SoundRecover

Evidence of improvements in music perception

Previous studies have already documented improved speech intelligibility with the use of SoundRecover. This study investigated the potential for improvement in music enjoyment as a result of the expanded audibility of high-frequency sounds. The performance of hearing instruments with SoundRecover was evaluated in comparison to conventional amplification using the Music Perception Test (MPT) and a subjective questionnaire. Forty experienced hearing instrument users with a moderate to severe sensorineural hearing loss participated in the study. Results showed that the use of SoundRecover significantly improved subject's perception of timbre and melody. Evaluation using a questionnaire demonstrated an increased level of satisfaction in the way subjects perceived some musical qualities, namely overall fidelity, tininess and reverberance.

Introduction

Several studies have indicated improved speech perception benefits with the use of Phonak's non-linear frequency compression algorithm, SoundRecover (Stuermann, 2009; Nyffeler, 2008). Research on frequency lowering hearing instruments and music perception is however limited and this is problematic as listening to music is an integral part of people's daily lives. Music further enhances the quality of a person's life and serves as a medium that models social structures, facilitates the acquisition of social competence by young people and provides a medium for human interaction (Cross, 2006).

The effects of hearing instrument processing on musical signals and on the perception of music have received very little attention in research (Wessel, Fitz, Battenberg, Schmeder & Edwards, 2007) although listeners with a hearing loss are no less interested in music than normal hearing listeners. Every person is immersed in an environment filled with sound, and being able to understand speech is not the only function of hearing. For most people, listening to music is also a significant and enjoyable experience. Therefore, it is not surprising that people with a hearing instrument frequently express a wish to be able to enjoy listening to music with their device instead of removing it due to the reduced sound quality provided by the amplification device (Chasin & Russo, 2004).

The value of musical perception in quality of life cannot be ignored, as music has a significant influence on a person's physiological, psychological, social and emotional well-being. Music therapy has also been proven to be useful for post-operative pain as well as anxiety, mood, comfort and relaxation (Luis *et al.*, 2007).

A modification of the output of conventional hearing instruments in the form of SoundRecover was investigated as this technology may improve the music perception abilities of some adults with a hearing loss. With this in mind, this study focused on how subjects perceive the rhythm, timbre, pitch and melody with the use of the Music Perception Test (MPT). Subjects were also asked to indicate with the use of a questionnaire how they perceived the musical qualities of loudness, fullness, crispness, naturalness, overall fidelity, tininess, reverberance and pleasantness when listened to with and without SoundRecover.

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These musical qualities, as used in this study, are defined as:

Loudness	The music is sufficiently loud, as opposed to soft or faint.
Fullness	The music is full, as opposed to thin.
Crispness	The music is clear and distinct, as opposed to blurred and diffuse.
Naturalness	The music sounds as the patient remembered it, (before acquiring hearing loss). It does not sound as though it is being processed by a hearing aid.
Overall fidelity	The dynamics and range of the music is not constrained or narrow.
Tininess	Hearing the quality of tin or metal, a sense of cheap, low quality sound.
Reverberance	The persistence of sound after the original sound is removed, a series of echoes.
Pleasantness	A feeling of enjoyment or satisfaction, as opposed to an annoying or irritating feeling.

Set-up of the study

The setup of the study was approved by the relevant research committees of the University of Pretoria. The study was conducted at the Ear Institute in South Africa over a period of 12 weeks. Test data was obtained with the hearing instruments on conventional settings (SoundRecover inactive) and with SoundRecover active.

Subjects completed three visits. During the first visit they underwent a hearing evaluation to determine candidacy and were fitted with the prototype hearing instruments. Prior to fitting the prototype hearing instruments, subjects' current hearing instruments were verified with real-ear measurements to ensure that they were optimized to reflect the current best practice (Flynn, Davis & Pogash, 2004). Real-ear measurements were also performed to ensure accurate comparisons were made between the different technologies in order to ensure that positive changes could be contributed to SoundRecover and not to optimization of the current hearing instruments. For all subjects who had poorly fitted hearing instruments at the start of the study, extra time were provided to adjust to the optimized fitting without SoundRecover. After three weeks of acclimatization, the study commenced for these subjects.

Subjects were divided into four groups of ten persons each. A randomized schedule was implemented in order for half of the subjects to start with SoundRecover active and the other half with the algorithm inactive. Furthermore, single blinding was used to remove any potential subject bias (Cox, 2005) as subjects did not know whether SoundRecover was activated or not. For listening to music, all automatic sound features such as noise reduction and adaptive directionality were turned off to prevent these systems from interpreting the music as noise or feedback, so as not to affect the sound quality that subjects perceived (Hockley, Bahlmann & Chasin, 2010).

Subjects had to wear the hearing instruments for four weeks after which they returned to the institute. Four weeks were allocated for acclimatization because previous research with SoundRecover indicates that benefits are best achieved with an acclimatization period of at least four weeks (Stuermann, 2009, Nyffeler, 2008).

During the second visit, the hearing instruments were verified electro-acoustically to ensure that they were working properly (Flynn *et al.*, 2004). The MPT, a self-compiled music perception test, was performed. It consists of four sections which assess rhythm, timbre, pitch and melody. Subjects were facing a loudspeaker at 45 degrees at a distance of approximately one meter. The stimuli were presented via a two channel audiometer. The sound level was averaged at 75 dB SPL and hearing instrument users were permitted to adjust the volume on their hearing instruments for maximum comfort. Subjects then completed the test and no feedback was given to them either during or after the test.

Following the MTP, a questionnaire was used to obtain subjective data on how subjects perceived different musical qualities with their current hearing aid settings. The questionnaire, which was specially developed for this study, used a five point perceptual rating scale reflecting different levels of satisfaction. After the MPT was performed, the hearing instrument settings were switched – subjects that had their hearing instruments with SoundRecover active now had this algorithm deactivated and vice versa. Again, subjects were asked to wear the hearing instruments for a period of four weeks before returning to the practice.

During subjects' third visit to the practice the hearing instruments were once again verified electro-acoustically and the MPT and questionnaire were performed again. The results obtained from the MPT and questionnaire with SoundRecover activated and deactivated were compared for each subject.

Subjects and devices

Forty adults with a bilateral, moderate to severe, sensorineural hearing loss (see average hearing loss in Figure1) and age from 18 to 64 years (average age: 57.7 years) participated in the study. No musical background or particular experience was required for participation. Forty percent of the subjects (n=16) received musical training ranging from 1 to 20 years. After the initial fitting of Naída III UP hearing instruments, SoundRecover settings were adjusted and fine-tuned, if necessary, during follow up sessions. The cut-off frequency was chosen individually for each subject based on the respective audiogram.

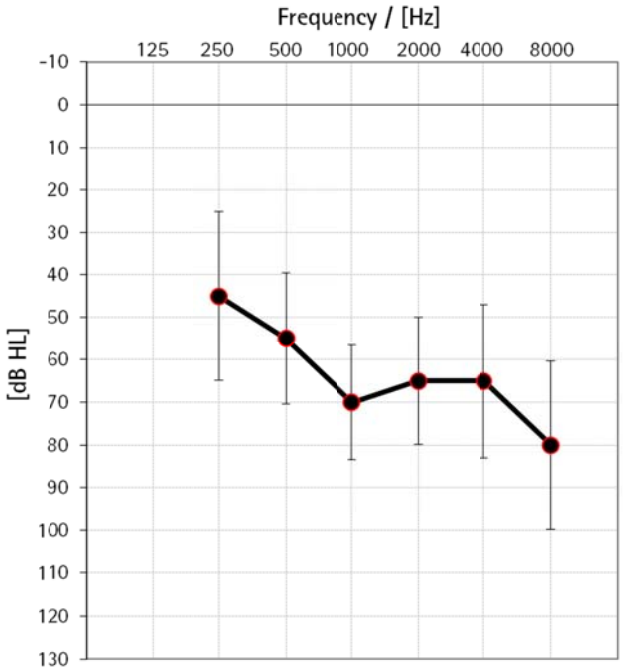

Figure1
Subjects' average hearing loss with standard deviation: moderate to severe.

Results

As can be seen from Figure 2, subjects perceived rhythm (2.4% increase), timbre (5.7% increase) and melody (3.4% increase) better with SoundRecover compared to without SoundRecover, while almost identical scores were obtained for the perception of pitch (0.5% decrease). In terms of statistical significance, results were mixed; only the benefit for the perception of timbre (p=0.01) and melody (p=0.04) were found to be statistically significant. Subjects' increased performance for the perception of rhythm were not significant (p=0.06).

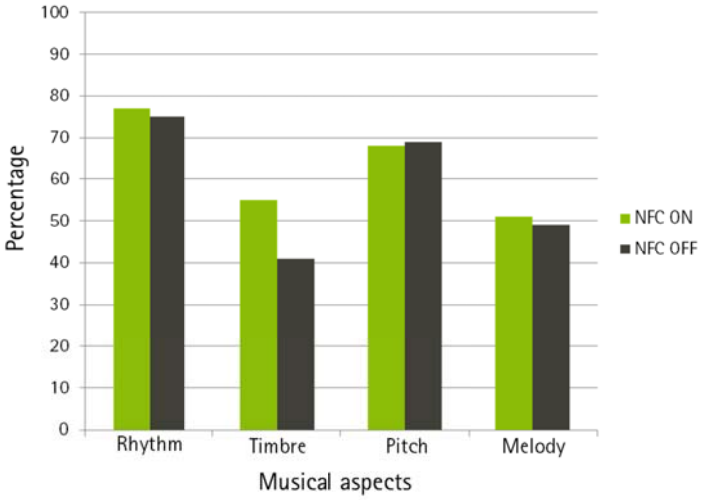

Figure 2
Subjects' mean scores for the rhythm, timbre, pitch and melody sections of the Music Perception Test with SoundRecover OFF and SoundRecover ON.

Beside their participation in the music perception test, the subjects also completed a questionnaire to gauge subjective perception of musical sound quality. Most subjects reported more satisfying sound quality with SoundRecover for all the musical qualities assessed except loudness, as depicted in Figure 3. The results of statistical analysis of these observations were however mixed, since only the perceived benefit for overall fidelity (p=0.04), tininess (p=0.01) and reverberance (p=0.005) were statistically significant. Although subjects perceived naturalness (p=0.09), fullness (p=0.31), crispness (p=0.11) and pleasantness (p=0.13) of music as slightly better with SoundRecover, these benefits were not significant. No subjects reported worse sound quality and musical enjoyment with SoundRecover compared to conventional amplification.

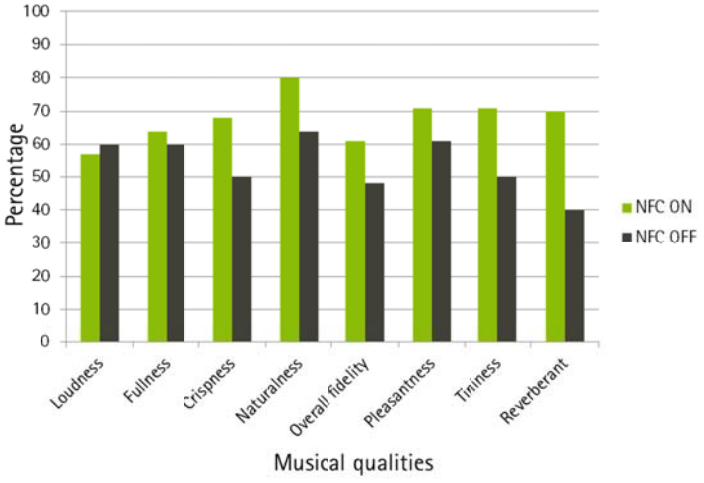

Figure 3
Subjects' mean scores for the different musical qualities assessed in the questionnaire with SoundRecover OFF and SoundRecover ON.

Conclusion

These data show evidence for improved musical enjoyment with SoundRecover. Subjects obtained a statistically significant benefit with SoundRecover for the perception of timbre and melody as tested with the MPT. Further, SoundRecover positively impacted subjective ratings of different musical sound qualities. Furthermore, regardless of whether SoundRecover was active or not, the results indicate that the musical perception abilities of hearing instrument users are highly variable.

References

Chasin, M. & Russo, F.A. (2004). Hearing aids and Music. *Trends Amplif 8* (2): 35-47.

Cox, R.M. (2005). Evidence-based practice in provision of amplification. *J Am Acad of Audiol 16* (7): 419-438.

Cross, I. (2006). The Origins of Music: Some Stipulations on Theory. *Music Percept 24* (1): 79-81.

Flynn, M.C., Davis, P.B. & Pogash, R. (2004). Multiple-channel non-linear power hearing instruments for children with severe hearing impairment: Long-term follow-up. *Int J Audiol 43* (8): 479-485.

Hockley, N.S., Bahlmann, F. & Chasin, M. (2010). Programming hearing instruments to make live music more enjoyable. *Hearing J 63* (9): 30-38.

Luis, L., Castro, A., Bastarrica, M., Perez-Mora, R., Madero, R., De Sarria, J. & Gavilan, J. (2007). Does music perception have an impact on quality of life following cochlear implantation? *Acta Oto-Laryngol 127*: 682-686.

Nyffeler, M. (2008). Study finds that non-linear frequency compression boosts speech intelligibility. *Hearing J 61* (12): 22-26.

Stuermann, B. (2009). Field Study News: Audéo YES. SoundRecover for mild to moderate hearing loss. Retrieved from www.phonak.com.

Wessel, D., Fitz, K., Battenberg, E., Schmeder, A. & Edwards, B. (2007). *Optimizing Hearing Aids for Music Listening.* Retrieved from http://cnmat.berkeley.edu/publication/optimizing_hearing_aids_music_listening

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