Aero and DSL: A perfect match

Summary
The purpose of this study was to evaluate potential benefits provided by use of Phonak Aero 211 DSP hearing aids in terms of accurately fitting to prescription targets. The results demonstrate that the digital Aero 211 is significantly more capable of matching prescriptive targets for mild to severe hearing loss than analogue hearing aids currently available through the National Health Service (NHS). Benefits of this improvement to the patient include a reduced risk of over-amplification and significantly better access to speech sounds.

Introduction
It is presumed that the closer a hearing aids output to the prescriptive target the greater proportion of speech will be audible to the patient. At the same time, the risk of over-amplification will be reduced. This is in particular important for children. A prescription rule which is widely used in pediatric fittings is DSL[i/o] [1]. In general, DSP hearing aids have a more flexible frequency response. Therefore DSP hearing aids should have an improved ability to match prescriptive targets over analogue hearing aids. The aim of this study is to determine if increased frequency channels improves the ability to match a hearing aid response to the target and to predict the benefits of this for the patient*.

Method and Design
The "fit" to a prescriptive target can be assessed subjectively by visual inspection or by the use of an objective scoring system such as the "Manchester Goodness of Fit Calculator Mk IV" produced by the University of Manchester. This calculator derives a score between 1.0 (best fit) and 0 (worst fit) based on the closeness of the hearing aid output to the target, how similar in shape the hearing aid output is to the target and the amount of gain received from the hearing aid compared to the prescribed gain.

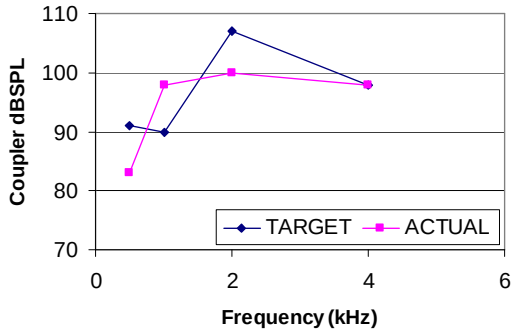
The possible benefit provided by a hearing aid's electroacoustic performance in terms of audibility of speech may be predicted by use of an articulation index (AI). Based on the electroacoustic characteristics of the hearing aid and various Long Term Average Speech Spectrums (LTASS) a prediction can be made as to the proportion of speech that will be audible to the hearing aid user. This can be achieved using the Situational Hearing Aid Response Profile (SHARP) [2]. Using SHARP an Aided Audibility Index (AAI) can be calculated. The AAI is a number from 0 (no audible speech) to 1.0 (all of speech signal is audible).

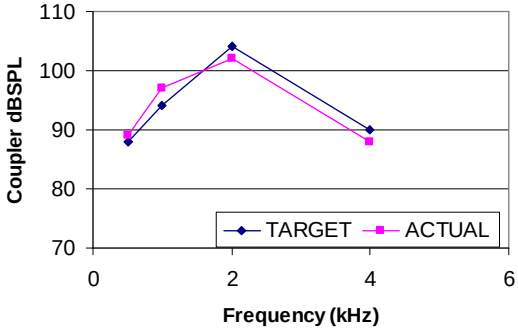
Subjects were children (n = 9) who were exchanged from linear analogue hearing aids to non-linear DSP hearing aids (Phonak Aero 211). The Phonak Aero 211 processes sound in 15 independent channels and allows for a choice of signal processing strategies. In all cases dWDRC was manually selected. Subjects were aged between 2 years and 15 years, and hearing impairment ranged from mild to severe.
The existing analogue hearing aids were optimised against DSL linear prescriptive targets and DSP hearing aids were optimised against DSL non-linear targets. Anecdotally it was noted that only minimal adjustment away from the DSP hearing aids pre-calculated gain and output was needed to optimally match the DSL

target. Comparison of the hearing aid output (2cc) with the prescription target for a 65 dB modulated speech noise input was made for analogue and DSP hearing aids for each child using the "Manchester Goodness of Fit Calculator Mk IV".

Results

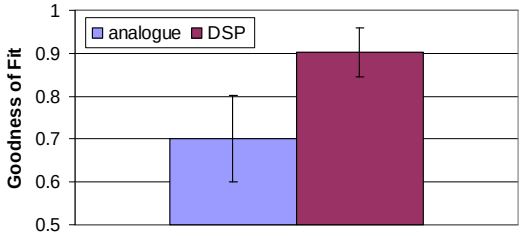
As an example, the figure below shows the average target and hearing aid response curves for optimised analogue hearing aids for one client at 65 dB input. Visual inspection reveals poor matching of targets in terms of frequency response shape and required gain at all frequencies. Note the over-amplification at 1 kHz and under-amplification for higher frequencies.





The second figure shows the same example for DSP hearing aids. It illustrates an improved fit to target in terms of frequency response shape and required gain at all frequencies compared to analogue hearing aids.

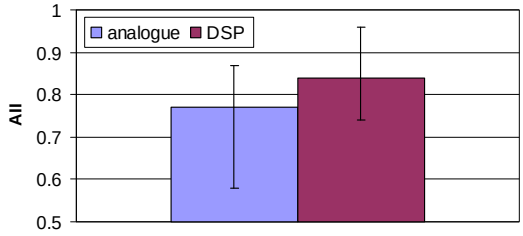
On average, the "goodness of fit" score clearly increased with DSP instruments, which is shown in the next figure. At the same time,



the standard deviation of the "goodness of fit" score further decreases with DSP instruments.

Articulation Index

Median and 10th / 90th percentile AAI scores for all subjects are shown in the figure below. Results demonstrate improved AAI scores for the Phonak Aero 211.



Articulation index measures have been shown to closely correlate to perceived benefit and increased hearing aid use [3].
Therefore, in summary, DSP hearing aids have a greater capability to match prescriptive targets than analogue hearing aids routinely available through the NHS. This results in an improvement in predicted aided audibility of speech that in turn has positive subjective effects for the child.

* The study was conducted by Ted Killan and Rob Gardner, Audiology Department, Bradford Royal Infirmary, UK.

References

[1] Seewald, RC (1994). The Hearing Journal, 47(9):48-51
[2] Stelmachiowicz, PG, Kalberer, A and Lewis, D. (1996). In Bess, FH, Gravel, JS and Tharpe, AM: Amplification for Children with Auditory deficits. Nashville, TN
[3] Holcomb, LM, Nerbonne, MA, and Konkle, DF (2000). J Am Acad Audiol 11:224-229

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