How Do You Verify “Binaural Processing” in Hearing Aids?

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Overview:
- An overview of trends in verification
- Exploring hearing aid features
- How these features can be employed binaurally
- How to verify binaural features
- Talking to patients about these features
- Summary, closing and questions

Trends in Verification
- Surveys suggest that Probe microphone measures (PMM) are regularly used by approximately 40% of audiologists
- The PMM most frequently used are to ensure audibility and target matching
- Some PMM of advanced features are used either in pre-fit or as a counseling type tool.
Binaural Verification

- Reasons to verify:
  - Align expectations
  - Provide mental construct from which clinicians can develop effective counseling messages
  - Ensure proper function

When to Verify Binaural Features

- Verifying binaural features for patients is probably not a priority
- Could help demonstrate very strong benefits
- During pre-fit
- When evaluating different manufacturers products

Understanding Which Features to Verify

- Binaural processing is a “buzz word”
- Some features may be easily verified
- Others may be extremely difficult or impossible
ReSound Template

- Binaural Features include:
  - Binaural Directionality
  - Comfort Phone
  - Environmental Optimizer II
  - Synchronized Softswitching
  - Synchronized PB and VC
  - Tinnitus features

Binaural Directionality

Software Setup: Program 1
Presence of speech or noise on one side will alter which hearing is in a directional pattern. With one test box we can establish that changing the stimulus to one instrument changes the other instrument.
Setup and Expectations

- Transition time between Omni and Directional is gradual, over 10–20 seconds
- Prevents switching due to instantaneous sound events in the environment
- Prevents perceptual changes in sound quality

Binaural Directionality

Comfort Phone – using d2d
Setup and Expectations

- Use a magnet to trigger the comfort phone in the HI outside of the test box
- The HI inside the test box should reduce by 6 dB
- When the magnet is removed the aid should return to baseline gain
- The test box lid is opened and the magnet is held near the HI in the test box
- Test box HI does not reduce

Software Setup

Comfort Phone
Binaural Environmental Optimizer II

Steps in the process:
- Analyzes the environment at each ear
- 2.4 GHz wireless information exchange
- Classifies the environment based on inputs from both hearing instruments
- Noise reduction and gain adjustments are synchronized and optimized between the two hearing instruments
• With both aids in the test box and speech in noise I expect the output of the measured HI to increase by approximately 6 dB
• With one HI out of the test box, I expect the difference in environments to cause the increase to be slightly reduced
• Softswitching is an environmentally dependent automatic change between omnidirectional and a directional setting.
• The Synchronization ensures that these changes happen in both simultaneously.
• This is difficult to visualize within a test box.
Synchronized SoftSwitching

Verifying inter-device features in other top products
**Widex Dream 440**

- InterEar TruSound Compression
  - Supports localization abilities with compression processing
  - In Dream 440, Super 440 and Clear 440 models
- IE Feedback Cancelling
  - Enhanced identification and cancellation of feedback.
  - In Dream, Super and Clear models
- IE Speech Enhancer
  - Promotes speech enhancement for the dominant voice in a crowd
  - In Dream 440, Super 440 and Clear 440 models
- Personal Acclimatization (IE)
  - Facilitates hearing aid use
  - In Dream models
- IE volume control
  - In Dream, Super and Clear models
- IE program shift
  - In Dream, Super and Clear models

**InterEar TruSound Compression**


- Goal is to maintain interaural level differences between ears in a situation where sound arises from one side
- May help with localization abilities

**Binaural Compression Features**

- Goal is to maintain interaural level differences between ears in a situation where sound arises from one side
- May help with localization abilities
Imagine a Symmetric Hearing Loss...

10 dB Gain Prescribed for 65 dB SPL input levels, standard compression applied

- Signal arrives at 65 dB SPL.
- Gain at 65 dB SPL = 10 dB

- Signal arrives at 64 dB SPL.
- Gain at 64 dB SPL = 11 dB

Interaural level difference may be diminished through typical compression.

Imagine a Symmetric Hearing Loss...

10 dB Gain Prescribed for 65 dB SPL input levels, binaural compression applied

- Signal arrives at 65 dB SPL.
- Gain at 65 dB SPL = 10 dB

- Signal arrives at 64 dB SPL.
- Gain at 64 dB SPL = 9 dB

Assumed benefit: Interaural level difference is maintained through binaural compression.

How Might You Verify Binaural Compression?

- Probe microphone measure
- Set-up
  - Hearing aids programmed with user’s gain settings but all other algorithms off
  - Real-ear speaker at 90 degrees (on the right side of the patient)
  - Probe tube calibrated and properly inserted in left ear with hearing aid in place and turned on
  - Stimulus at comfortable level, corresponding to the levels in the fitting software (e.g., 65 dB SPL)
  - Measure REIG for the left ear
What might you expect to see for the left ear REIG??

- Gain may be **slightly less** than prescribed for that stimulus level (re: left ear targets)
  - Actual results may depend on:
    - How the algo actually works - especially regarding the frequency specificity of the result
    - Severity of the individual’s hearing loss
    - Ambient room noise
    - Compression ratio (more linear = less gain change per input level change)

- Gain may be **equivalent to** the prescribed gain for the stimulus level for the left ear
  - If this occurs, measure the level at the left ear with a sound level meter while the same stimulus is running
  - For previous example, stimulus = 65 dB SPL.
    Prescribed gain at 65 dB SPL = 10 dB. If the SLM at the left ear measures 64 dB SPL, 10 dB gain may still verify that binaural compression is working (provided it’s programmed as nonlinear!)

- Gain greater than the prescribed gain for the stimulus level
  - This may mean binaural compression is turned off
Siemens micon

- **Speech Focus**
  - Part of the miFocus automatic directional system
  - Automatically suppresses noise in front, and focuses on speech coming from a different direction, such as from behind
  - Uses 3 different directivity patterns operating simultaneously: omnidirectional, adaptive directional, and reverse directional
  - Selects directivity pattern most effective in focusing on that speech source. Can be most valuable for situations where the user cannot turn to face the speaker, such as while driving a car.
  - Needs to be enabled in the automatic program for bilateral information exchange between HA’s

How might you verify a directional algorithm that creates a reverse directional response?

- **Probe mic measure**
  - Patient seated in front of speaker (0 degrees azimuth)
  - Manual or Multi-curve option
  - Continuous noise signal at 65 dB SPL
  - 2 tests: one with noise only, the other with speaker behind patient reading “Rainbow Passage” or similar

Reverse Directional REM Test

1. Noise
2. Speech
How might you verify a directional algorithm that creates a reverse directional response?

- Test box measure
  - Directional test set-up in Verifit

Reverse Directional Test Setup—Test Box Option

- Test box with dual speakers and directional test (e.g., Audioscan Verifit)
- Hearing aid programmed with all algos off except Speech Focus in automatic program
- Position hearing aid microphones in a line parallel to the right (front) speaker

Expected result:
Curve\textsubscript{front} < amplitude than Curve\textsubscript{back}
Spatial Sound Premium
If there is a difference in signal-to-noise ratio at the two ears, Alta will exaggerate the difference in gain and noise reduction at the two ears to enhance the ear with the best SNR.

Example of How to Verify:
Program both hearing aids identically (symmetric hearing loss, with same feature settings on each side)
Put each HA in a separate Verifit Test Box.

SNR Enhancement Verification in Dual Test Boxes
- Use Verifit Directional Test in Test Box
- Set up stimulus, level and SNR as follows:
  - Right Test Box
    - Stimulus: [Noise]
    - Level: [65]
    - Speech S/N: [OFF]
  - Left Test Box
    - Stimulus: [Noise]
    - Level: [65]
    - Speech S/N: [9]
- Observe the resulting gains in each device over ~20 seconds
  - Noise reduction changes may occur and manifest as gain differences between the two devices

After first measurement, change SNR as follows:
- Right Test Box
  - Stimulus: [Noise]
  - Level: [65]
  - Speech S/N: [9]
- Left Test Box
  - Stimulus: [Noise]
  - Level: [65]
  - Speech S/N: [OFF]
- Again observe the resulting gains in each device over ~20 seconds
  - May see difference in level between the two identically-programmed hearing aids (provided no significant magnetic shielding of the Verifit test boxes)
Talking to patients about binaural features
• Bond the feature to their daily routine
• Emphasize a realistic expectation
• In many cases the benefit provided by binaural features are:
  • Ease of listening
  • Ease of use
  • Natural sound experience

Summary
• Verifying binaural features can help align expectations between manufacturers and clinicians and between clinicians and patients.
• Two test boxes can provide the most controlled environment.
• Single test box and probe mic verification can be effective.

Questions?
• THANK YOU!
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