2017 Signia Expert Series

July 11, 2017 at 12 PM ET

Over-the-counter hearing aids - opportunity or disaster?

Presented by Catherine Palmer, Ph.D.

How to position your practice and your thinking to embrace over-the-counter hearing aid sales will be discussed. Strategies to engage patients at all points of entry into hearing health care will be explored based on the current evidence base.

August 3, 2017 at 12 PM ET

Hearing aid speech mapping verification: Some explanations for puzzling outcomes.

Presented by H. Gustav Mueller, Ph.D.

Speech mapping has become a routine method to verify prescriptive fittings. Sometimes, however, things just don't look right, and we wonder… is it the equipment, the hearing aid, the patient, or me? In this course, we'll take a look at some of these unusual findings, and see if we can determine who the culprit really is.

August 16, 2017 at 4 PM ET

Tinnitus Activities Treatment.

Presented by Richard Tyler, Ph.D.

This protocol is focused on collaborative counseling in the four areas affected by tinnitus: thoughts and emotions, hearing, sleep, and concentration. Principles of cognitive behavior therapy, acceptance and mindfulness, are included. TAT is picture-based to facilitate ease and interaction with client. Low-levels of partial masking are included.

August 25, 2017 at 12 PM ET

Nonlinear Frequency Compression for the Busy Clinician.

Presented by Joshua Alexander, Ph.D.

The purpose of this talk is to empower the busy clinician by reviewing the hearing aid fitting process as it relates to nonlinear frequency compression. Goals for using frequency lowering for different hearing losses will be reviewed, factors that may influence its effectiveness will be briefly described, and general guidelines for verification using probe microphone measurements will be discussed.

Nonlinear Frequency Compression for the Busy Clinician

Joshua M. Alexander, Ph.D.

- This course is offered for Continuing Education Units (CEU)s for Total Access Online members.
  - Stay logged in for the duration of the course to be eligible to earn CEU credit.
  - Take the exam following course completion to earn credit.
  - For questions or assistance, contact 800-753-2160.
- Please visit the AudiologyOnline website for other live and recorded events from Signia.

  http://www.audiologyonline.com/ce/signia-siemens

Hearing Systems

SIEMENS

Course Objectives

1. After this course, participants will be able to identify potential candidates for nonlinear frequency compression.
2. After this course, participants will be able to describe the advantages and disadvantages of nonlinear frequency compression.
3. After this course, participants will be able to describe the goals in selecting the most appropriate nonlinear frequency compression settings and how to verify that these goals have been met.

Hearing Systems

SIEMENS

Joshua M. Alexander, Ph.D.

Nonlinear Frequency Compression for the Busy Clinician

Joshua M. Alexander

Ph.D., CCC-A

www.tinyURL.com/FLassist

PURDUE UNIVERSITY

Hearing Aid Fitting Process

- **Rehabilitation Plan – *6 stages***
  1. Assessment
  2. Planning
  3. Selection
  4. Verification
  5. Orientation
  6. Validation

Pre-Fitting (1–3) → **Benefit**

Fitting (4–5) → **Benefit**

Benefit → Post-Fitting (6)

(ASHA Ad Hoc Committee on Hearing Aid Selection and Fitting, 1998)

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Assessment & Planning

- *Type and magnitude of hearing loss*
- *Candidacy for frequency lowering*
- *Areas of need and potential benefit*

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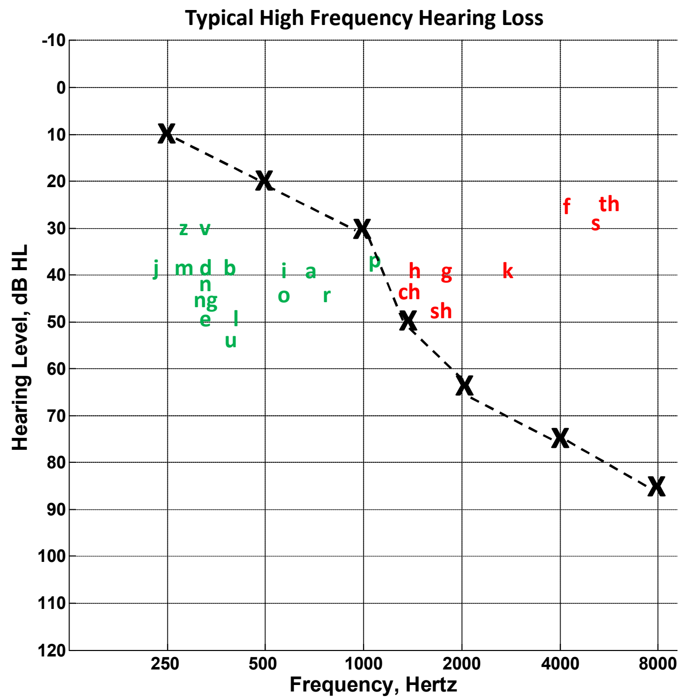

Typical High Frequency Hearing Loss
Hearing Level, dB HL
Frequency, Hertz
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
250
500
1000
2000
4000
8000
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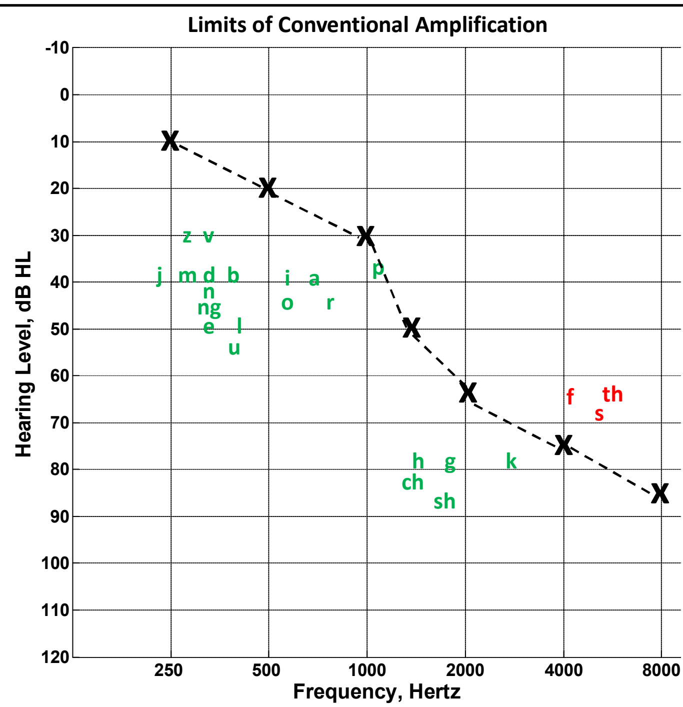

Limits of Conventional Amplification
Hearing Level, dB HL
Frequency, Hertz
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
250
500
1000
2000
4000
8000
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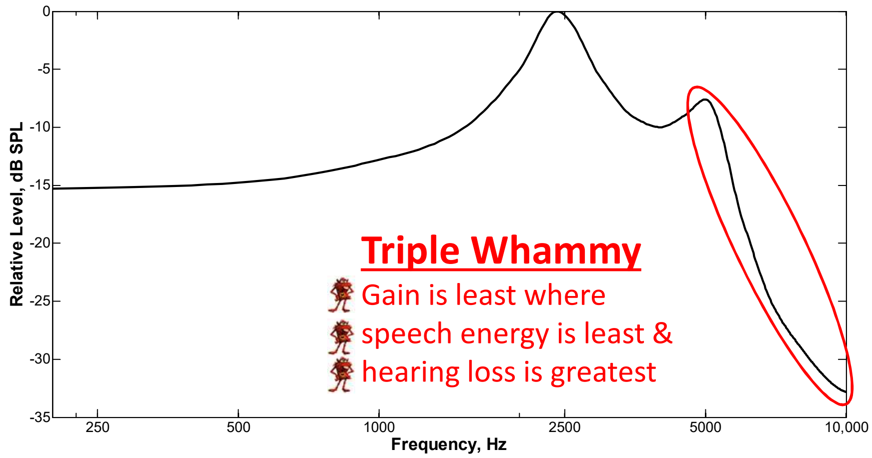
Typical HA Receiver Response



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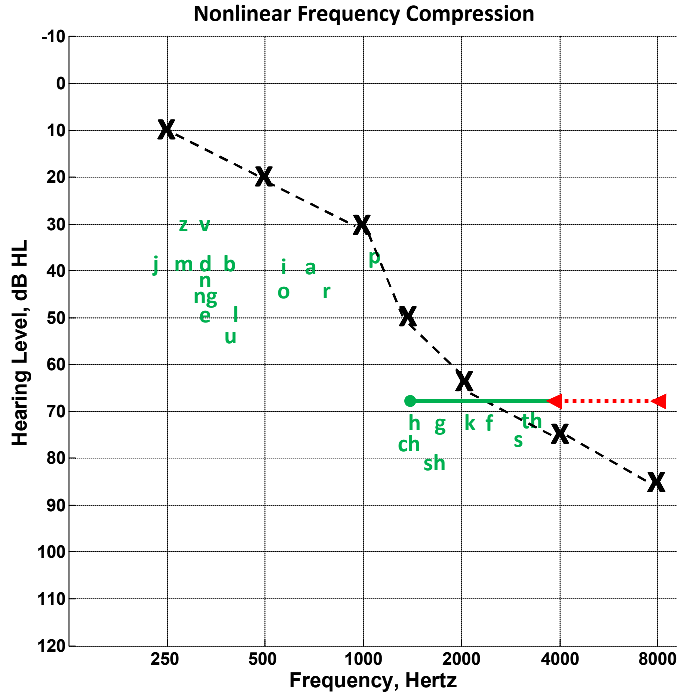
Nonlinear Frequency Compression



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Candidacy

- **Expected outcomes** vary depending on **severity of loss**
  - Moderately severe or greater loss
  - Precipitous high-frequency loss
  - Mild to moderate loss

- Influenced by the information we hope to 'recover' from the speech spectrum
  - **Different needs/goals** for different hearing losses

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Moderately Severe Losses (or worse)

- Limitations in hearing aid **gain and feedback**
  - Important mid-frequency information is inaudible
- High-frequency **dead regions**
  - May not make as effective use of amplified high-frequency **speech-in-quiet** and may even **perform worse** when made audible
    - E.g., Moore, 2004; Baer *et al*., 2002; Vickers *et al*., 2001
- **Possible goals for outcomes**
  1. Provide users with information that is normally available to those with less severe hearing loss (~5kHz)
  2. Avoid dead regions

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Precipitous Losses

- Need help that conventional amplification cannot provide
  - **Marginal candidates** for amplification
  - **Limited frequency range** with which to amplify speech because of difficulty getting sufficient gain in regions of hearing loss
    - **Too normal** to amplify and **too severe** to amplify

- **Possible goals for outcomes**
  - Help users make better use of a very limited residual bandwidth of audibility (e.g., < 2000 Hz)

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Limitations in Candidacy

- Most nonlinear frequency compression algorithms **do NOT lower frequencies < 1500 Hz**
  - Done intentionally to limit the amount of degradation to sound quality and pitch that results when low-frequency harmonics are altered

- **There must be a region of *aided* audibility above 1500 Hz**
  - Someone with severe or profound loss starting at 1500 Hz or lower is NOT a candidate for '*conventional*' nonlinear frequency compression

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Mild to Moderate Losses

- **Rationale for frequency lowering**
  - Provide users with information that is beyond the bandwidth normally achievable with conventional amplification (>5 kHz)
  - **Improve perception (and production) of fricatives, especially /s/**
  - *Possibly* reduce listening fatigue and improve sound quality by providing a fuller, richer signal

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Importance of High Frequencies

- High occurrence of fricatives/affricates that carry significant morphological importance in English
- Developmental delays
  - **Fricative/affricate production** in toddlers, despite early amplification (Moeller *et al.*, 2007)
  - **Morpho-syntax** in 5-7 year-olds identified late, especially for the morpheme /s/ (Moeller *et al.*, 2010)
- Other potential benefits of extending bandwidth
  - Speech recognition, novel word learning by children, speech clarity and music quality, listening effort, localization, spatial unmasking

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Candidacy Summary

- **Loss ≥ Moderately-severe**
  - Go ahead, but be careful of distorting low frequencies
  - **WARNING!** If the hearing aid has NFC, it might default to "ON" for certain audiometric configurations

- **Loss ≤ Moderate**
  - Do **not** base hearing aid selection on whether it has NFC
    - There are **other important considerations**: cost, wireless connectivity, etc.
    - If the hearing aid you select has NFC, it might be worth trying (*i.e.*, experimenting)

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To Fit or Not to Fit

- Ultimately, a decision has to be made whether the **potential pros** outweigh the **cons**
  - *Does the patient experience speech perception deficits with conventional amplification, despite your **best efforts** to achieve high-frequency audibility?*

- If the decision is to fit, there are a few things to ask:
  1. *How does the technology of choice work?*
     - **Fundamental differences between manufacturers**: techniques, terminology, adjustments, etc.
  2. *How much of the lowered information is **audible**?*
  3. *Can the patient **use** the lowered information?*

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Selection

- *Choosing the frequency lowering technology whose electroacoustic characteristics are most likely to address the* ***areas of need*** *and result in benefit*

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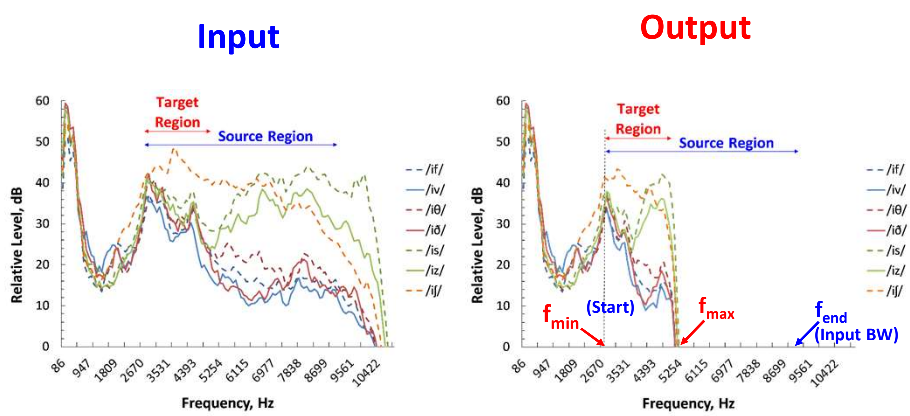
Nonlinear Frequency Compression



(Alexander & Rallapalli 2017)

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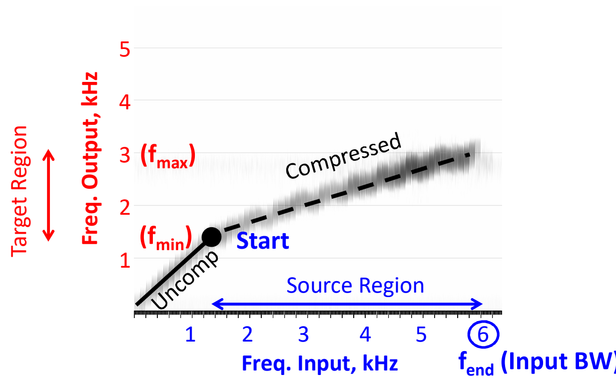
Nonlinear Frequency Compression (NFC)



- Adjustable start frequency (f_{min}) and CR (f_{max})
- **Key feature is that frequencies below the start are unaltered**

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NFC Differs between Manufacturers

- What does "*nonlinear*" mean anyway???

- From the start frequency, the input-output frequency relationship is **defined by the compression ratio** (CR)
  - Higher CRs = greater reduction of source bandwidth
  - The *mathematical* relationship on a Hz scale is

1. **Nonlinear** (but linear on a log scale) – Phonak/Unitron
2. **Linear** – ReSound
3. **Other** – Signia

CR is not compatible across manufacturers!
Cannot apply same settings when switching brands and expect the same output.

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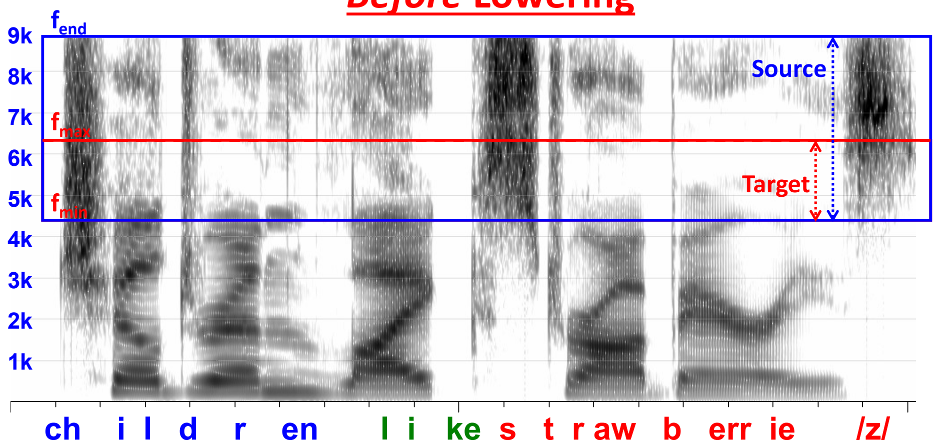
NFC for Mild-Moderate Loss

***Before* Lowering**



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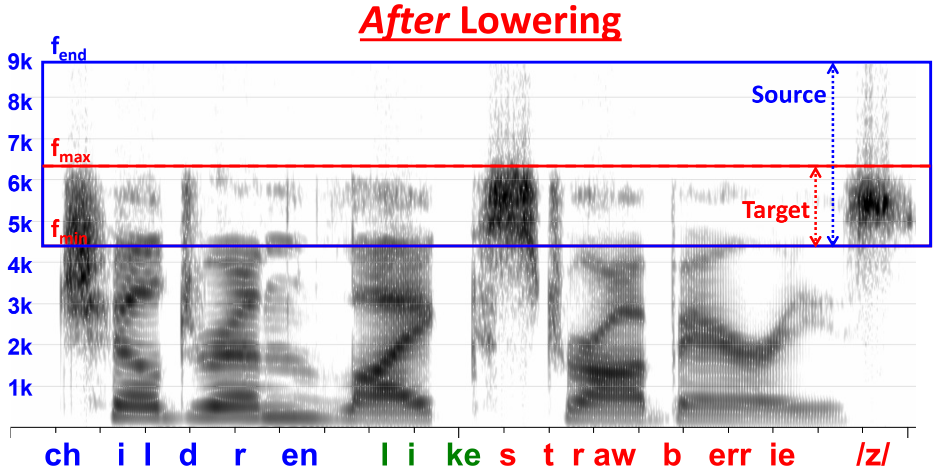
NFC for Mild-Moderate Loss

***After* Lowering**



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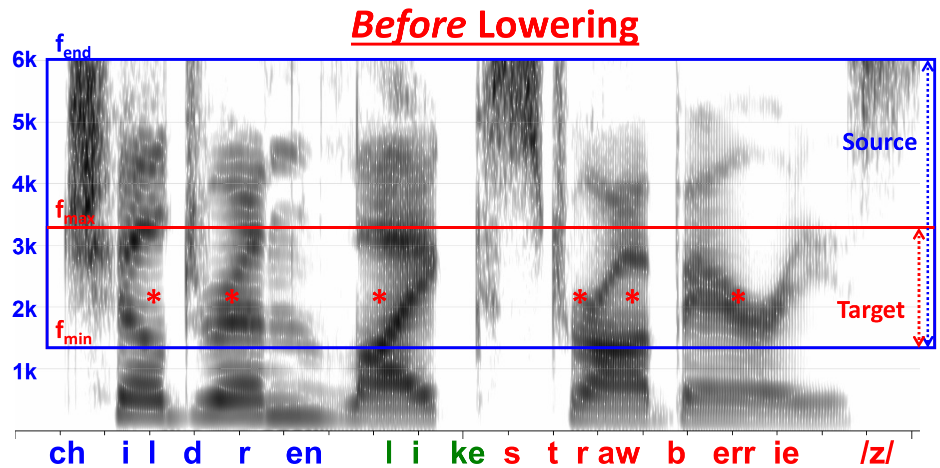
NFC for Moderately Severe Loss



* *Formant transitions*

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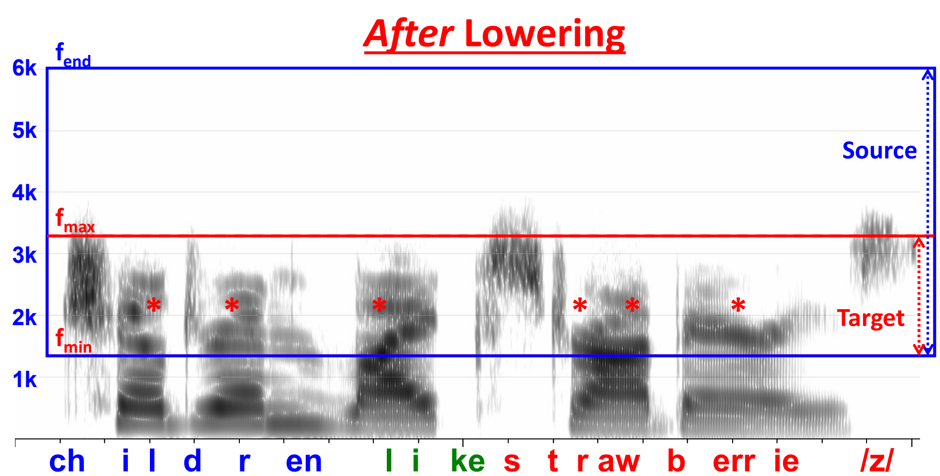
NFC for Moderately Severe Loss



* *Formant transitions (now flattened)*

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Potential Side Effects

- While the speech code is relatively 'scale invariant,' it is heavily dependent on frequency
  - No hearing aid feature has as much potential to change the **identity of individual speech sounds**
  - Potential to make speech understanding worse because **low-frequency information has to be altered** to accommodate displaced high-frequency information

- **Re-coded information must go somewhere**
  - Regions that otherwise would be amplified normally
  - Concern is not so much fidelity of re-coded information as it is **newly introduced distortion** and **sound quality**

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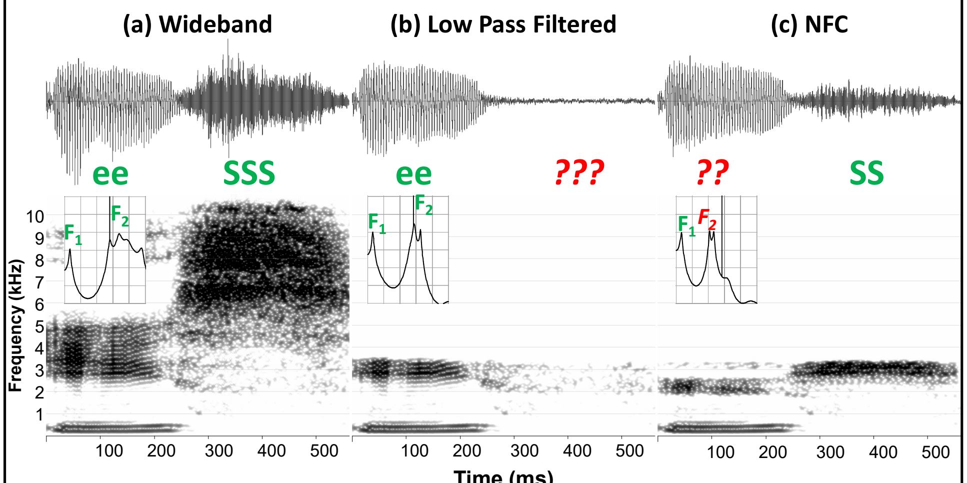
Potential Pros vs. Cons



(Alexander, 2016)

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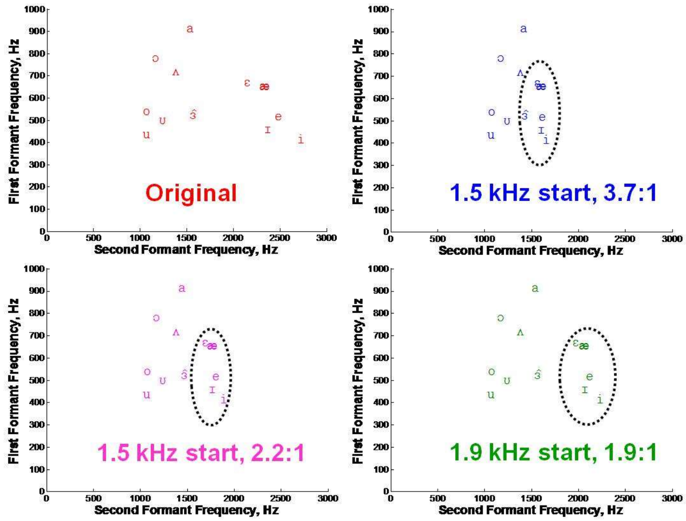
Side Effects

Formant alteration, vowel reduction with **low start (f_{min})**



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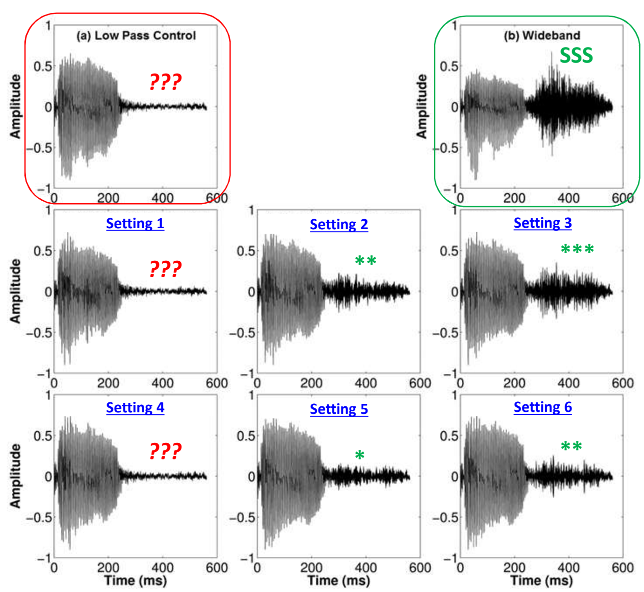
Settings vary Potential Pros vs. Cons



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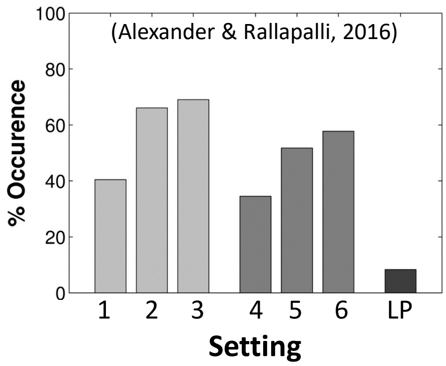
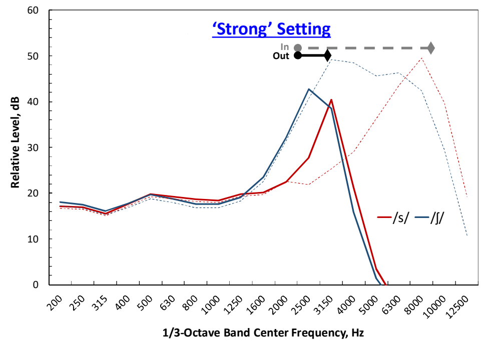
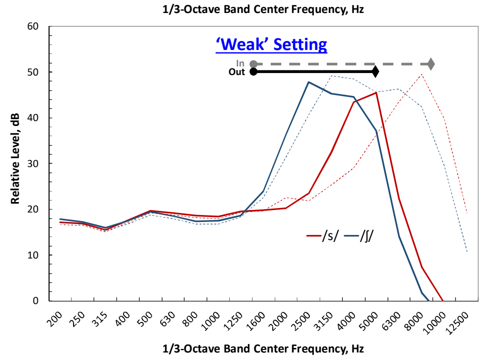
(Rallapalli & Alexander, 2016)

/ʃ/ for /s/ Confusions







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Verification

- *Probe microphone measurements to guide programming of different frequency lowering techniques for individuals*

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To Fit or Not to Fit

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Importance of Probe Mic Measures

With the possibility of **side effects** causing 'harm,' if you plan to fit a hearing aid with NFC, you must **know what you are delivering to the patient**

"I stopped taking the medicine because I prefer the original disease to the side effects."

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Primary Goals for Probe Mic Measures

1. The audible bandwidth after NFC is activated should not be less than it was before it was activated
   - **Do not unnecessarily restrict the audible bandwidth**
2. The lowered information should be audible
3. The 'weakest' NFC setting should be used to accomplish your *objective*
   - **Frequency Lowering Fitting Assistants:** www.tinyURL.com/FLassist

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Protocol for Fitting NFC Hearing Aids

1. **Deactivate frequency lowering** and fit hearing aid to targets using probe mic as for a conventional aid

2. Find **maximum audible output frequency**, MAOF
- The highest frequency at which output **exceeds threshold** on the SPL-o-gram (Speechmap)
- **Activate NFC** and position the lowered speech in the audible bandwidth (MAOF) while not reducing it further
  - Most of the target region should be **audible**
  - **Avoid too much lowering**, which will unnecessarily restrict the bandwidth you had to start with and **reduce intelligibility**

3. **Verify** that the MAOF is reasonably close to what it was when it was deactivated

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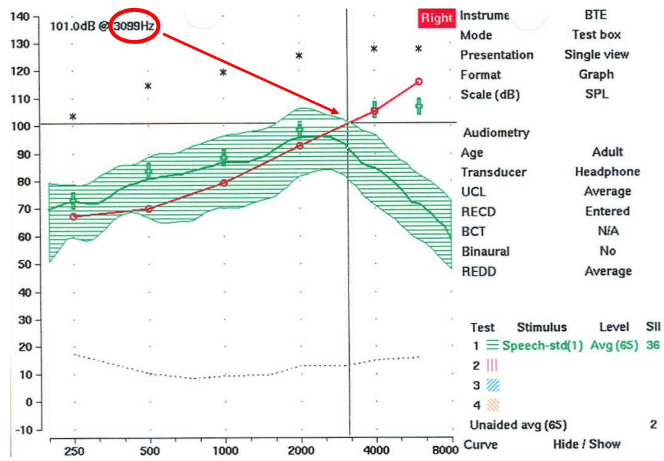
1. Deactivate NFC and Fit to Targets

2. Find the maximum audible frequency



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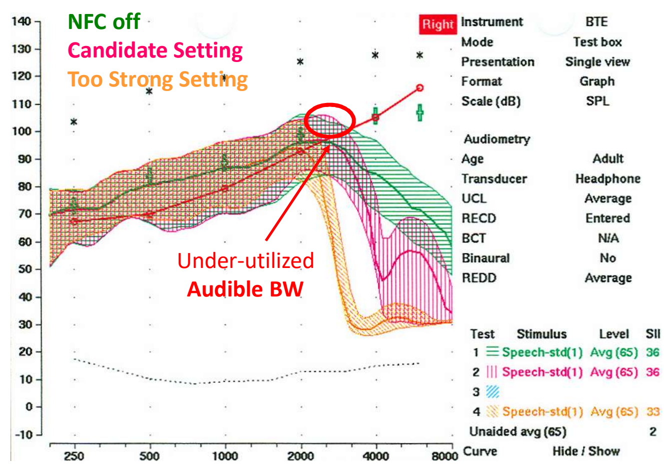
3. Activate NFC, adjust settings

www.tinyURL.com/FLassist



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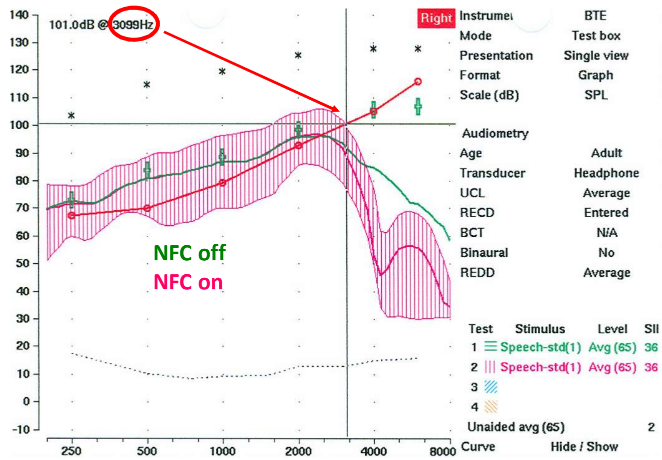
3. Verify Bandwidth of Chosen Setting



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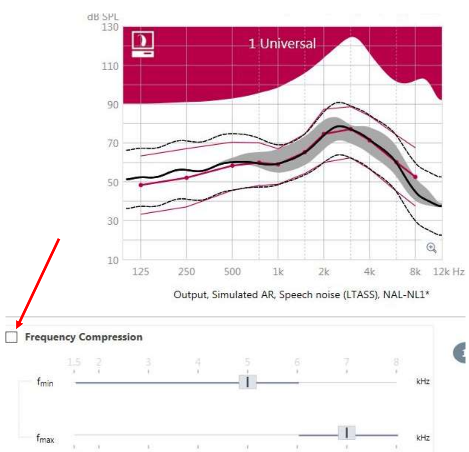
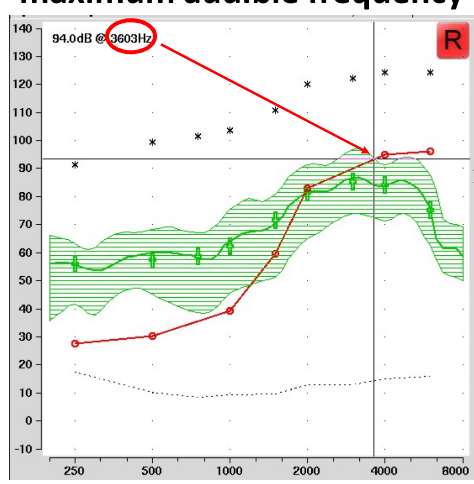
Steps 1 & 2 (Signia NFC)

Deactivate NFC



Fit to targets and find the maximum audible frequency



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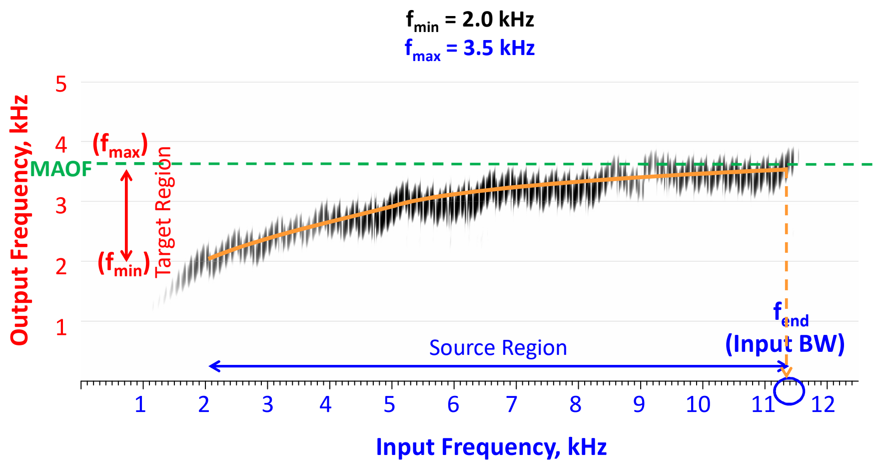
Step 3 (Signia NFC)



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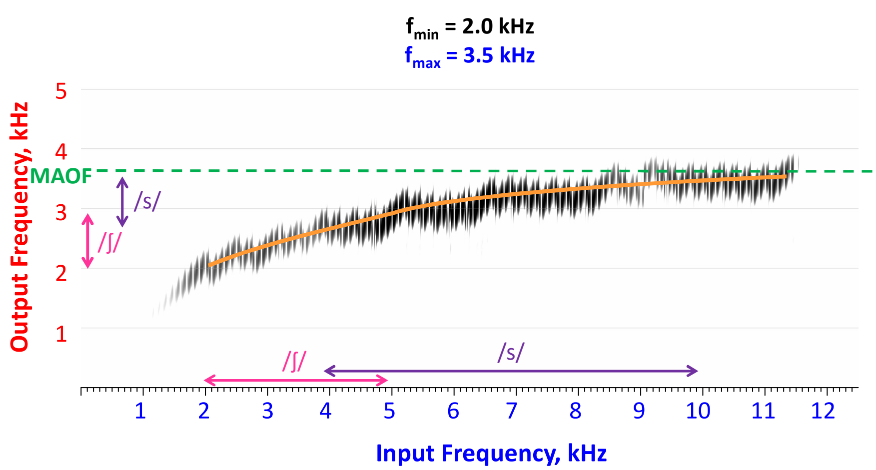
Step 3 (Signia NFC)



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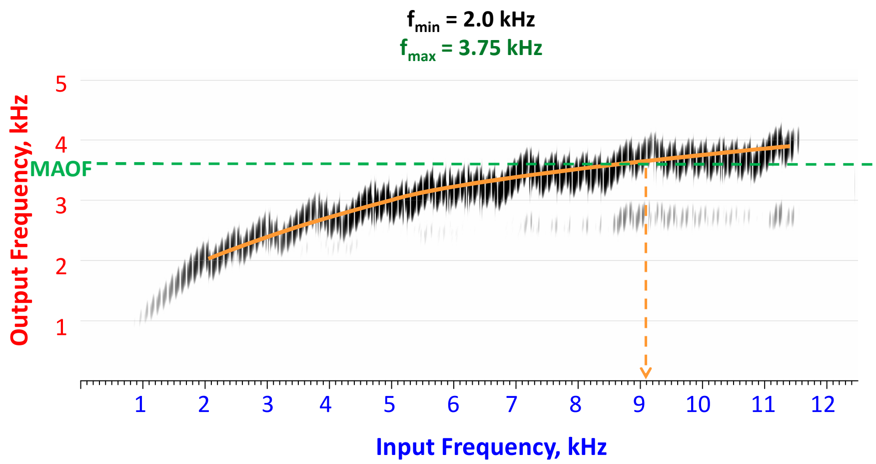
Step 3 (Signia NFC)



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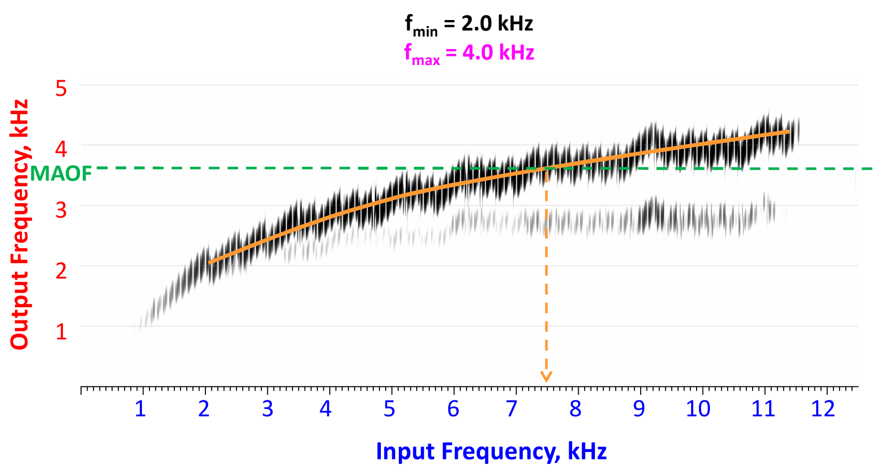
Step 3 (Signia NFC)



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Signia FCo Fitting Assistant

www.tinyURL.com/FLassist

FCo Fitting Assistant v1.0

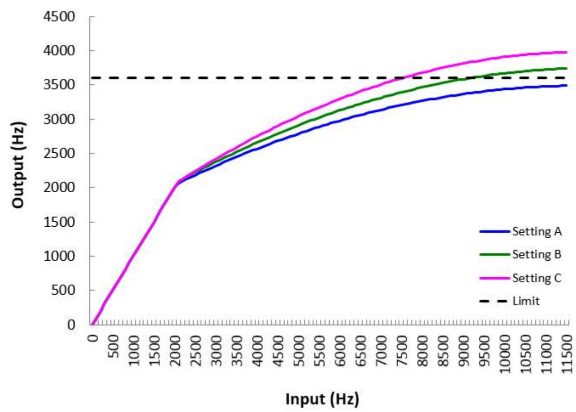
Maximum Audible Output Freq. (Hz)

3600

SETTING A			Max
fmin (kHz)	fmax (kHz)	CR	Audible Input
2.00	3.50	2.43	11500 Hz

SETTING B			Max
fmin (kHz)	fmax (kHz)	CR	Audible Input
2.00	3.75	2.18	9100 Hz

SETTING C			Max
fmin (kHz)	fmax (kHz)	CR	Audible Input
2.00	4.00	1.99	7500 Hz



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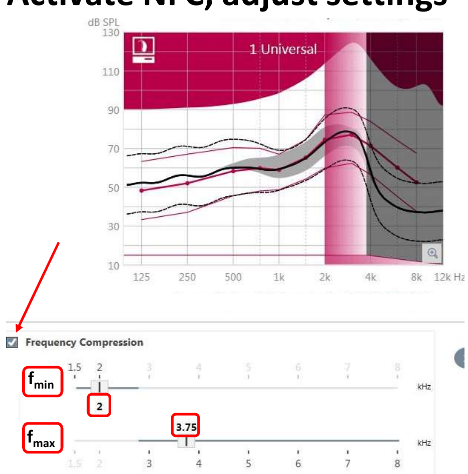
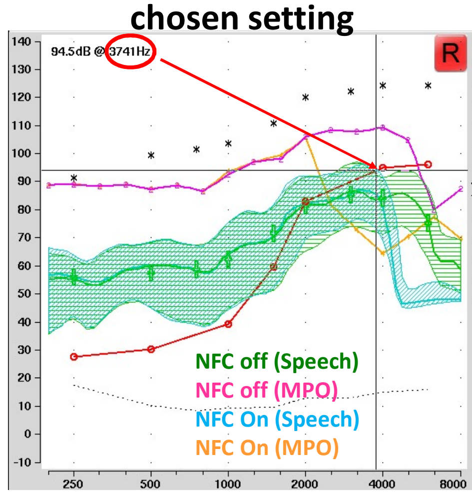
Step 3 (Signia NFC)

Activate NFC, adjust settings



Verify bandwidth of chosen setting



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Alexander's Priorities for Signia NFC

1. f_{max} ≥ maximum audible output frequency (**MAOF**)
   - Do **NOT** restrict the aided bandwidth
   - Watch the CRs, don't be afraid to set **f_{max} beyond MAOF** (e.g., 0.5 kHz), especially as audibility becomes more restricted
     - **Tradeoff:** less high-freq. energy is lowered into audible region
2. If possible, keep f_{min} ≥ 2.25 kHz (Alexander, 2016)
3. **Audible** target region (MAOF – f_{min}) = 1.25-2.0 kHz
   - Connexx 8 will not allow target region to be < 0.75 kHz
     - If f_{min} ≥ 2.25 kHz, might still benefit with 1 kHz *(Alexander, 2016)*

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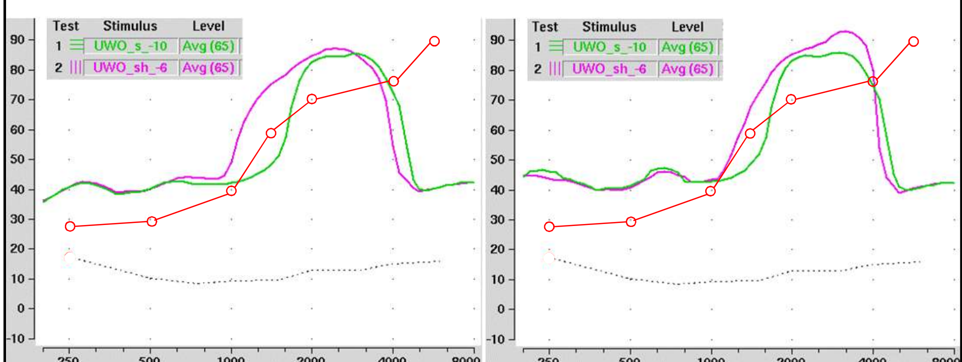
/s/ - /ʃ/ Verification

- Calibrated /s/ and /ʃ/ test stimuli provided by the Western University (UWO)
  - Evaluate audibility for /s/ and amount of overlap with /ʃ/



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Orientation

- *Counsel on use of the technology and foster realistic expectations*

Validation

- *Evaluate impact of the technology on areas of need and overall benefit*

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To Fit or Not to Fit

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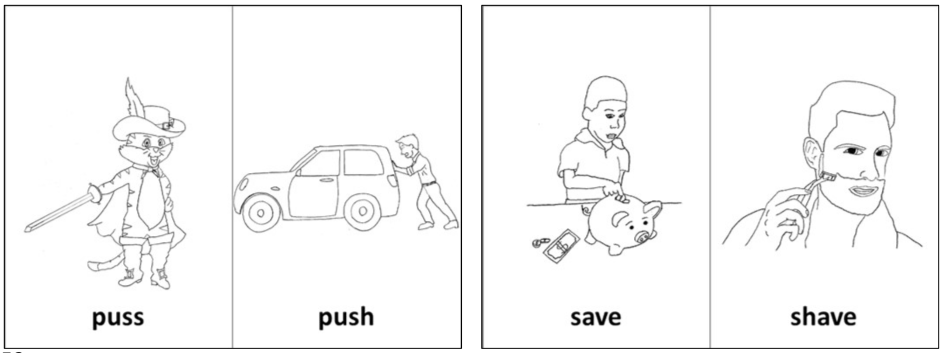
Speech Tests

- **UWO Plurals Test:** Glista & Scollie (2012)
- **Phoneme Perception Test (PPT):** Schmitt *et al.* (2015)
- **ORCA Nonsense Syllable Test:** Kuk *et al.* (2010)
- **Purdue s-sh Test (PUSSH):** Alexander (201X)



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More on AudiologyOnline.com

- **20Q: Frequency Lowering Ten Years Later - New Technology Innovations** (Article #18040) by J. Alexander
- **An Update on Modified Verification Approaches for Frequency Lowering Devices** (Article #16932) by D. Glista, M. Hawkins, & S. Scollie
- **20Q: The Highs and Lows of Frequency Lowering Amplification** (Article #11772) by J. Alexander
- **20Q: The Ins and Outs of Frequency Lowering Amplification** (Article #11863) by S. Scollie
- **20Q: Frequency Lowering - The Whole Shebang** (Article #11913) by G. Mueller, J. Alexander, & S. Scollie
- **Frequency Compression - Understanding the Clinical Application** (Webinar #23078) by S. Scollie

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Thank you!!!