Phonak Insight

Every ear is unique– now every fitting is too

Easy new way to improve fitting accuracy

Introduction

The advancements in modern digital hearing instruments and the sophistication of hearing instrument fitting software offers hearing professionals the flexibility to very precisely fine-tune hearing instruments to provide maximum benefit for all configurations of hearing loss. The challenge that remains is in deriving an accurate initial setting for the gain and output that arrive at the eardrum, as this can only be effectively accomplished by using either an individual in situ probe tube measurement or an RECD (Real Ear to Coupler Difference). Examination of real world practices would suggest that in many cases these individual measurements are not performed. Although there is widespread agreement that measuring RECD values for children is a necessity, it is much less common for hearing professionals to measure RECD values for adults. This can be problematic because research has demonstrated that there can be large variance in RECD values for adults (Fig 1). Without individual RECD data the fitting pre-calculation is performed with average RECD values. As individual variance is large the accuracy of the pre-calculation can be significantly impacted, leading to poor spontaneous enduser acceptance and increased finetuning.
With individually measured RECD values fitting efficiency can be significantly improved, leading to a more successful first fit, increased enduser satisfaction and fewer follow up appointments. With these goals in mind, Phonak has developed a new method to easily and accurately extract individual RECD values by using the information derived by measuring the feedback threshold.

The underlying challenge

The process of adjusting a hearing instrument frequently uses target curves which provide a visual representation of the outcome of adjustments. The limitation, however is that these curves are actually an approximation based largely on age-appropriate average measurements conducted in a standard 2cc coupler. As a result these curves may not accurately reflect the real situation because the acoustic conditions in an individual ear canal could be significantly different from the acoustic properties of the coupler. Coupler curves do not take into account the residual volume of the individual ear, middle ear compliance or vent loss. By measuring an RECD, we are in effect individualizing the fitting by converting the values measured in the coupler to correspond to the values of the actual ear canal.

What does RECD mean?

RECD denotes Real Ear to Coupler Difference. Review of the literature provides the following definition:

- "RECD is the difference across all frequencies, measured in dB with an insert earphone with a foam tip, resistance tip or an earmold *in situ* and in a 2cc coupler" (Bagatto, 2001).

If we know the RECD, the actual output of a hearing instrument in the ear canal can be predicted on the basis of a simple 2cc coupler measurement. RECD values reflect the unique properties of a person's ear canal and take them into account to individualize a fitting outcome.
The specific transducer should also be considered; we could add to the above definition"...generated by a transducer delivering the same signal". This reinforces that RECD is not only individual to each ear but also dependent on the electrical and mechanical properties of the hearing instrument and of the measurement system being used. The acoustic impedance of the earphone transducer and the coupler system used can vary substantially. (Munro 2005). The result is that there is not just one individual RECD, but potentially many (Butsch et al, 2002).
As mentioned previously, all manufacturers of hearing instruments use acoustic coupler curves by way of illustration in their fitting software, typically measured in a 2cc coupler. Using reference target curves, the hearing professional fine tunes the system, with the goal that the (coupler) curve of the hearing instrument most closely matches the reference target curve. These values are then converted to the individual ear by taking into account either RECD values that were manually entered into the software or using the average RECD values. Figure 1 illustrates why using average RECD values is not always ideal.

PHONAK life is on

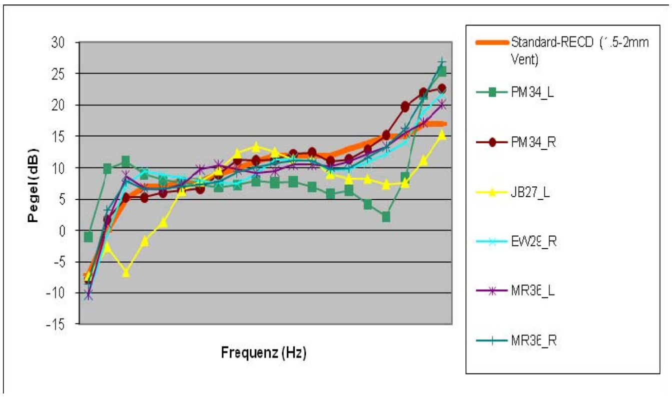

Fig. 1: A variety of individual RECD curves compared with an average RECD curve with a 1.5-2 mm vent.

This graph shows that individual RECD can differ markedly among subjects, by more than 15 dB at some frequencies. The use of average RECD values could potentially result in hearing instrument output being significantly less or more than desired in individual cases. As mentioned previously, RECD values among children can vary greatly. A child's residual ear canal volume is far smaller than an adult's, resulting in an increase in sound pressure level at the eardrum. In fact, in the case of small ear canals, whether in children or adults, it is particularly important to obtain individual measurements in order to achieve the best finetuning result. RECD values are also impacted by the venting of an earpiece or custom shell, which can create a pronounced effect on the acoustic properties of the hearing instrument and as a result on the individual RECD.

Considering all of these factors, it is clear that an accurate, individual RECD can only be achieved by having the enduser's hearing instrument correctly positioned in the ear. Past procedures designed to measure RECD with probe tubing temporarily attached to the hearing instrument, have been used with some success but have the limitation of being time consuming.

Phonak is the first manufacturer of hearing instruments to develop an intelligent algorithm within the programming software which establishes an individually estimated RECD by extracting this from data obtained when measuring the feedback threshold.

Maximum amplification

Almost all modern hearing instruments include sophisticated feedback suppression and cancellation systems. Phonak encourages the use of a feedback test as part of the fitting process. This test determines the most gain that can be applied at each frequency prior to feedback. From practical experience it is well- known that feedback is most likely to occur when gain is applied for higher frequencies. If we apply this individual maximum amplification (or "individual feedback threshold") across the frequency range, the typical result is a curve which decreases as the frequency increases. An example of this type of curve is shown in Figure 2. This curve is of interest, because it includes the acoustic parameters of the earpiece or custom shell. Every earpiece/shell and the material from which is it produced has different acoustic properties, and any leakage from an earpiece/shell or variations in vent size will alter the maximum achievable amplification at each frequency.

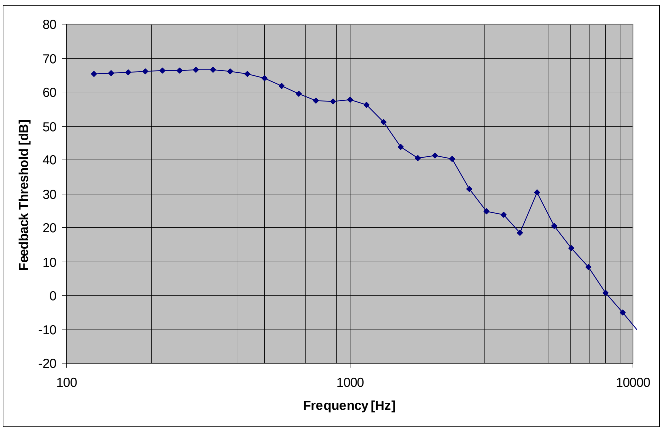

Fig. 2: Example individual 2cc feedback threshold measured with a BTE with an open vent.

The importance of the vent

Maximum achievable amplification is highly dependent on the size of the vent, as well as the physical fit of the instrument. The amount of leakage that occurs varies greatly and is impacted by the size and shape of the ear canal and the fit of the hearing instrument. The size of the vent plus the amount of leakage defines "acoustic mass." Acoustic mass and the maximum achievable amplification are highly dependent on each other. Acoustic mass was extensively analyzed in the development of the Phonak algorithm, and an impressive 2300 individual RECDs and feedback measurements were considered. Measurements of the maximum achievable amplification as a function of frequency were obtained and used to derive acoustic mass. The individual variations that occur when these measurements were obtained was statistically analyzed and the effective vent mass was calculated. From these results a functional connection was derived between effective vent diameter and maximum achievable amplification, as shown in Figure 3.

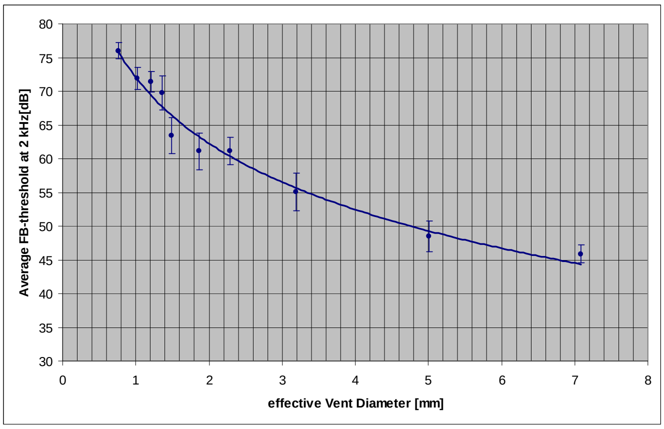

Fig. 3: Maximum achievable amplification as a function of effective vent diameter based on 2,300 individual measurements.

Reduction in the maximum achievable amplification corresponds to a sound pressure level exiting the vent; which also impacts individual estimated RECD measurement.

Easy new method to obtain accurate RECD estimate

The difference between maximum achievable amplification and actual amplification obtained provided the information required to create a more accurate, individually estimated RECD using Phonak Target fitting software. This is accomplished using two simple steps which are integral components to any hearing instrument fitting protocols.

As described above, the individually estimated RECD is dependent on the size of the vent.

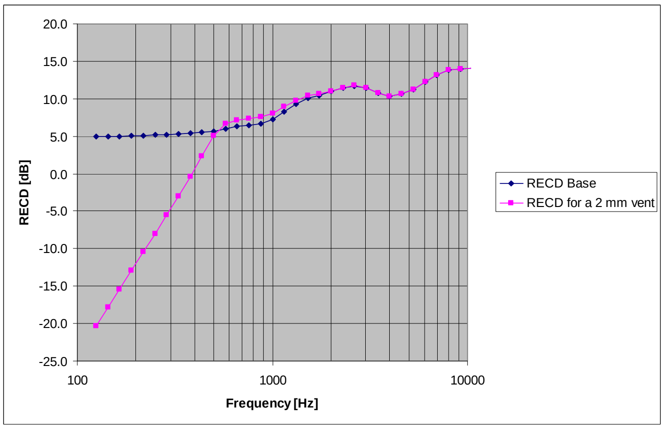

Fig. 4: ITC RECDs for a completely occluded vent and for a vent diameter of 2 mm.

The first step in the process is to enter the vent size into Phonak Target fitting software. For Custom instruments with Acoustically Optimized Venting (AOV), this information is automatically entered when the hearing instrument is identified. For BTE instruments, a default is selected by the Phonak Target software which can be changed if necessary.

The second step is to run the feedback manager. The conversion algorithm within the Phonak Target fitting software automatically calculates an estimated RECD individualized to that enduser. This RECD estimate can now be used by the hearing professional to adjust amplification with greater precision and accuracy. It is important to note that the hearing professional always has the option in Phonak Target fitting software to accept or reject the derived estimated RECD measurement and use manual RECD measurements or averages as an alternative.

Summary

Phonak has successfully developed a method to obtain a very reliable estimation of an individual's RECD by simply running the feedback test. Most hearing professionals routinely run the feedback test, so this opportunity to add additional individualized information to the fitting does not result in an additional step.

The hearing professional verifies the current venting and runs the feedback test. The new algorithm will automatically create an individualized more accurate pre-calculation based on the more accurate RECD estimate.

The result is that finetuning can be adjusted more effectively, resulting in individualized settings that are calibrated to the individual enduser and their particular hearing situations. An additional benefit of this useful tool is its simplicity. The hearing professional can work with familiar curve diagrams and a finetuning process that is unchanged but more precise and effective than ever before. The resulting benefit for both the hearing professional and enduser is higher spontaneous acceptance at the first fitting and reduced finetuning effort.

Literature

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