office, or at a restaurant.
THANK YOU.

Thank you and all the best with your submission.

If you have any questions, please do not hesitate to contact HISA on innovation@hisa.org.au.