



13th International Conference on Cochlear Implants and Other Implantable Auditory Technologies

Munich, Germany | June 18–21, 2014

The effect of adaptive dynamic range optimization on speech intelligibility in adverse listening conditions for cochlear implant users

Hussnain Ali¹, Oldooz Hazrati¹, John H. L. Hansen^{1,2} Emily A. Tobey²

¹Department of Electrical Engineering, ²School of Behavioral and Brain Sciences

The University of Texas at Dallas, Richardson, TX, USA

Introduction

Aim: Investigate the effect of Adaptive Dynamic Range Optimization (ADRO) on speech identification in adverse listening conditions for cochlear Implant (CI) users.

ADRO: A multi-channel signal equalization strategy (used in conjunction with sound coding for CIs) to select most information-rich section of the input dynamic range (DR) and optimally place the signal in the users' limited electrical DR.

Study Procedures

Listening Conditions:

1. Anechoic Quiet ($T_{60} \approx 0.0$ s)
2. Noisy, SNR = 10 dB, speech shaped noise (SSN)
3. Reverberant ($T_{60} = 600$ ms)
4. Noisy Reverberant (NR) ($T_{60} = 600$ ms, RSNR = 10 dB) *noise is added to the reverberant speech*
5. Reverberant Noisy (RN) (SNR = 10 dB, $T_{60} = 600$ ms) *both speech and noise are reverberated*

Stimuli

- Recorded IEEE sentences presented in free field at 65 dB SPL in a double-walled sound proof chamber.
- 20 sentences per condition.

Subjects:

- Ten adult post-lingually deafened CI recipients,
- Native speakers of American English language,
- Devices from Cochlear Corp. with ACE sound coding strategy,
- All subjects had sensitivity level (SL) of 12, except S1 (SL=9) and S6 (SL=10).

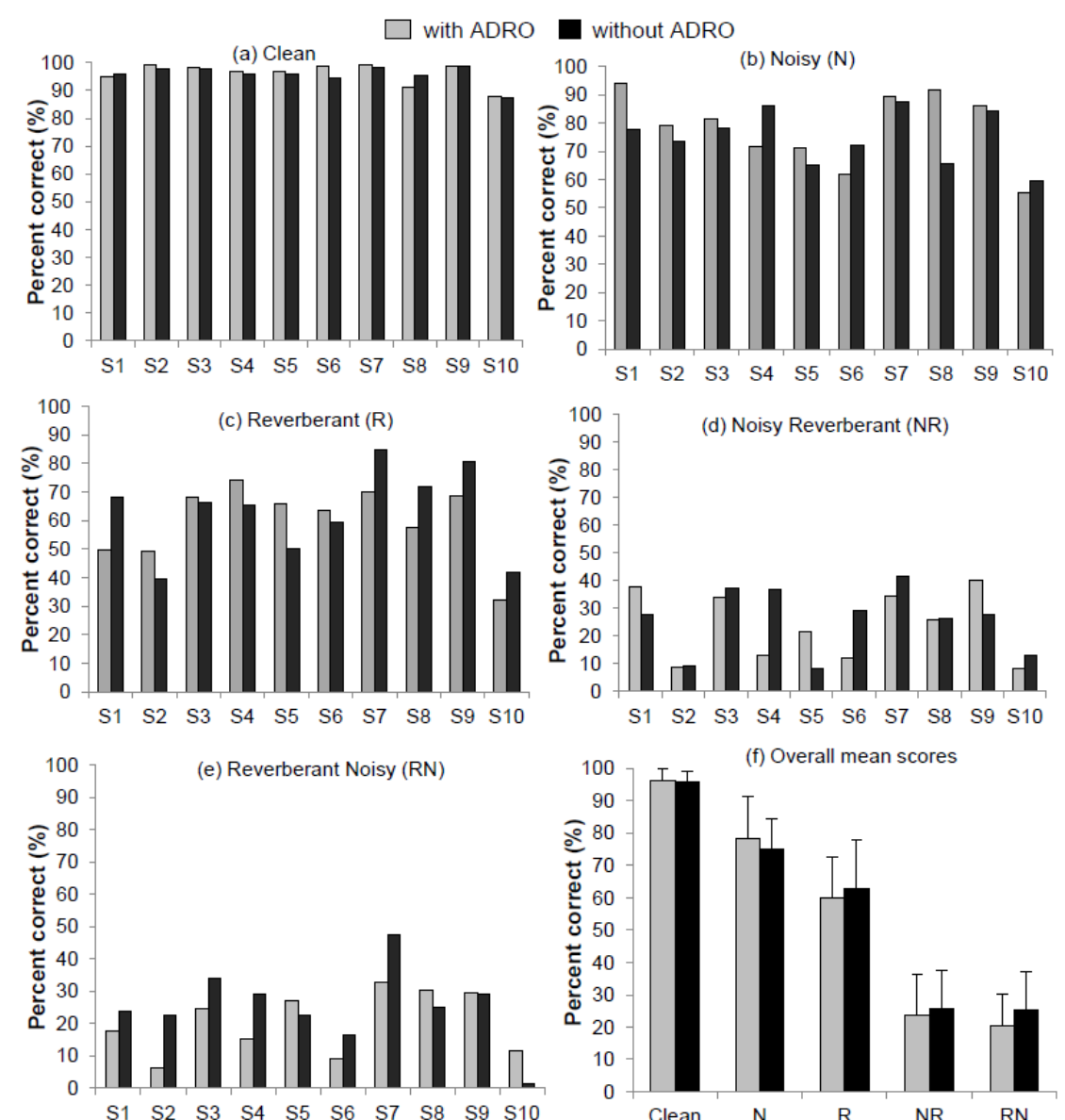
Subject ID	Gender	Age (yrs)	Years implanted	Etiology of hearing loss	Avg. elec. dynamic range
S1	M	60	3	Noise	38
S2	F	62	7	Unknown	21
S3	F	54	4	Unknown	48
S4	F	56	3	Hereditary	39
S5	M	80	8	Hereditary	30
S6	F	60	3	Hereditary	10
S7	F	65	4	Antibiotics	51
S8	M	61	3	Meniere's Disease	45
S9	M	65	3	Hereditary	52
S10	M	70	8	Unknown	5

Tests

- Speech intelligibility tests in 5 listening environments.
- Clinical processor was configured to operate with and without ADRO for each environment .
- Order/sequence of test conditions was randomized.
- All words were scored for correctness.

Results and Conclusion

- The intelligibility scores progressively declined with the level of difficulty (96% for clean, 23% in RN).
- Repeated measures analysis of variance (ANOVA) revealed no statistical significant speech intelligibility difference between ADRO/non-ADRO program ($F_{1,9} = 0.56, p = 0.439$).
- On average, non-ADRO program performed slightly better than ADRO by 3.23% in R, NR, and RN.
- 7 out of 10 subjects had equal or better scores for the non-ADRO program in NR and RN.
- High subjective variability in scores was found among the test conditions.
- No clear trend between the test scores and the sensitivity/volume level or processing parameters was observed.



Individual speech intelligibility scores of 10 CI users in (a) anechoic quiet (clean), (b) noisy (SNR = 10 dB), (c) reverberant ($T_{60} = 600$ ms), (d) noisy reverberant ($T_{60} = 600$ ms, RSNR = 10dB), and (e) reverberant noisy (SNR = 10 dB, $T_{60} = 600$ ms) conditions. Panel (f) shows average scores in all conditions. Error bars represent standard deviation.

Research supported by NIH/NIDCD, grant no. R01 DC010494.