CI SIGNAL ENHANCING PARAMETERS AND STRATEGIES SELECTION AND SPEECH RECOGNITION

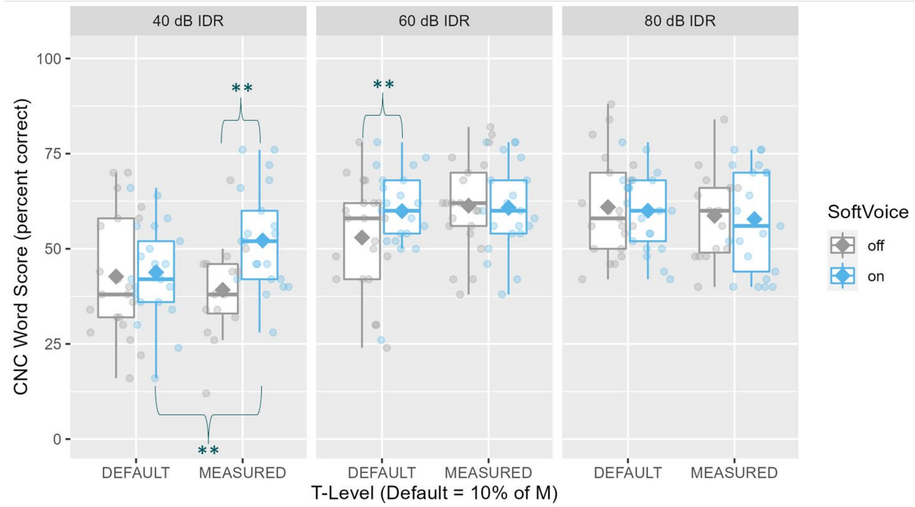
Sara Neumann[1], Au.D., Bob Dwyer, Au.D.[2] , Sabrina Calise[1], B.A., Jace Wolfe[1], Ph.D., Jacy Manning[1], Au.D., Ph.D., Smita Agrawal, Ph.D.[2]
[1]Hearts for Hearing, Oklahoma City, OK, USA, [2] Advanced Bionics, Valencia, CA

Background

- Cochlear implant (CI) recipients often report difficulty understanding soft speech and speech in adverse listening environments.
- While audibility of soft sounds can be influenced by adjusting lower stimulation levels (Threshold or T-levels) in the programming software, signal-enhancing and noise management technologies can help improve speech recognition further:
  - **ClearVoice™** can identify frequency bands in which non-speech energy is present and reduce the gain of those bands to enhance the overall signal-to-noise ratio (SNR) and improve speech recognition in noise[1].
  - **AutoSense OS™ 3.0** can activate sound cleaning features based on the listener's sound environment[2].
  - **SoftVoice** can optimize audibility of soft environmental sounds by removing system noise, and in particular, the noise introduced by the microphone(s)[3].
  - **Input dynamic range (IDR)** coupled with automatic gain control can provide access across a wide intensity range of acoustic inputs including soft sounds[4].
- **To date, no published studies have examined the effect of IDR and T-level settings on speech understanding in Advanced Bionics CI recipients who use these technologies with Marvel CI sound processors.**

AIM 1: to evaluate the impact of the following on speech recognition at soft levels: (1) input dynamic range (IDR), (2) threshold (T) levels (10% vs measured), (3) SoftVoice (SV)

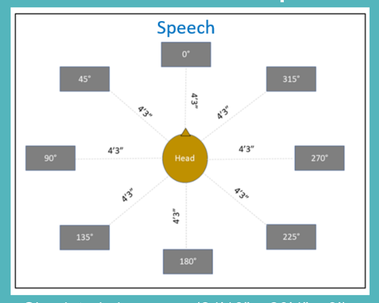
Soft Level Speech (CNC words[5] – 45 dBA)



Participants

- 12 females, 9 males, ages 16-79 years (mean age 48.8)
- At least 6 months of CI use experience (range 1y8m-21y7m)
- 14 bilateral, 3 unilateral, 4 bimodal
- 18 participants used Optima-S programming strategy
- Testing completed with preferred CI ear (right ear = 13) with participant's preferred program (all used measured T-levels) and Marvel CI sound processor.

Test Room Set Up



Simulated classroom (24'10" x 20'4" x 9')
- Ambient noise level: ~32 dB A
- Reverberation time (RT60): 0.4 sec

Group Results and Conclusions:

- **Best performance was achieved using a 60 dB IDR with SoftVoice enabled.**
- **IDR of 60 dB or higher was most appropriate for participants.**
- **Measuring T-levels did not have a statistically significant effect at the group level using 60 or 80 dB IDR, but did improve results at 40 dB IDR.**
- **Use of 40 dB IDR is *not* recommended.**
- **SoftVoice should be enabled, especially for new recipients.**

Individual data: Effect of IDR on recognition of soft speech

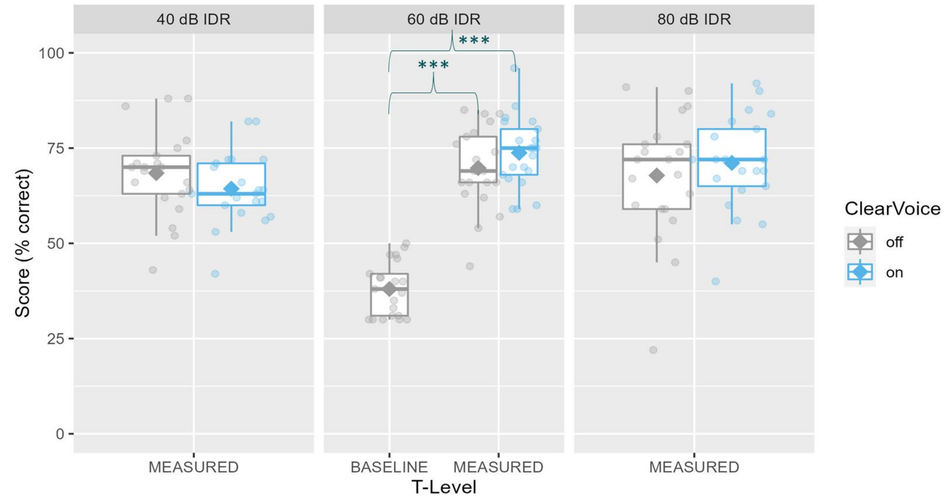
With Ts set to 10% of M levels and SoftVoice ON
- **40 to 60 dB IDR**: 20 out of 21 participants' scores improved, 9 of 21 improved significantly[7]
- **40 to 80 dB IDR**: 20 out of 21 participants' scores improved; 9 of 21 improved significantly[7]
- **60 to 80 dB IDR**: 10 out of 21 participants' scores decreased, 8 improved, 3 remained the same, 1 improved significantly (26% to 62%)[7]

With Ts set to 10% of M and SoftVoice OFF
- **40 to 60 dB IDR**: 18 out of 21 participants' scores improved, 1 did not change, 3 of 21 improved significantly[7]
- **40 to 80 dB IDR**: 20 out of 21 participants' scores improved, 9 of 21 improved significantly[7]
- **60 to 80 dB IDR**: 7 out of 21 participants' scores decreased, 13 improved, 1 remained the same, 4 of 21 improved significantly[7]

AutoSense Calm Situation (T-mic/RES) with CV ON at default		
Input Dynamic Range (IDR)	T-level settings	Soft Voice (SV)
40	10% of M	ON
60	10% of M	ON
80	10% of M	ON
40	10% of M	OFF
60	10% of M	OFF
80	10% of M	OFF
40	Measured	ON
60	Measured	ON
80	Measured	ON
40	Measured	OFF
60	Measured	OFF
80	Measured	OFF

AIM 2: to evaluate the impact of the following on speech recognition in noise: (1) input dynamic range (IDR), (2) threshold (T) levels (10% vs measured), (3) ClearVoice (CV)

Speech in Noise (65 dBA classroom noise, AzBio Sentences[6] at individualized SNR)



The Baseline condition in 60 dB IDR plot represents speech recognition with AutoSense and ClearVoice off.

AutoSense Speech in Noise Setting (UltraZoom with SNR Boost)	
Input Dynamic Range (IDR)	Clear Voice (CV) Default = Medium
40	ON- Default
60	ON- Default
80	ON-Default
40	OFF
60	OFF
80	OFF

Group Results and Conclusions:

- **Best performance observed at 60 dB IDR with AutoSense OS 3.0 & ClearVoice enabled.**
- **AutoSense OS 3.0 significantly improved speech understanding in noise, with and without ClearVoice.**
- **Increasing IDR to 80 dB may be beneficial to some and detrimental to others.**
- **Magnitude of ClearVoice effectiveness likely impacted by noise type used in the present study.**

Individual data: Effect of ClearVoice on speech recognition in noise

With ClearVoice set to ON (medium strength)
- **40 to 60 dB IDR**: 6 out of 21 participants improved significantly[6], no significant change in others
- **60 to 80 dB IDR**: 2 out of 21 improved significantly, 5 showed a significant reduction[6]

With ClearVoice set to ON vs. OFF
- **40 dB IDR**: 8 / 21 participants improved with CV on, 1 improved significantly, 4 decreased significantly[6]
- **60 dB IDR**: 12 / 21 participants improved with CV on, 3 showed significant improvement[6]
- **80 dB IDR**: 13 / 21 participants improved with CV on, 3 showed significant improvement[6]

References

1. Koch, D.B., Quick, A., Osberger, M.J., Saoji, A., & Litvak, L. (2014) Enhanced hearing in noise for cochlear implant recipients: Clinical trial results for a commercially available speech-enhancement strategy. *Otology & Neurotology, 35*(5), 803-809. doi: 10.1097/MAO.0000000000000301. PMID: 24691504.
2. Buechner, A., Kliesch, S., Bardt, M., & Brendl, M. (2021). Investigation of a classification system for CI users in various acoustic situations. Poster presentation at CI 2021 Virtual Meeting: Cochlear Implants in Children and Adults, April 28 – May 1.
3. Holden L.K., Firszt, J.B., Reeder, R.M., Dwyer, N.Y., Stein, A.L., & Litvak, LM. (2019). Evaluation of a New Algorithm to Optimize Audibility in Cochlear Implant Recipients. *Ear and Hearing 40* (4), 990-1000. doi: 10.1097/AUD.0000000000000680. PMID: 30418283; PMCID: PMC6506395.
4. Holden, L.K., Reeder, R.M., Firszt, J.B., & Finley, C.C. (2011). Optimizing the perception of soft speech and speech in noise with the Advanced Bionics cochlear implant system. *International Journal of Audiology, 50* (4):255-69. doi: 10.3109/14992027.2010.533200.
5. Peterson, G.E. & Lehiste, I. (1962). Revised CNC lists for auditory tests. *The Journal of* Speech and Hearing Disorders, 27, 62–70.
6. Spahr, A.J., Dorman, M.F., Litvak, L.M., Van Wie, S., Gifford, R.H., Loizou, P.C.,…Cook, S. (2012). Development and validation of the AzBio sentence lists. *Ear and Hearing, 33*(1):112-117.
7. Thornton, A., & Raffin, M. (1978). Speech-discrimination scores modeled as a binomial variable. *Journal of Speechand Hearing Research, 21*(3), 507-518.

Conclusions

- Based on group mean performance, AB CI Recipients with Marvel CI can be programmed using default parameters of T levels set to 10% of M levels, IDR set to 60 dB and AutoSense OS, ClearVoice and, SoftVoice enabled.
- A review of individual results supports the importance of exploring the manipulation of IDR, T levels, and SoftVoice based on individual needs long-term.