



Are electroacoustic output measures of Cochlear Implant (CI) speech processors and Digital Modulation (DM) receivers necessary?

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Introduction

Proprietary remote microphone (RM) systems or dynamic RM systems (or radio aids) help improve speech understanding in challenging environments with distance, noise, and reverberation (Thibodeau, Leach, Sivaswami, & Qi, 2024). They include a transmitter microphone worn by the speaker and a receiver physically connected or licensed within the listener's device (Roger Direct). The signal is sent via a digital radio signal to DM receivers.

The UK Assistive Listening Technology Working Group, in collaboration with the National Deaf Children's Society, has published standards and guidance on amplification systems for hearing aids and auditory implant sound processors (ALTWG 2024; NDCS 2017). Previous research (Whyte, 2019; Nair, Sousa, & Wannagot, 2017; (Schafer, Musgrave, Momin, Sandrock, & Romine, 2013)) adapted guidelines from the American Academy of Audiology (AAA), which recommend using objective electroacoustic measures and behavioural testing when fitting remote microphone systems to hearing aids. The goal of the ALTWG and Schafer, et al. electroacoustic test protocols is to achieve transparency, meaning similar average output from the CI sound processor and the CI with the DM system when providing the same inputs.

Methods

Electroacoustic responses routinely taken in clinic of CI speech processors and the patients DM radio aid receivers are taken according to the UKALTWG and NDCS published standards. These were analysed and transparency agreed according to two methods.

Method one, averages of the three frequencies 750, 1000 and 2000 Hz as per Schafer et. al. (2013) were reported as transparent at +/-3dB.

Method two, averages of six frequencies, adding in 1500, 3000 and 4000Hz, as proposed by the ALTWG, these were also deemed to achieve transparency at +/-3dB.

A total of 41 CI speech processors and 41 DM receivers were analysed. 13- N7, 16- N8 with Roger 21 receivers, 9-Sky CIM with Roger Direct and 3 Sonnet 2 with Roger 21 receivers.

Discussion

Many tested devices had to be excluded from these results as limitations on clinic time meant some were measured only at the settings the child was already using. If these were found to be transparent, the device was not reset to default. A change in clinic protocol means all devices will now be checked at default. Data will continue to be gathered.

Devices that did not match at default were adjusted accordingly in steps of +/- 2dB. Further work needs to be undertaken to report on these.

Issues with microphone covers, DM receivers and processors were identified in those that could not achieve transparency after adjustment.

Both methods also require a 'common sense' approach. Averaging out may mask a significant discrepancy at one frequency, and this merits further investigation, regardless of the method used.

Conclusions

Electroacoustic measures are essential for identifying and resolving processor and receiver combination issues. EasyGain 0 is generally acceptable in most cases, however a significant number of combinations were found NOT to achieve transparency by default.

- Method 1 (3 frequencies) 27% did not achieve transparency on default.
- Method 2 (6 frequencies) 22% did not achieve transparency on default.

Both methods are suitable for testing, method 2 includes frequencies that are particularly important for consonant discrimination.

Common issues include blocked microphone covers or faulty connections. Keeping a record of baseline measures helps spot performance deviations.

User feedback and speech-in-noise tests are also crucial for validation.

Results

Table 1. Comparison of calculation methods

Processor	Difference - Processor Only & Proc + rec @ EGO	
	Method 1	Method 2
	Mean 3 frequencies	Mean 6 frequencies
Cochlear N7	12 Yes	11 Yes
	1 No	2 No
Cochlear N8	11 Yes	13 Yes
	5 No	3 No
AB Sky CI M	7 Yes	7 Yes
	2 No	2 No
MED-EL SONNET 2	0 Yes	1 Yes
	3 No	2 No
	41	41
	73% 30 Yes	78% 32 Yes
	11 No	9 No
	41	41



Cochlear N8 processor in Auricle HIT

References

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