Validating fitting protocols for design-integrated radio aid receivers and cochlear implants.

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Introduction

The University of Southampton Auditory Implant Service radio aid study considers the validation of proposed electroacoustic verification protocols for design-integrated radio aid receivers coupled to cochlear implant sound processors. The United Kingdom (UK) Children's Radio Aid Working Group (formerly the FM Working Group) in collaboration with the UK National Deaf Children's Society have published standards and guidance on amplification systems used with hearing aids and auditory implant sound processors (UKFMWG, 2017). In the United States (US) adaptations of the American Academy of Audiology guidelines for hearing aids have been proposed for implant sound processors in peer-reviewed research (Nair, Sousa, & Wannagot, 2017; Schafer, Musgrave, Momin, Sandrock, & Romine, 2013).

Background

It is important that when hearing aids or auditory implants are coupled with radio aids that an appropriately qualified individual ensures that the whole system provides the desired benefit. However, the approaches by the UK and the US to achieve the balance or 'transparency' of the combined systems differ. The traditional approach of the UK, built on work associated with the NHS Modernising Children's Hearing Aid Service programme, was first produced as guidance in 2006 and published in 2008. The original US work was published in 2013 and followed up by an article in 2017. It only uses test signals of 65dB and allows transparency within 3dB.

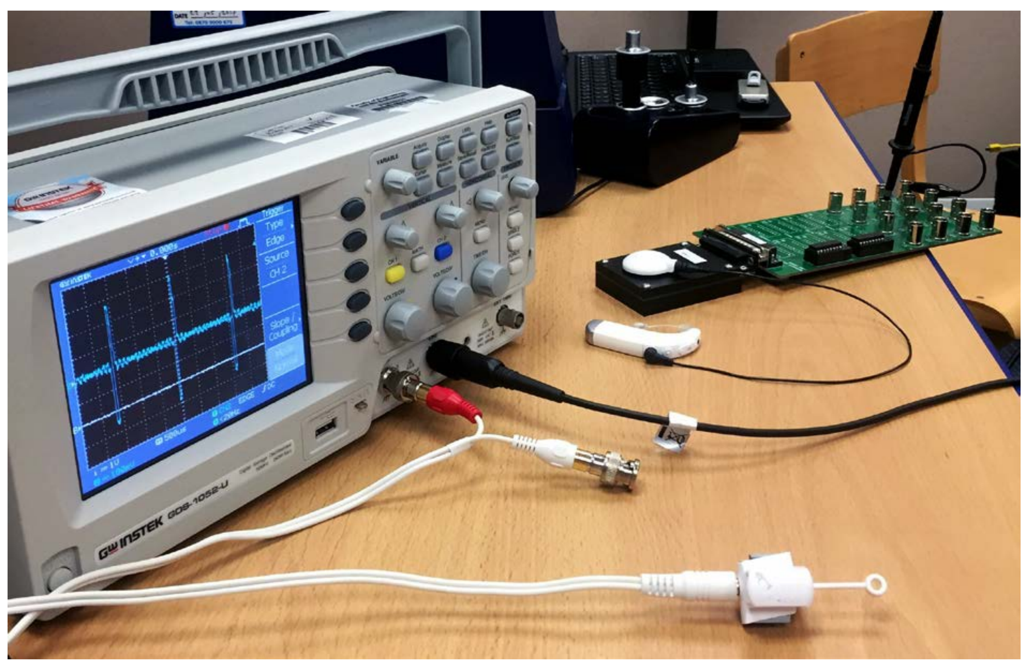
This study looks at the two approaches to determine which is most effective. The balance or electroacoustic transparency is demonstrated when the hearing instrument analyser outputs of the sound processor on its own and then coupled with the radio aid are equal to within 2dB in the range 750Hz, 1kHz and 2kHz.

Objective

To test the validity of electroacoustic verification of radio aid systems in cochlear implant (CI) users and to examine the rationale of proposed protocols for design-integrated receivers for CI.

Method

Measures of output at the implant electrode level and electroacoustic responses of contemporary CI sound processors were conducted with their design-integrated receivers at different gains.

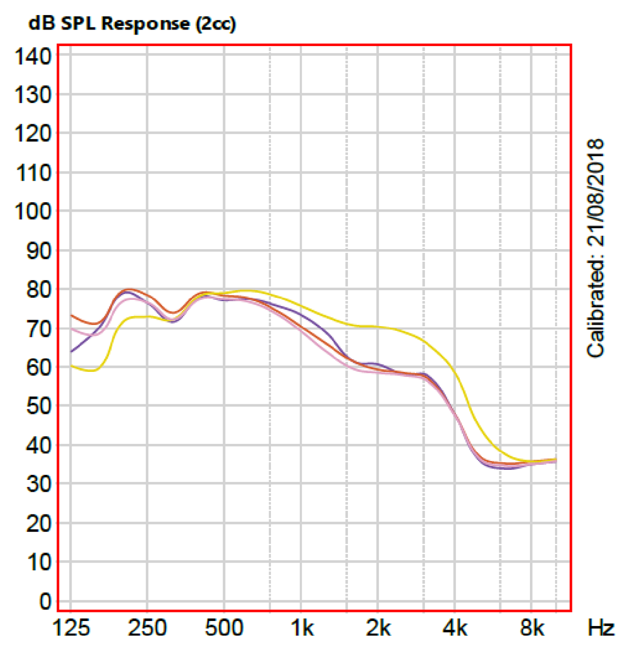


Naida CI Q90 HiRES 90 setup with Phonak Roger 17

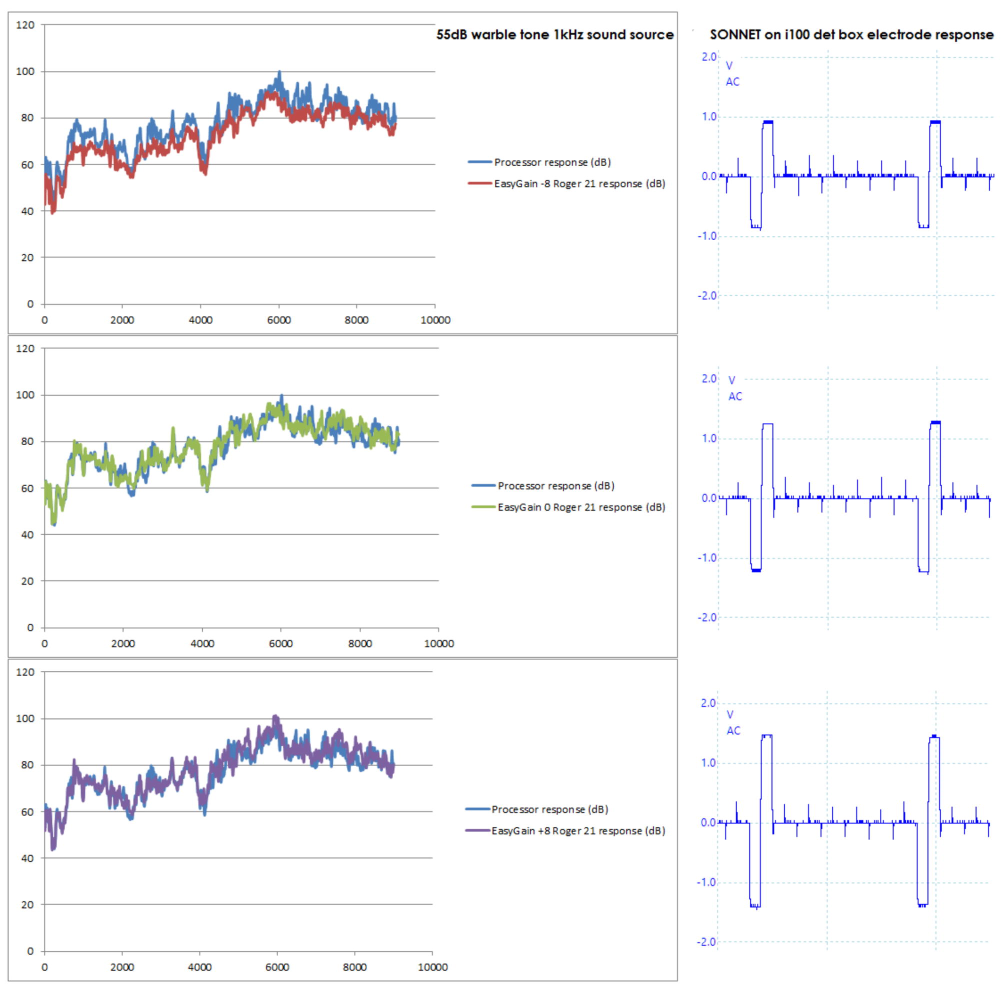
The current UK and US electroacoustic test protocols for radio aid receivers coupled to CI sound processors were used. Measurements were conducted in the laboratory with the CIs and their design-integrated receivers to determine transparency, where suitable inputs to the CI and to the CI and radio aid give equivalent outputs.

Results

Changes in the gain of the radio aid receiver resulted in corresponding changes in implant output at the electrode level. This was found to be similar in the electroacoustic output of the processor shown by the test box response curves. To avoid compression effects in the SONNET, CP1000 (N7) and CP910 (N6) processors 55dB signal levels were used as a maximum and a maximum of 65dB for Naida CI.



MED-EL SONNET and Roger 21 graphical results:
Left: test box response curves, 55dB to processor then 55dB and 80dB to the radio aid;
Right: electrode responses with different gains.



Conclusions

Although the test box curves only indicate the microphone output, this has been shown to correspond at the implant electrode level. Initial results show that suitable signals of equal intensity presented to the sound processor and the radio aid transmitter are appropriate for design-integrated receivers coupled to CI sound processors, a modification of the US approach.

Device combination	SPL level to processor	SPL level to radio aid	Connevans Test Lead
MED-El SONNET and Roger 21	55dB	55dB	DCTEST4 +MTD adaptor
Cochlear Nucleus 7 and Roger 20	55dB	55dB	DCTEST4 + mono adapter
Cochlear Nucleus 6 and Roger 14	55dB	55dB	DCTEST3
Cochlear Nucleus 5 and Roger 14	65dB	65dB	DCTEST3
Advanced Bionics Naida CI and Roger 17	65dB	65dB	DCTEST4

The protocols need further validating with speech in noise testing to provide more evidence that the desired benefit has been achieved and that the user is satisfied with the quality.

Similar investigation needs to be undertaken with other ear level receivers and with receivers coupled by electromagnetic induction to the telecoil of the processor.

Nair, E. L., Sousa, R., & Wannagot, S. (2017). Verification of a Proposed Clinical Electroacoustic Test Protocol for Personal Digital Modulation Receivers Coupled to Cochlear Implant Sound Processors. J Am Acad Audiol, 28(7), pp. 625-635. doi:10.3766/jaaa.16070 Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/28722645

Schafer, E. C., Musgrave, E., Momin, S., Sandrock, C., & Romine, D. (2013). A proposed electroacoustic test protocol for personal FM receivers coupled to cochlear implant sound processors. J Am Acad Audiol, 24(10), pp. 941-954. doi:10.3766/jaaa.24.10.6 Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/24384080

UKFMWG. (2017). Quality Standards for the use of personal radio aids: Promoting easier listening for deaf children. London: The UK Children's FM Working Group & the National Deaf Children's Society. https://www.ndcs.org.uk/documents-and-resources/quality-standards-for-the-use-of-personal-radio-aids-promoting-easier-listening-for-deaf-children/ .

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