Candidacy and Verification of Oticon Speech Rescue™ technology

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A B S T R A C T

This paper will introduce a new frequency lowering strategy by Oticon called Speech Rescue™. This feature will be available in Sensei and Dynamo super power aids for children and adults with severe-to-profound hearing loss. The Speech Rescue processor lowers high-frequency sound with minimal distortion of low-frequency spectral features by use of a multi-layered lowering technique. Here, we provide guidelines of when to activate Speech Rescue and show how to use the frequency lowering protocol from Western University to verify the Speech Rescue settings.

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Verifying Hearing Instruments with Speech Rescue

The application of frequency lowering is recommended in hearing aids only if verification measures indicate that high-frequency speech audibility cannot be achieved with conventional processing (AAA, 2013). The pediatric amplification guidelines of the American Academy of Audiology (AAA) states:

"Frequency lowering should be treated as a form of distortion purposefully introduced to the amplified pathway. Fine-tuning and the accompanying verification and outcome assessment should have the goal of providing the least possible effect (distortion) that allows access to high frequency sound. Frequency lowering should not be prescribed until electroacoustic verification has revealed that high-frequency speech audibility cannot be restored through conventional means".

This paper will present a fitting protocol to assist clinicians in verifying and fine-tuning the Speech Rescue feature on a case-by-case basis. For further details on the development of this protocol and accompanying stimuli, refer to the article entitled "Fitting frequency-lowering signal processing applying the AAA Pediatric Amplification Guideline: Updates and protocols" (Scollie et al., in press).

Applying the Protocol

It is recommended that the fitter maximize the output bandwidth available to the listener prior to activating Speech Rescue. This involves fitting the hearing aids to a validated prescriptive targets, and then determining the frequency at which the output of the hearing device falls below audibility for a given audiogram. This is described in the literature as the "maximum audible output frequency" (MAOF) (McCreery et al., 2013; McCreery et al., 2014). In this paper, we have illustrated how to do this using the Audioscan® Verifit 2. When verifying with a speech-based signal such as the ISTS, the fitter can use an MAOF range to help guide fine-tuning of Speech Rescue. This MAOF range spans from the LTASS-defined limit to the peak-defined limit of audibility, as shown in Figure 1. We use this as a target region, by lowering a calibrated /s/ into the MAOF region so that it is audible (Scollie et al., in press).

In Oticon super power devices, Speech Rescue is OFF by default for both children and adults. Once activated, an individual Speech Rescue setting is automatically prescribed by the Oticon fitting software, Genie; this includes a setting for the configuration as well as the strength. The ⟳ sign in the fitting software indicates what configuration setting is automatically generated. This default configuration is based on an estimation of the participant's MAOF as dictated by the aided speech spectrum output of the hearing aid. (For further details refer to the Speech Rescue White Paper, Angelo, Alexander et al. 2015: http://ipaper.ipapercms.dk/Oticon/Whitepaper/WHITEPAPER_SPEECH_RESCUE/)
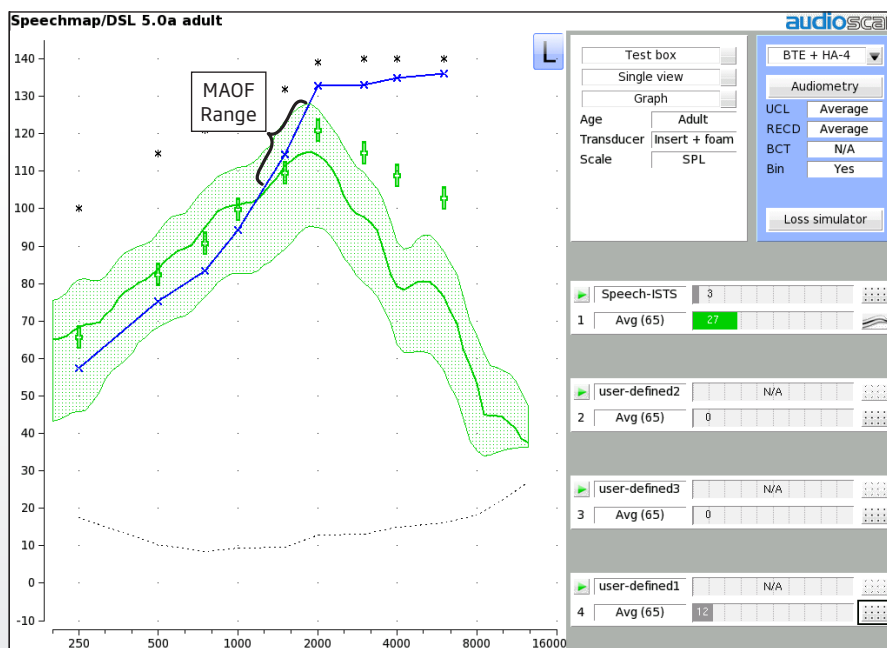

Figure 1: Depiction of the MAOF range used in determining a target region for frequency lowering of the calibrated /s/ stimulus.

The following verification steps can be used with Speech Rescue:

1) Fit to targets leaving Speech Rescue OFF.

2) Measure the calibrated /s/ stimulus. If inaudible, proceed to Step 3.

3) Turn Speech Rescue ON and fine-tune the configuration setting to the weakest setting where /s/ falls within the MAOF range and is audible to the listener.

4) If audibility cannot be maximized with the configuration slider, adjust the Speech Rescue strength to maximize /s/ audibility.

5) Optional fine-tuning steps can be followed to evaluate /s-sh/ separation on a case-by-case basis (see below).

The full verification guidelines and a .wav file of the calibrated /s/ stimuli are available for download from: http://www.dslio.com/?page_id=166.

Case example: Typical severe hearing loss.

A fitting was completed using the Oticon Dynamo SP10, behind-the-ear (BTE) 13 hearing instrument fitted to a typical severe hearing loss. Programming was completed using Oticon Genie software version 2015.2. The audiogram was chosen for this case because it is appropriate for the fitting range of the Dynamo (Figure 2).

The instrument was connected to the fitting software for programming using the DSL v5.0 adult prescription and Speech Rescue turned OFF. Steps 1 and 2 of the verification protocol were competed using the ISTS speech passage presented at 65 dB SPL and the calibrated /s/ stimulus available in the Verifit 2. After fine-tuning, the fitting met targets up to and including 3 kHz (Figure 3: green line). The conventional fitting is therefore below target amplification levels for many of the high frequencies and the /s/ signal was below threshold when Speech Rescue was OFF (Figure 3: blue line). Thus, this case would be considered a candidate for Speech Rescue and the fitter would move to Step 3 of the protocol.
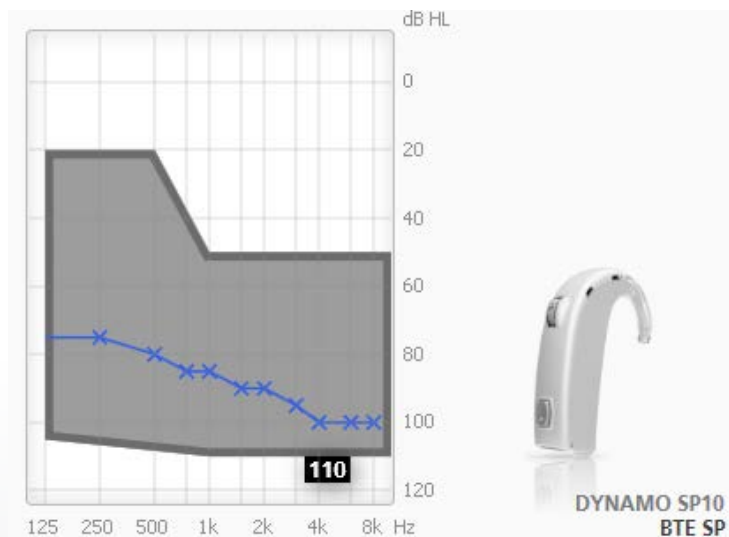

Figure 2: A typical severe hearing loss and the Dynamo fitting range.

Speech Rescue was then activated at the default setting and /s/ was re-measured at 65 dB SPL (Figure 3: orange). The effect of enabling Speech Rescue is that the /s/ signal has been moved to a lower frequency region; however audibility has not yet been achieved. Since the frequency region aligns with the MAOF range, the configuration frequency was maintained and the strength of Speech Rescue was increased (Figure 4), as suggested in Step 4 of the fine tuning protocol, above. By increasing the strength of Speech Rescue, the /s/ stimulus was made audible because the Strength slider maintained its frequency location within the MAOF range, but applied more gain to the frequency-lowered signal. The end result is a Speech Rescue setting that provides some audibility of /s/ when activated.
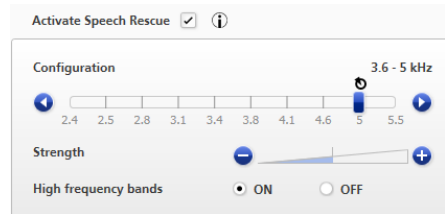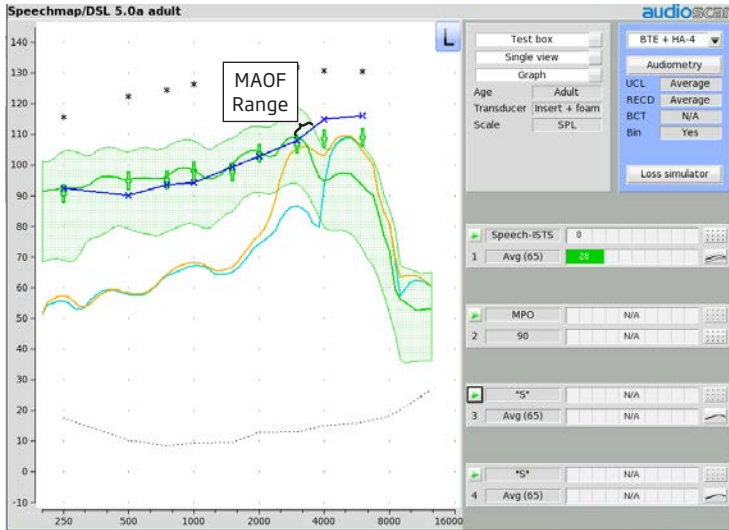

Figure 3: Verification of a fitting for the audiogram using the ISTS speech passage (green) and the /s/ stimulus with Speech Rescue turned OFF (blue) and ON at the default setting (orange). Note that there are two bumps on the orange curve because the Speech Rescue Processor uses a "Copy and Keep" approach i.e. the original high frequency /s/ is preserved, To the right the Speech Rescue tool in Genie shows the default speech configuration setting, as indicated by the sign ↻ , and default strength setting.
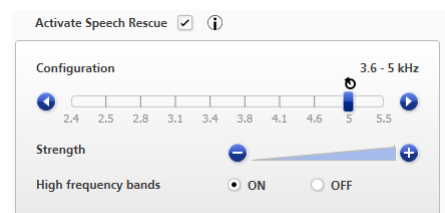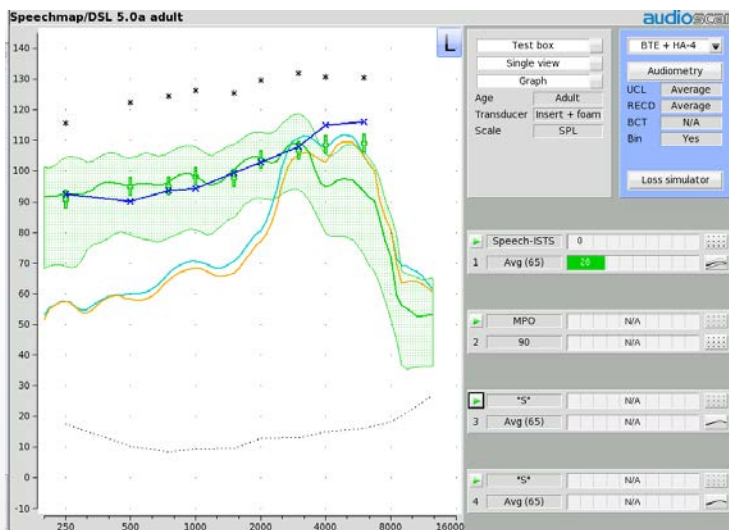

Figure 4: The default setting (orange) was fine-tuned by increasing the strength of Speech Rescue to maximize audibility of the /s/ stimuli (blue).

Considering Speech Rescue across settings

It may be possible to achieve audibility of the /s/ stimulus using various Speech Rescue settings. Therefore, the fitter may want to verify the hearing aid output using different configuration/strength combinations to ensure that /s/ audibility is maximized at the weakest possible setting (AAA, 2013). Exploration of different Speech Rescue settings is illustrated in the example presented below. Figure 5 explores what happens with the /s/ stimulus when the configuration setting is either increased or decreased by one step size. When the configuration frequency is increased to 5.5 kHz (Figure 5: pink line), audibility of /s/ is lost. Decreasing the configuration to 4.6 kHz (Figure 5: orange line) results in a higher sensation level of /s/, but is a stronger setting overall. Empirical trials are necessary to determine the impact of stronger versus weaker settings of Speech Rescue.

The role of high frequency speech band settings

The Speech Rescue algorithm applies lowering by re-creating a high frequency peak at a lower frequency region, while keeping the original signal in the output bandwidth. This is a "copy and keep" type strategy, which maintains the full bandwidth of the hearing aid. The frequency range above the destination band is referred to as the "high-frequency bands" in the Genie software. When the high-frequency band are turned OFF the output of all frequency channels above the end of the destination region is removed. Thus, the lower the configuration of Speech Rescue, the lower the cut-off frequency will be. The fitter has the option of turning the high-frequency bands OFF or leaving it ON during verification of a fitting. An example of measurements obtained with the high-frequency bands turned OFF can be seen in Figure 6. With the high-frequency bands turned OFF, aided sound above the destination region is filtered out, which is apparent in the verified aided speech signal, and may also sound different during a listening check.
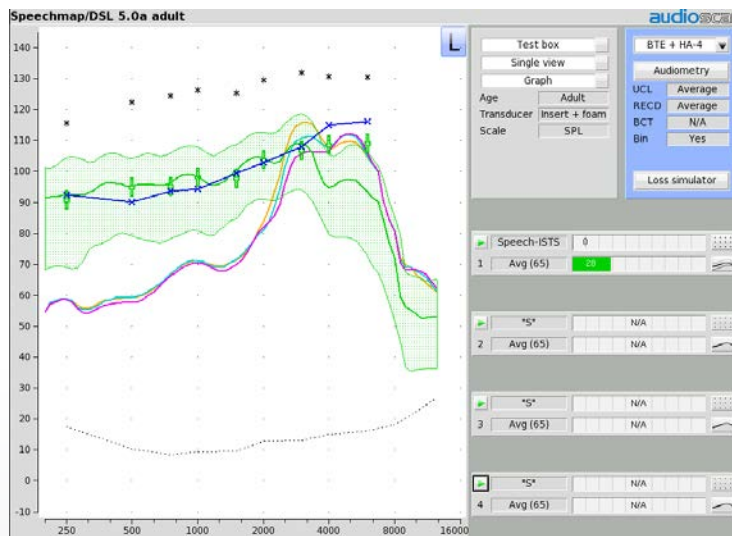

Figure 5: Exploring and fine-tuning the Speech Rescue settings further. The Speech Rescue configurations run with the /s/ stimuli at 65 dB with the configuration 4.6 kHz (orange), 5 kHz (blue) and 5.5 kHz (pink) kHz, all with a full strength setting.
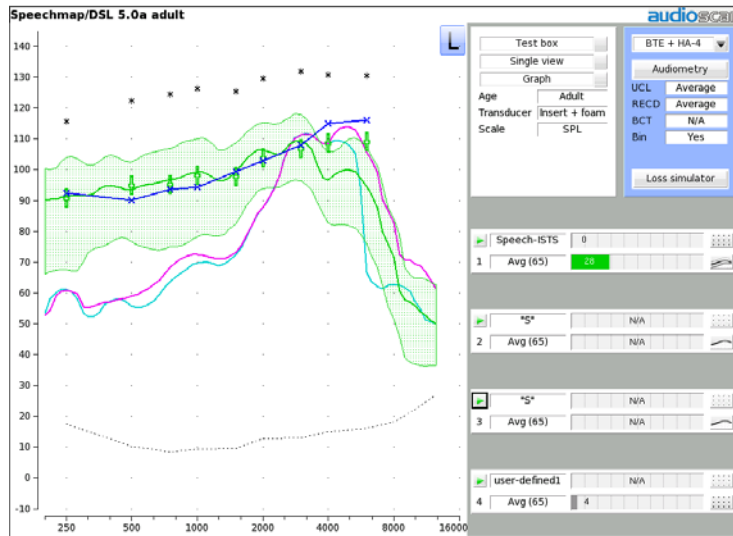
Figure 6: Illustration of the /s/ fine-tuned setting, with the high-frequency bands turned ON (pink) and OFF (blue).

Optional Fine-Tuning Steps

Further measurement using the calibrated /sh/ available in the Verifit 2 can assist in guiding appropriate /s-sh/ separation for a given fitting. Separation of /s/ and /sh/ may assist the listener in discrimination of these two sounds (Scollie et al., in press). Figure 7 illustrates the spectral separation for the setting chosen after completing Step 4 of the protocol (configuration setting: 5 kHz, Strength: maximum). We can observe that at this setting, the spectra of /s/ and /sh/ are at different levels and frequency locations, so we would expect good discrimination of the two sounds. A listening check can also be performed to assess the quality of running speech and to compare the sound quality of /s/ and /sh/ stimuli for different Speech Rescue settings. The fitter may consider whether /s/ and /sh/ sounds are distinguishable at a particular setting. When possible, listener feedback can assist in determining settings that offer acceptable sound.
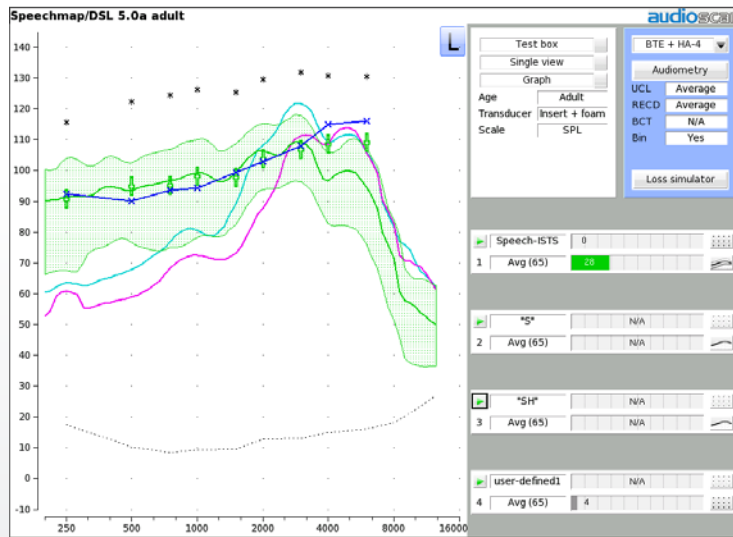

Figure 7: Measurements of the /s/ stimulus (pink) and /sh/ (blue) for the chosen Speech Rescue setting.

Assessing Candidacy in a Group of Listeners

Candidacy for the Speech Rescue Processor was further assessed, per ear, in 10 sample research participants at Western University. For this sample of 20 audiograms, Oticon Dynamo hearing aids were fitted using coupler-based verification in each ear independently. The hearing aids were fitted using the Desired Sensation Level v5 prescription. Ten audiograms were not deemed candidates for frequency lowering. Audiograms shown in Figure 8 (left) had /s/ audibility with Speech Rescue OFF. Thresholds at 4000 Hz ranged from 65 to 85 dB HL for these possible non-candidate audiograms. The ten audiograms for participants who were deemed candidates for frequency lowering are shown in Figure 8 (right). In these audiograms, the /s/ stimulus was below threshold with Speech Rescue OFF. The clinical step would be to enable Speech Rescue and fine tune following the protocol presented above. In general, the participants who required activation of Speech Rescue had thresholds at 4000 Hz that were 85 dB HL and poorer. Field trials were not completed with these participants and further studies are needed to determine if verification-based candidacy decisions align with real-world and perceptual outcomes.

Future directions

The verification protocol presented in this paper can be easily applied to Speech Rescue fittings. The steps outlined can assist the fitter in determining when to activate Speech Rescue and how to fine-tune the configuration and strength settings. The case example presented in this paper incorporated calibrated speech signals created at Western University that have been integrated into the Audioscan® Verifit 2 system. It may also be possible to use these calibrated stimuli with other hearing aid fitting systems when verifying frequency lowering fittings. Further research is needed to assess perceptual benefits obtained with Speech Rescue fittings with listeners with severe-to-profound hearing loss.
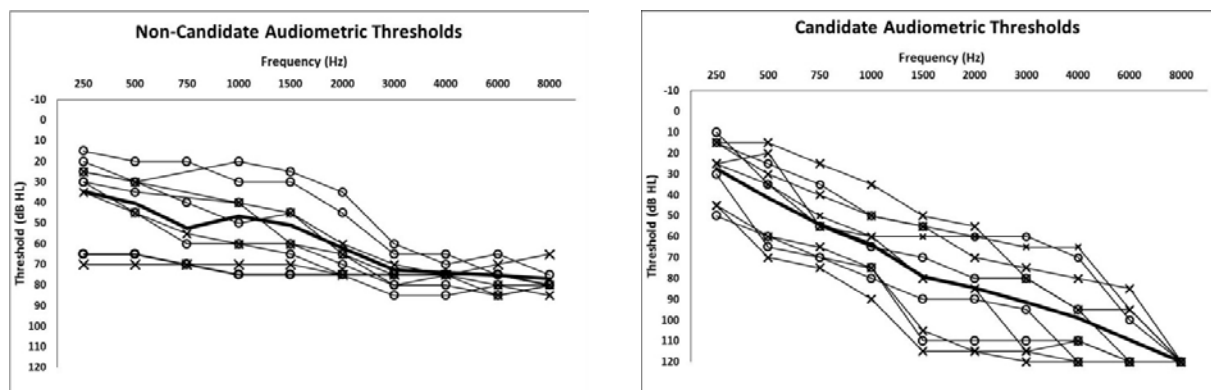

Figure 8. Audiograms of participants fitted with the Dynamo hearing aid that were not deemed candidates for Speech Rescue (left) and for those who were deemed candidates for Speech Rescue (right).The heavy black line on each pane indicates the average threshold of each group.

References

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