2015 Expert Series

with Susan Scollie, Ph.D.

Frequency compression for adults: lessons learned from a clinical field trial

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• Brought to you in cooperation with AudiologyOnline
• Submitted to AAA, ASHA & IIHIS for one continuing education unit (CEU)

• Learning objectives for this course:
  • Participants will be able to describe a method of fine tuning the frequency compression using real ear measures to support an evidence-based method of hearing aid fitting.
  • Participants will be able to describe candidacy for frequency compression in the adult population.
  • Participants will be able to discuss real world expected benefit of frequency compression in adult hearing aid fittings.
Introducing Susan Scollie, Ph.D.

Frequency compression for adults: lessons learned from a clinical field trial

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Today’s Agenda
12:00-12:15 Review of frequency compression fitting
12:15-12:30 Project description
12:30-12:45 Results
12:45-1:00 Application to clinical fittings
The term “frequency lowering” is an umbrella term for a family of different processors.

- Today’s talk will focus on frequency compression specifically.

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**Our fitting protocol:**

- Verify and tune the hearing aid to DSL (FL off) to give the maximum possible aided bandwidth.
  - Find the Maximum Audible Output Frequency (MAOF) range. (picture on next slide)
- Assess candidacy:
  - Measure aided /s/. Does the upper corner fall within the MAOF?
- Fit frequency lowering if indicated:
  - Tune to the weakest possible setting that moves the upper shoulder of /s/ into the MAOF.

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**Major concept 1: MAOF range**

- Where LTASS crosses threshold is the lower limit of the MAOF range.
- Where peaks of speech cross threshold is the upper limit of the MAOF range.

Major concept 1: MAOF range

Where LTASS crosses threshold is the lower limit of the MAOF range.

Where peaks of the LTASS crosses threshold is the upper limit of the MAOF range.

Major concept 2: Calibrated /s/

In this fitting example, frequency compression is turned off. The “s” is below threshold, because it is above the MAOF.
Here, the “s” has been lowered in frequency, and is now audible.

Fine tuning of the processor helps us to avoid settings that are too weak or too strong.

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Clinical Field Trial with the Siemens Motion hearing aid.

Acknowledgement to Sivantos for support, and to Maja Serman, Ph.D. for review of this material.

Participants

• 21 participants, 1 dropout, leaving 20 participants
  - (3 F, 17 M)
  - Average age 72 y
  - Range 32-89
• All had hearing aid experience although several were infrequent users
  - 15 wore own aids on a regular basis
  - 10 users had frequency lowering activated in some form on their current aids

We individualized the fittings for a randomized crossover study.

6 week trials (on and off)
Frequency compression was tuned to stronger settings as hearing loss was greater.

- This indicates that the fitting protocol provided systematic but personalized fine tuning.

We tested perception with frequency compression on and off, for a variety of tasks.

- Can you hear word-final plurals? (e.g., ants versus ant)
  - This tells us if frequency compression is helping to provide access to fricatives.
- Can you recognize the 21 consonants of English?
  - This tells us whether frequency compression changes recognition of speech sounds.
- Can you understand sentences in noise (HINT)?
  - This tells us whether frequency compression helps in difficult listening situations.
- How is the sound quality of the hearing aid? (in quiet & noise)
  - This tells us about the acceptability of the sound of the hearing aid, with and without frequency compression.

Sound Quality

- Participants listened to the Costa Collida passage at 55 and 65 dB SPL and a Male Increased Vocal Effort passage at 70 dB SPL presented via loudspeaker at 0 degrees azimuth. were used. Using the Gabrielson ratings for clarity and overall impression, the participants were asked to assign a rating via paper/pencil to each passage for each Fco off and Fco the Clarity and Total Impression Scales shown below.

Access to fricatives was better with frequency compression on.

- Mean change: 7%
- Overall significant change \((F(1,19)=28.5, p<.001, \eta^2=0.6)\)

People with more high frequency hearing loss tended to benefit more.

No significant group change on average, but some individuals had significant benefit.

- Mean change: 1 to 3%.
- Maximum change: CNT to 58% (with acclimatization)
There was a trend for benefit on the HINT for those with greater hearing losses.

Sound quality ratings were higher for conversational and loud speech, neutral otherwise.

What about overall satisfaction?

- In this and other studies, overall satisfaction with hearing aids depends on more than just one signal processor. We received opinions from our participants:
  - Hearing aid style (e.g., a seasoned RIC user who didn’t want to wear a BTE).
  - Hearing aid accessories (e.g., a user who liked his own wireless accessory at home, and couldn’t use it with the study hearing aids).
  - The time commitments required to complete a study like this (4 months in total!) was sometimes a factor, regardless of the hearing aid setting.
- Frequency compression is one of many tools ... we don’t necessarily expect it to affect overall satisfaction in every hearing aid user.
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Fittings with more increase in aided /s/ had more tests with significant benefits.

Case Study 1
A straightforward case with clear candidacy and good outcomes.
Verification changed “s” from inaudible to audible.

- Settings:
  - 1.75 to 3 kHz
- Outcomes:
  - Plural detection: 77% to 97%
  - Consonants:
    - 50 dB: 29% to 48%
    - 60 dB: 52% to 67%
  - HINT: better in noise surround
  - Sound quality: equivocal.

Case Study 2

A case in which the person's candidacy for hearing aid use was very limited without frequency compression. Why? Loudness was intolerable in the "off" condition, but this resolved in the "on" condition.

Our ability to provide a broad audible bandwidth was severely limited by the dead regions/tolerance.

- Settings:
  - 1.5 to ±25 kHz
- Outcomes:
  - Plural detection: 57% to 97%
  - Consonants:
    - 50 dB: 64% to 62%
    - 60 dB: CNT to 57%
  - HINT: better in noise front
  - Sound quality:
    - CNT to 9/11 for conversational speech.
Case Study 3
Why verification really matters.

If the hearing aid’s gain is underfit, the frequency-compressed signal could be inaudible.

- Fitting 1: Green
- Fitting 2: Blue

<table>
<thead>
<tr>
<th></th>
<th>Plurals</th>
<th>Consonants (60)</th>
<th>Consonants (50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitting 1</td>
<td>75%</td>
<td>76%</td>
<td>57%</td>
</tr>
<tr>
<td>Fitting 2</td>
<td>82%</td>
<td>85%</td>
<td>76%</td>
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</tbody>
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A few lessons were learned.
Lesson 1

- Frequency compression is not a bandaid that resolves all problems, but it can be helpful for:
  - Providing access to all of the sounds of speech when hearing aid bandwidth alone cannot do this. This benefit appears to be more likely when hearing loss is great or bandwidth is limited.
  - Reducing feedback problems in some cases.
  - Reducing tolerance problems in cases of extremely sloping hearing losses.

Lesson 2

- Routine verification is needed to:
  - Personalize the “base fitting” to maximize the bandwidth and acceptability of the fitting.
  - Personalize the need for and strength of frequency compression.

Lesson 3

- When testing out a new processor, we have to fit the whole person with a complete hearing aid... their subjective outcomes are affected by their preferences, their life, and comparison to their own hearing aids.
Selected References