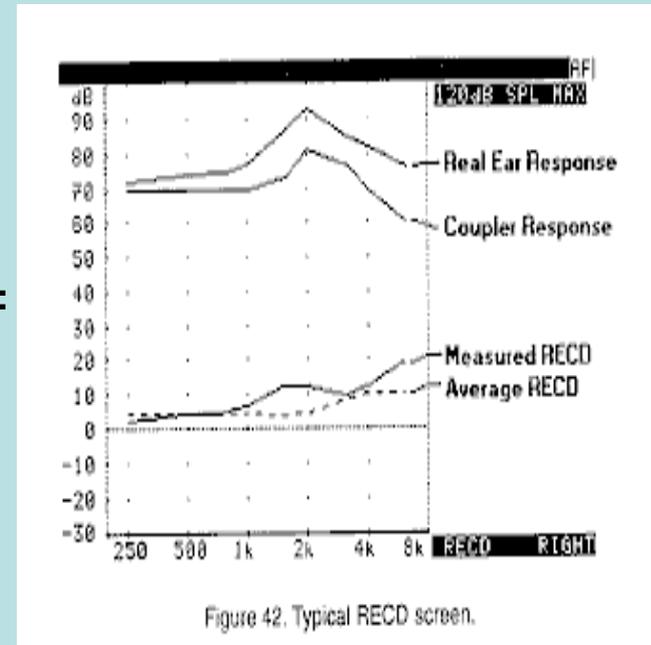
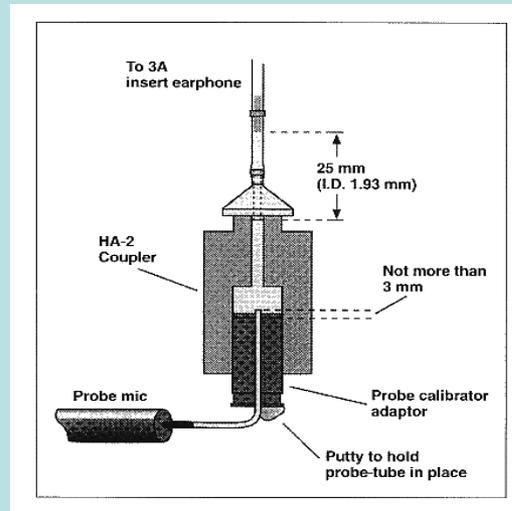
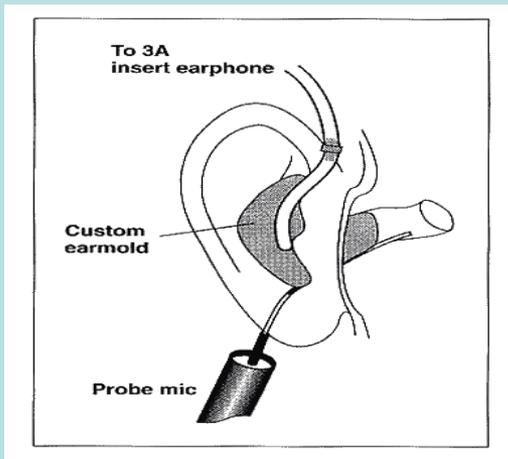


# RECD Measurements

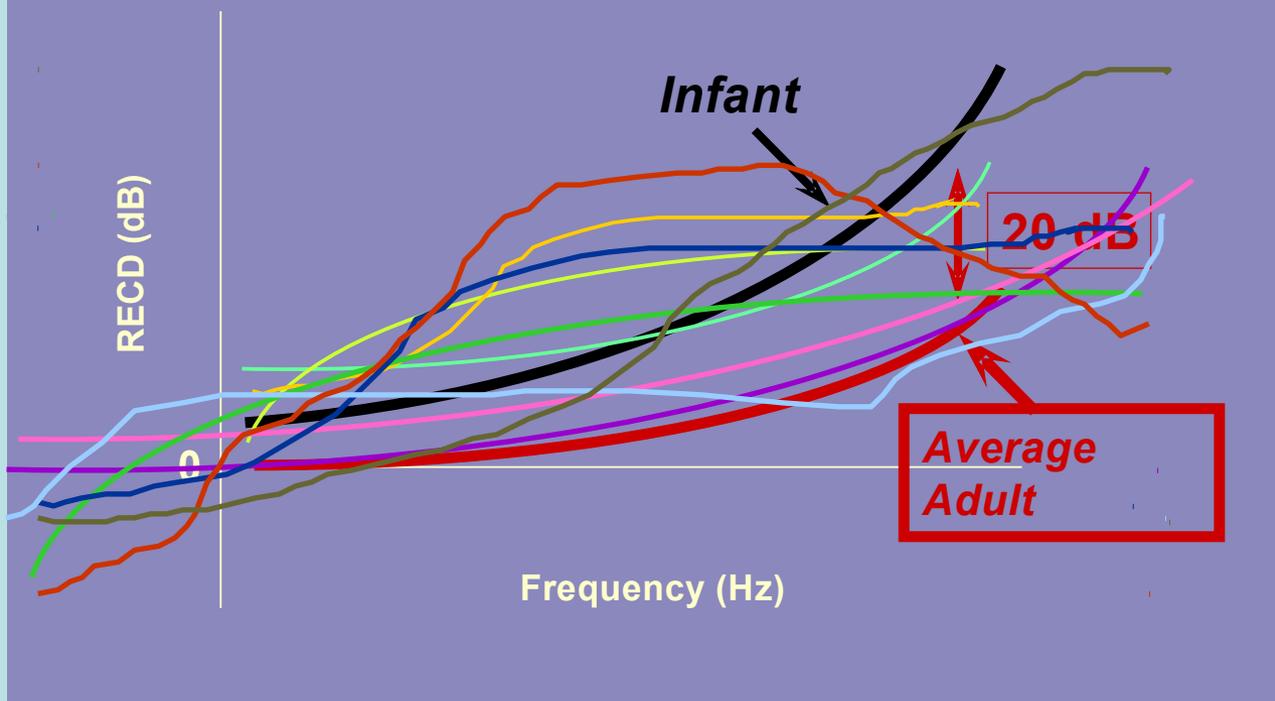
# RECD Definition



Difference between the SPL measured in the real ear and SPL measured in a 2 cc coupler.

# Typical RECD

## *RECDs for Infants and Toddlers*



- Positive values indicate the extent to which levels measured in the **Real Ear** exceed levels measured in the coupler.
- The smaller the ear canal (younger the child) the greater the SPL measured at the ear drum and hence the greater the RECD.

# How Are RECDs Used?

# RECD Use

## 1

Used to convert HA performance measured in 2 cc coupler, into **real ear** hearing aid performance.

# RECD Use

- If you know the acoustic difference between a 2 cc coupler and a child's occluded ear canal then you can **Add** this difference to the HA coupler response to predict what is happening in the child's real ear.

H/A coupler SPL  
[85 dB]

*RECD [10 dB]*  
→

Real-ear SPL  
[95 dB]

# RECD Use

## 2

Used to convert hearing levels in dB HL  
to ear canal SPL.

# RECD Use

- Can only be used in this way when hearing thresholds have been measured using insert earphones. This is because in addition to the RECD another calculation based on 2 cc coupler data is used to convert from audiometer HL to ear canal SPL. This additional calculation is made automatically by the REM software.

Indirect method discussed by Kevin Munro on generic training (see his lecture).

**Audiometer HL**  
(using insert earphones)  
[70 dB]

CDD  
[4 dB]  
Gives coupler SPL

+

**RECD**  
[6dB]

**Real-ear SPL**  
[80 dB]

# REDD Use

➤ If hearing thresholds have been measured using supra-aural headphones you need to measure a 'real-ear-to-dial-difference (REDD). REDD's are **Not** appropriate for this conversion because supra-aural headphones are calibrated in a 6 cc coupler.

'Direct' method discussed by Kevin Munro on generic training (see his lecture). This direct method can also be used with insert headphones.



# In-Situ Audiometry

- A method for directly measuring hearing levels in dB SPL.
- Sine wave generator which presents pure-tones through the hearing aid while in the ear.
- In-situ air conduction (AC) and uncomfortable loudness level (UCL) thresholds can then be used to generate new targets for “Best Fit”.
- Note: In-situ audiometry does not replace diagnostic testing

# In-Situ Audiometry

The screenshot displays the PFS Hearing Aid Fitting software interface. The main window is titled "PFS Hearing Aid Fitting [Morning Day 2]" and shows a "Binaural Fitting" session. The interface includes two audiometry graphs: "Right Ear" and "Left Ear". The "Right Ear" graph plots "Hearing Level in dB re ANSI S3.6 1996" (y-axis, 0 to 120) against "Frequency (Hz)" (x-axis, 125 to 8k). A purple line represents the hearing level, with a green dot at 500 Hz. The "Left Ear" graph plots "2 cc Coupler Output (dB SPL)" (y-axis, 0 to 100) against "Frequency (Hz)" (x-axis, 125 to 8k). Between the graphs is a control panel with "Read", "Best Fit", and "Program" buttons. Below the graphs is a control panel with "Mute", "Active Mode", "Present Tone", "Pulsed", "Use In Situ Audiogram to Calculate Target", "Threshold", and "UCL" options. The "Present Tone" button is highlighted with a red circle. The software is running on a Windows XP desktop with a taskbar showing "Start", "Day 2", "NOAH - [Legacy Host]", and "PFS Hearing Aid Fittin...". The system tray shows "EN", "11:55", and "Microsoft Office" icons.

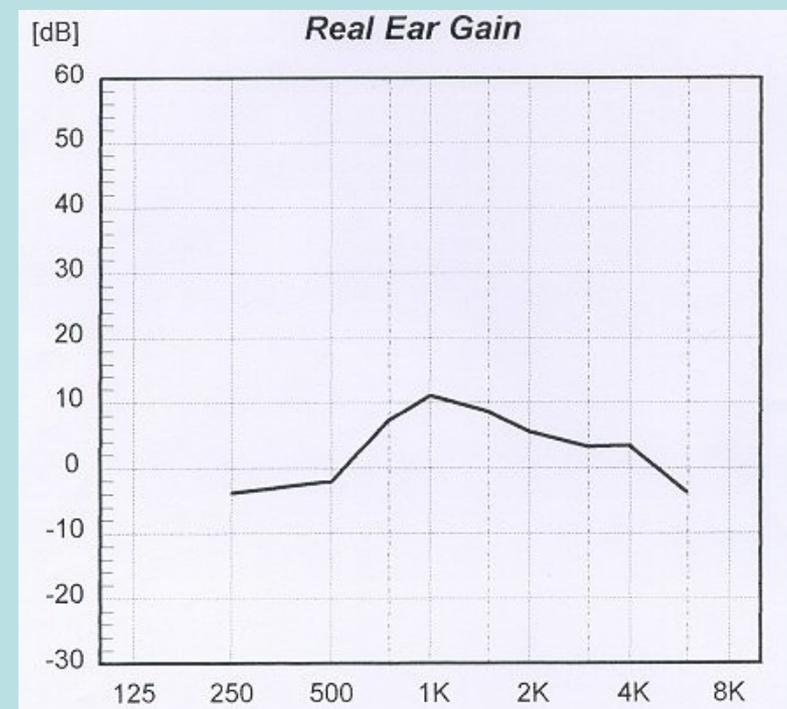
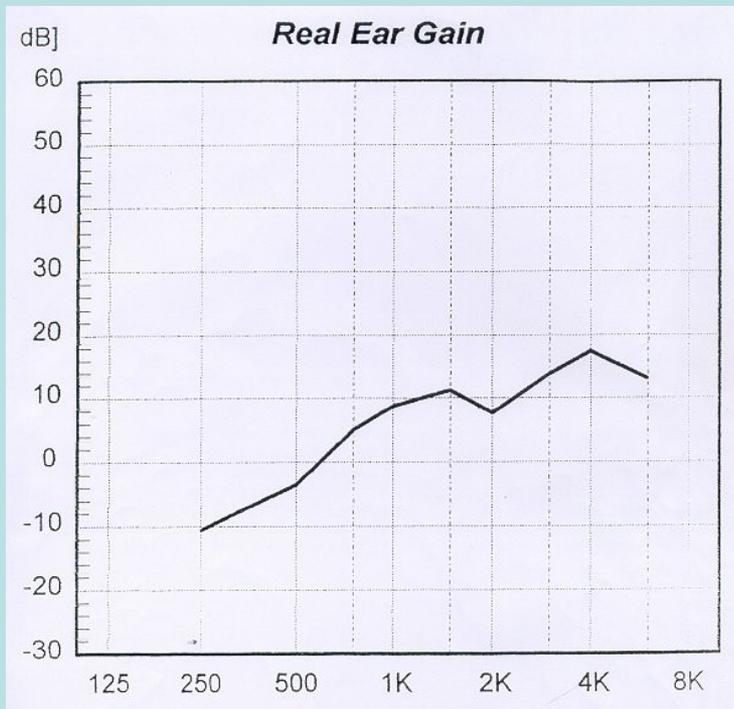
# In-Situ Audiometry

- An RECD is **Not** required to convert hearing thresholds into ear canal SPL (because they are already measured in dB SPL)
- If you want to **Verify** the hearing aid response in the coupler you will still need to measure an RECD.

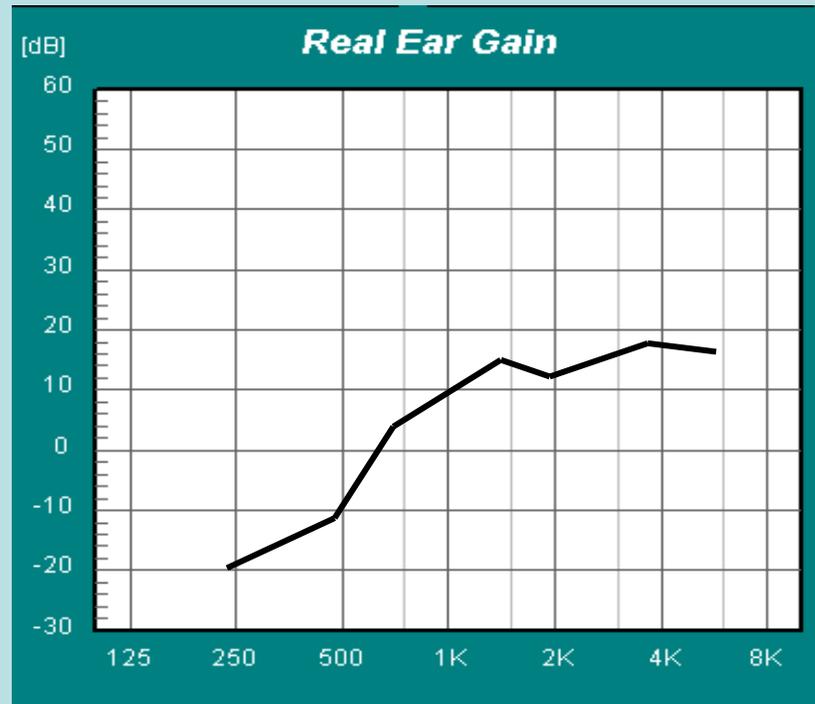
# Trouble Shooting

## ➤ Leakage around earmould

- low frequency sound escapes. May get similar effect with a vent larger than 1mm or if the earmould tubing has hardened.

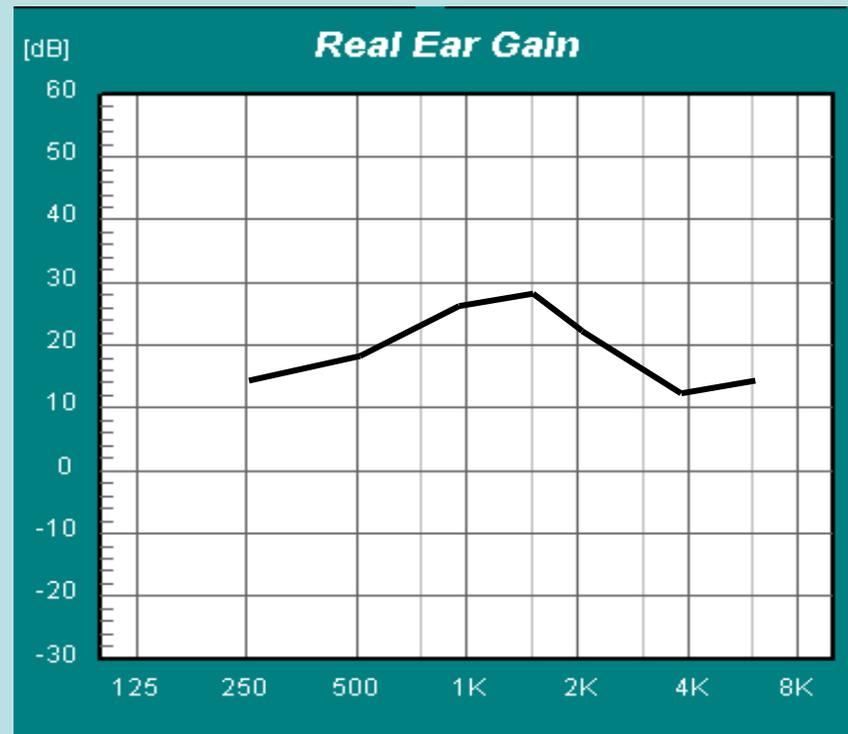


- Perforated eardrum or grommet
  - Negative values typically between -10 & 15 dB. Check with otoscopy.



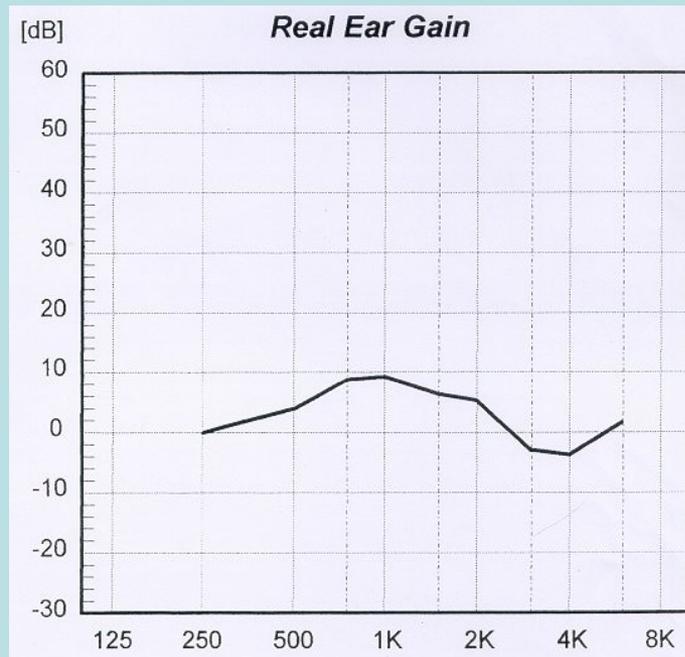
## ➤ Middle ear effusion

- Increased positive values in the low and mid frequencies. Check with tympanometry



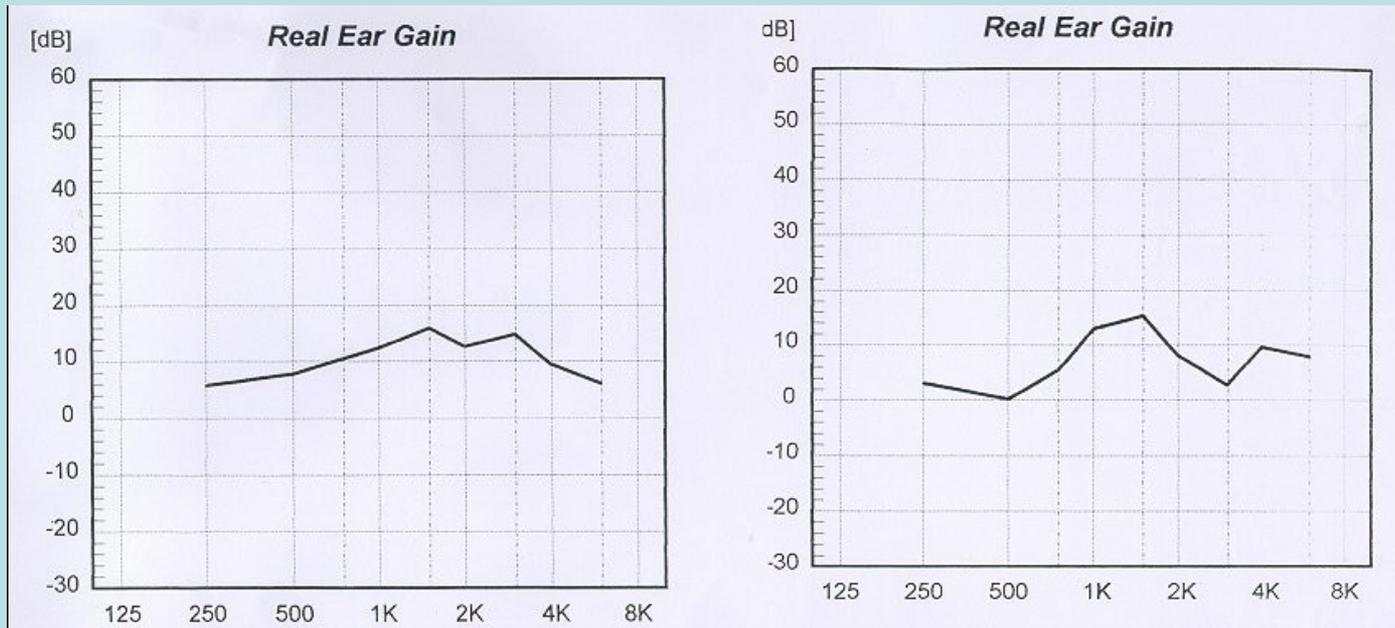
## ➤ Sub-Optimal Probe Placement

- Ensure you are no more than 5-6 mm from the TM (otherwise HF tail off- see below)
- Can use 6 kHz pure tone method or REUR to assess probe position



# Other Issues

- Try and measure bilateral RECDs but if this is not possible use the RECD measured from one ear rather than relying on predicted *(See Tarpe article)*
- May not be as valid for RECDs measured with an earmould (ongoing research).



# Other Issues

- Measure the RECD with the ear mould tubing cut to the appropriate length.
- If employing a thorough approach, RECDs should be re-measured whenever new earmoulds provided...
- ...in practice probably at each planned review appointment.
- ...which may be very frequent for a neonate or young infant

# RECD Validity

- Adding the RECD/REDD will take you, on average, to within 1 dB of the ear canal SPL
- The error will never be more than 5 dB (in 95% of subjects)
- There are issues regarding transducer type/methodology when measuring RECD

# RECD Clinical Use

- Can be used to improve accuracy of some manufacturer “first fit” procedures
- Only require co-operation for one measurement rather than multiple real ear measurements
- Prescription can be verified in coupler without child present and/or “off line”
- More effective use of clinic appointment time
- Skills (e.g. insert PTA & RECD versus full prescription procedure)
- REAR still advisable if viable

## Is the real-ear to coupler difference independent of the measurement earphone?

Munro KJ, Salisbury VA.

ISVR Hearing and Balance Centre, University of Southampton, UK. kevin.j.munro@man.ac.uk

Direct measurement of real-ear hearing aid performance can be obtained using a probe tube microphone system. Alternatively, it can be derived by adding the real-ear to coupler difference (RECD) to the electroacoustic performance of the hearing instrument measured in a 2-cc coupler. Inherent in this derivation is the assumption that the RECD measured with one transducer can be applied to a coupler measurement performed with a different transducer. For the RECD procedure to be valid, it should be independent of the measurement transducer. The Audioscan RM500 is an example of a commercially available real-ear measurement system that incorporates a clinical protocol for the measurement of the RECD. The RECD can be measured on the Audioscan RM500 using a standard EAR-Tone ER-3A insert earphone or the Audioscan's own RE770 insert earphone. The aim of this study was to compare the RECDs obtained with these two earphones. The Audioscan RM500 was used to measure the RECD from the right ears of 18 adult subjects ranging in age from 22 to 36 years (mean 25 years). Measurements were made with the EAR-Tone ER-3A and RE770 insert earphone and three earmould configurations: (1) the EARLINK foam ear-tip; (2) a hard acrylic shell earmould with the same length of acoustical tubing as the foam ear-tip (25 mm); and (3) the shell ear mould with the appropriate length of tubing for a behind-the-ear (BTE) hearing aid fitting (approximately 35-45 mm). The results show that the mean RECD was around 3 dB higher at 1.5 kHz with the foam ear-tip when measured with the RE770 earphone than when measured with the ER-3A earphone. The same magnitude of difference was obtained with the shell earmould and 25-mm tubing; however, this increased to 9 dB when the tubing was increased to around 40 mm for a BTE fitting. The difference in mean RECD with the two earphones was statistically significant on a repeated-measures ANOVA for every earmould configuration ( $p < 0.001$ ). The results of this study demonstrate that the RECD procedure that uses an HA2 coupler and earmould is not independent of the measurement earphone. This has important implications for clinical practice.

## Customized acoustic transform functions and their accuracy at predicting real-ear hearing aid performance.

Munro KJ, Hatton N.

Institute of Sound and Vibration Research, University of Southampton, United Kingdom.

**OBJECTIVE:** The purpose of the study was to evaluate the validity of predicting the real-ear aided response by adding customized acoustic transform functions to the performance of a hearing aid in a 2-cc coupler. **DESIGN:** The real-ear hearing aid response, the real-ear-to-coupler difference (RECD/HA2), and field to behind-the-ear microphone transfer functions were measured in both ears of 24 normally hearing subjects using probe-tube microphone equipment. The RECD/HA2 transform function was obtained using both insert earphones and with the hearing aid/ pressure comparison method. An RECD/HA2 transfer function was also obtained with a customized earmold, ER-3A foam tip, and an oto-admittance tip. **RESULTS:** Validity estimates were calculated as the difference between the derived and measured real-ear response. The derived response was generally within 5 dB of the measured real-ear response when it incorporated an RECD/HA2 transform function obtained with a customized earmold for the specific ear in question. Discrepancies increased when the RECD/HA2 transfer function was obtained from the same subject but the opposite ear. There were significant differences between the RECD/HA2 transform function obtained with customized and temporary earmolds. As a result, the derived response incorporating these transforms differed significantly from the measured real-ear response obtained with the customized earmold. The insert earphone and the hearing aid RECD/HA2 transfer function were equally valid. **CONCLUSIONS:** The derived response may be used as a substitute for in situ hearing aid response procedures when it incorporates acoustic transform functions obtained with a customized earmold from the specific ear in question.

## Use of the 'real-ear to dial difference' to derive real-ear SPL from hearing level obtained with insert earphones.

Munro KJ, Lazenby A.

ISVR Hearing and Balance Centre, University of Southampton, UK.

The electroacoustic characteristics of a hearing instrument are normally selected for individuals using data obtained during audiological assessment. The precise inter-relationship between the electroacoustic and audiometric variables is most readily appreciated when they have been measured at the same reference point, such as the tympanic membrane. However, it is not always possible to obtain the real-ear sound pressure level (SPL) directly if this is below the noise floor of the probe-tube microphone system or if the subject is uncooperative. The real-ear SPL may be derived by adding the subject's real-ear to dial difference (REDD) acoustic transform to the audiometer dial setting. The aim of the present study was to confirm the validity of the Audioscan RM500 to measure the REDD with the ER-3A insert earphone. A probe-tube microphone was used to measure the real-ear SPL and REDD from the right ears of 16 adult subjects ranging in age from 22 to 41 years (mean age 27 years). Measurements were made from 0.25 kHz to 6 kHz at a dial setting of 70 dB with an ER-3A insert earphone and two earmould configurations: the EAR-LINK foam ear-tip and the subjects' customized skeleton earmoulds. Mean REDD varied as a function of frequency but was typically approximately 12 dB with a standard deviation (SD) of 1.7 dB and 2.7 dB for the foam ear-tip and customized earmould, respectively. The mean test-retest difference of the REDD varied with frequency but was typically 0.5 dB (SD 1 dB). Over the frequency range 0.5-4 kHz, the derived values were found to be within 5 dB of the measured values in 95% of subjects when using the EAR-LINK foam ear-tip and within 4 dB when using the skeleton earmould. The individually measured REDD transform can be used in clinical practice to derive a valid estimate of real-ear SPL when it has not been possible to measure this directly.