13th International Conference on Cochlear Implants and Other Implantable Auditory Technologies
Munich, Germany | June 18–21, 2014

Topic: Speech Coding Strategies
2nd Topic: Sound Processing
3rd Topic: Sound Coding

**Title: The effect of adaptive dynamic range optimization on speech intelligibility in adverse listening environments for cochlear implant users**

Author(s): Ali, Hussnain[1], Hazrati, Oldooz[1], Hansen, John H.L.[1], Tobey, Emily A.[2]

*Institute(s): [1]The University of Texas at Dallas, Electrical Engineering, Richardson, United States, [2]The University of Texas at Dallas, Behavioral and Brain Sciences, Richardson, United States*

Abstract: Electric hearing presents challenges in terms of the real-state available for mapping the input dynamic range of the acoustic signal (~ 90dB) to the limited output electric dynamic range (which could be as low as 5 dB). This emphasizes the need to perform intelligent compression to optimally place the characteristic features of speech in the limited output range for better intelligibility and quality. Commonly used cochlear implant (CI) sound coding strategies such as CIS and ACE use a global compression scheme at the output level to compensate for the loudness growth. Adaptive Dynamic Range Optimization (ADRO), on the other hand, is a multichannel signal equalization strategy to improve the audibility, comfort, and intelligibility of sounds for individuals who use CIs and/or hearing aids (HA).

ADRO uses statistical features of the acoustic signal to select the most information-rich section of input dynamic range in multiple frequency channels and adaptively adjusts the channel gains based on a set of fuzzy logic rules to optimally place the signal in the users´ hearing range. It is used in conjunction with sound processing in clinical HA and CI processors as a pre-processing strategy. Clinical studies with new and experienced HA and CI users indicate preference for ADRO over alternative amplification strategies for speech in noise. However, past studies have not considered naturalistic everyday listening conditions where CI users are challenged to understand speech in the presence of

both reverberation and noise. CI users´ speech perception score drops substantially in the reverberant environments when early and late reflections of the direct sound are added to speech and blur temporal and spectral characteristics of speech. In this study, we aim to investigate the effect of ADRO on speech identification for CI users in adverse listening conditions involving noise and reverberation.

Ten adult CI users were tested acutely for speech intelligibility task in five unique listening environments: anechoic quiet ($T_{60} \approx 0.0$ s), reverberant ($T_{60} = 0.6$ s), noisy (SNR = 10 dB), noisy reverberant (NR) ($T_{60} = 0.6$ s, RSNR = 10 dB), and reverberant noisy (RN) (SNR = 10 dB, $T_{60} = 0.6$ s) each with and without ADRO. Results indicated statistically significant improvement with speech in noise but the performance in the reverberant environments was highly subjective. While there was no significant advantage of ADRO on mean intelligibility scores, one group (6 out of 10 subjects) reported significant reduction in performance with ADRO in reverberant, NR and RN environments. The effect was particularly pronounced in RN environment. The findings from this study suggest that ADRO may not be equally beneficial in diverse listening environments and, in fact, may reduce the speech intelligibility in some conditions. These results will be beneficial in designing environment specific speech processing strategies.