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- Email customerservice@AudiologyOnline.com
Audiology Online Grand Rounds: Why Perform Real Ear Verification?

Lata A. Krishnan, PhD, Jillian Hubertz, AuD & Jennifer Simpson, AuD

Department of Speech, Language, and Hearing Sciences
Purdue University

Acknowledgement

- Gus Mueller
- Purdue University Audiology Clinic patients
Outline

- Why this topic?
- Manufacturer first fit vs. prescriptive methods
- The SPL-o-gram
- Troubleshooting
- Frequency lowering
- Questions/discussion

Why This Topic?
Lata A. Krishnan
Evidence-based Practice

Provide evidence to verify audibility, comfort, and tolerance

Recommended by AAA and ASHA

Evidence for REM

- Reduced number of patient follow-up visits
  (Kochkin, 2011)
- Improved patient perceptions of devices:
  - Better quality
  - Better value
  - More positive emotions
  - More willingness to pay
    - Among experienced, “in-the-drawer” and first time users
      (Amlani, Pumford & Gessling, 2016)
Yet Little Used…

- Only 30-40% of professionals use REM
- Only 30% use it “always” or “almost always”
- Only 50-60% who have the equipment use it
- Up to 30% may not understand the purpose of REM
  - And the numbers have not changed over the years 1995-2010 (Mueller & Picou, 2010)

Rationale for/against REM?

- **Those who use REM:**
  - Improves acceptance, reduces returns, and substantiates value

- **Those who don’t use REM:**
  - Equipment is too expensive
  - Not trained
  - All that matters is the user likes the sound quality and is happy
  - The ‘first fit’ in the manufacturer’s software is sufficient
Challenges Educating Students

Adults

- 41% Never
- 23% Sometimes
- 23% Always
- 9% No equipment

Pediatrics

- 11% Never
- 58% Always
- 26% Sometimes
- 5% No equipment

A Plea Going Forward

Dear New Generations of Audiologists,

Although fewer than half of our generation of audiologists has embraced REM, we believe the next generations can do better, and so we write you this:

We have confidence in you. Your doctoral education has empowered you with foundational knowledge in hearing science, advanced clinical skills, and an understanding of how to use research to guide your independent clinical decision-making.

Expect the best from yourselves and for your patients. Use data to drive decision-making in your workplace. Use evidence-based, clinically relevant research to shape your care of patients. Your patients and your profession are counting on you.

With much respect,
Older Generations of Audiologists

Krishnan & Simpson, 2018
Manufacturer First-fit vs. Prescriptive Formulae

Lata A. Krishnan

What’s the Difference?

- **First-fit:**
  - Proprietary algorithm
  - Simulation
  - No evidence
  - Not verifiable

- **Prescriptive formulae:** (NAL, DSL, etc.)
  - Real-ear measure
  - Evidence based
  - Verifiable
What’s the Difference?

- Manufacturers’ first fit within 10 dB of prescriptive target 36% of the time (Aazh & Moore, 2007)
  - Not enough gain for soft inputs
  - Roll-off of high frequencies (>2000 Hz)
  - Too much gain for loud inputs (Saunders et al., 2015)
- Better aided Quick-SIN scores when using a prescriptive method compared to manufacturers’ first fit (Leavitt & Flexer, 2012)

The SPL-o-gram

Lata A. Krishnan
The SPL-o-gram

SPL-o-gram
The SPL-o-gram

Case Examples
Lata A. Krishnan
Case 1: “Mr. Frank”

- 80 year-old retired airplane pilot
- Flew from FL to IN to get a second opinion on his hearing aids
- Purchased his second pair of hearing aids (RIC) ~4 years ago
- Has not worn them for over a year
  - Doesn’t perceive any benefit with speech understanding
  - Reported that he was told:
    - The hearing aids were “maxed out”
    - And set as high as they could go before feedback

Mr. Frank

---

<table>
<thead>
<tr>
<th>Acuity Reflux</th>
<th>0.5 kHz</th>
<th>1 kHz</th>
<th>2 kHz</th>
</tr>
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<tbody>
<tr>
<td>B Lpsi</td>
<td>90</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>L Lpsi</td>
<td>80</td>
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<td>95</td>
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<td>L Contra</td>
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<td>Reflex Decay</td>
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</tbody>
</table>
Mr. Frank
Mr. Frank

- Email follow up:
  - “I am still thrilled by the hearing improvement that is possible with these hearing aids!”
  - “Doing fairly well with the left ear. Speech clarity is good. The non-speech noises are still a bit sharp, but tolerable.”
  - “Speech clarity is good in the right ear, but some of the non-speech sounds are uncomfortably loud…”
- Facing a dilemma:
  - “Difficulty with trusting another audiologist.”

Case 2: “Fay”

- 6-year-old painfully shy kindergartner
- Late identified hearing loss at age 5 years
  - Passed newborn hearing screening
  - Multiple ENT appointments prior to diagnosis
  - Could not be tested with earphones, and had a sedated ABR to confirm hearing loss
  - Fit with hearing aids by a local hearing aid dispenser
  - Referred to us by her school because she was still having difficulty hearing in class
Fay

- Came in wearing open-ear hearing aids
- Concerns even before verifying fitting:
  - Open style for LF loss
  - No FM capability
  - No T-coil
Fay: New Hearing Aids
### Fay: Report from School

<table>
<thead>
<tr>
<th>Contrasts for Auditory &amp; Speech Training Levels</th>
<th>With entry level audiograms fit in July 2017 by Audiologist</th>
<th>With hearing aids fit by PU, after one year’s use, Sept. 2018</th>
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<tbody>
<tr>
<td>Recognition of SuprasegmentalFeatures</td>
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</tr>
<tr>
<td>Recognition of Phonemically dissimilar Words</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Recognition of Wide Vowels (feet vs. flat)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Recognition of Narrow Vowels (sock vs. sack; heat vs. hit)</td>
<td>70% 90%  ⭐</td>
<td>90% 90%  ⭐</td>
</tr>
<tr>
<td>Recognition of Consonant Manner Features</td>
<td>95% 100%</td>
<td>95% 100%</td>
</tr>
<tr>
<td>Recognition of Consonant Voicing Features</td>
<td>70% 85%  ⭐</td>
<td>85% 85%  ⭐</td>
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<tr>
<td>Recognition of Consonant Place Features</td>
<td>95% 100%</td>
<td>95% 100%</td>
</tr>
<tr>
<td>Recognition of Final Consonant Differences</td>
<td>75% 95%  ⭐</td>
<td>95% 95%  ⭐</td>
</tr>
</tbody>
</table>

### Troubleshooting

Jennifer M. Simpson
REM for troubleshooting

- Real ear is probably most used for verification at initial fitting of hearing aids
- But there are other uses!
  - Feedback issues
    - Measuring after feedback managers are used
  - Patient complaints of “too soft”, “too loud”
  - Checking the function of the HAs with a pediatric patient

Case Study: Anna

- 8 year old female
- Diagnosed with mild SNHL in both ears at another clinic
- Evaluated by local ENT
  - Normal CT scan; cleared to pursue HAs
- Referred to Purdue for HA consultation
Anna: Case History

- Anna is an excellent student academically
- Sits in the front of the class
- No major medical concerns
- 3-4 diagnosed and treated ear infections per year most of her life. Only one last year.
- In the past year, Anna had noticed more difficulty hearing speech at home and school, especially in noise

Anna: Results

- Clear ear canals
- Normal tympanograms
- Mild SNHL in both ears
- WRS excellent in both ears
- DPOAEs low amplitude, partially present in both ears
Anna: HA Fitting

- Fit with BTE HAs, remote mic, and black/red/white swirl earmolds
- Anna was excited about her hearing aids and had a fantastic reaction when they were fit
- She mentioned she thought something was “funny”.
  - Counseled and said things will sound “funny” at first

Anna: REM

- Performed real ear using DSL as targets
- Right ear: approximated targets
Anna: REM

Left ear
- Not meeting targets

Anna: Troubleshooting

- Performed REM again, repositioning the probe tube-no change
- Took HA and earmold apart. HA seemed to be functioning
- Checked earmold
  - Glue was adhered to the entire bore preventing sound from passing through
  - Retubed earmold
- Anna reported that it sounded much better now
- Re tested real ear-meeting target ranges
Anna: Troubleshooting

- Without performing real ear measures on this child, we may have continued to tell her things will sound “different”, “funny” with her new HAs.

Frequency Lowering (FL) Verification

Jillian Hubertz
Frequency Lowering

- **Goal:** Provide audibility of high-frequency information when conventional amplification is insufficient
- **Methods**
  - Compression, transposition, translation, composition
  - Adaptive or static
- **Disclaimer:**
  - I am not an expert on frequency lowering techniques, but I was motivated to figure out how to apply this feature in an evidence-based way and with more confidence for my patients. I was pleasantly surprised at how approachable it was!

Frequency Lowering

- **Candidacy**
  - Consider the degree and configuration of hearing loss
  - Hearing device factors
  - When high-frequency audibility is insufficient with conventional amplification
    - Maximum Audible Output Frequency (MAOF)
  - Patient report

Adapted from Glista, D., Hawkins, M., Scollie, S., (2016)
Frequency Lowering

- Maximum Audible Output Frequency (MAOF)
  - Highest frequency where output of hearing aid intersects with patient's threshold
  - Suggested target range to improve audibility of frequency lowered signals (McCreery et al., 2014; Scollie et al., 2016)
- Lower limit of MAOF range:
  - Where the LTASS intersects with the audiogram
- Upper limit of MAOF range:
  - Highest frequency where the peak of LTASS intersects with the audiogram

Frequency Lowering

- Verification guidelines/protocols/tools
  - Several sources exist!
- Protocol (Glista et al., 2016)
  1. Verify shape and gain of the hearing aid fitting without frequency lowering.
  2. Determine candidacy for frequency lowering
  3. Enable frequency lowering and adjust to optimize. Use the least amount of frequency lowering needed to obtain audibility of /s/ and /ʃ/
  4. Provide post-fitting supports
- Used in conjunction with manufacturer specific guides if needing more context regarding specific manufacturer software parameters
**Case 1: “Mark”**

- 76 years old
- Known HL & previous HA use
- WRS excellent in both ears
- QuickSIN in soundfield
  - 9.5: Moderate SNR loss

---

**“Mark”, HA1, Verify FL**

1. Verified gain settings using NAL-NL2 targets
   - Average speech
2. Identified MAOF
3. Ran “s” stimulus w/FL turned off
   - Is it audible?
4. Ran “s” stimulus w/FL turned on at default settings

Is the peak & upper shoulder of “s” stimulus output falling w/in the MAOF?

Is it audible to the patient?

If NO, then adjust FL settings

“Mark”, HA1, Verify FL

- Increased “Strength”* of FL, “s” stimulus
  - *Term used in software

- (“s” stimulus at FL default)
- (“s” stimulus w/no FL)
Mark’s Outcomes

- Very happy with HA performance
  - Improvement in conversations with wife
  - Better in environments with background noise, but still some struggles

- Aided QuickSIN
  - 6.5 mild SNR loss (previous score = 9.5)

Case 2: “Charlie”

- 65 years old
- Failed hearing screening
- WRS excellent in both ears
- QuickSIN in soundfield
  - 8: Moderate SNR loss
“Charlie”, HA1, Verify FL

1. Verified gain settings using NAL-NL2 targets
   Average speech

2. Identified MAOF

3. Run “s” stimulus w/FL turned off
   Is it audible?

4. Out of curiosity I turned FL on at default settings
“Charlie”, HA1, Verify FL

4. Out of curiosity I turned FL on at default settings
5. Increasing FL “strength”

In the end, FL was not used for this patient at this time

Charlie’s Outcomes

- Noticeable differences with hearing aids
  - Family conversations
  - TV

- Aided QuickSIN
  - 4.5 mild SNR loss (previous score = 8)
FL Verification Resources

- Apply generally to frequency lowering technology
- More specific to manufacturer
- Alexander, J. Frequency Lowering Fitting Assistants

In Conclusion

Lata Krishnan
“Mr. Price”

- April 2001:
  - Purchased CIC hearing aids at another clinic
  - c/o feedback in R HA and has been back to other clinic several times but feedback persists
Mr. Price

Chart note from 4/18/2001:

“REM indicated that the feedback was caused by too much gain at the high frequencies. Programming was adjusted to reduce the gain and alleviate the feedback”

Mr. Price is 97 now and continues to be my patient
Conclusion

- REM are not “new”
- Their effectiveness has been known for years
- Yet, as a profession we continue to have fewer than 50% of clinicians using this evidence-based technique for successful hearing aid fittings
- Is it time to make a change now?.....

Thank You!