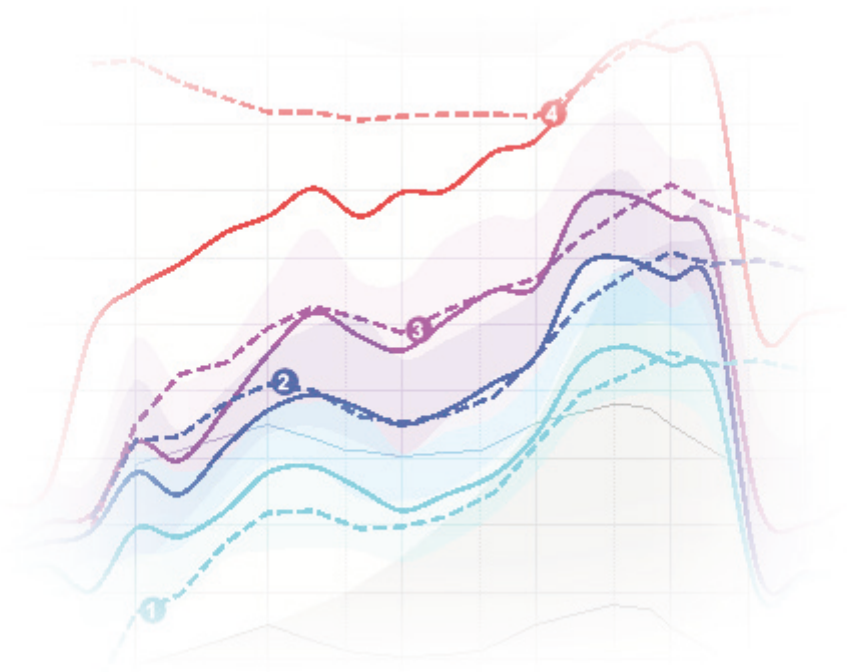
WHITE PAPER

Dynamic REM with Percentile analysis

Author
Mona Dworsack-Dodge, Au.D.; Peter Kossek

Background

Historically, the primary goal of hearing instrument fitting has been to restore speech intelligibility by providing audibility as a necessary foundation for speech detection, discrimination and finally recognition. As hearing instruments became more and more powerful, algorithms were developed with the purpose of optimizing the benefit from the hearing instruments in various acoustical environments. Obviously, the effect of these algorithms could not be verified until a practical approach was brought forward and the industry could come to the point where the hearing instruments' algorithms were activated throughout the fitting process for the ultimate benefit of the hearing impaired person. Aurical Freefit and Otosuite supports the optimal approach to Dynamic REM using Percentile Analysis. Dynamic REM is a part of the Otosuite PMM (Probe Microphone Measurements) module.



natus®

What matters?

The essential elements of dynamic fitting are: stimulus, target curve and analysis.

Stimulus

The stimulus type itself is required to have certain spectral and dynamic properties in order to be processed correctly by the hearing instrument and relate to the prescriptive target. Obviously, a signal that is as close to real speech as possible is preferred. Otosuite features – among other signals – the International Speech Test Signal (ISTS), which is the state of the art speech signal of the industry. As we need to make sure that the hearing instrument is performing in a predictable and reproducible way, the just-in-time calibration of the stimulus ensures the correct level and spectrum of the stimulus in the current acoustical environment.

The spectrum of a speech sample varies over time. For the Long Term Average Speech Spectrum (LTASS) measurement to result in a stable, repeatable result, it must be based on a sound sample with a minimum duration of 10 seconds. The default LTASS measurement duration in PMM is 14 seconds, to accommodate the signal length of our standard passages. The LTASS is calculated on samples of 128ms, and it is displayed and stored in 1/3 octave bands in Unaided Response, Occluded Response, Aided Response and Noise Reduction.

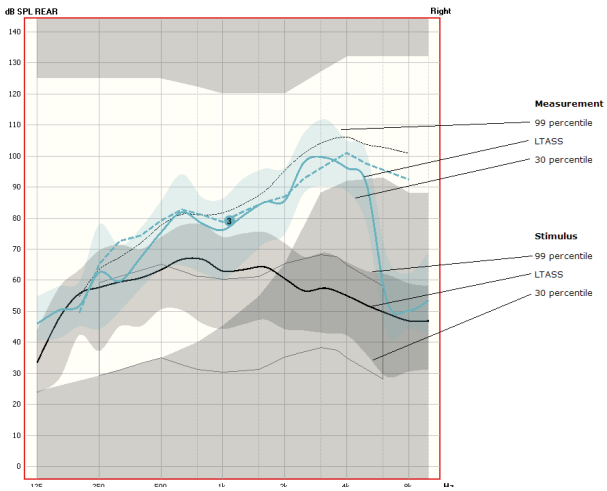
Knowing that the spectrum (or envelope) of speech changes depending on the effort applied at differing levels of speech, appropriate vocal effort filters are applied in order to provide a stimulus which is as realistic as possible.

Target curve

Today's Real Ear Aided Response (REAR) target curves are adapted to speech signals and analysis of the measured speech spectrum – DSL v5.0 in particular. Using the stimulus level-dependent target curves with your measurement curves allows you to adjust the hearing instrument for a variety of levels covering the dynamic range of the patient. For NAL NL1 and Fig6, the REAR targets are derived by converting the corresponding insertion gain targets. The SPL thresholds for deriving the REAR target use the same average Real Ear to Coupler Difference (RECD) and Real Ear Unaided Gain (or the patient's measured REUG) as DSL. Freefit is unique in that it allows you to conduct percentile analysis in the REAR SPL view and to view the same measurement curves in Real Ear Aided Gain (REAG) and Real Ear Insertion Gain (REIG) simply by toggling a button, and without the need to re-measure curves to meet achieve different targets.

Analysis

The analysis is the way that the measurements are processed before they are shown on the screen. Using speech signals which are by nature very dynamic over time, the use of long-term average curves alone is no longer sufficient. The cornerstone of dynamic fitting is the percentile analysis. The percentile analysis is a statistical method which evaluates the dynamic properties of the measured signal. The percentile curves display a dynamic view of the signal spectrum, measured at the eardrum. This dynamic view includes the LTASS, the 99th and 30th percentiles. The 99th percentile curve shows levels which are exceeded by 1% of the signal measured at the eardrum, and is commonly referred to as the peaks of speech. The 30th percentile curve illustrates the levels which are exceeded by 70% of the signal and is commonly referred to as the valleys of speech. Also, the percentile and LTASS curves (commonly referred to as the speech envelope, speech banana, or speech spectrum) are measured at the eardrum, and thereby reflect fully the dynamics of the aided response.



Further, it is possible to compare the measured speech spectrum with that of the known stimulus input spectrum to see the impact of the amplification on the dynamics of speech.

The measured percentile curves are displayed dynamically, whereas the signal spectrum is a static average for the input signal and its full duration.

Putting theory into practical use

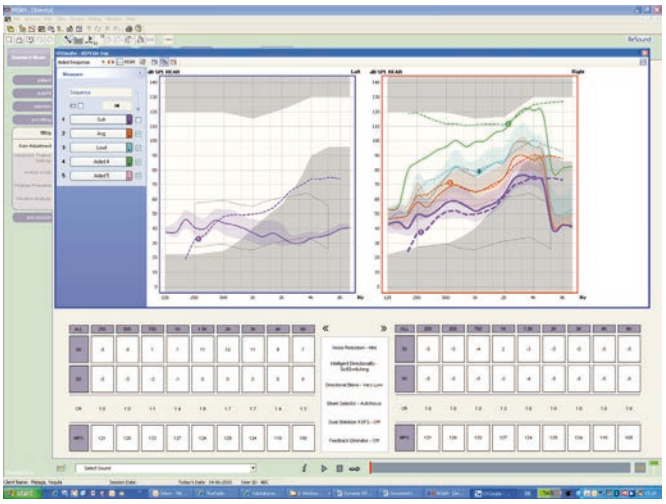
Dynamic fitting can be a cumbersome undertaking when only manual operation of the verification system is possible. Having to manage a multi-level set of measurements including different signal types and Maximum Power Output (MPO) makes the list of steps a really long one.

However, the implementation of Dynamic REM in Otosuite has been optimized to enable the user to carry out the procedure with one single mouse click. Customizable User Tests allow the user to create the desired measurement sequence with regards to stimulus type, duration of the measurement and stimulus level for each step of the sequence. Here is where you define how many levels you will measure– many people choose 65 dB average and 80 dB loud speech and MPO. Others prefer adding a 55 dB soft speech stimulus as well. Users will commonly make all adjustments for the average input and then run a sequence to document that all other levels have come into place based on the average settings.

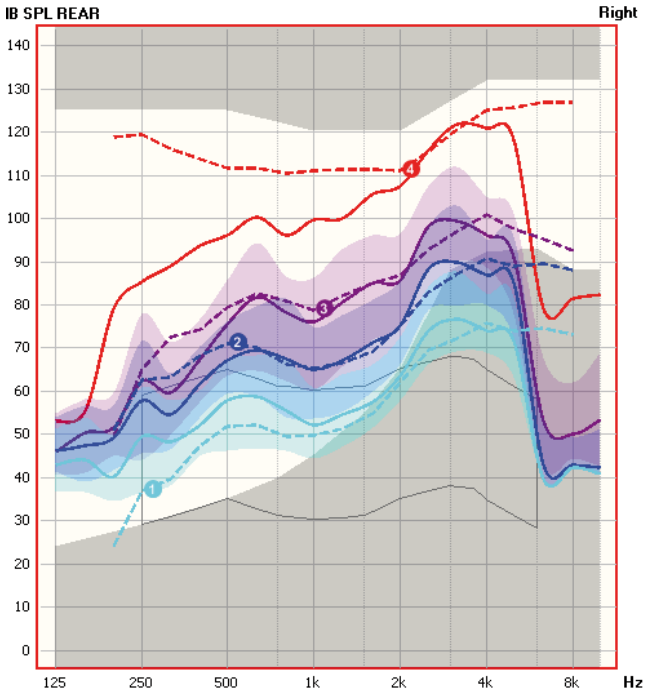
Control panel for intuitive sequencing of the verification process.

Activating that sequence – one mouse click! – will return a family of measurement curves that will show the dynamic performance of the hearing instrument – with all algorithms activated – at different stimulus levels. The patient's thresholds and UCLs can be activated as overlays in order to be able to view the entire dynamic range of the patient.

The LTASS measurement curve is used for comparison with the selected target curve in order to intuitively determine which adjustments need to be made in the fitting software to achieve audibility, comfort and coverage of the patient's dynamic range. The information given by the percentile curves clearly reveals if any speech peaks (99th percentile) are too close to the patient's UCL causing discomfort and /or if the speech valleys (30th percentile) are audible. You can also relate an MPO target to the corresponding measurement to ensure loud signals don't exceed the patients UCL.



An intuitive OnTop mode allows you to view and control the Otosuite display while operating the fitting software.



Family of curves for a multi-level measurement sequence including percentile curves.

The ultimate goal of carrying out dynamic and individual fittings using real speech in a quick and accurate way is hereby achieved!

Healthcare solutions with one thing in mind. You.

natus®
Natus Medical Incorporated
natus.com