

VERIFICATION OF SOFT SPEECH AMPLIFICATION: A COMPARISON OF METHODS

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INTRODUCTION

Three widely accepted goals of hearing aid fitting are to make soft sounds audible, average sounds comfortable, and loud sounds loud but tolerable. Each of these goals must be verified in a unique manner during the hearing aid fitting. There are two widespread clinical methods for verifying soft sounds: (1) aided soundfield thresholds, and (2) real ear aided response (REAR) by probe microphone system.

Recent literature has questioned the utility and accuracy of aided threshold measurement in the verification of non-linear hearing aids. With the availability of probe microphone systems, it has been suggested to abandon aided threshold measurements altogether (e.g., Stelmachowicz et al., 2003).

However, others support the continued use of aided thresholds in conjunction with probe microphone measures during the verification process (Fabry, 2003; Kuk and Ludvigsen, 2003).

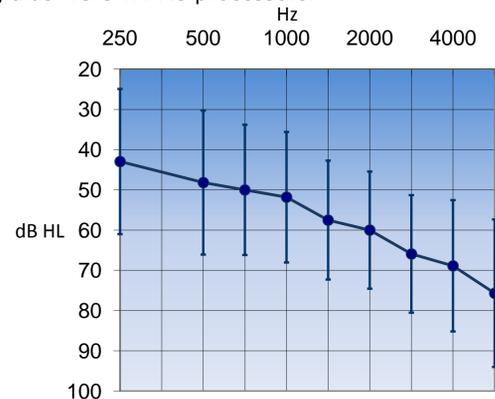
In this study we asked whether both approaches lead to the same estimate of soft sound audibility.

RESEARCH QUESTIONS:

1. Do sound field threshold data and REAR data lead to consistent conclusions regarding audibility of soft speech?
2. Is the estimated audibility the same when using two popular probe microphone systems – the Audioscan Verifit (ver. 2.4) and Fonix 7000 (ver. 1.4-1.5) real ear analyzers?

METHODS

Data were collected for 12 subjects and a total of 22 ears. All subjects used their own hearing aids. Based on input/output functions, approximately half of the hearing aids were WDRC processors.



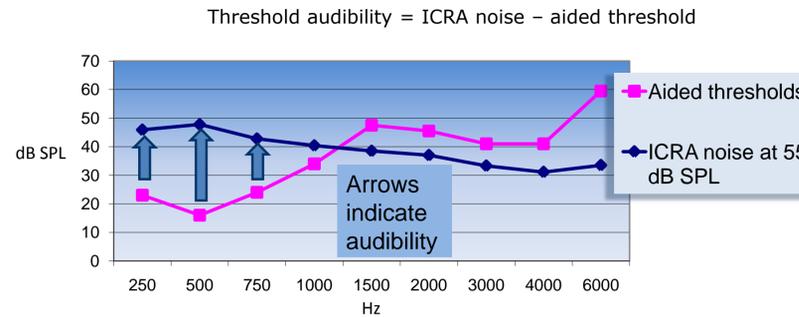
- Unaided thresholds were obtained using ER-3A insert earphones.
- Aided soundfield thresholds were obtained for each test ear
 - Unaided ear plugged, VC of hearing aid taped in place, if applicable
 - Soundfield thresholds measured using randomly pulsed FM stimulus
- RECDs measured using Verifit
- REAR measured using 55 dB input (real speech "carrot" passage in Verifit and ICRA-weighted Digi-speech in Fonix)

RESULTS AND DISCUSSION

Data were used to calculate audibility for each of three methods: audibility by threshold and audibility by the Verifit and Fonix probe microphone systems.

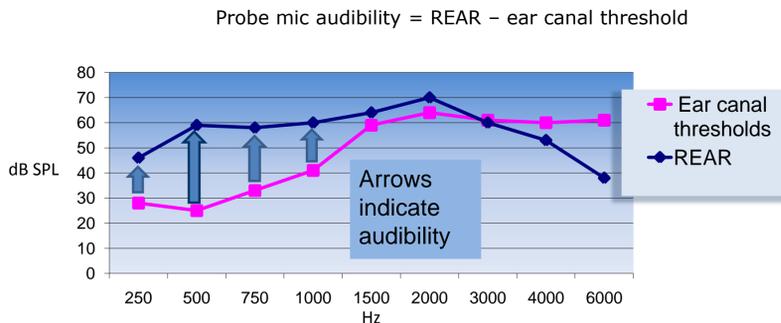
THRESHOLD AUDIBILITY

❖ Audibility is equal to the 1/3 octave band speech spectrum level minus the subjects' aided threshold at a given frequency

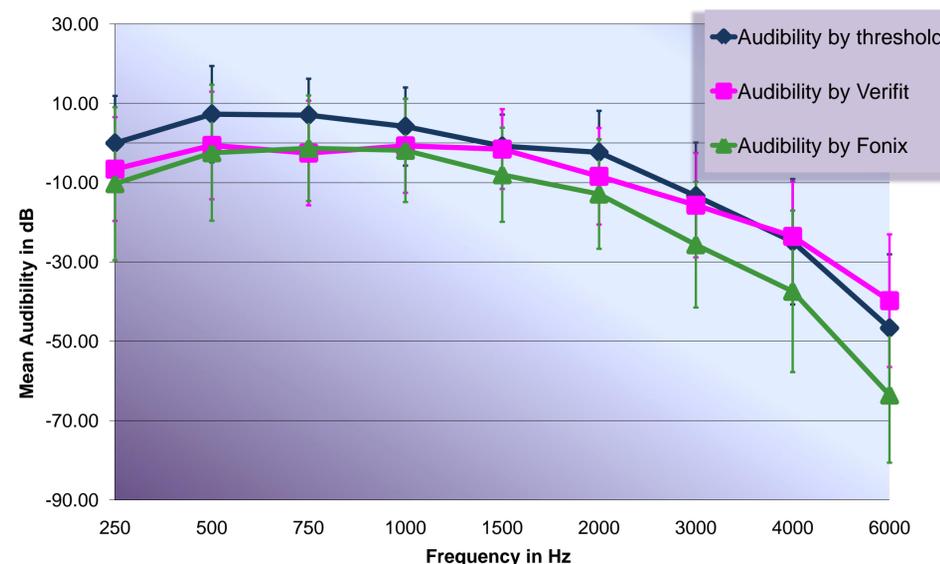


PROBE MICROPHONE AUDIBILITY

❖ Audibility is found by taking the difference between the speech level in the ear canal and the threshold in SPL for a given frequency



COMPARISON ACROSS METHODS



1. Did the three methods show consistent audibility?

Statistical analysis was completed using a repeated measures ANOVA with Bonferroni post hoc adjustment. These analyses revealed two main trends across methods according to frequency:

1. In the low frequencies (from 250-750 Hz) threshold measures yielded significantly more audibility than did REAR measures in either real ear system. The Verifit and Fonix yielded similar audibility.
2. At 1000 Hz and above (with the exception of 2000 Hz) audibility by threshold was consistent with audibility by Verifit. These estimates of audibility were significantly higher than audibility by the Fonix system.
3. All methods yielded statistically different amounts of audibility at 2000 Hz.

2. How can we explain the greater low frequency audibility by threshold data as compared to the other two methods?

It is possible that probe microphone placement may cause a small leak during REAR measurement. Also, WDRC hearing aids may provide more gain at low frequencies in response to the warble tones at threshold level than they do for speech-like/speech spectrum noise at 55 dB.

3. Why were results with the two real ear systems not consistent?

The two systems use different computation and analysis methods.

Verifit (ver. 2.4)	Fonix (ver. 1.4-1.5)
• 1/3 octave BW analysis	• 100 Hz BW analysis
• Uses individual RECD when calculating SPL for REAR and targets	• RECDs not used to calculate SPL REAR or targets
• Transducer used for thresholds affects HL to SPL	• Transducer does not affect SPL threshold values; HL to SPL derived from ANSI table

4. Are these differences clinically significant?

Yes. At many frequencies, there was more than a 5 dB difference between methods (more than a clinical step size). The largest mean difference was 24 dB.

CONCLUSIONS

- Results of this study show that aided threshold and REAR measures do not lead to consistent conclusions about soft sound audibility.
- Estimated audibility via REAR is affected by the real ear analyzer used for the measurement.
- Because different methods of verification will yield different results; at a minimum clinicians and researchers should specify how aided audibility was assessed.

REFERENCES

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- Stelmachowicz, P.G., Hoover, B., Lewis, D.E. & Brennan, M. (Nov 2002). Is functional gain really functional?. *The Hearing Journal*, 55(11), 38-39.