

Constructing a Hearing Aid Fitting Using the Latest Clinical Evidence

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Unitron

Overview of 1-Hour Course

1. Quick review of EBP
2. Why fitting a hearing aid is a lot like constructing a house
3. Clinical application of hearing aid research findings, relating features to benefits using evidence

Motivation for this Presentation

Manufacturer's use a lot of jargon,
which leads to confusion.

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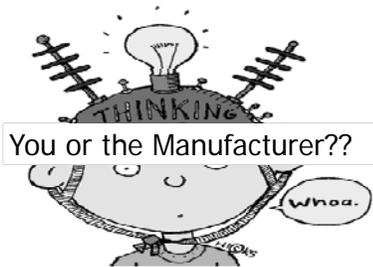
Manufacturer's use a lot of jargon,
which often leads to confusion.

Spatial Sound, SoundRecover, FLEXIfocus,
NoiseTracker, Tri-State Speech Guard, Cochlear
Dynamics, Band Warp Compression, C-ISP,
SmartFocus, SpeechFocus, EchoBlock, etc.....

Who should do most of the thinking
when selecting and fitting hearing
aids?



Who should do most of the thinking
when selecting and fitting hearing
aids?



How do people make decisions?

- Charismatics
- Thinkers
- Followers – about 50% of audiologists?
- Skeptics
- Controllers

From Miller & Williams, The Art of Selling Your Message: The 5 Paths to Persuasion

How do you make clinical decisions?

- “Follow the (opinion) leader”
- “Do what has worked for you in the past”
- “Listen to the manufacturer’s rep”
- “Read the journals and apply the evidence”
- A combination of evidence and experiences

“evidence-based thinking” can be time consuming

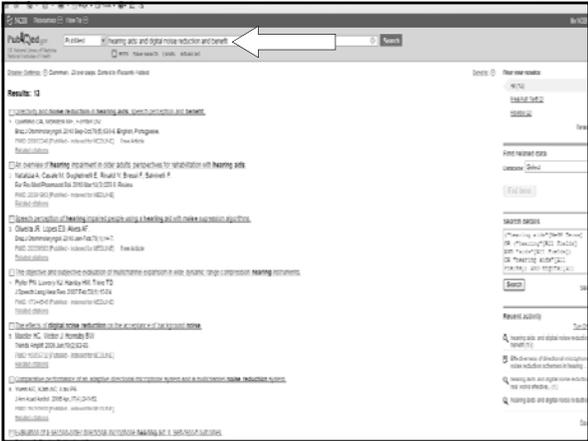


Step 1:
Generate a Focused Question

Does directional microphone technology improve speech intelligibility in noise in everyday listening situations?

Step 2: Go to Pub Med and conduct key word searches

- Directional microphones +
- A. Benefit = 20
- B. Satisfaction = 15
- C. Real World Effectiveness = 4



**Step 3:
Narrow the Search**

- Carefully read all the abstracts (37)
- Eliminate all those that pertain to children, or cochlear implants, used only lab results (20)
- Those that make the cut (17) carefully read the entire article

**Step 4:
Grade the Evidence**

- Pay attention to:
 - Number of subjects
 - Blinding of subjects
 - Blinding of authors
 - Study design (randomized or non-randomized)
- Grade the evidence based on the study design

Study Design

<p><u>1. Randomized</u></p> <ul style="list-style-type: none">■ Subjects are assigned to one of two groups (treatment and control) using a specific randomization method	<p><u>2. Non-Randomized</u></p> <ul style="list-style-type: none">■ A study that does not use a control group
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Levels of Evidence

- **Level 1:** Well-designed randomized control trials
- **Level 2:** Well-designed controlled study without randomization
- **Level 3:** Well-designed non-experimental study (case studies)
- **Level 4:** Expert opinion or consensus statement

Step 5: Make a Recommendation /Modify a Clinical Procedure Based on Your Reading of the Evidence

Constructing a Hearing Aid Fitting



Hearing aids have gotten smaller



And so have houses



Jay Shafer,
Tumbleweed Houses

Constructing a House

- Clear the building site
- Build a foundation
- Post and beam construction
- Building and raising walls
- Putting up a sloping roof with rafters
- Installing windows, and doors
- Inspecting your work

Constructing a Hearing Aid Fitting

If we do our job rights, all modern hearing aids will.....

Restore Audibility and Maintain Comfort in Quiet

Constructing a Hearing Aid Fitting

Provide Comfort in Noise

Provide Comfort in Noise

Restore Audibility and Maintain Comfort in Quiet

Constructing a Hearing Aid Fitting

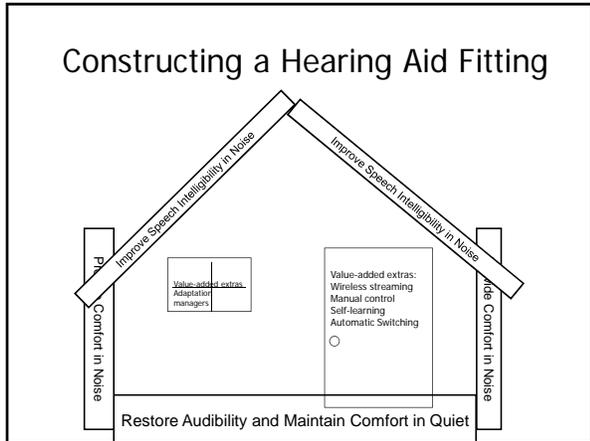
Provide Comfort in Noise

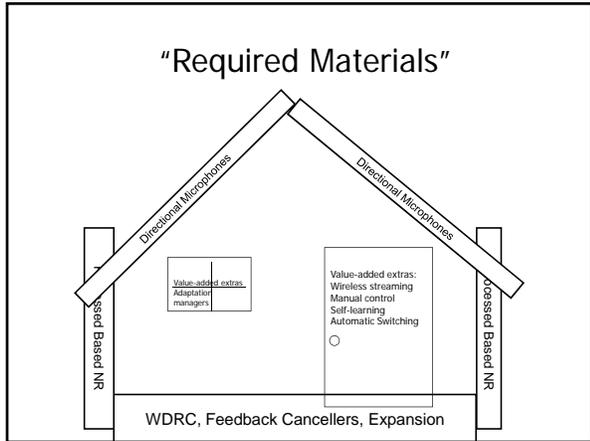
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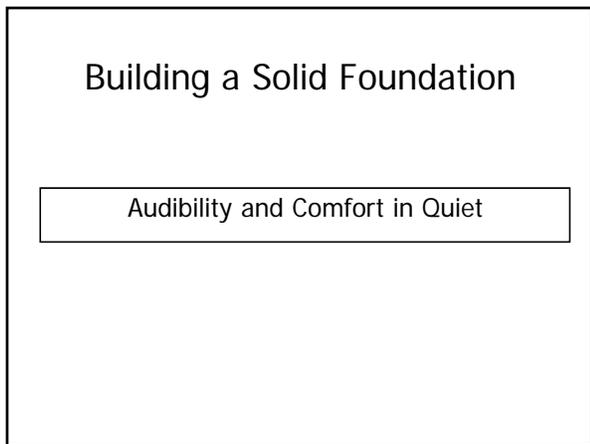
Improve Speech Intelligibility in Noise

Improve Speech Intelligibility in Noise

Restore Audibility and Maintain Comfort in Quiet







■ How many channels of WDRC are needed to optimize speech intelligibility?

Laboratory Evidence

■ Speech Quality & Intelligibility:

- 4 Channels to optimize in quiet (Woods, et al, 2006)
- 8 to 16 Channels to optimize in noise (Yund & Buckles, 1995)

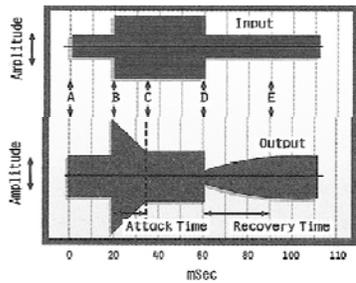
Laboratory Evidence – Prescriptive Fittings

- 7 Channels to match a prescriptive target with 98% accuracy
- 36% of manufacturer's "first fit" settings come with +/- 10 dB of NAL-NL1 target (Aazh & Moore, 2007)

- How many channels of WDRC are needed to optimize speech intelligibility?

Answer: Probably more than 8-16 is not a selling point

Release Time



Release Time Variables

- Short release time: 10-100 msec
- Long release time: greater than 500-600 msec

■ Does getting the release time right contribute to a more successful fitting?

Release Time

- Short RT: improved audibility, normal loudness perception, but increased distortion/noisiness
- Long RT: maintain intensity relationships between speech sounds, thus more natural sounding, but "off-the-air" sound may occur with soft sounds

Laboratory Evidence

- Long release times preferred by "slow thinkers"
(Gatehouse, et al, 2006; Foo et al, 2007)

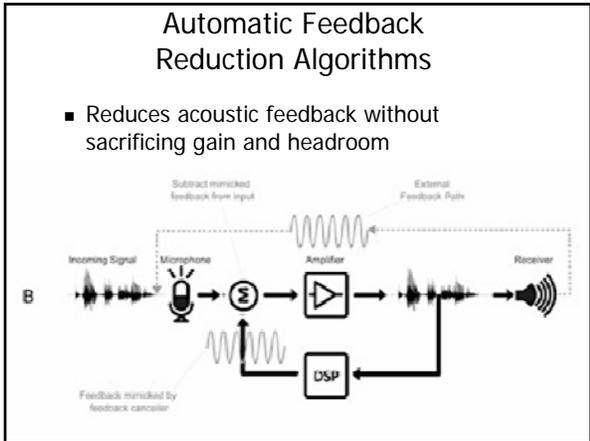
Real World Evidence

- Cox and Xu, 2010
- N = 24, divided into 2 groups based on cognition scores
- Cross-over design, long (640ms) vs. short (40 ms) release time
- No significant relationship between cognition score and release time preference
- APHAB scores were better for the release time that the subject preferred

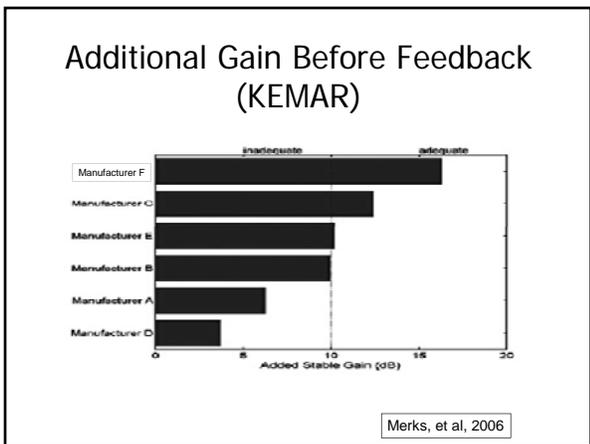
- Does getting the release time right contribute to a more successful fitting?

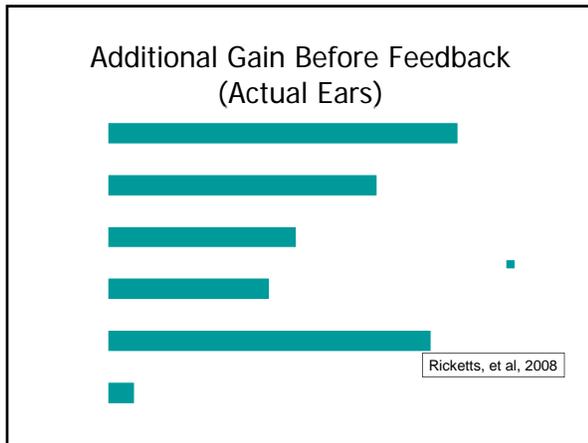
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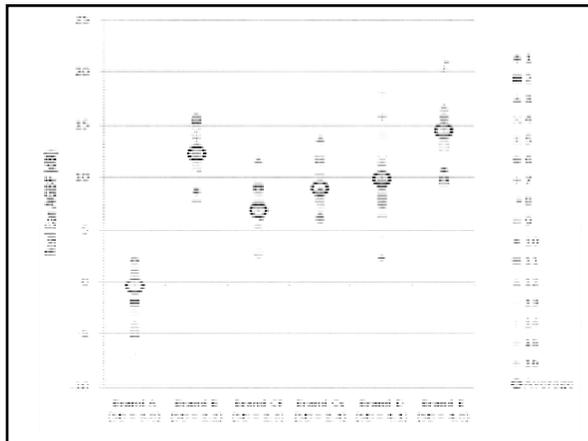
Answer: It probably doesn't matter all that much

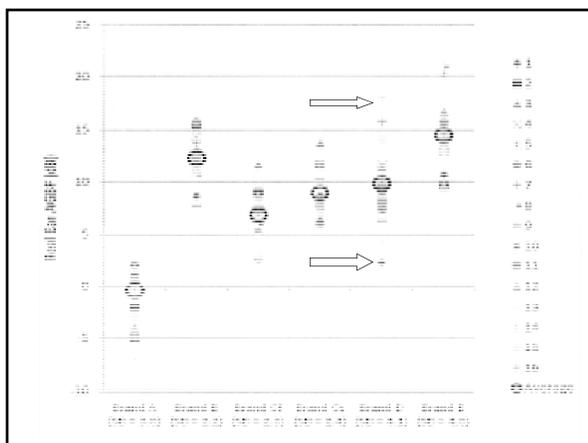


- Is one manufacturer's automatic feedback canceller better than another?









■ Is one manufacturer's automatic feedback canceller better than another?

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Answer: There are big differences across manufacturers, perhaps most critical variable is geometry of individual ear canal. Best to measure the AGBF

One or Two Car Garage?



One or Two Hearing Aids?



Unilateral vs. Bilateral

1. Current bilateral fit rate is about 90% (Kochkin, 2009)
2. Many advantages to binaural hearing including:
 - Reduced head shadow
 - Improved localization
 - Improved understanding in noise (binaural squelch)
 - Loudness summation
3. There is a significant number of patients with bilateral hearing loss that actually do well and prefer a unilateral fit

Preference for Unilateral

1. Field Trials:
 - Patients switch between 1 and 2 hearing aids in a controlled manner over a period of time
 - An average of several studies indicate that 41% of patients preferred to wear one hearing aid
2. Retrospective Studies:
 - Patients originally fitted with two hearing aids are asked whether they prefer wearing one or two devices
 - An average of several studies indicate that 21% of patients have a preference for one hearing aid

Conclusions from Most Studies

1. There are a substantial number of patients who prefer a unilateral arrangement
2. These variables appear to be non-predictors:
 - Audiometric data
 - Age
 - Binaural release from masking
 - Only 10% have binaural interference problems (Jerger, et al, 1993)

Cox, et al 2011

- 12-week field trials comparing unilateral to bilateral fitting
- Used modern hearing aids
- 49 participants
- Hearing aid styles:
 - BTE = 73 (no Open Canal products)
 - ITE = 18
 - ITC/CIC: 3
- Looked at several predictors of bilateral/unilateral preference:
 - Audiometrics
 - Personality
 - Binaural processing variables

Methods

- 49 participants went through a series of pre-fitting tests
 - Routine Audiometrics
 - Pre-Fitting Questionnaires (APHAB/Lifestyle, etc)
 - Personality Assessment
 - Binaural Loudness Summation/Squelch/Interference
- All subjected fitted using the same approach
- 12-week wearing schedule
 - Three 1-week periods, each aid worn unilaterally, followed by bilateral
- Outcome measures collected following 12-week field trial
 - Including exit interview on preference

Results

- Comparing Outcomes Between Two Groups (Prefer 1 vs. Prefer 2)
- Note: Subjects categorized based on their own preferences
- Patients that wore 2 devices reported better real world outcomes on three self-reports
 - IOI-HA
 - DOSO
 - APHAB

Results

- 43 of 94 subjects (46%) preferred wearing one hearing aid
- 90% of those preferring unilateral fitting were "very" or "reasonably" certain of their choice – only 1 person was "very uncertain" of their choice
- Choices were stable over time
- Only 1 pre-fitting variable was a significant predictor of preference: subjective hearing problems (unaided APHAB)

5 Reasons One Device Was Preferred*

1. In quiet, I understand speech as well or better when I wear only one.
2. My voice sounds more natural/comfortable.
3. In noisy situations, I understand speech as well or better when I wear only one.
4. One hearing aid helps me as much as two,
5. It's inconvenient to use the telephone when I wear two hearing aids.

* Reported by at least 50% of this group

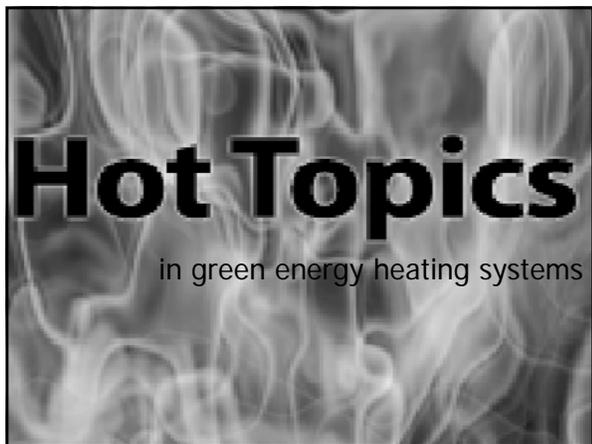
Are 2 hearing aids better than 1?

Answer: Probably not as often as we think.
It depends on patient preferences.

**Clinical Quandary:
What's best for each patient?**

Suggested Approaches:

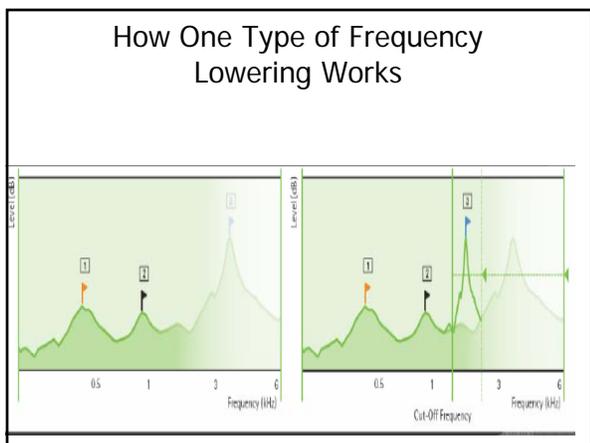
1. Informational counseling – provide patient with clear and accurate information about wearing one vs. two
2. Use battery of pre-fitting tests to guide your recommendation decision
 - APHAB
 - Dichotic Digits
 - Binaural Loudness Summation
3. Allow patients an extended trial to compare one vs. two





Hot Topics

- Frequency Lowering
- Extended Bandwidth
- "Binaural Enhancements"



Is frequency lowering effective?

- O'Brien et al 2010
- Examined Frequency lowering and high frequency directionality
- N=23
- Each subject experienced frequency lowering "on" and "off" for 8 weeks

Lab results

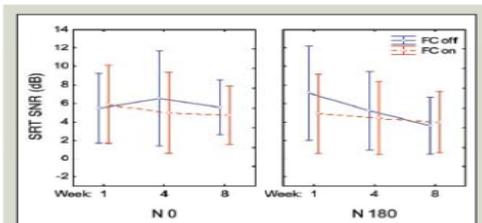


Figure 5. Average SRT SNR over time (averaged across microphone modes) with frequency compression on and off, for noise from 0° and 180° azimuth. Vertical bars indicate 95% confidence intervals.

Real World Results

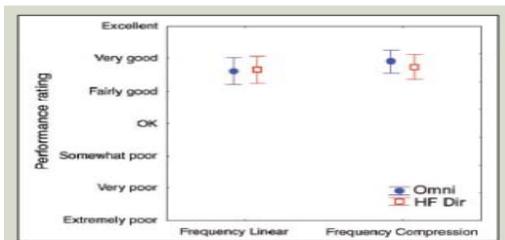
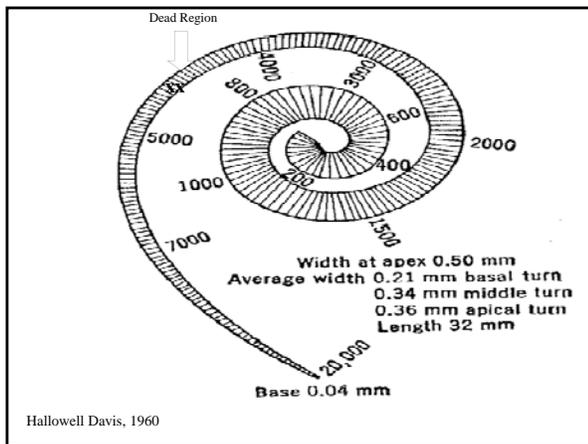


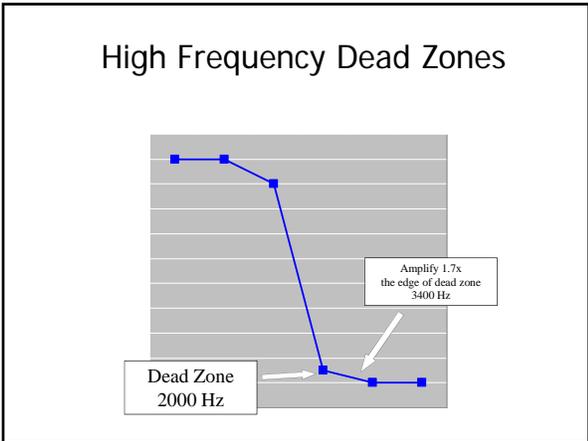
Figure 6. Average performance rating for frequency compression on/off with omnidirectionality and high-frequency directionality. Vertical bars indicate 95% confidence intervals.

Summary

- Frequency lowering has no significant effect on
 - Localization
 - Speech recognition
 - Real world reports of benefit (SSQ)

Frequency Lowering & Dead Zones





- ### Dead Zones and HF Amplification
- Cox et al 2011
 - N=170 (307 ears)
 - 31% of subjects had a dead region
 - Compared HFE to HFE-LP, using QSIN

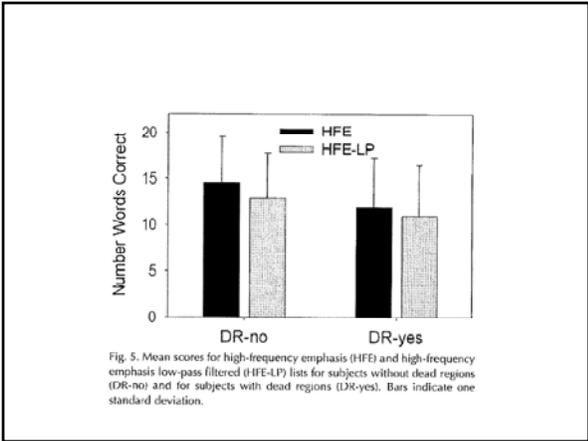


Fig. 5. Mean scores for high-frequency emphasis (HFE) and high-frequency emphasis low-pass filtered (HFE-LP) lists for subjects without dead regions (DR-no) and for subjects with dead regions (DR-yes). Bars indicate one standard deviation.

Conclusions

- Providing high frequency amplification was beneficial to both groups
- “no evidence to support a proposal for reducing high frequency gain in hearing aid fittings for these types of listeners”

Building and Raising Walls

Processed Based NR

Processed Based NR

Comfort in Noise

Goal: Improve Listening Comfort, More Relaxed Listening, Improved Resource Allocation

Important Feature: Processed-Based Noise Reduction Algorithms

Comfort in Noise

Goal: Improve Listening Comfort, More Relaxed Listening

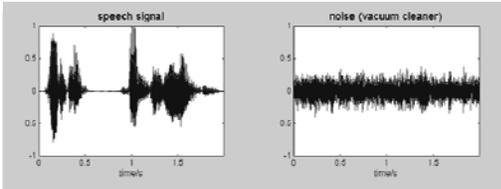
Selection & Counseling Tool: Acceptable Noise Level Test

**Digital Noise Reduction
(Processed Based NR)**

- How does it work?
- One or more types in many products

NR – Modulation Detection

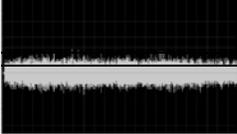
- Reduces gain in each channel that the signal is classified as noise



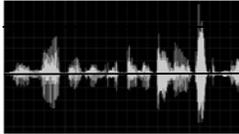
Processed Based NR

■ Modulation Depth

Low Modulation Depth



High Modulation Depth



Processed Based Noise Reduction (Other Considerations)

1. Onset and Offset Times
 - Between 2 seconds and 30 seconds – depending on the product
2. Amount of attenuation
 - Between 2 dB and more than 10 dB

Questions

1. Does DNR improve speech intelligibility in noise?
2. Do patients "like" DNR?
3. How might DNR help a patient?

Laboratory Evidence

Speech Intelligibility in Noise:

Processed-based NR does not improve speech intelligibility

(Ricketts & Dhar, 1999, Alcantara, et al 2003, Ricketts & Hornsby, 2005)

Laboratory Evidence

- Listening Preference for DNR
- Several studies suggest that patients prefer DNR in quiet and in noise:

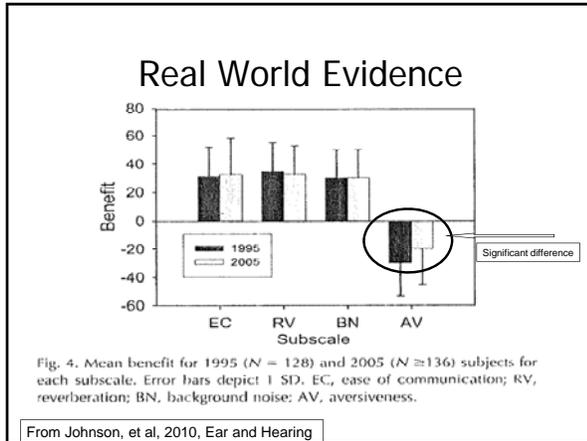
- Walden, et al 2000; Boymans & Dreschler, 2000; Ricketts & Hornsby, 2005; Alcantara et al, 2003; Marcoux et al, 2006, Mueller, et al 2006; Powers, et al, 2006, Keidser, et al, 2007

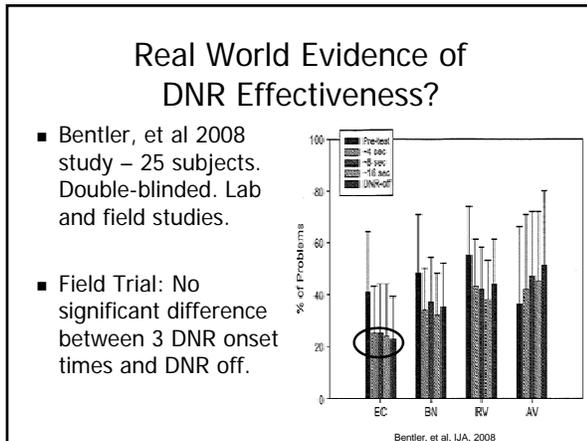
Laboratory Evidence

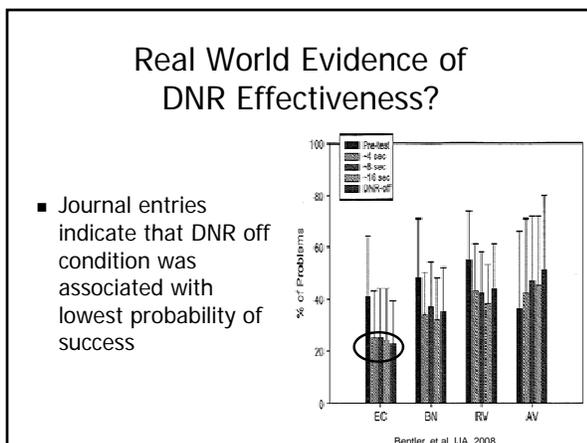
- Listening Comfort

- In paired comparison studies, patients prefer DNR on when listening in both low and high noise conditions (Ricketts & Hornsby, JAAA, 2005)





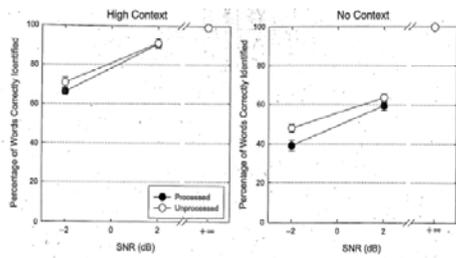




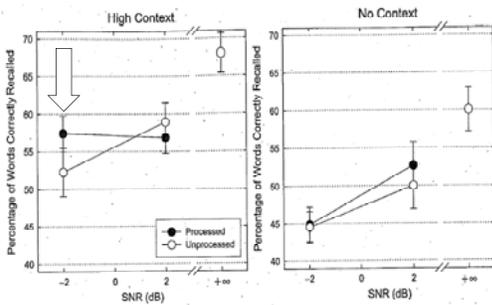
Dual Processing Tasks

- Sarampalis, et al 2009
- N= 25 normal hearing subjects
- SPIN-R
- Three Tasks with NR and without NR
 - Speech Intelligibility in Noise
 - Recall from Memory
 - Visual Reaction Time

Speech Intelligibility in Noise

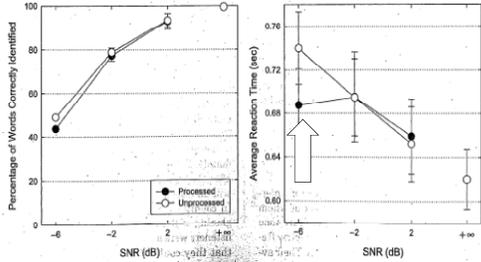


Memory Recall



Visual Reaction Time

Figure 4. Mean speech intelligibility performance (left panel) and mean reaction times (right panel) as a function of SNR, averaged across 25 listeners in Experiment 2. The parameter is presence of NR processing. Error bars denote 1 SEM.

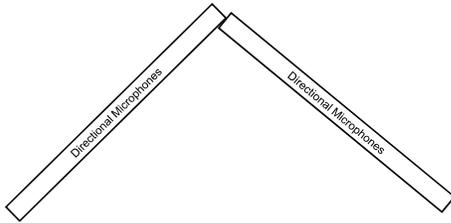


1. Does DNR improve speech intelligibility in noise? **No, but it may improve listening comfort & aversiveness to noise**

2. Do patients "like" DNR? **Yes and it probably doesn't make things worse**

3. How might DNR help a patient? **DNR might “free up” brain space on dual processing tasks. And may reduce cognitive effort**

A Sloping Roof with Rafters



Speech Intelligibility in Noise

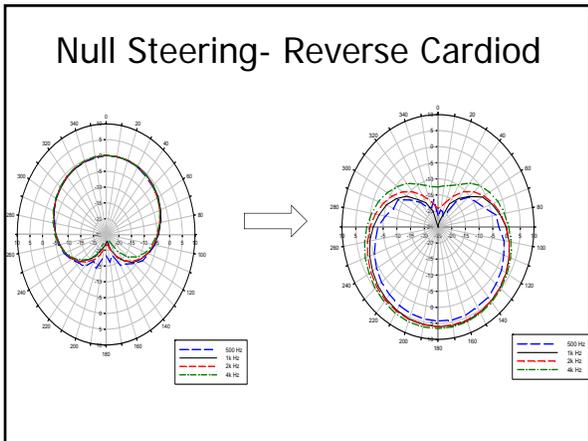
Goal: Improve Signal to Noise Ratio of Listening Situation

Important Feature: Directional Microphones

Speech Intelligibility in Noise

Goal: Improve Signal to Noise Ratio of Listening Situation

Selection & Counseling Tools: Quick SIN

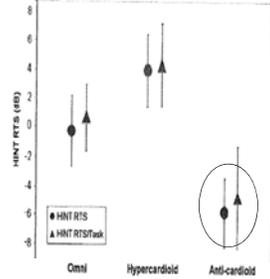


Efficacy of reverse cardioid directivity patterns

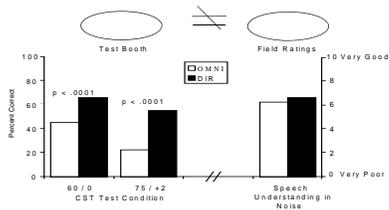
- Mueller, et al 2011
- N =21

Results

- Noise in front, Speech in Back, HINT improvement of 5.7dB
- Anti-cardoid pattern works!



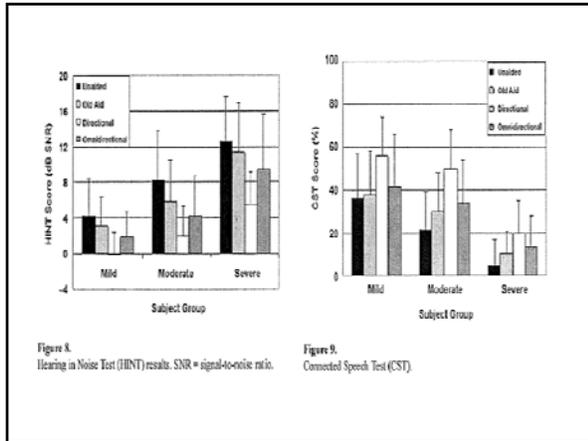
Directional Mics: Typical Findings

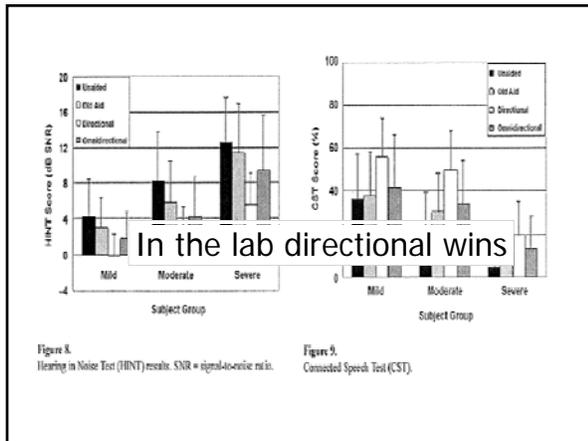


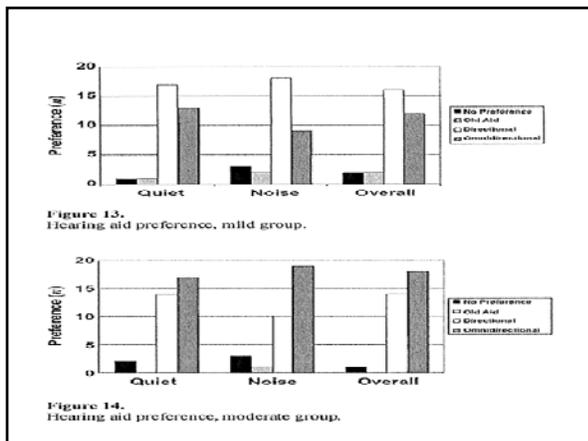
Walden & Walden, 2004

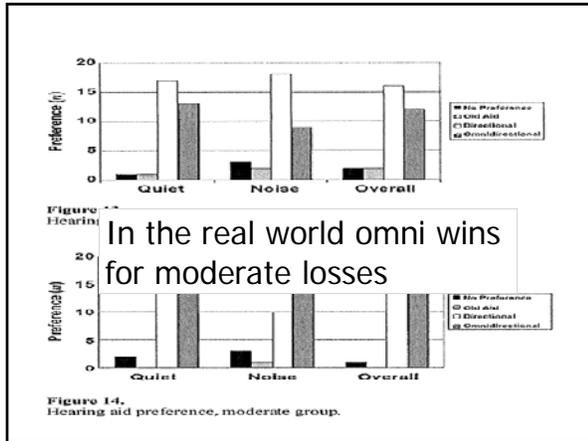
Recent study on real world benefits of directionals

- Gnewikow et al, JRRD, 2009
- 3-year double-blinded study
- N = 94
- Three hearing loss groups: mild, moderate, severe
- Wore 1 month in omni mode and 1 month in directional mode
- Objective tests: HINT, CST
- Subjective tests: PHAB, SADL, Patient preference questionnaires





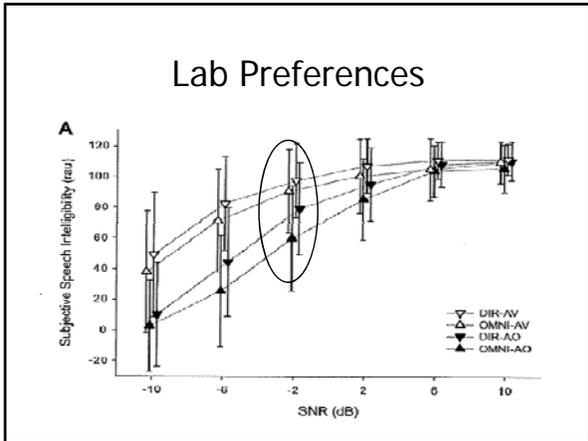


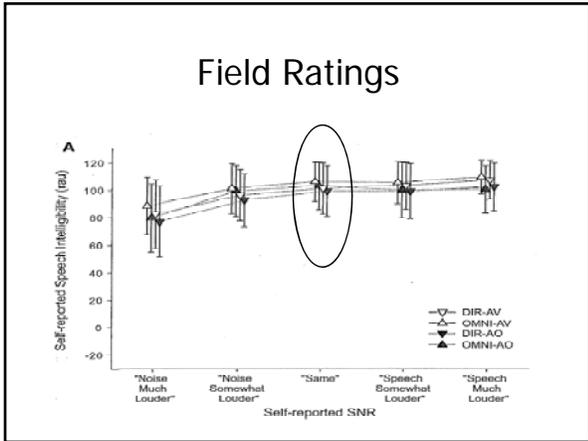


Visual Cues and Aging

1. Impact of Visual cues on Directional Benefit and Preference (Wu & Bentler, 2010):
 - Part 1: Laboratory Tests
 - Part 2: Field Trials
2. Effect of age on directional microphone benefit and preference (Wu, 2010)

- Wu and Bentler, Ear & Hearing, 2010
- Impact of Visual cues on Directional Benefit and Preference:
 - Part 1: Laboratory Tests
 - Part 2: Field Trials
- N = 25 adults, between 20 & 80 years old
- Mild to moderate-severe, symmetrical hearing loss
- 8 new users, 16 experienced users
- **Compared OMNI to DIR performance in the AO and AV conditions**





Conclusions from the Real World Study

- No effect for visual cues on preference for directional (having visual cues available didn't affect preferences)
- A-V lab testing predicted field outcomes more accurately than A only testing

Directional Mics and Older Patients

- Age range 36 to 80
- Wore switchable microphone devices
- Lab test: HINT
- Real world: 4 weeks, paired comparison + journal entries
- Subjects trained to recognize best places to use directional mode

Directional Mics and Older Patients

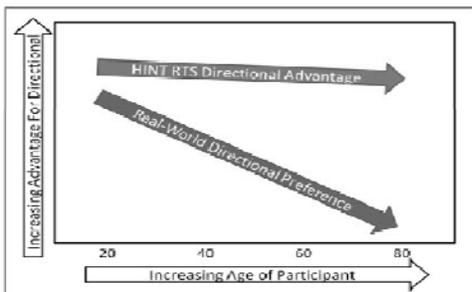


Figure from Mueller & Palmer, 2011

Conclusions

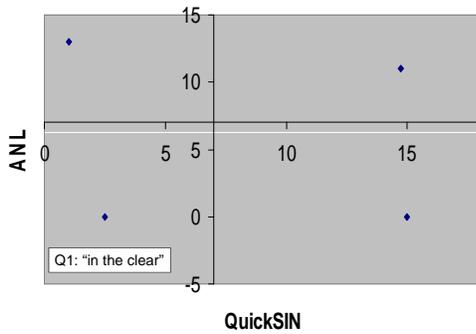
- Directional microphones do provide benefit to older patients (see lab results)
- But, they may not notice them as much (see real world results)
- Older patients need to be counseled differently

Things to Think About

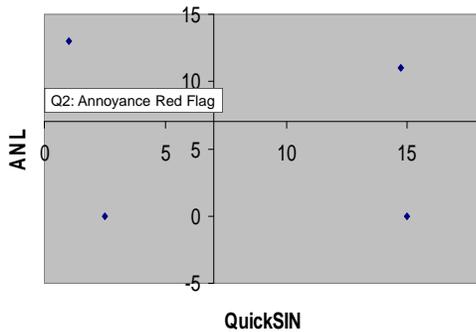
Why real world results are less than expected

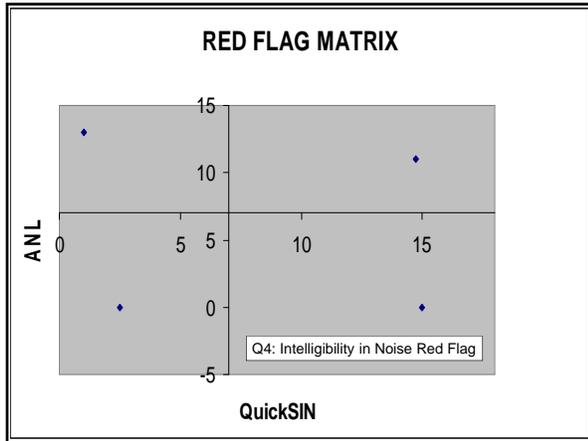
- Quick SIN and ANL results of patient
- Listener Intent/Expectations
- Evaluate patients lip reading ability
- Age of the listener

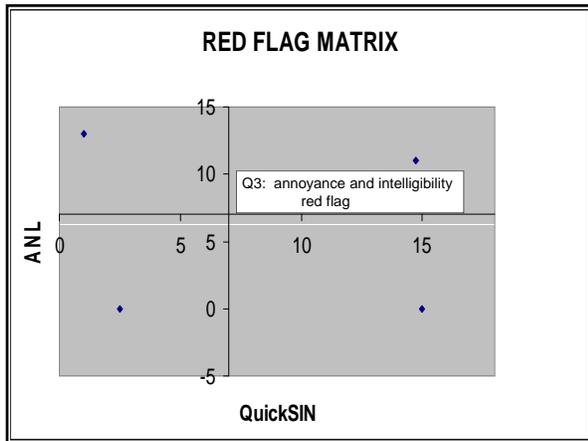
RED FLAG MATRIX

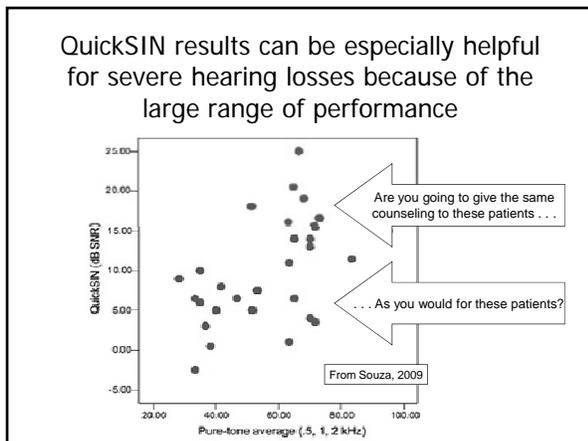


RED FLAG MATRIX









Installing Doors and Windows

Value-added Adaptator managers	Value-added extras
--------------------------------------	-----------------------

Value-added extras:
Wireless streaming
Manual control
Self-learning
Automatic Switching

Automatic Switching, Trainability, User Control, etc

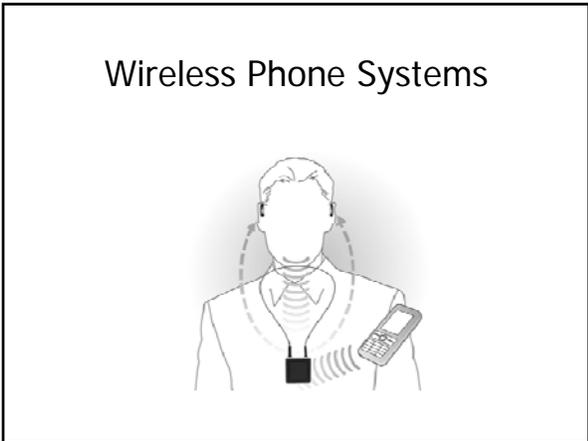
Goal: Improve Ease of Use, Flexibility and Convenience

Important Features: Automatic Switching & Trainable Algorithms, Remote Control, Binaural Sharing Algorithms, Wireless Communication

Automatic Switching, Trainability & User Control

Goal: Ease of Use, Flexibility and Convenience

Selection Tools: COSI, TELEGRAM, COAT



Comparison of Wireless and Acoustic Hearing Aid-Based Telephone Listening Strategies

Erin M. Picou and Todd A. Ricketts

- Ear in Hearing, 2011
- N = 20
- Examined speech recognition across several listening situations, including bilateral and unilateral processing
- Mini BTE thin wire products
- CST test

Fig. 4. Average hearing thresholds of study participants (n = 20) for left ear (top) and right ear (bottom). Solid lines represent the maximum and minimum thresholds of all participants.

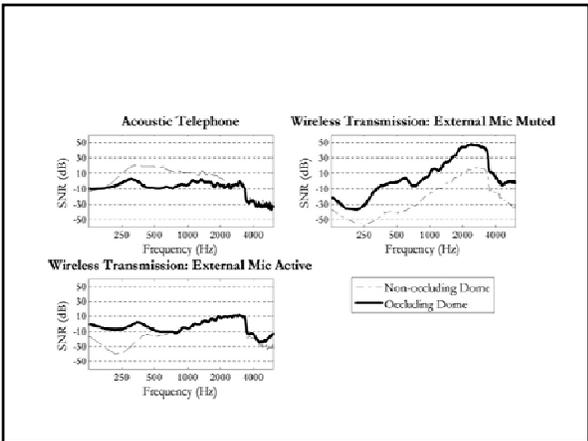
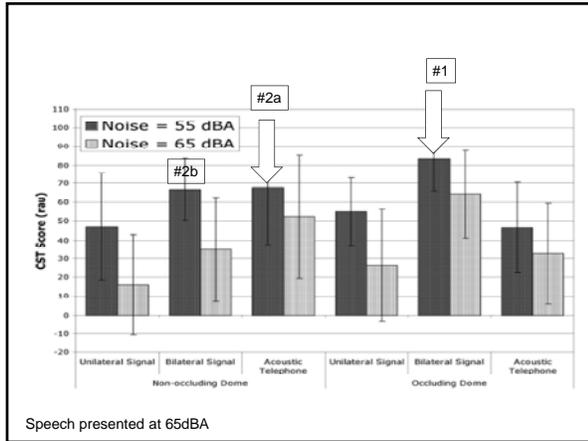
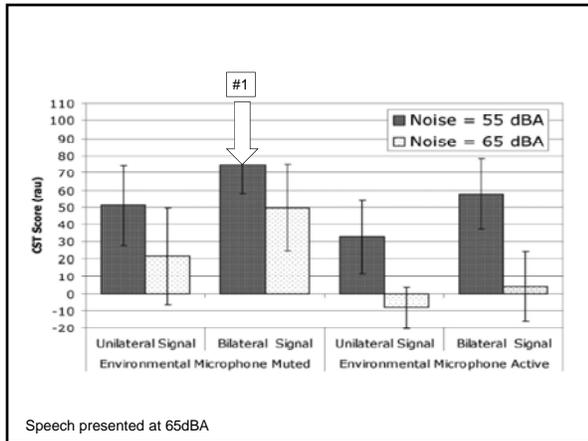


TABLE 1. General descriptions of the hearing aid conditions under evaluation

Name	Condition	Speech Signal	Background Noise	Purpose
U _{noise}	Wireless speech signal to one ear, contralateral hearing aid removed, C.A.R. plug inserted	Delivered to one test ear via hearing aid	Arrives at test ear via hearing aid vent Attenuated at contralateral ear by C.A.R. plug	Is plugging the ear with no speech signal helpful?
U _{noise}	Wireless speech signal to one ear, contralateral hearing aid turned off	Delivered to one test ear via hearing aid	Arrives at test ear and non-test ear via hearing aid vents	Is turning off the contralateral hearing aid helpful?
U _{noise}	Wireless speech signal to one ear, contralateral hearing aid turned on	Delivered to one test ear via hearing aid, external microphone is activated	Arrives at test ear via hearing aid vent Amplified by hearing aid in non-test ear	Typical configuration
U _{noise}	Wireless speech signal to one ear, contralateral hearing aid turned on	Delivered to one test ear via hearing aid, external microphone muted	Arrives at test ear via hearing aid vent Amplified by hearing aid in non-test ear	Typical configuration
B _{noise}	Wireless signal sent to both ears simultaneously	Delivered to both ears via shared signal, external microphone activated	Arrives at both ears via hearing aid vents	Is a bilateral speech signal helpful?
B	Wireless signal sent to both ears simultaneously	Delivered to both ears via shared signal, external microphone muted	Arrives at both ears via hearing aid vents	Is a bilateral speech signal helpful?
Phone	Speech signal delivered via telephone handset to the test ear only	Delivered to one ear from telephone	Arrives at test ear via hearing aid vent Amplified by hearing aid in non-test ear	Is the standard listening condition different than wireless speech transmission?





Conclusions

1. The 3 unilateral conditions were similar to each other
2. Unilateral wireless condition did not outperform acoustic telephone condition

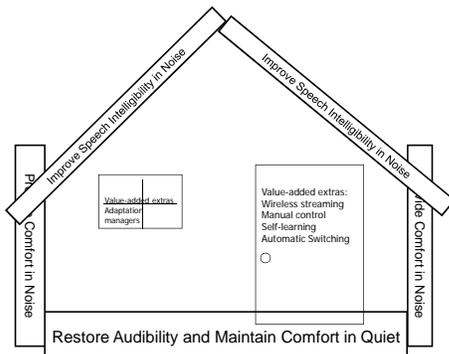
TABLE 2. Average score (raw) in the unilateral hearing aid conditions

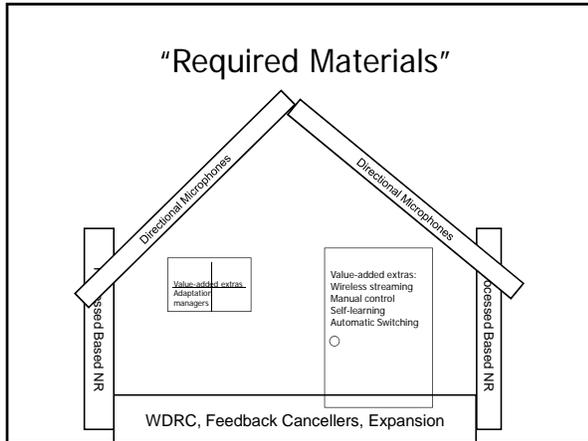
Condition	55 dB Background Noise	65 dB Background Noise
U _{acoustic}	54.06	28.07
U _{wireless}	53.87	28.11
U _{acoustic}	51.01	20.74

Conclusions

3. Amount of improvement in bilateral condition was dependent on the coupling
 - When occluding domes were used bilateral condition resulted in best performance
 - When non-occluding domes were used, bilateral condition did not outperform acoustic telephone (unilateral)
 - Activating the external mic negatively affected performance

Constructing a Hearing Aid Fitting





Making Sense of All The Jargon

Hearing Aid Feature	Generic Benefit	Individual Benefit
<p style="text-align: center;">so what?</p> <p>→</p> <p><i>List here</i></p> <ol style="list-style-type: none"> 1. 2. 3. 4. 5. 6. 7. 	<p style="text-align: center;">so my patient can..</p> <p>→</p>	

Question

Who should do most of the thinking when selecting and fitting hearing aids?

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Questions & Thanks

■ Brian.Taylor@unitron.com
