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Vanderbilt Audiology's Journal Club with Dr. Todd Ricketts

Presenter: Todd A. Ricketts, Ph.D.
Associate Professor at the Vanderbilt Bill Wilkerson center for Otolaryngology and Communication Sciences & Director of the Dan Maddox Hearing Aid Research Laboratory

Moderator: Gus Mueller, PhD - AudiologyOnline Contributing Editor

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Hearing Aid Month

- Advances in Implantable Amplification Devices (#24716)
  Brad A. Stach, PhD
- Hearing Aid Solutions for the Speech-in-Noise Problem (#24702)
  Joshua M. Alexander, PhD
- Vanderbilt Audiology's Journal Club (#24207)
  Todd A. Ricketts, PhD
- An Evidence-Based Approach to Reporting Hearing Aid Benefit (#24714)
  Ron Leavitt, AuD
- Hearing Aid Technology Industry Roundtable (#24717)
  moderated by Catherine Palmer, PhD

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Vanderbilt Audiology's Journal Club: Hearing Aid Features and Benefits - Research Evidence

Todd A. Ricketts, Ph.D.

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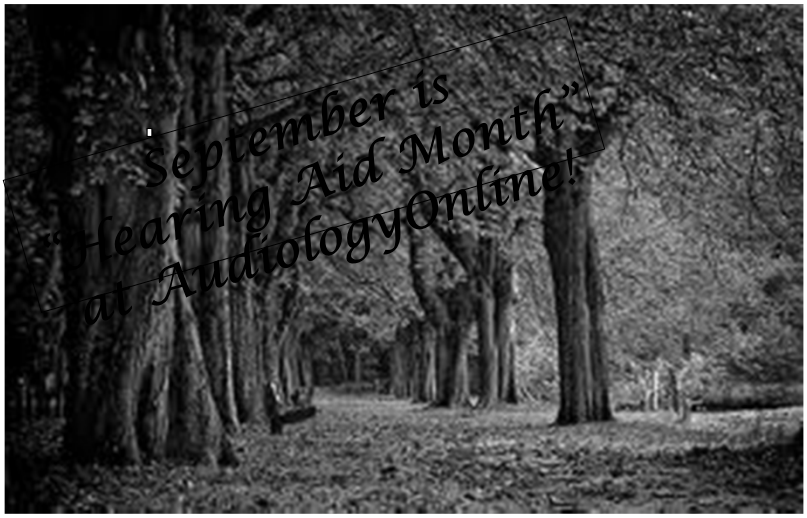

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What We're Planning At Vandy

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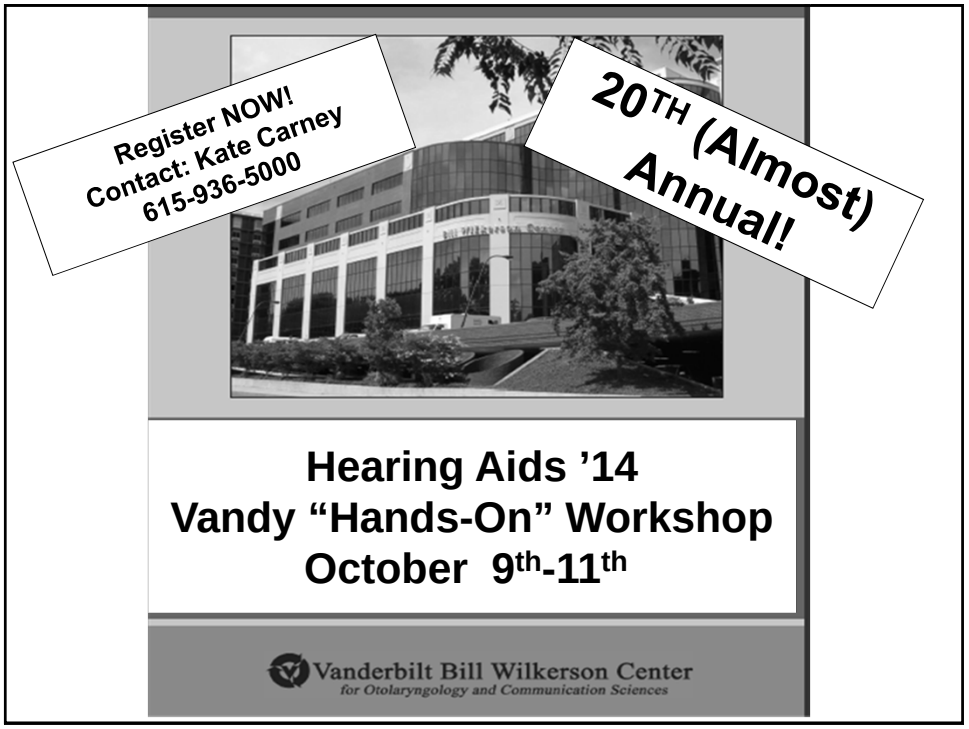
Register NOW!
Contact: Kate Carney
615-936-5000
20TH (Almost) Annual!
Hearing Aids '14
Vandy "Hands-On" Workshop
October 9th-11th
Vanderbilt Bill Wilkerson Center
for Otolaryngology and Communication Sciences


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Vanderbilt Audiology's Journal Club: Hearing Aid Features and Benefits - Research Evidence

Todd A. Ricketts, Ph.D.

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Relating working memory to compression parameters in clinically-fit hearing aids

Pamela E. Souza and Lynn Sirow

American Journal of Audiology (2014), ePub ahead of Print

What they asked . . .

- Previous work suggests that working memory may influence speech recognition performance as a function of compression speed in very controlled (laboratory) conditions, typically using very simple compression schemes (Foo, Rudner, Ronnberg, & Lunner, 2007; Gatehouse, Naylor, & Elberling, 2006; Lunner & Sundewall-Thoren, 2007; Ohlenforst, Souza, & Macdonald, 2014).
- This study explored whether similar effects might be evident in clinically fitted hearing aids.

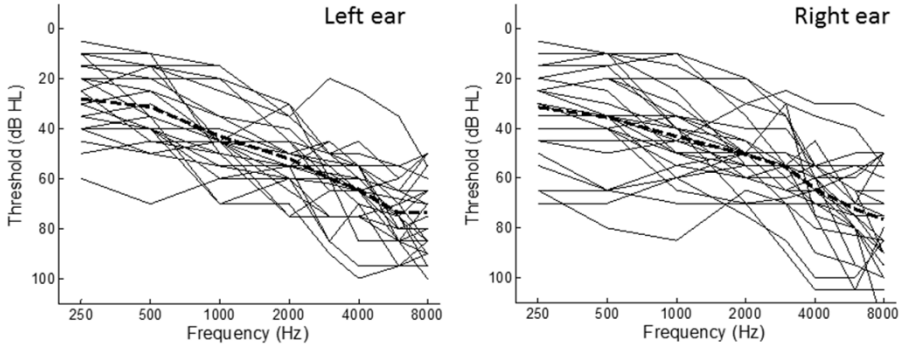
Why it matters. . .

- Fast-acting WDRC alters the speech envelope potentially creating difficulty matching this altered acoustic signal to long term memory stores in listeners with low working memory.
- Support for a real world relationship may support clinical measures for optimizing selection of compression speed for individuals.

What they did . . .

- 27 older adults who were patients in a private practice audiology clinic served as participants.
- Fitted with mini-BTE instruments (RIC) via DSL v5 and appropriate real ear verification.
- Working memory was assessed using a reading span test (Daneman & Carpenter, 1980; Ronnberg, Arlinger, Lyxell, & Kinnefors, 1989)
  - Did the sentence make sense (half do not) – usually reaches ceiling performance.
  - Measure is recall of the first or last words in percentage correct as the number of words is increased.
- Two Quick-SIN list for each condition presented at 83 dB SPL (70 dB HL) – Loud but OK.

A range of mostly sloping hearing losses



A range of compression parameters in commercial instruments (Mini-BTEs)

17 tested with 3 instruments, 10 with 4 instrument

Table 1. Compression parameters for tested aids.

Hearing aid	A	B-slow	B-fast	C
Release time	≤ 20 sec	1000	75	< 50 ms
Attack time	≤ 2 sec	5 ms	10 ms	< 5 ms

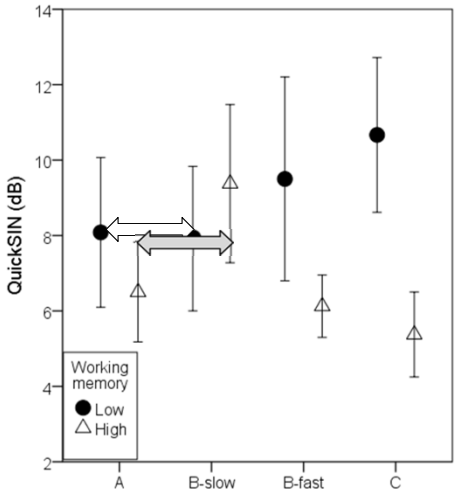
Very Slow Slow Fast Faster

What they found. . .

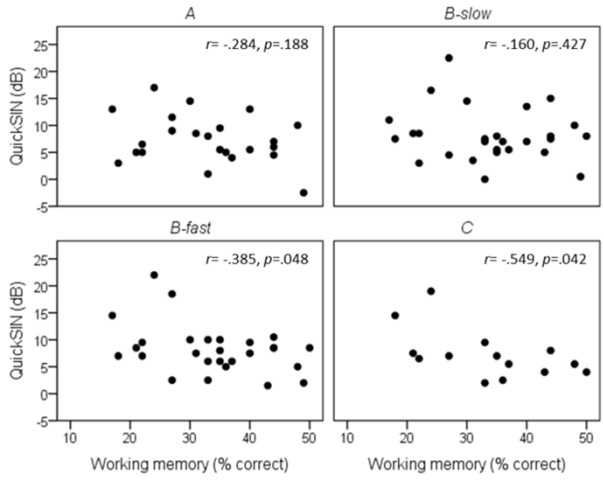
Both groups are similar for slow

-Those with low working memory perform significantly worse with fast.

-Those with high working memory performed significantly better with fast.



What about Individuals?



The bottom line? Working memory was not a good predictor for slow (instead hearing loss and age).

Working memory (alone 30%) + hearing loss (combined 70% of the variance) were significant predictors for fast.

Why is this important?…

- Younger patients with less hearing loss and high working memory may benefit from faster compression time constants.
  - While older patients with more hearing loss may perform more poorly with faster compression
- "The use of cognitive testing in a real-world setting may contribute to an evidence-based method of prescribing appropriate compression parameters…fruitful discussion with patients…"

The effect of hearing aid technologies on listening in an automobile

Yu-Hsiang Wu, Ruth A. Bentler & Rachel W. Stanziola

J Am Acad Audiol. 2013; 24(6): 474–485

What they asked . . .

Are there differences between five signal processing schemes (omnidirectional, conventional adaptive directional (comparable to the standard automatic mode), back directional, side-transmission, and side-suppression) in the speech recognition afforded in an automobile (actually pre-recorded signals from a Van traveling at 70 mph on I-80 between exits 249 and 284 in Iowa).

Why it matters. . .

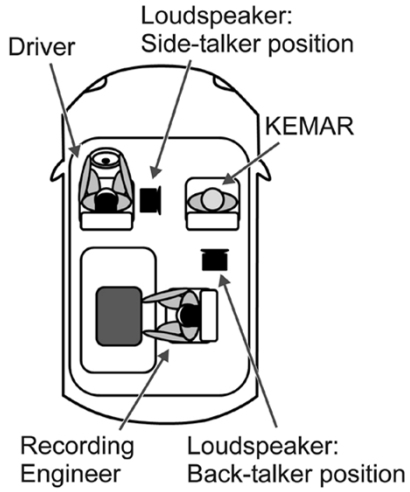
- While listening in a vehicle is only a single listening situation, it is somewhat unique because of lack of visual cues, talker position; as well as noise position and type.
- Communication in a vehicle is an issue that we hear about clinically.

What they did . . .

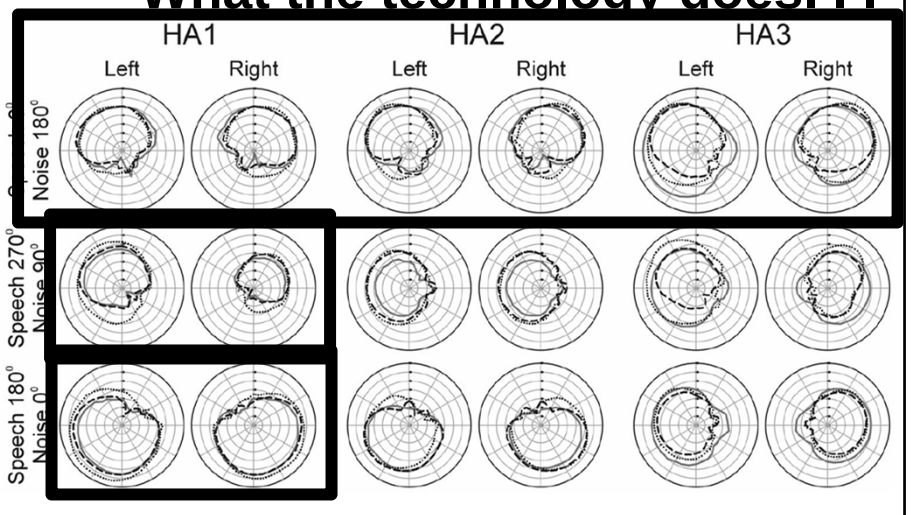
- Speech recognition performance for 25 listeners with bilateral symmetrical sensorineural hearing loss was measured via the Connected Speech Test (CST).
- Sentences were recorded through hearing aids in a standard van using hearing aids fitted to a KEMAR seated in the passenger seat.
  - Three different models (mini-BTE thin tube) programmed to a sloping hearing loss (NAL-NL1).
- The recorded materials were presented to listeners via earphones.

What they did . . .

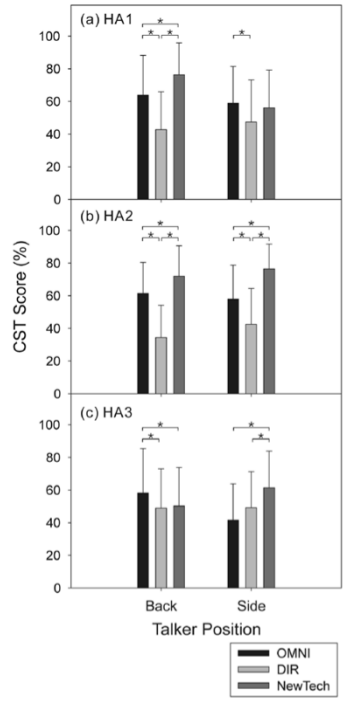
- Sentences were presented from both the side and back of the KEMAR (position of the driver and someone in the back seat)



What the technology does. . .



Back-Dir/Steering | Signal Sharing | Side Suppression



What they found. . .

Back-Dir/Steering
Better for back,
not better for side

Signal Sharing
10-18% better
Localization?

Side Suppression
Not better for back

Caveats:
-Noise fluctuations?
- Road noise was relatively high compared to some passenger cars (78 dBA versus 60-73 dBA in sedans – some at lower speeds) leading to poor SNRs and performance.

- Results were generally consistent with preference data and measured SNR.

Why is this important?…

- ❑ New microphone technologies can provide considerable benefits in specific vehicle based listening situations.
- ❑ Standard automatic directional hearing aids may lead to significant decrements when listening in a vehicle.
- ❑ The specific situation which lead to benefits, and the potential trade-offs related to localization and other factors depend on the specific technology that is implemented.

Impact of Advanced Hearing Aid Technology on Speech Understanding for Older Listeners with Mild to Moderate, Adult-Onset, Sensorineural Hearing Loss

Robyn M. Cox, Jani A. Johnson & Jingjing Xu

Gerontology (2014) – ePub ahead of print DOI: 10.1159/000362547

What they asked . . .

Do patients fit with "premium" and "basic" hearing aids lead express different outcomes for speech understanding and quality of life?

Why it matters. . .

- Hearing aids differ greatly by price (as a function of "level of technology"). These levels are generally marketed as "higher is better" – however this model ignores matching the "right technology" to the individuals specific communication needs.
- A lack of difference may suggest that differences in technology are not large enough for patients to notice (and perhaps increases are not worth the money).

What Does "Level" Mean?

- In current modern hearing aids all levels (even the most basic) typically include many features: multichannel compression, directional microphones, digital noise reduction, and feedback suppression noise reduction.
- Higher level hearing aids general distinguish themselves by including more complex, automatic and adaptive versions of these basic features
- As well as a few additional features – depending on the manufacturer - bilateral data sharing, learning VC, impulse noise reduction, reverberation suppression, wind noise suppression

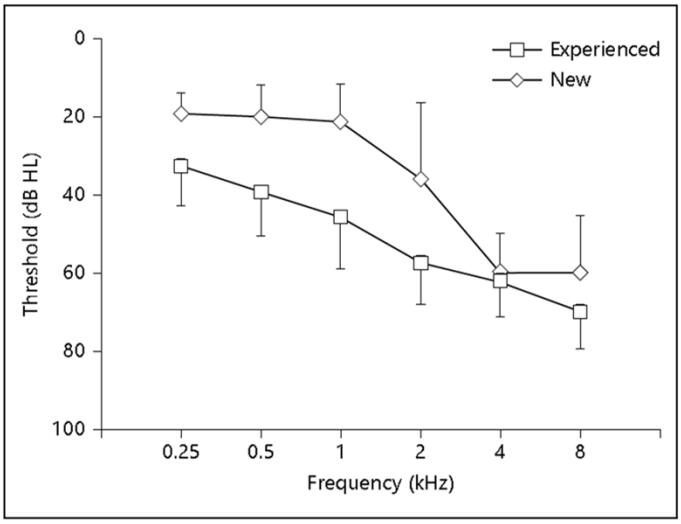
What they did . . .

- 25 participants, including both new and experienced hearing aid users, completed blinded month-long field trials
- Each participant wore four pairs of hearing aids: two basic and two premium level (two different manufacturers) all were mini-BTE style.
- Fittings were compared via laboratory speech understanding tests (Four Alternative Auditory Feature test - SSN surrounding), standardized questionnaires and open-ended (5+5) diary items.
- All fittings were NAL-NL2 with real ear verification and fine tuning.
  - Fine tuning used rule-based subjective assessments of bilateral loudness balance, loudness of average speech, loudness comfort, and quality of own voice; follow-up further fine-tuning (within week 1); Remote controls and hearing aid learning capabilities were available for premium devices.

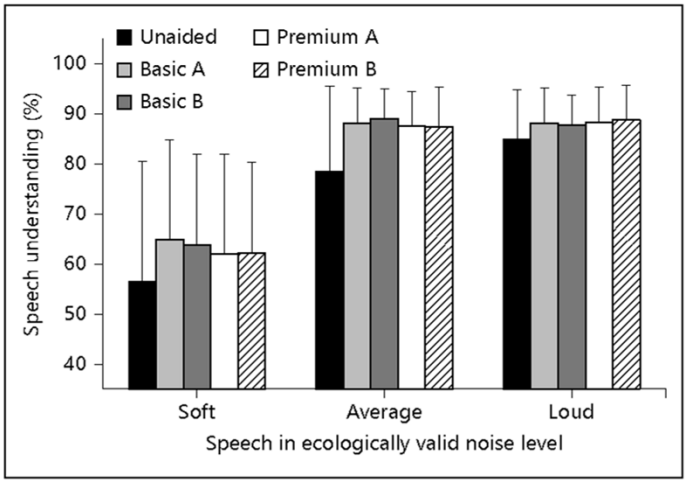
Questionnaires after each 1 month trial

- The Abbreviated Profile of Hearing Aid Benefit (APHAB) - aided and unaided
- The Speech, Spatial and Qualities of Hearing Scale (SSQ-B) - as a second hearing aid benefit measure in challenging and dynamic listening situations
- The Device-Oriented Subjective Outcome (DOSO) Scale – Hearing Aid Performance
- Change in overall quality of life and diaries related to hearing when listening with the trial hearing aids.

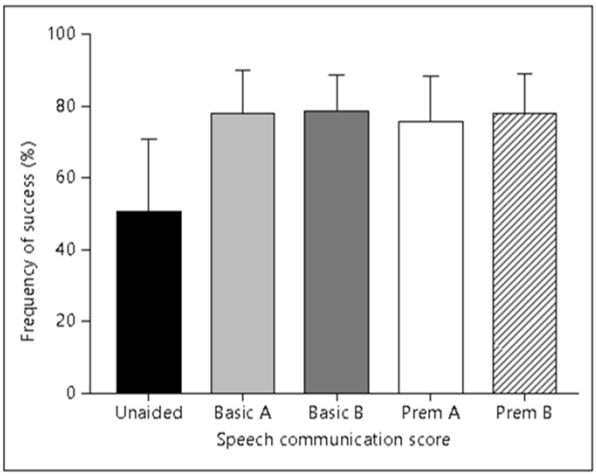
Average Hearing Loss by Group



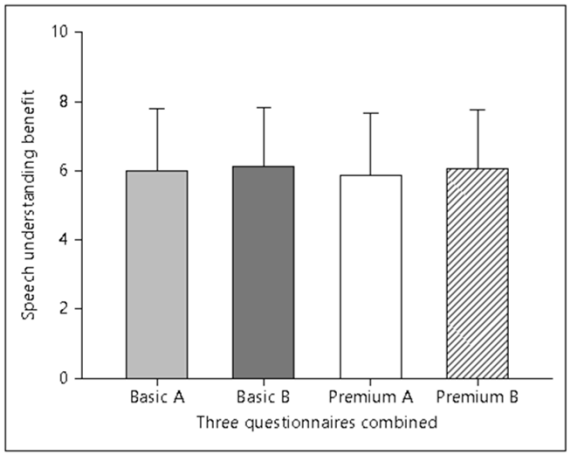
What they found – Laboratory speech recognition



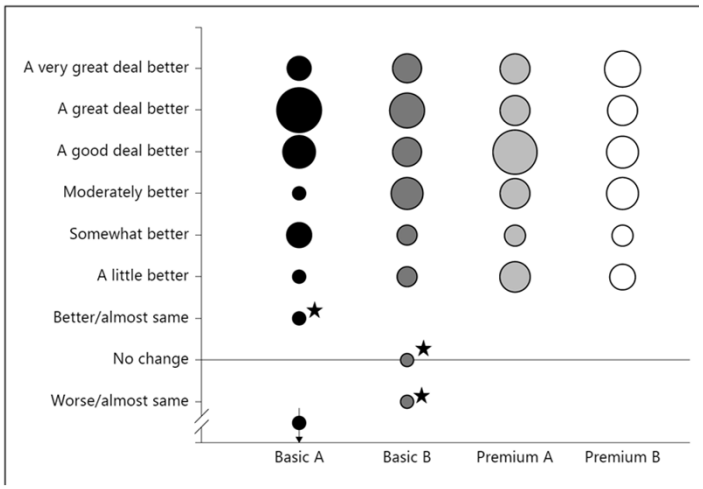
What they found – APHAB composite score



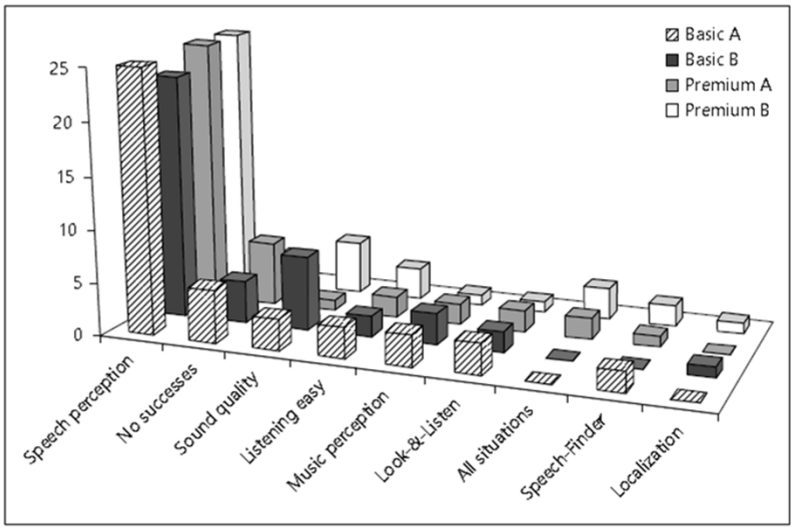
What they found – Overall composite of self report inventories



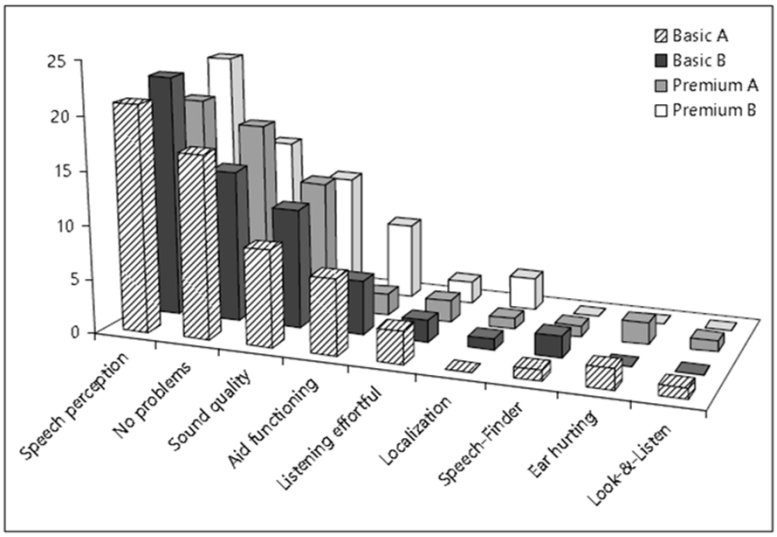
What they found – Quality of life



What they found – Diaries (+)



What they found – Diaries (-)



What they found (Summary). . .

- Amplification results in large and significant benefits
- Issues surrounding speech understanding are by far the most pivotal for patients assignment of benefit
  - Consequently, technologies that do not effect speech understanding are likely to have little effect on general outcomes (premium features?).
- There were no statistically significant or clinically important differences in improvement between the premium- and basic-level hearing aids for either new or experienced users

Why is this important?…

- Can't assume that more expensive hearing aids will be better!
- My take/bias – the role of the clinician in selecting, fitting and optimizing hearing aid technology is at least as important as the technology itself.
  - More is not better – accurately applying technology that addresses the individual needs of the patient is better.
- "Comprehensive best-practice fitting protocols should be followed to optimize results for every patient."

Commodore Award

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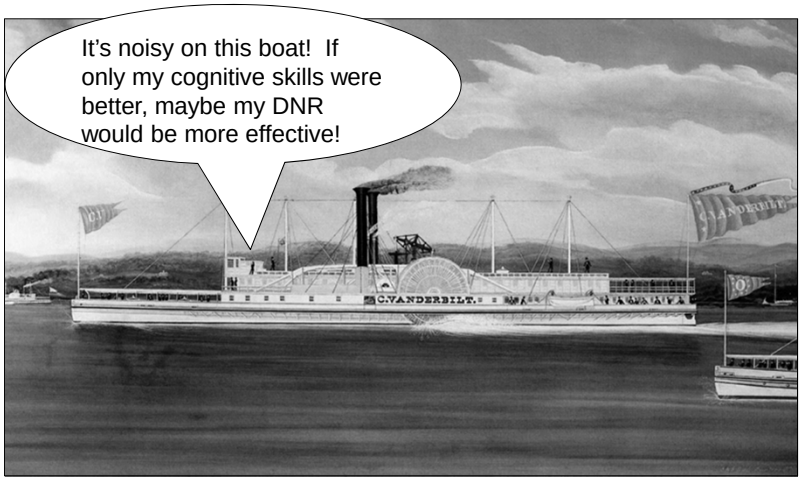
Commodore Cornelius Vanderbilt

Commodore Vanderbilt Steamship (circa 1860)



The Effect of Hearing Aid Noise Reduction on Listening Effort in Hearing-Impaired Adults

Jamie L. Desjardins & Karen A. Doherty

Ear and Hearing (2014), ePub ahead of Print

What they asked . . .

- NR algorithms do not significantly improve listeners' speech recognition in background noise (Valente et al. 1998; Boymans et al. 1999; Boymans & Dreschler 2000; Walden et al. 2000; Bray & Nilsson 2001; Levitt 1971; Mueller 2002) but are still often preferred by listeners (Keidser 1996; Preves 1990; Ricketts & Hornsby 2005; Bentler et al. 2008).
- What are the effects of DNR on listening effort as measured by dual task?

How do the authors define listening effort?

- The cognitive resource requirements necessary for an individual to understand speech (Broadbent 1958; Feuerstein 1992; Gosselin & Gagne 2011; Sarampalis et al. 2009; Desjardins & Doherty 2013).
- The amount of mental capacity the performance of a listening task occupies in a capacity-limited system (Broadbent, 1958).
  - Common to assess using a dual task paradigm.

Why it matters. . .

- Hearing aid processing such as DNR may interact with other factors of the listening experience in addition to speech recognition.
- If listening effort is reduced by processing it may lead to less fatigue, more time on task, and a variety of other potential benefits.

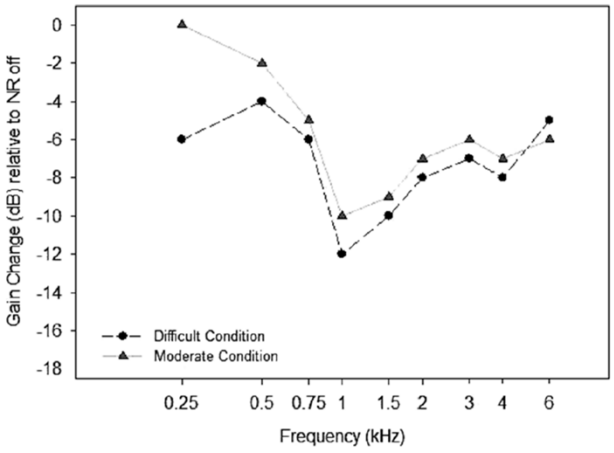
What they did . . .

- 12 experienced hearing aid users were bilaterally fitted with BTE hearing aids (DNR was a modified spectral subtraction) and disposable canal earmolds with no venting (DSL v.5 with real ear verification).
- Both low and high probability R-SPIN sentences were presented to participants in a female two-talker babble
  - Individualized moderate listening condition (76%) and difficult listening condition (50%).
- Secondary task was visual motor tracking of a circle-shaped target that rotates along an elliptical track with visual feedback (red to green).
  - Participant's time-on-target (TOT) is scored during speech presentation.

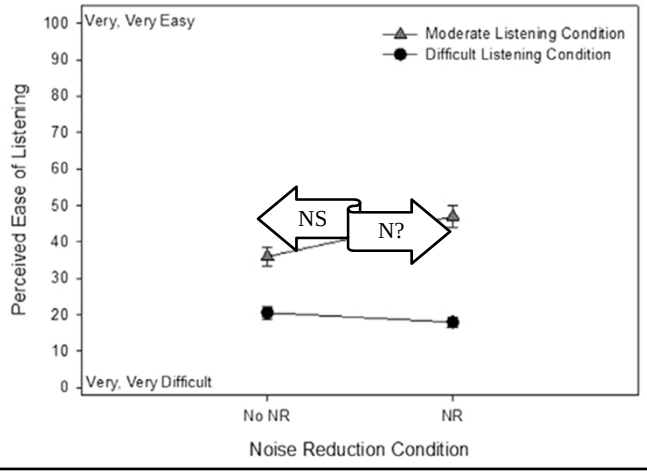
What they did . . .

- Working memory was assessed using the Reading Span test
- Perceptual processing speed was assessed by the Digit Symbol Substitution Test (DSST) from the Wechsler Adult Intelligence Scale-III
  - Code as many numbers with their correct symbol as possible in 2 minutes.
- Self-perceived ease-of-listening

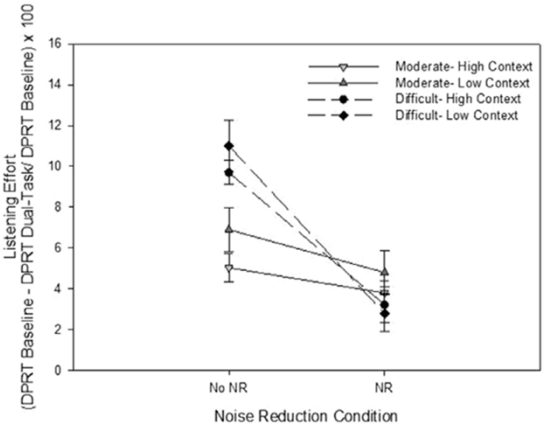
What they found: Effect of DNR on Gain. . .



What they found: Ease of Listening. . .



What they found: Noise Reduction. . .



- No change in speech recognition.
- Significantly lower effort, but only in the more difficult environment (~1.6 dB SNR – compared to 4.4 dB SNR).
  - No interaction with context.

What they found (predictors) . . .

- Trend for individuals with faster processing speed to expend less listening effort with the NR activated in the more difficult listening condition.
- Another example of the "rich get richer" those with best processing/cognitive functions/least hearing loss seem to benefit more from complex signal processing aimed at improving listening in noise.

Why is this important?…

- These data add to and more specifically support benefits for DNR that are unrelated to changes in speech recognition.
- They also suggest that LE benefits from DNR are most likely found when listening is most difficult (consistent with Sarampalis et al 2009 with normal hearing listeners).
- Finally these benefits do not appear to be effected by level of context.

Clinical Tidbits: Some interesting research findings

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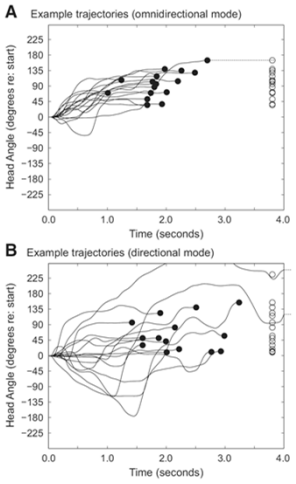
Directional Microphones may lead to loss of audibility for sounds in the rear hemisphere increasing localization problems

Listeners were tasked to face a female talker in simultaneous surrounding male-talker babble (Vicon motion tracking system).

For larger off-axis target angles, listeners using directional microphones took longer, used more complex movements and frequently made initial turns in the wrong direction (directional was better for smaller off-axis target angles)

The authors argue that an increase in movement complexity indicates a switch from a simple orienting movement to a search behavior and listeners could experience a loss of initial target speech while turning toward a new signal of interest.



Brimijoin WO, Whitmer WM, McShefferty D, Akeroyd MA. (2014) The effect of hearing aid microphone mode on performance in an auditory orienting task. Ear Hear. 35(5):e204-12.

Long term language benefits from frequency lowering technologies may be limited

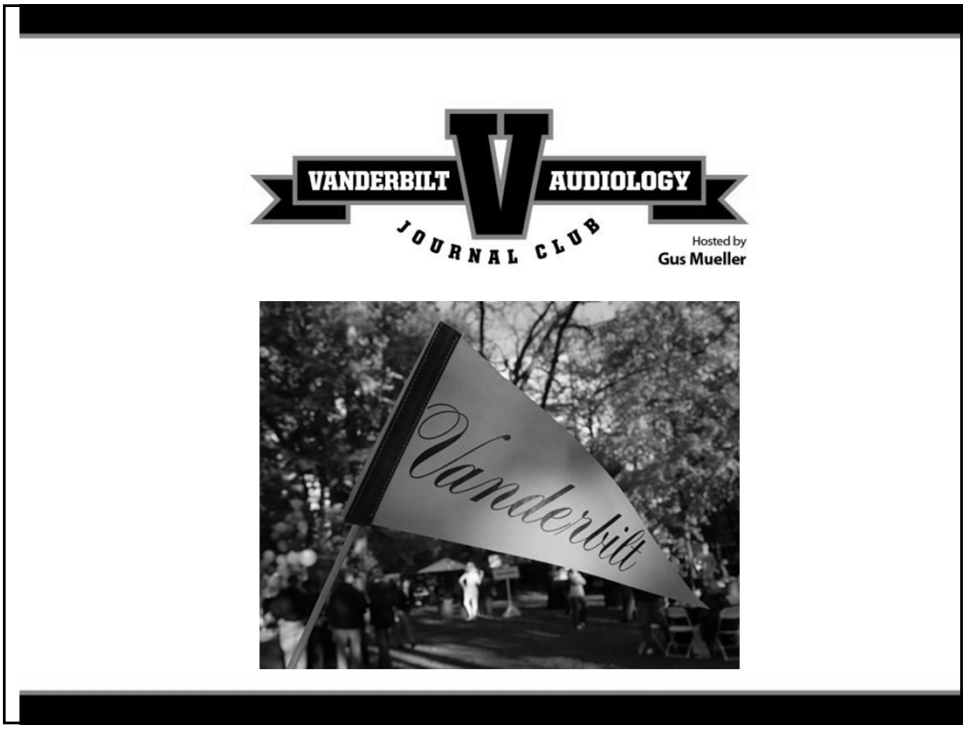
- 66 3-, 4-, and 5-year-old children with hearing loss (recruited as part of NIH-OCHL) fitted with either NLFC or conventional amplification for at least 6 months served as participants.
- Demographic characteristics, audibility, speech/language outcomes, and speech-perception (5-yo only) were compared across the two technology groups.
- The data revealed no differences in speech or language outcomes or speech perception between the technologies.
  - Similar findings in 3 yo children from Ching et al (2013)

Bentler R, Walker E, McCreery R, Arenas RM, Roush P. (2014). Nonlinear frequency compression in hearing AIDS: impact on speech and language development. Ear Hear. 35(4):e143-52.

A greater emphasis on emotionally focused communication within audiology could result in improved outcomes and relationships

- Analysis of 65 videos of clinic appointments with 23 different audiologists.
- Patients concerns regarding hearing aids are typically psychosocial in nature (emotional response) and carry a negative emotional stance inviting an empathic response (directly addressing emotions, validating feelings, and inviting further disclosure or expansion).
  - However, audiologists typically don't address these concerns and instead focus on progression of process.
- Patients therefore re-raise their concerns in subsequent turns, sometimes leading escalations in the expressions and failures in the process.

Ekberg K, Grenness C, Hickson L. (2014). Addressing patients' psychosocial concerns regarding hearing AIDS within audiology appointments for older adults. Am J Audiol. 23(3):337-50



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