Learning Outcomes

After this course learners will be able to…

- Describe clearly the different methods manufacturers use to create a frequency lowering result.
- Identify when frequency lowering should be employed to enhance patient understanding of speech.
- Explain how to implement a step-by-step fitting procedure that programs frequency lowering for maximum patient benefit.

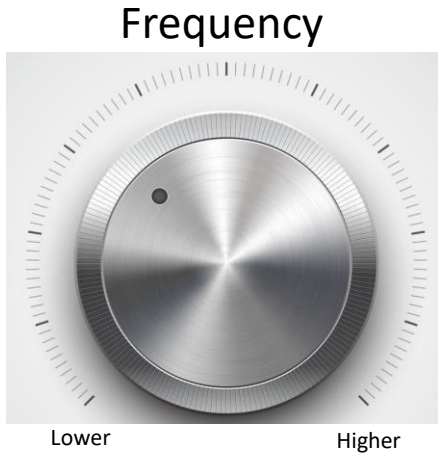
Outline For Today's Webinar

- An overview of frequency lowering and when to use it
- Types of frequency lowering approaches
- Goals of frequency lowering verification
- Frequency lowering fitting and verification protocol
- Frequency lowering and the SII score

Frequency Lowering: When to use it

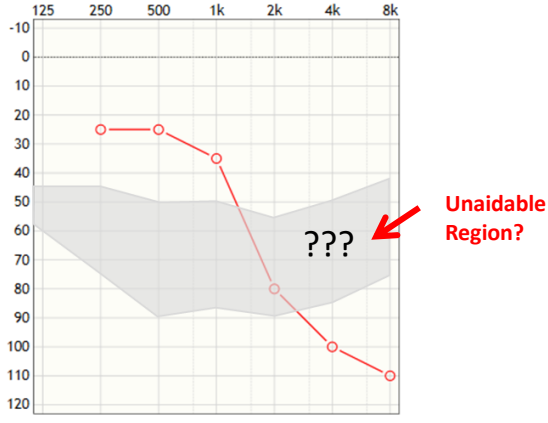
Frequency Lowering

- Process of shifting a range of input frequencies into a lower range of output frequencies
- Designed to improve the audibility of sounds for listeners with high frequency hearing loss



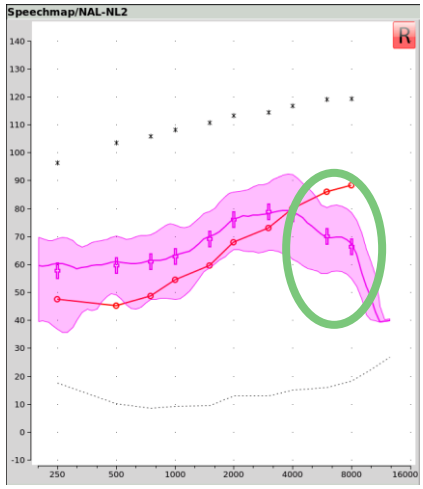
The Concept Behind Changing Output Frequency Content

- Some hearing losses have un-aidable regions where important speech information exists
- Re-positioning input energy in these regions to regions that are aidable can provide access to these important speech cues



When To Consider Frequency Lowering

- The area in the green circle has limited audibility (and may contain important speech cues)
- If Audibility cannot be restored
  - By adjusting gain, or
  - By selecting a different hearing aid
- This might be a time to consider frequency lowering



Frequency Lowering: Technological Approaches

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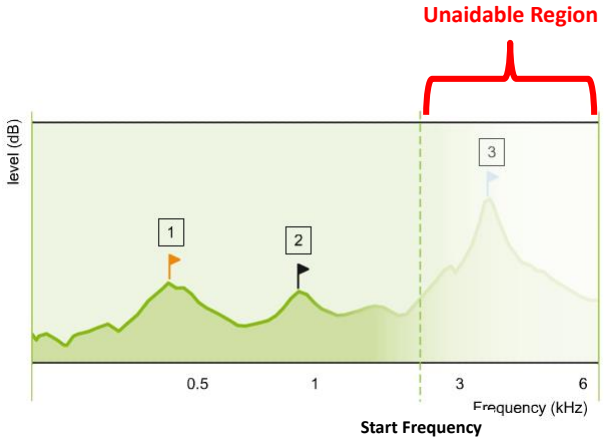
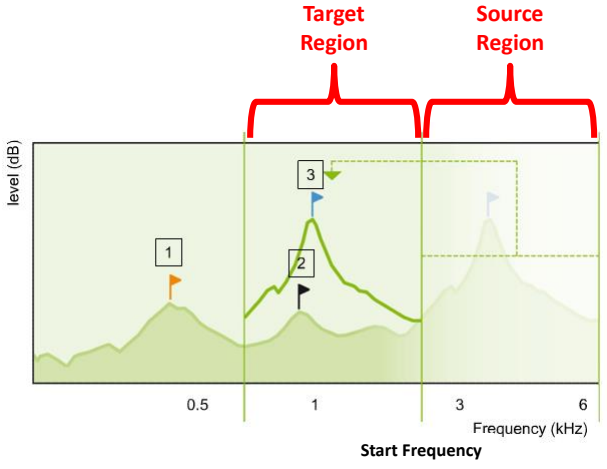
Approach #1: Frequency Transposition



With permisson from Christine Jones, Au.D., VP of Audiology for Phonak USA

Myirel Nyffeler, Speech Study Coordinator, Phonak Hearing Instruments, Switzerland, Phonak Virtual Audiology Conference, May, 2009

Approach #1: Frequency Transposition



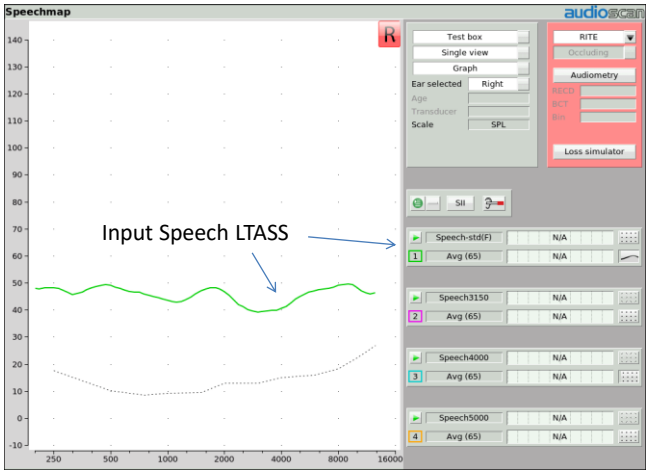
"Cuts" or "Copies" the input frequencies in the Source Region and "Pastes" them as output frequencies within the Target Region

With permisson from Christine Jones, Au.D., VP of Audiology for Phonak USA

Myirel Nyffeler, Speech Study Coordinator, Phonak Hearing Instruments, Switzerland, Phonak Virtual Audiology Conference, May, 2009

How Might This Look In A Test Box?

Consider the following input condition:



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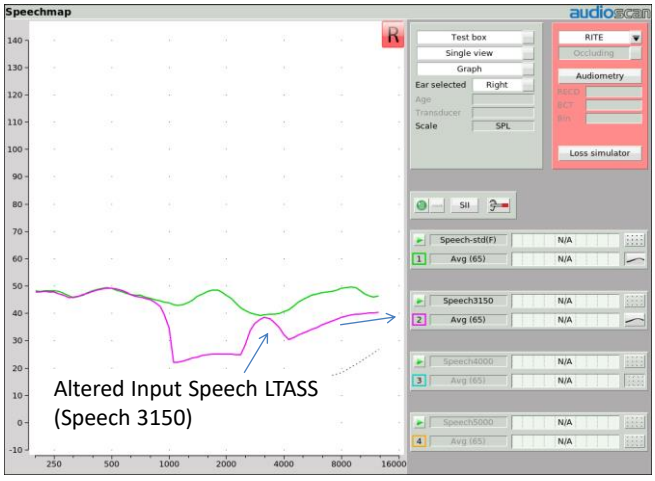

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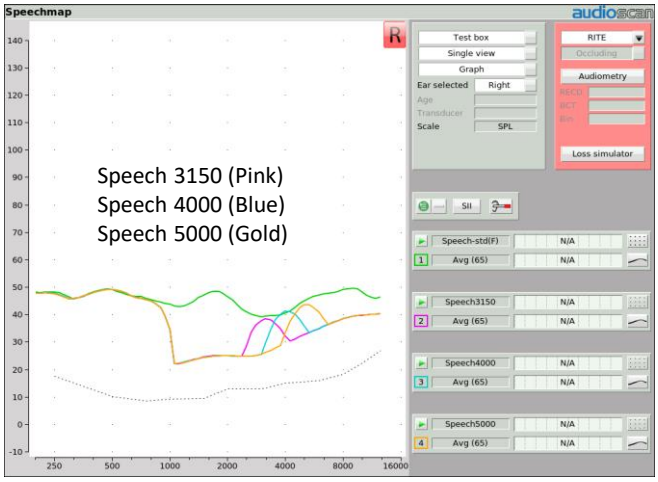

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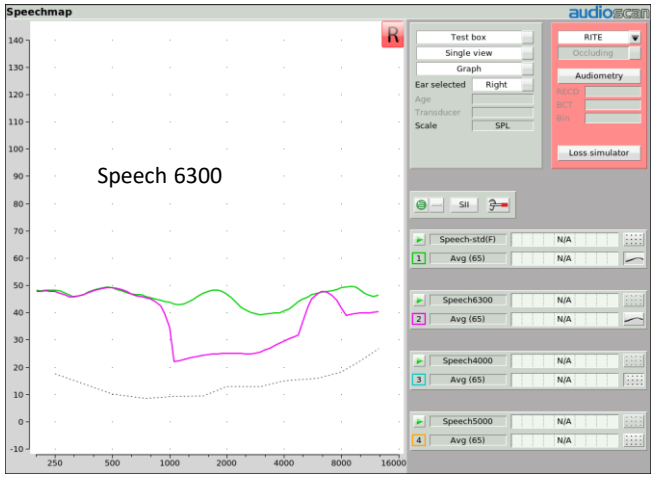
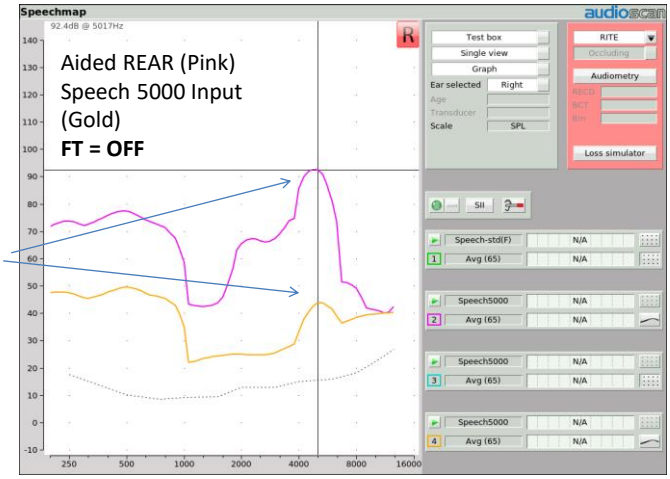


How Might This Look In A Test Box?

Here is how these stimuli can be used to “display” frequency transposition:

Note alignment of 5000Hz “hump”



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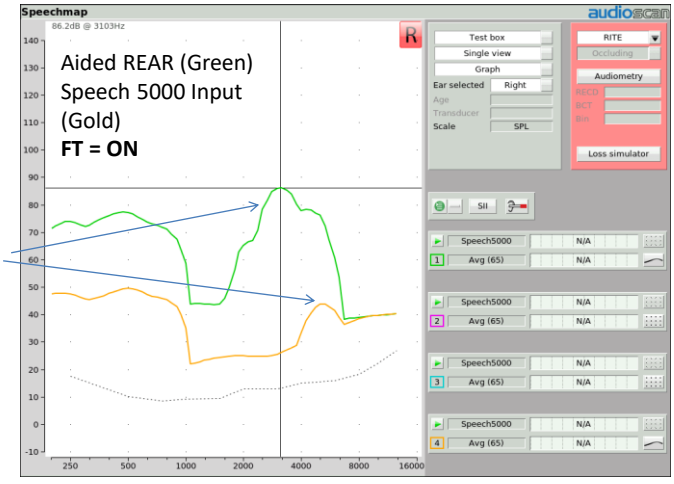
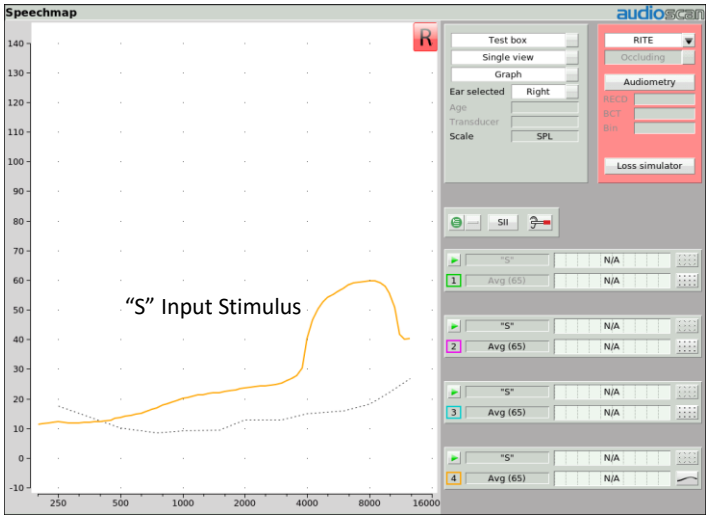
Note transposition of 5000Hz “hump”



Another Stimulus Option For FL Verification

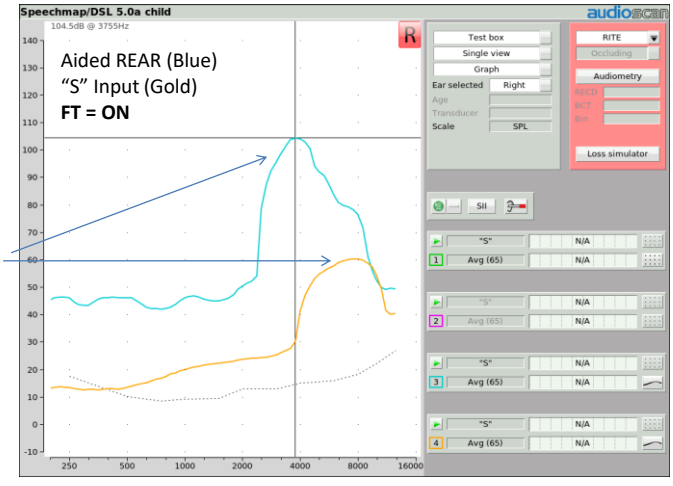


Glista, D., & Scollie, S. (2009). Modified verification approaches for frequency lowering devices. *AudiologyOnline,* Article 871. Retrieved from www.audiologyonline.com

How Might This Look In A Test Box?

Here is how the "S" stimulus can be used to "display" frequency transposition:

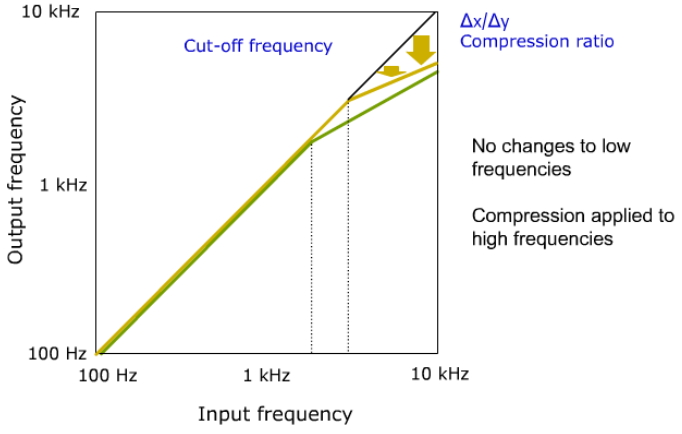
Note transposition of "S" hump



Frequency Transposition Can Be Found In

- Widex (Audibility Extender)
  - Use a “Cut” and “Paste” Approach
- Oticon (Speech Rescue)
  - Uses a “Copy” and “Paste” Approach

Approach #2: Frequency Compression



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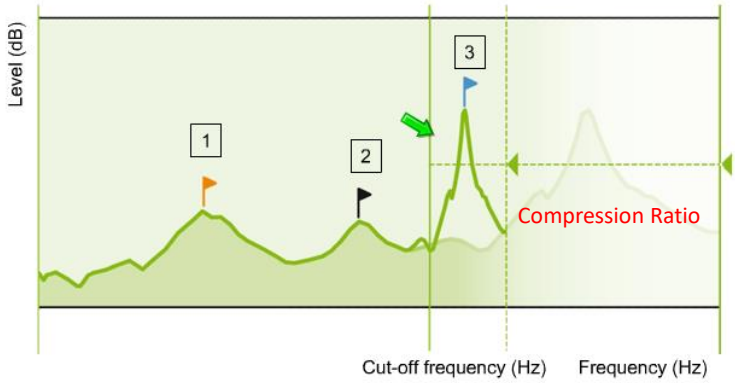
Approach #2: Frequency Compression



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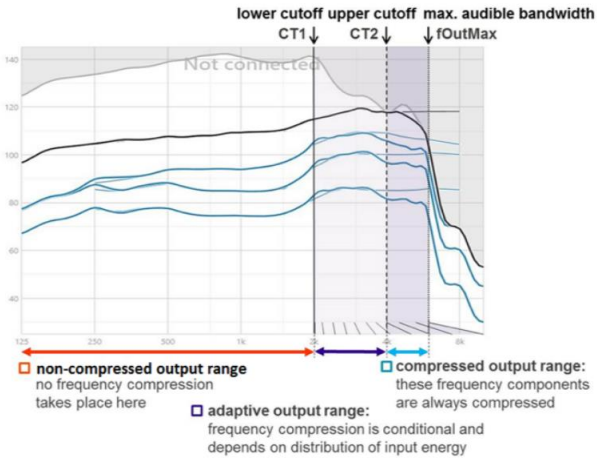


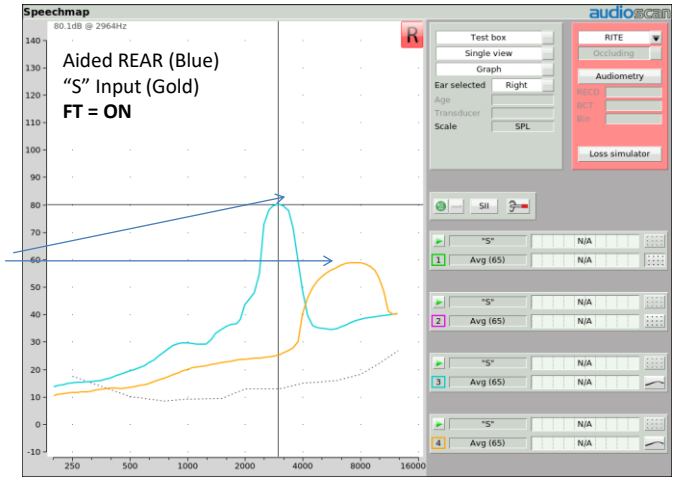
With permisson from Christine Jones, Au.D., VP of Audiology for Phonak USA

https://www.hearphonak.com/soundrecover-2-help-children-teens/

How Might This Look In A Test Box?

Here is how the "S" stimulus can be used to "display" frequency compression:

Note relocation of "S" hump



Frequency Compression Can Be Found In

- Phonak (Sound Recover)
- Sivantos (FC)
- Unitron

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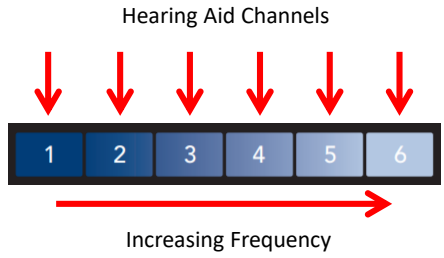
Approach #3: Frequency Translation

- Let's start with the following illustration:
  - Imagine that this image represents hearing aid channels
  - The higher channel numbers represent increasing frequencies



https://starkeypro.com/pdfs/technical-papers/Spectral_iQ_Technical_Paper.pdf

With permisison from Jeff Crukley, Ph.D. Senior Research Scientist, Starkey Labs

Approach #3: Frequency Translation

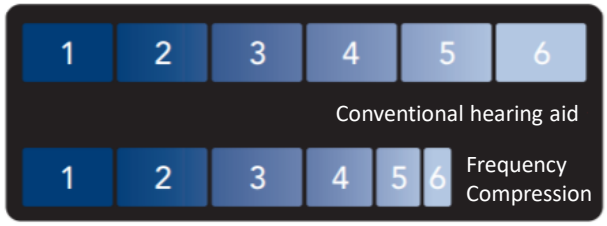
- Then, this is how frequency transposition could be represented

https://starkeypro.com/pdfs/technical-papers/Spectral_iQ_Technical_Paper.pdf

With permission from Jeff Crukley, Ph.D. Senior Research Scientist, Starkey Labs

Approach #3: Frequency Translation

- And, this is how frequency compression could be represented

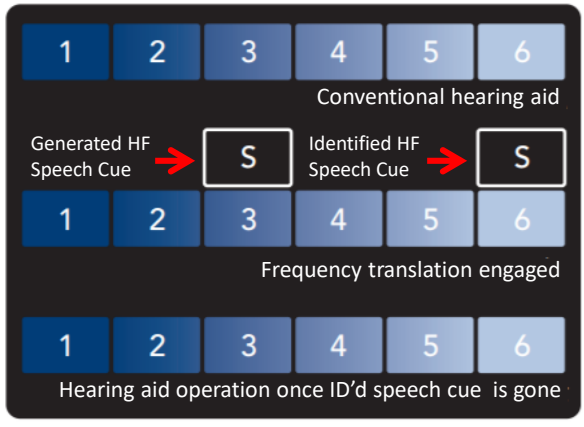


https://starkeypro.com/pdfs/technical-papers/Spectral_iQ_Technical_Paper.pdf

With permission from Jeff Crukley, Ph.D. Senior Research Scientist, Starkey Labs

Approach #3: Frequency Translation

- Based on these representations, here is how frequency translation is designed to function



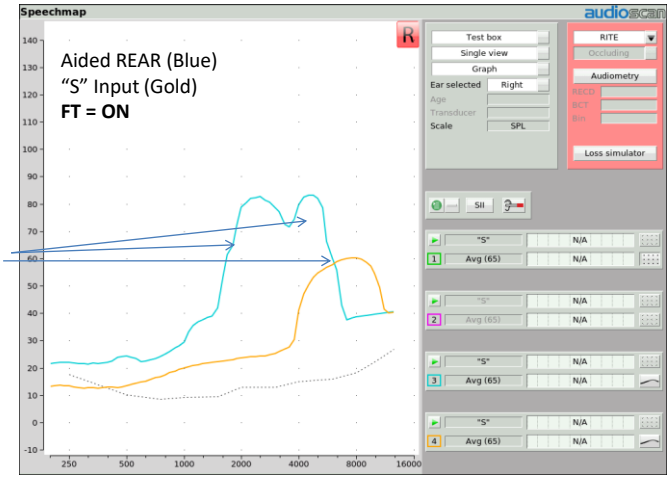
https://starkeypro.com/pdfs/technical-papers/Spectral_iQ_Technical_Paper.pdf

With permission from Jeff Crukley, Ph.D. Senior Research Scientist, Starkey Labs

How might this look in a test box?

Here is how the “S” stimulus can be used to “display” frequency translation:

Note relocation of “S” hump AND maintenance of original “S” energy (within the H.A.’s output bandwidth)



Frequency Translation Can Be Found In

- Starkey (Spectral IQ)

Frequency Lowering: Verification Protocol

Goals of Frequency Lowering Verification

- To objectively determine frequency lowering candidacy

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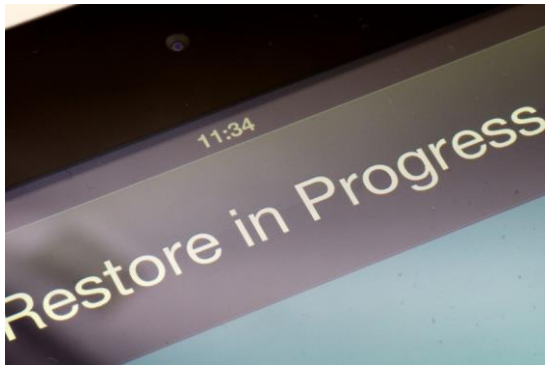
Goals of Frequency Lowering Verification

- Confirm restoration of audibility for missing target speech cues
- Confirm restoration accomplished with minimal impact on the original audible bandwidth
- Accomplish the above two goals regardless of frequency lowering approach used

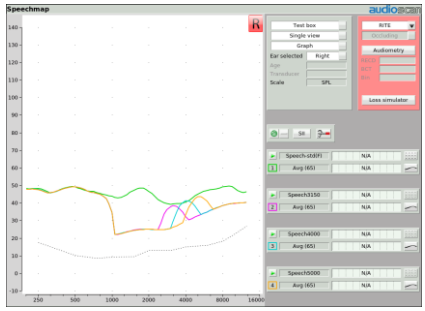


Stimulus Options

- Live “S” and “SH” produced by testing clinician:
  - Advantages:
    - Represents critical phonemes important to capture when frequency lowering is being used
    - Easily produced
  - Disadvantage:
    - Not presented at a calibrated spectrum and level, thus subject to inter-test variability

Stimulus Options

- The Audioscan "filtered" carrot passage input options:
  - Advantage:
    - Calibrated and pre-stored in system, eliminating issue of inter-test variability
  - Disadvantages:
    - Bandwidth narrower than the frication bandwidth of naturally produced "S" and "SH"
    - Based on LTASS level rather than peak level
    - May underestimate delivered audibility



Stimulus Options

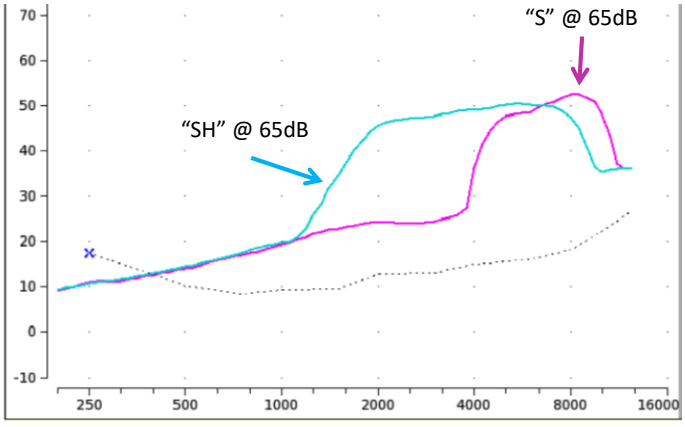
- Calibrated and stored "S" and "SH" stimuli
  - Advantages
    - Delivers a more representative bandwidth of these fricatives
    - Captures peak energy level components that contribute to overall audibility
    - Stored and calibrated for solid test-retest reliability

Method For Creating Calibrated Fricative Stimuli

- Excised fricatives from the ISTS signal
  - Multiple talkers and running speech
- Compared these fricatives to other clinically produced signals
  - Single talker and isolated fricative production
- This led to a solid definition of the frequency range and energy levels of interest for each phoneme
- White noise was then shaped to fabricate these targeted bandwidth and energy level components.

Scollie, S., et. al., (2016) Fitting Frequency-Lowering Signal Processing Applying the American Academy of Audiology Pediatric Amplification Guideline: Updates and Protocols – J Am Acad Audiol 27:219-236

The "S" and "SH" Input Stimulus Spectra

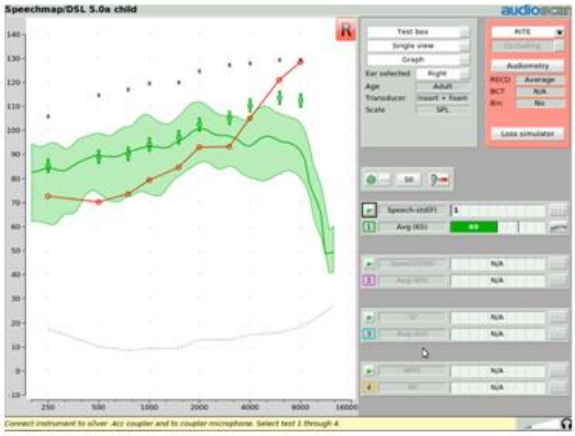


Scollie, S., et. al., (2016) Fitting Frequency-Lowering Signal Processing Applying the American Academy of Audiology Pediatric Amplification Guideline: Updates and Protocols – J Am Acad Audiol 27:219-236

Clinical Procedure

Step One:

- Complete a Speechmap verification fitting
  - Ensure that any frequency lowering feature has been turned OFF during this process
  - Isolate and display the 65dB REAR image



Clinical Procedure

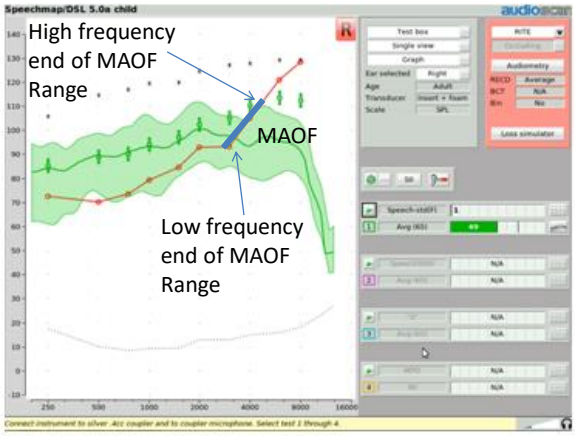
Step Two:

- With noise reduction OFF, determine if this fitting restores audibility for the "S" stimulus at 65dB SPL input level
  - If not, your options are:
    - Add more high frequency gain until "S" audibility has been restored
    - Switch to a different hearing aid that may be capable of delivering this additional gain
    - Activate frequency lowering to move the "S" stimulus into an aidable frequency area

Clinical Procedure

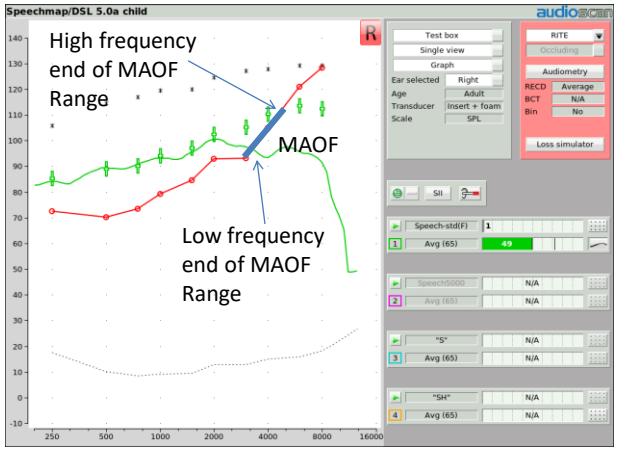
Step Three:

- Identify the MAOF Range
  - (Maximum Audible Output Frequency)
  - Low frequency end of the MAOF Range = frequency where aided LTASS crosses under threshold
  - High frequency end of the MAOF Range = frequency where the peaks of speech (99th percentile line) crosses under threshold



Activating the Audioscan MAOF "Highlighter"

- Select a test and activate the "S" stimulus option (as before)
- While test is running, open the "Show MAOF" pull-down menu
- Select the 65 dB REAR you wish to use to identify the target MAOF Range
- This will automatically display a highlighted area on the audiogram that is the MAOF Range



Clinical Procedure

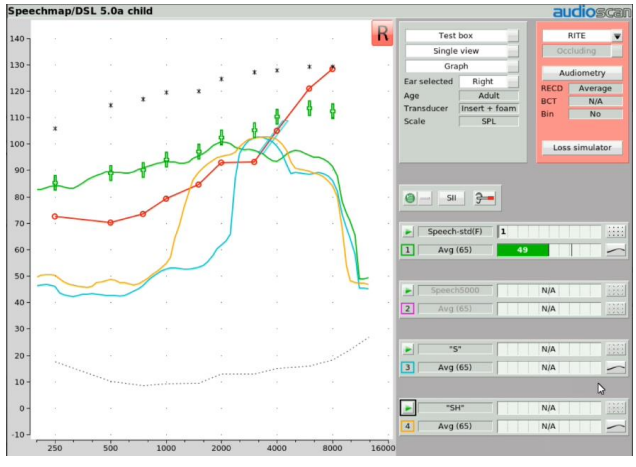
Step Four:

- Turn frequency lowering feature ON at its default settings
- Check for audibility of “S” stimulus
  - Target positioning the upper shoulder of the “S” stimulus within the MAOF Range
- If default settings don’t achieve target positioning, adjust the FL feature until target positioning has been acquired

Clinical Procedure

Step Five:

- Activate another test, now using the “SH” stimulus instead of the “S” stimulus
- Check for the following:
  - That the “SH” stimulus is also audible
  - That the “SH” audibility spectrum is different than the “S” audibility spectrum



Clinical Procedure

Step Six:

- Perform a listening check
  - Determine whether the sound quality and distinctiveness of speech are acceptable

Clinical Procedure

Step Seven:

- Re-enable noise reduction if this is a component of the fitting

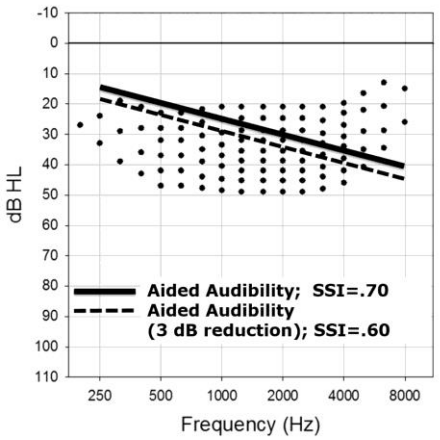
Fitting and Post Fitting:

- At Fitting and Follow up, consider listener's responses, and/ or outcome measures re: perceived sound quality & ability to distinguish "S" and "SH".
- Inform caregivers and/or therapists of the altered sound quality that has now been engaged

Frequency lowering and the SII score

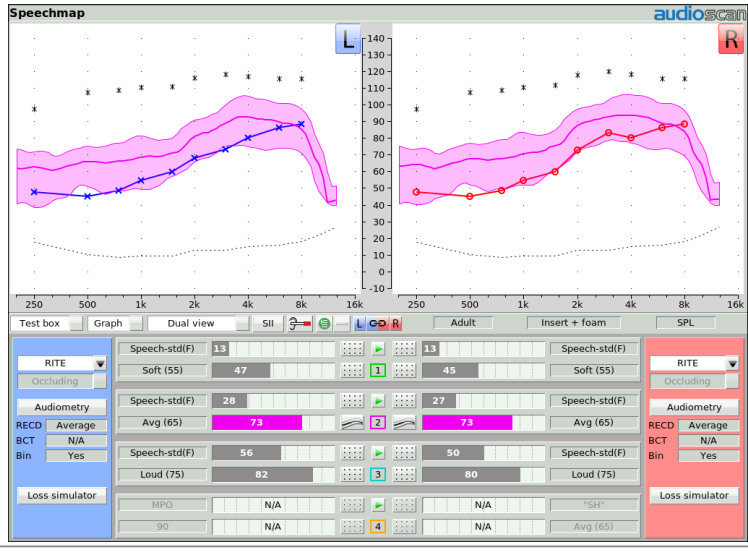
What Is SII?

- Quantifies likely intelligibility based on the audibility of various speech cues



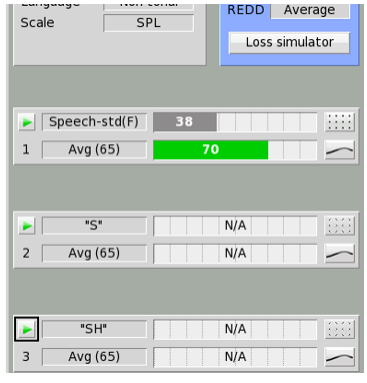
Killion MC, Mueller HG. Twenty years later: A NEW Count-The-Dots method.*Hear Jour.* January 2010; 63(1):10-17.

Aided and Unaided SII Inside of Speechmap



SII Scores Do Not Appear With "S" and "SH"

- Main Reason:
  - These stimuli do not produce an aided broadband speech result - which is what the SII calculation is designed to quantify

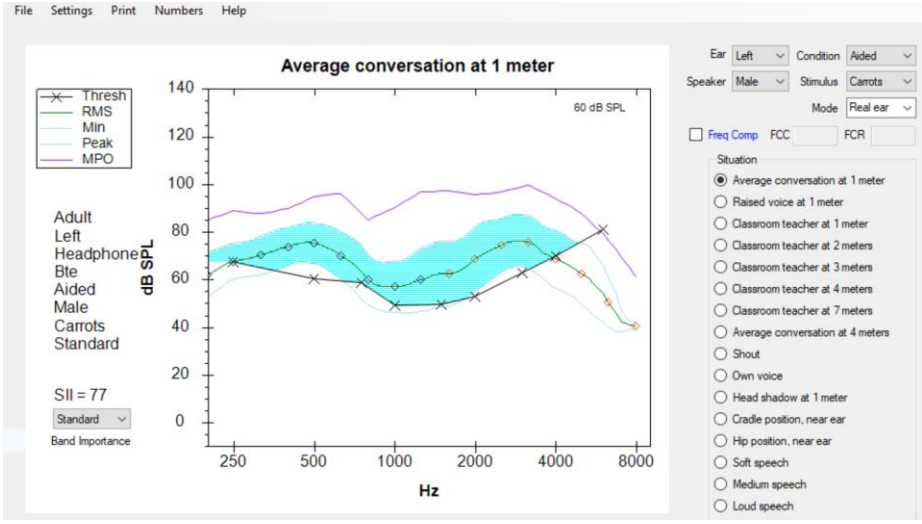


The SHARP Audibility Estimates with Nonlinear Frequency Compression

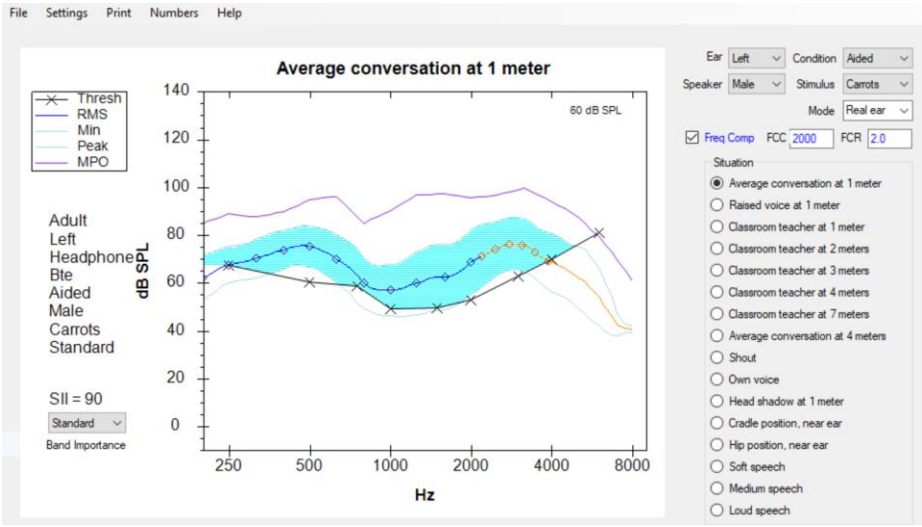
- The "Situational Hearing Aid Response Profile"
- Developed at the Boys Town National Research Hospital
- Added a frequency lowering intelligibility estimate feature in 2014

https://journals.lww.com/thehearingjournal/Fulltext/2014/03000/SHARP_Updates_Enable_Audibility_Estimates_with.7.aspx

Conventional SHARP Display



SHARP Display With "Freq Comp" Selected



To Summarize:

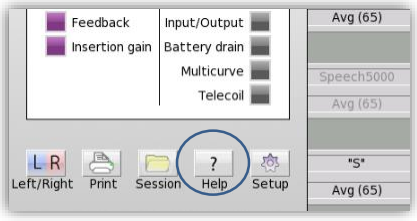
- Frequency lowering can be activated to restore audibility for speech sounds that may fall outside of a patient's aidable frequency range
- Several methods of applying frequency lowering are available
  - Frequency transposition
  - Frequency compression
  - Frequency translation

To Summarize:

- Verification technology can be used to:
  - Objectively determine frequency lowering candidacy
  - Adjust frequency lowering settings to restore audibility for important speech cues with minimal interference with the existing aided bandwidth
  - Verify sound quality and distinctiveness
  - Aid in counseling

Follow-Up

- For additional information on frequency lowering verification:
  - Visit the education section of the Audioscan website (www.audioscan.com)
  - Consult the User Guide of your Audioscan verification equipment




Education
The Science of Hearing Aid Fitting
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