Hearing Aid Features & Tier Levels Examined Within & Beyond the Clinical Setting

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THE UNIVERSITY of TENNESSEE HEALTH SCIENCE CENTER

Audiology and Speech Pathology

Presentation Overview

- Part I: Hearing Aid Features
  1. Frequency Compression, Noise Reduction ✓
  2. Extended Input Dynamic Range ✓

- Part II: Hearing Aid Tier Levels
  3. Adaptive Program Switching
  4. Noise Management Features
  5. Hearing Aid Fittings

Why Study Tier Levels?

- UT Courses
  - Year 1: ASP 543 (basics)
  - Year 2: ASP 544 (theory)
  - Year 3: ASP 664 (seminar)
- Year 2 ASP 544
  - Correction factors for selection
  - Old order form
    - Students absolutely hate it ☺

Extended Warranty ☐ 24 Months ☐ 36 Months

Color ☐ Beige ☐ Tan ☐ Brown

Custom Products

L	R	*Life*Sound™ ITE	L	R	*Life*Sound Canal
L	R	*Life*Sound Low Profile	L	R	*Life*Sound Mini-Canal
L	R	*Life*Sound Half Shell	L	R	*Life*Sound (CIC)
			L	R	Helix

Programmable Circuit Options

L	R	TRITON 3004	L	R	*Intelli*Venience
L	R	TRITON 2004	L	R	INFINITI 3+
L	R	FRONTIER	L	R	INFINITI Class A
L	R	MUSIC	L	R	INFINITI Class D

Non Programmable Circuit Options

L	R	ATC/AGC-I	L	R	ATC
L	R	Linear D (Filament VC)	L	R	AGC-I Class A
			L	R	AGC-I Class D
L	R	AGC-I/RPC	L	R	RPC
L	R	PP-AGC-I	L	R	PP
L	R	K-AMP *PLUS*	L	R	Basic Class A
L	R	K-AMP	L	R	Basic Class D

Additional Control Options

L	R	Low Cut Tone (N-H)	L	R	Gain Control
L	R	High Cut Tone (N-L)	L	R	Output Control
L	R	Screw Set Volume Control	L	R	T/K Control
L	R	Low Cut (N-H) Toggle Switch	L	R	On/Off Switch
L	R	Telephone Coil with Pre-Amp and Switch (ITE/HS)			

Canal Length

L R Short L R Medium L R Long

Custom Options

L	R	Windscreen	L	R	Extended Receiver Tubing
L	R	Removal Notches	L	R	Acoustic Horn
L	R	Canal Lock	L	R	Bell Bore
L	R	Helix Lock	L	R	Cooked Shell-color
L	R	Raised Volume Control	L	R	Cooked Shell-clear
L	R	Dip Canal in Soft Material	L	R	No Wax Spring
L	R	Soft Canal			

Venting

L	R	No Vent	L	R	Small SAV (.060)
L	R	ROS	L	R	Medium SAV (.100)
L	R	Pressure Vent (.040)	L	R	Large SAV (.120)

Special Service ☐ 24 Hour Service

Spanish User Manual ☐

Client (Last Name, First Name/Initial) Age

Speech Audiometry ☐ HL ☐ SPL

		Left	Right	Binaural
SRT (Speech Reception Threshold)		dB	dB	dB
MCL (Most Comfortable Level)		dB	dB	dB
UCL (Uncomfortable Level)		dB	dB	dB
Discrimination in Quiet	Level of Speech	dB	dB	dB
	Score	%	%	%

Matrix Selection

Left			Right		
Peak Gain	Slope	Power Level	Peak Gain	Slope	Power Level

Desired 2cc Coupler Full-On Gain

	250	500	1000	1500	2000	3000	4000	6000
Left								
Right								

Maximum SSPL (2cc Coupler)

	250	500	1000	1500	2000	3000	4000	6000
Left								
Right								

If necessary, may we change the following: YES NO Please Call

Name:

CIRCA 1995?

Note the ***wide range*** of hearing aid "tier levels"

Programmable vs Non-Programmable

Class A, Class D, Push-Pull, AGC-I
K-Amp, WDRC

Control options

Desired 2cc coupler gain and SSPL

Student Inspiration

- Professor
  - *"How do you determine which tier-level to select for a given patient?"*
    - Case history
    - Audiogram
    - Speech Testing
    - APHAB & COSI
    - Lifestyle
    - Sales report – kidding ☺

Student Inspiration

- 2nd Year Au.D. Student
  - *"Well, if the patient has trouble in noise, I select the top-tier because they are better in noise."*
- Professor
  - *"So I guess all your patients get top-tier aids, right?"*
- 2nd Year Au.D. Student
  - *"What do you mean?"*
- Professor
  - *"How many patients report hearing **great** in noise?"*

Student Inspiration

- 2nd Year Au.D. Student
  - *"We were taught in in-service trainings that the top-tier aids are best in noise. Heard it from many companies in fact."*
- Professor
  - *"Really, do you have evidence to support that claim?"*
- 2nd Year Au.D. Student
  - *"What do you mean?"*
- Professor
  - *"How do you know top-tier aids are **really better** in noise?"*

Student Inspiration

- Professor
  - *"If you are basing your selection on this premise, shouldn't you have clear evidence to support it?"*
- 2nd Year Au.D. Student
  - *"You just blew my mind!"*

Student Inspiration

- Professor
  - *"So, if you select the "wrong" tier-level, could that impact hearing aid use patterns?"*
- 2nd Year Au.D. Student
  - "*Never thought about that…*

    let's research it."

Hearing Loss & Hearing Aid Use

- Hearing Loss
  - 55% of people in their seventies
  - 79% in their eighties
  - hearing loss that impacts their quality of life
- Hearing Aids
  - hearing aids improve
    - communication ability
    - cognitive function
    - quality of life in the aging population

Barriers to Hearing Aid Use

- Hearing Aid Use
  - Less than 25% in the United States actually use hearing aids
  - Why don't adults pursue hearing aids for these problems?
- Cost
  - Common belief
    - Hearing aids do not provide sufficient value to justify their expense
  - Modern hearing aids
    - Vary significantly in terms of their technological sophistication and, consequently, their cost

Technology Levels

- Basic Technology
  - Multichannel compression
    - Amplification adjustment in independent frequency bands
  - Noise combatting features
    - Directional microphones
      - Improve signal to noise ratio
    - Digital noise reduction algorithms
      - Suppress unwanted noises

Technology Levels

- Premium Technology
  - Multichannel compression
    - More channels
  - Noise combatting features
    - Directional microphones
    - Digital noise reduction
  - Additional complex automatic and adaptive versions
    - other features not included in the basic-level hearing aids
      - Binaural streaming, automatic learning, connectivity, etc.

Basic vs Premium Technology

- Assumption
  - The more sophisticated the hearing aid technology the more benefit the hearing aid user would receive in daily life, thereby providing justification for the increased cost of the premium devices
- Reality
  - Is this assumption true or false?
  - Does it depend on the individual patient?

Fact or Fiction?

- Cost-Benefit Analysis
  - Research
    - hearing aid users conduct a cost-benefit analysis to decide the value received from hearing aids
  - Higher self-perceived value
    - increased hearing aid acceptance and use
  - Lower self-perceived value
    - leads to hearing aid rejection and non-use

Cost-Benefit Analysis

- Factors Impacting Value
  - Unclear
    - Some place value on the advanced features in premium hearing aids
    - Others do not
    - Why?
  - Needed
    - method to “match” the hearing aid technology level to the needs of the elderly consumer
    - maximize self-perceived value of the hearing aids to the consumer

Series of Studies

- Basic vs Premium Tier Levels
  1. Adaptive Program Switching
  2. Noise Management Features
  3. Hearing Aid Fittings

Adaptive Program Switching

Listener Satisfaction Between Adaptive and Manual Program Selection in Multiple Listening Conditions

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American Academy of Audiology Convention
Poster, 2016
Phoenix, Arizona

Background

- Listening Environment
  - Hearing aid users experience countless listening situations daily
    - Speech in quiet
    - Speech in noise
    - Music
    - Telephone
- Hearing Aid Programs
  - Multiple programs
  - Settings change across programs
    - address different listening situations

Background

- Manual Program Switching
  - Hearing aid users
    - Reported poor satisfaction regarding manual program manipulation
    - 77% never switched programs between omni & directional microphone
      - Lack of benefit?
      - Lack of understanding?
    - Supported the need for adaptive program selection

Background

- Adaptive Program Switching
  - Based on individualized listening situations
  - As the environment changes, so does the hearing aid program
  - Constantly monitors the environment and adjusts automatically
- Goals
  - Increasing user satisfaction
  - Balance benefits and limitations across programs

Background

- Limited Research
  - Degree to which adaptive program switching successfully provides the optimal setting is unclear
  - Accuracy impacted by listening environment
    - Number of talkers
    - Location of talkers or noise sources
    - Types of noise sources
    - Level of speech or noise sources
    - Intent of the listener

Background

- Limited Research
  - Microphone switching
    - Studies suggested microphone switching algorithms have 80-90% accuracy
  - Cannot control for listener intent
    - Some listeners prefer their own decision to that of the algorithm
- In Practice
  - Many audiologists fit hearing aids using adaptive program switching so users do not have to manually select hearing aid programs

Purpose

- Automatic vs Manual
  - Is one better?
    - Is the program the hearing aid selects more satisfactory than the program the user would select if given the opportunity to manually change it?
- Purpose
  - To examine patient satisfaction of adaptive program changes when compared to manual selections made by the patient in various listening situations

Research Questions

- Does the listening environment and/or hearing aid program affect user satisfaction?
- Does user satisfaction across hearing aid programs depend on the listening environment?
- Is user satisfaction improved when using adaptive program switching versus manual program switching?

Methods

- Participants
  - 14 adults
  - Age range 40 – 85
  - Sensorineural hearing loss
  - Current hearing aid user
    - Phonak Bolero BTEs

Methods

- Hearing Aids
  - Phonak Bolero Q90 BTE devices
    - Same two devices for each participant
    - Slimtube and dome coupling used mimicked each participant's current setup
  - 4 programs assigned in random order
    - Calm
    - Speech-in-noise
    - Comfort-in-noise
    - Music

Methods

- Hearing Aid Fitting
  - Verification
    - National Acoustics Laboratory-Nonlinear 1
    - Audioscan Verifit Open
      - Speech at 55
      - Speech at 65
      - Speech at 75
      - MPO
    - Match targets using a criteria of +/- 6 dB from 500 – 4000 Hz

Methods

- Listening Conditions

Condition	Stimulus (SPL)	Noise (SPL)	Rating
Speech: Quiet	AZ. Travelogue @ 65 dB		Clarity
Speech: Noise	AZ. Travelogue @ 65 dB	Babble @ 60 dB	Clarity
	AZ. Travelogue @ 65 dB	Speech Noise @ 60 dB	Clarity
Comfort: Noise		Babble @ 75 dB	Comfort
		Speech Noise @ 75 dB	Comfort
Music	Rocky Top @ 65 dB		Quality

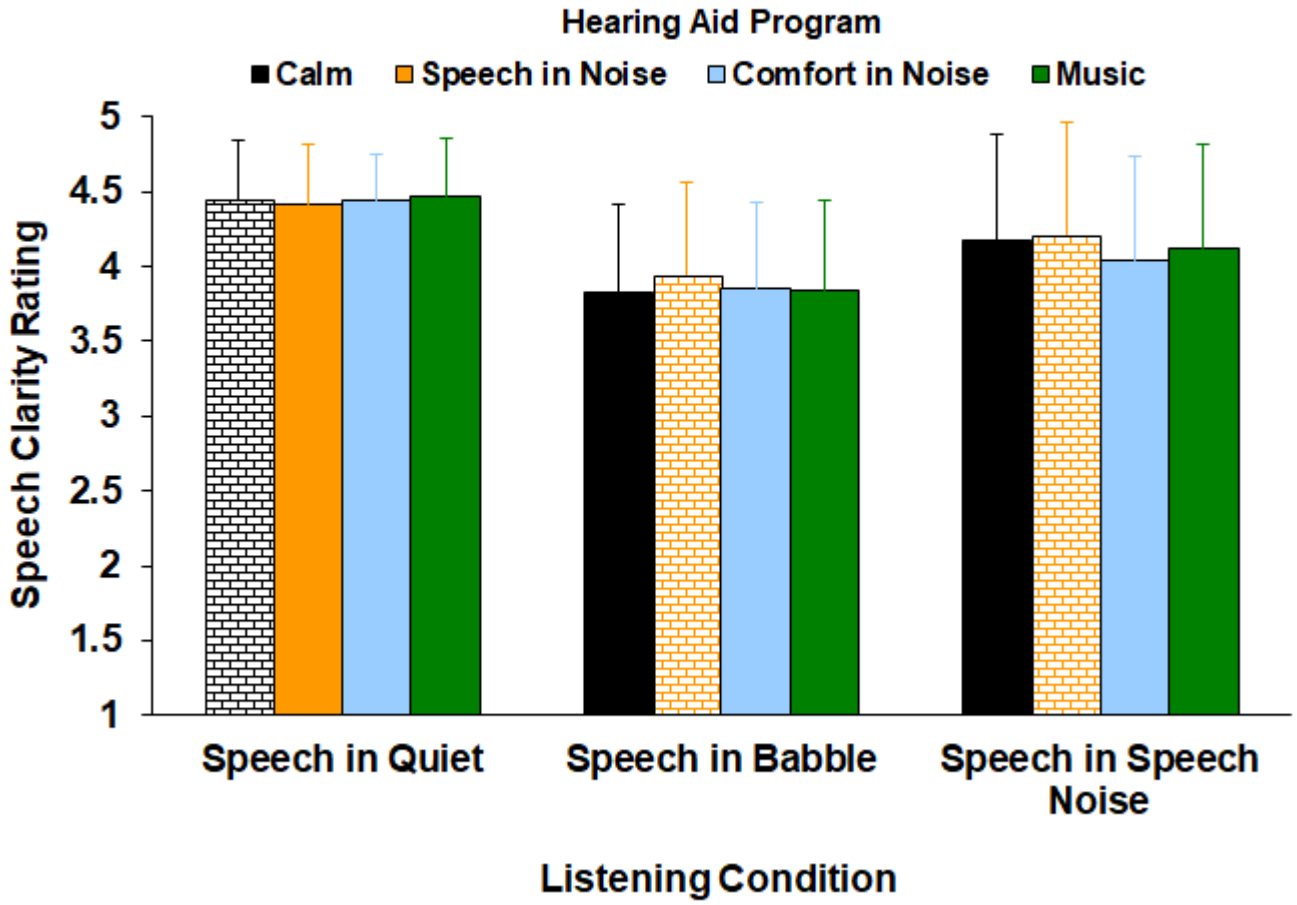
Methods

- Adaptive Program Switching Evaluation
  - Hearing aids were programmed and placed on a KEMAR
  - Each listening condition was presented for a minimum of 30 minutes
  - Data-logging revealed which program the hearing aids selected for each listening condition
    - Music condition hearing aid selected the “music program”
    - Speech in quiet condition hearing aid selected the ”calm program”
  - This confirmed the hearing aid program the adpative program feature would select for each listening condition

Methods

- Manual Program Switching Evaluation
  - Participants were seated 1 meter from a loudspeaker at 0 degrees azimuth in a sound treated booth
  - Stimuli for the six listening conditions were presented in random order
  - For each listening condition, participants toggled through the four hearing aid programs
    - Satisfaction ratings for each memory based on the listening condition
      - speech clarity
      - sound quality
      - comfort

Satisfaction Ratings
1 = very unsatisfied
2 = unsatisfied
3 = neutral
4 = satisfied
5 = very satisfied

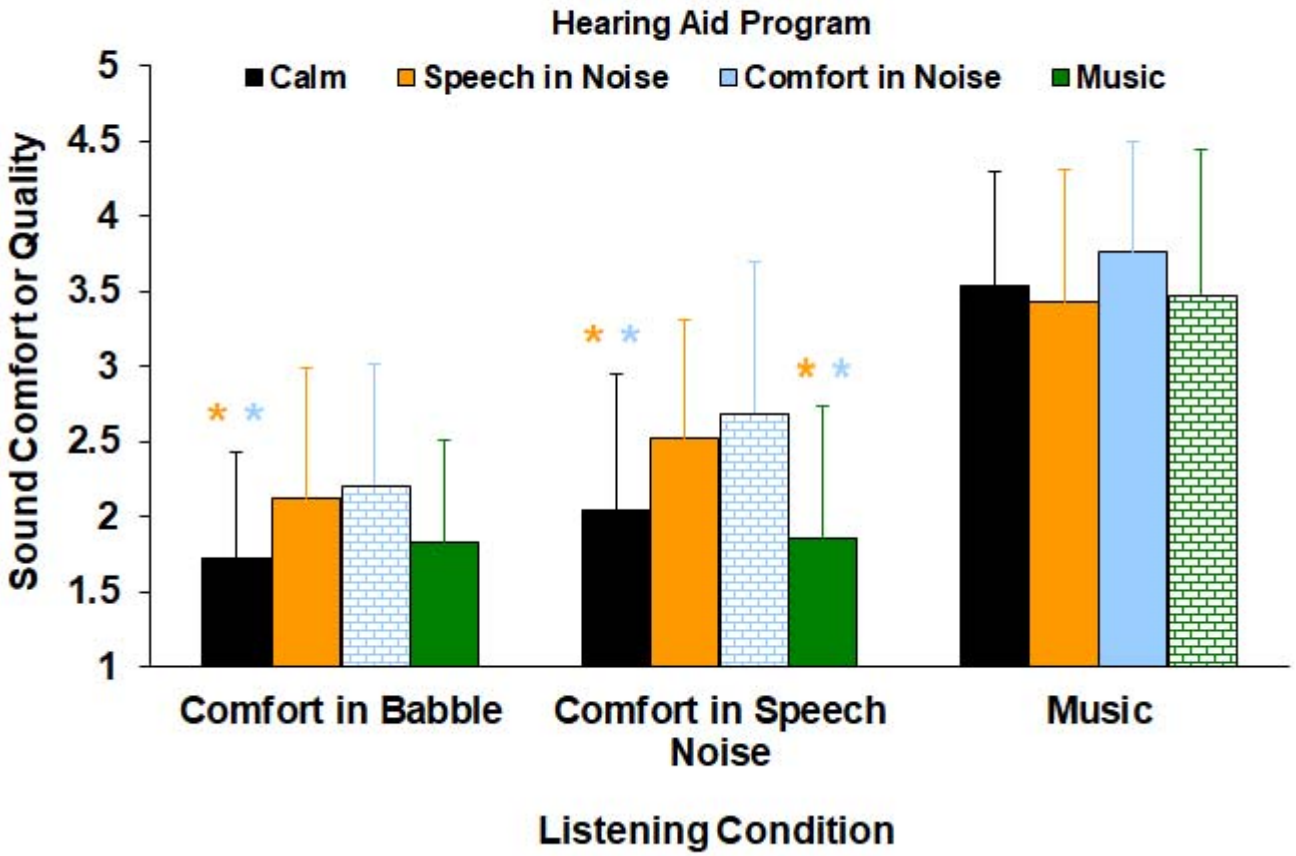


Adaptive Program

- Checkerboard

Speech Clarity

- ratings were not significantly different across programs



Sound Comfort

- ratings were significantly higher for the “noise” programs

Sound Quality

- ratings were not significantly different across programs

What does any of this mean?

- Does the listening environment and/or hearing aid program affect user satisfaction?
  - *YES: As expected, ratings varied across listening conditions and hearing aid programs*
    - *Listening Conditions*
      - *Quiet > all others & Both Comfort < all others*
    - *Hearing Aid Programs*
      - *Noise Programs > Calm & Music*

What does any of this mean?

- Does user satisfaction across hearing aid programs depend on the listening environment?
  - *YES:*
    - *Ratings were higher for both "noise" programs in both comfort in noise listening conditions*
    - *Ratings were not different across programs for*
      - *Speech in quiet*
      - *Speech in babble*
      - *Speech in speech noise*
      - *Music*

What does any of this mean?

- Is user satisfaction improved when using adaptive program switching versus manual program switching?

  – *YES:*

  - *Ratings were higher for the automatically selected program for both comfort in noise conditions*
  - *Ratings were comparable for the automatically selected program and the other programs for the other listening conditions*

What does any of this mean?

- Limitations
  - Laboratory Based
    - Efficacy study
      - Contrived listening conditions
      - Conditions didn't change across time
    - No field-trial data
    - No Preference data
  - Hearing Aids
    - Findings are limited to the aids and conditions under test
    - May not generalize to updated versions of the technology

Clinical Implications

- Automatic vs. Manual?
  - Automatic was capable of selecting a program that was satisfactory to the user
  - Either option appears effective
  - Clinical judgement
- Limited Program Options?
  - Noise program
    - more satisfied with a comfort in noise program for most listening conditions
  - Calm or Music (not both)

Clinical Implications

- Default
  - If using manual control, the default should be a noise program
  - If most people rarely change programs--this is the best bet
- Why Effects Only in Noise?
  - Qualitative vs. Quantitative
    - Differences were notice across programs
    - Satisfaction not impacted
  - Calm vs. Music Programs
    - May have similar settings
  - Noise Programs
    - Behave like Calm/Music when no noise is present
    - Activates when loud noise – no speech

Questions?

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Noise Management Features

Comparison of Noise Management Strategies in Hearing Aids

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American Academy of Audiology Convention
Poster, 2018
Nashville, Tennessee

Background

- Obstacle for Audiologists
  - Determining appropriate technology level
- Technology Tier Levels
  - Vary based on sophistication of noise management features
    - Digital noise reduction
    - Directional microphones
  - Implementation Variability
    - Across manufacturers
    - Across tier levels

Background

- Assumption
  - Listeners receive more benefit from noise management strategies in top-tier level hearing aids
- Assessment
  - No standard currently exists for measuring, documenting and reporting the effects of these features
- Verification
  - Hearing aid analyzers
    - Vary in terms of test signals, levels, analysis time, analysis type

Background

- Limited Research
  - Bentler & Chiou (2006)
    - Reported significant variability in noise management across hearing aids
      - Stimulus type (speech, musical instruments, noise, etc)
      - Frequency domain (where and how much)
      - Time domain (fast or slow)
  - Scollie et al (2017)
    - Reported significant variation across makes and models of hearing aids
      - Speed of noise reduction
      - Magnitude of noise reduction
    - Suggested greater standardization is needed

Purpose

- Basic, Mid-Level, or Premium
  - Is one better at managing noise than the other options?
  - Is this information readily available on website or ANSI sheets?
- Purpose:
  - To determine if the performance of noise reduction and directional microphone features differed significantly across technology tiers and/or hearing aid manufacturers when measured using simple, repeatable test conditions available to practicing audiologists

Research Questions

- Do DNR and /or D-Mic strategies differ across:
  - Technology-tier levels
  - Hearing aid manufacturers
  - Audiograms

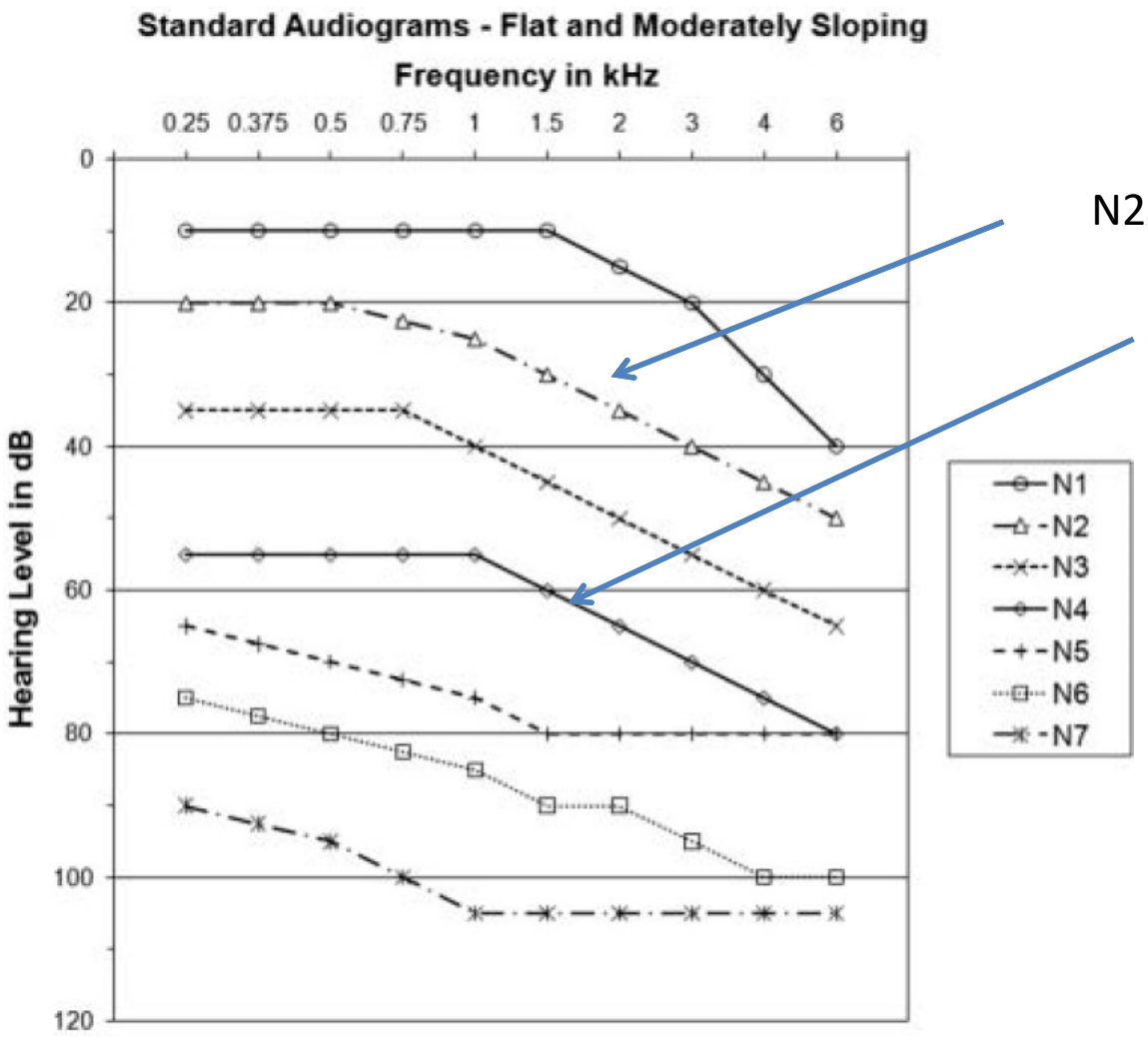
Methods

- Hearing Aids
  - Provided by 3 leading hearing aid manufacturers
    - Each manufacturer determined model per tier (Spring 2017)

	Oticon	Phonak	Starkey
Tier 1 (Basic)	Ria 2 Pro	Bolero V50 P	Muse i1600
Tier 2 (Mid)	Nera 2 Pro	Bolero V70 P	Muse i2000
Tier 3 (Premium)	Alta 2 Pro	Bolero V90 P	Muse i2400

Methods

- Hearing Aid Programming
  - National Acoustics Laboratory-Nonlinear 2
  - Two Audiograms
    - N2 & N4 standard audiograms (Bisgaard, 2010)
  - DNR & D-Mics
    - set to maximum effect in each hearing aid
  - Verification
    - Simulated Real-Ear
      - hearing aid fittings were verified using coupler-based simulated real ear measures in the Verifit 1



N2 audiogram

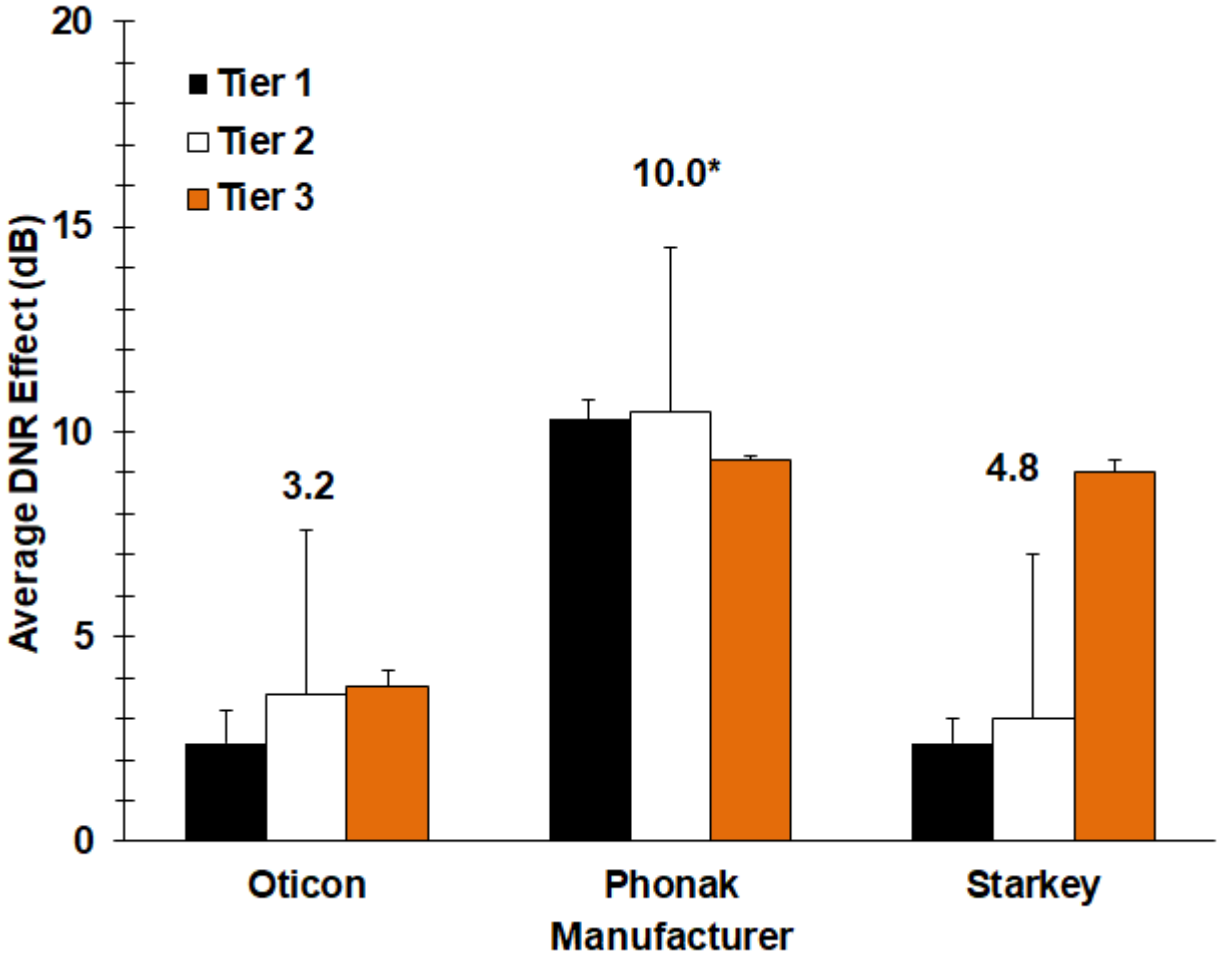
N4 audiogram

Methods

- Hearing Aid Testing
  - coupler-based test box measures features in the Verifit 1
- DNR
  - Air-conditioner stimulus
    - input levels of 50 -- 90 dB SPL (5 dB steps)
- D-Mic
  - Speech stimulus
    - input levels of 65 and 80 dB SPL
    - speech to noise ratios of 0 – 12 dB (3 dB steps)
- Measurements
  - 65 data points measured in 1/12th octave band steps (200 to 8000 Hz)
  - Coupler measurement downloaded to a personal computer for data analysis

Results

- DNR Measurements
  - DNR values were averaged across frequency per input level
    - 65 data points (200 to 4000 Hz)
  - DNR effect was calculated two ways:
    - averaged across level (90, 85, 80, 75, 70, 65, 60, 55 & 50 dB)
    - change across level (90-50 dB)
  - No significant effect for audiometric configuration for either measure
    - Data collapsed across audiogram type

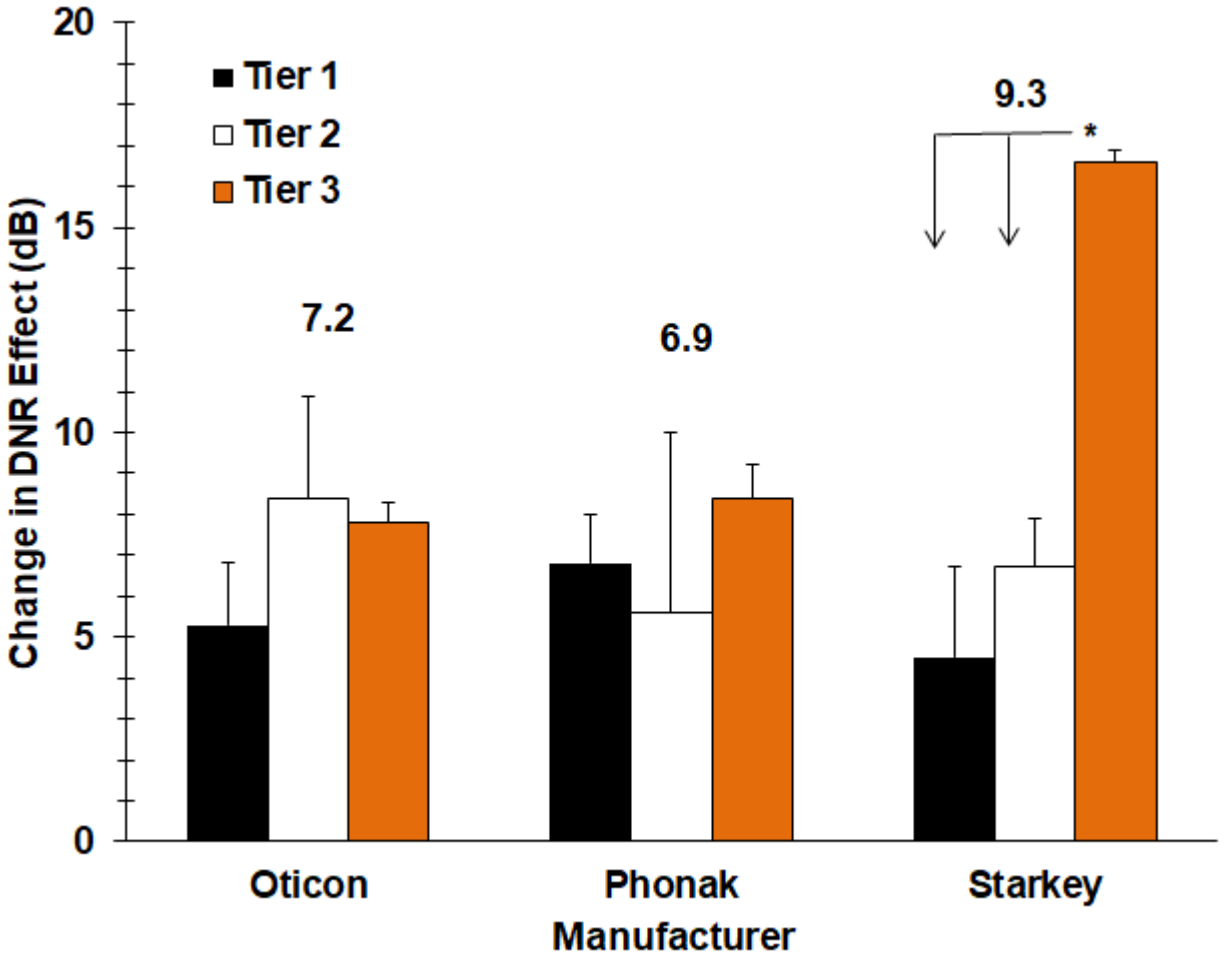


Manufacturer

- Phonak > Oticon & Starkey

Tier Level

- No effect



Manufacturer

- No effect

Tier Level

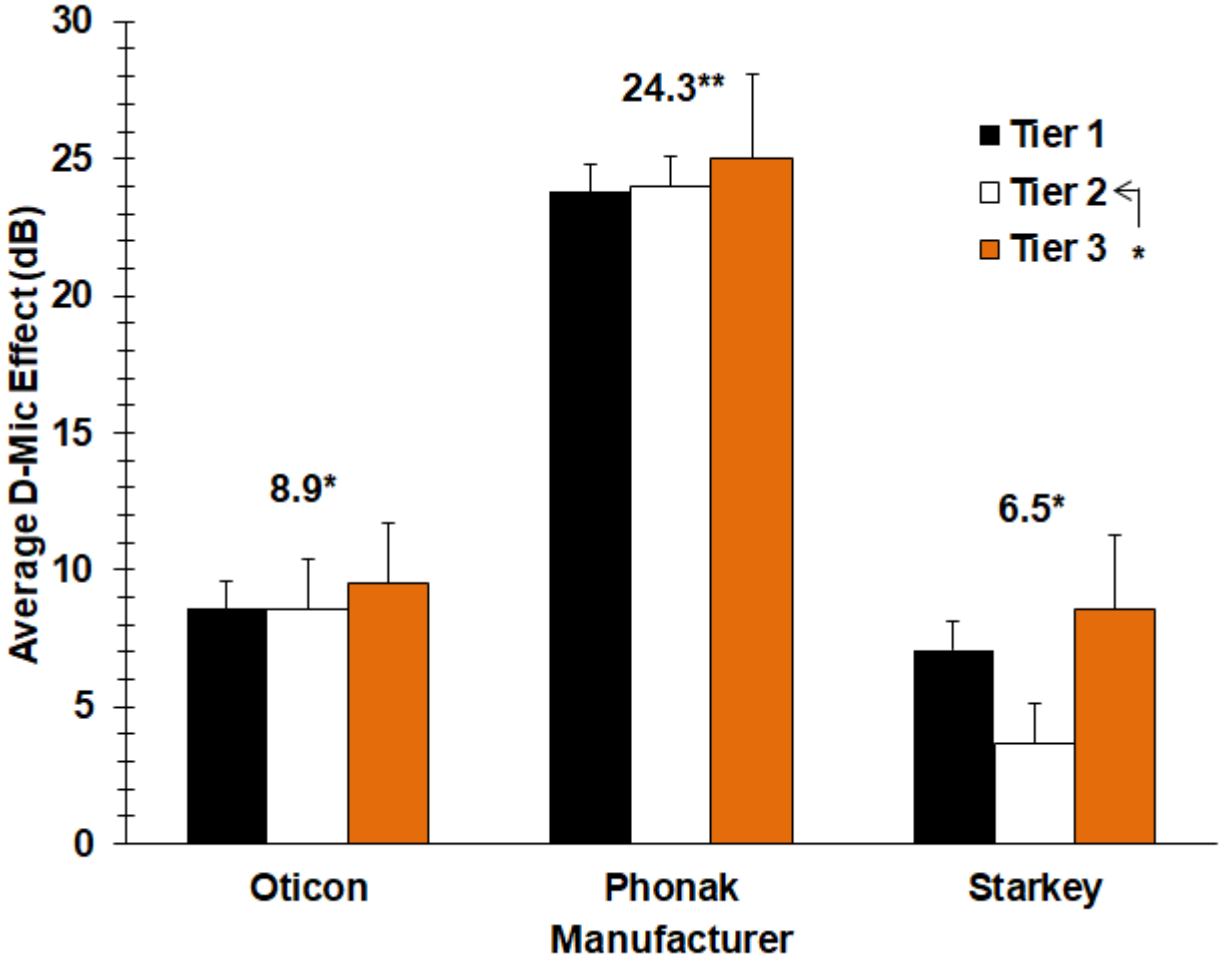
- Tier 3 > Tier 1 & Tier 2

Manufacturer x Tier Level

- Starkey 3 > Starkey 1 & 2
- No effect
  - Oticon
  - Starkey

Results

- D-Mic Measurements
  - D-Mic values were averaged across frequency per input level
    - 65 data points (200 to 4000 Hz)
  - D-Mic effect was calculated two ways:
    - averaged across SNRs (0, 3, 6, 9, 12 dB)
    - change across SNRs (0-12 dB)
  - No significant effect for audiometric configuration or speech level for either measure
    - Data collapsed across audiogram type & speech level

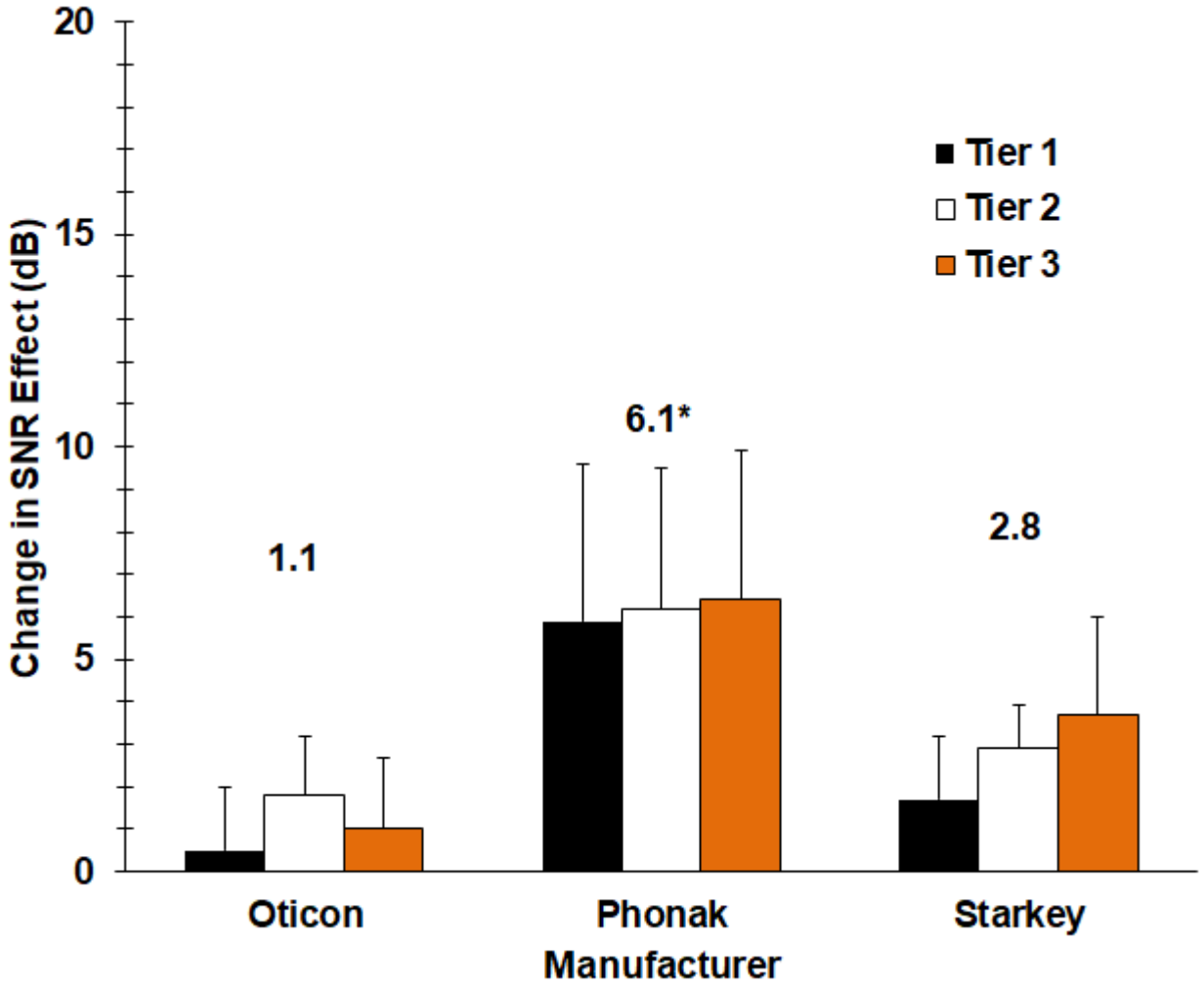


Manufacturer

- Phonak > Oticon & Starkey
- Oticon > Starkey

Tier Level

- Tier 3 > Tier 2
  - Effect was small (2 dB)
  - Starkey Tier 2 vs. 3
  - May not be meaningful



Manufacturer

- Phonak > Starkey & Oticon

Tier Level

- No effect

What does any of this mean?

- Do DNR and /or D-Mic strategies differ across technology-tier levels?

  – *NO: Performance of noise management strategies were generally similar across tiers*
    - *Exceptions:*
      – *Starkey Tier 3 vs Tier 1 & 2 average DNR*
      – *Starkey Tier 3 vs Tier 2 change in D-Mic*

What does any of this mean?

- Do DNR and /or D-Mic strategies differ across hearing aid manufacturers?

  – *YES*: *Effects noise management strategies were largest for Phonak aids*
    - *DNR average*
    - *D-Mic average*
    - *D-Mic change*

What does any of this mean?

- Do DNR and /or D-Mic strategies differ across audiograms?
  - *NO: Performance of noise management strategies were similar across audiometric configurations used*

What does any of this mean?

- Limitations
  - Contrived test conditions
    - Didn't change across time
    - Not sensitive to the value of adaptive features
  - No field-trial or preference data
  - Measurement methods
    - Average & change aren't the only ways to capture this
    - No measure of time
  - Hearing Aids
    - Findings are limited to the aids and conditions under test
    - May not generalize to updated versions of the technology

Clinical Implications

- Manufacturer vs. Tier Level
  - Features differed more between manufacturers
    - Little to no differences between tier levels
  - By Design?
    - Did our measurements meet “specs”?
      - What should the values have been?
      - Are the rationales simply different across manufacturers?
    - Is less more?
      - Do patients object to large changes?
      - What are the optimal settings for DNR & D-mics
        - » Patient dependent?

Clinical Implications

- Manufacturer vs. Tier Level
  - Would these differences be noticeable?
    - Real-world setting has varying targets & varying noise sources
    - Do coupler measures “under-value” tier-level effects?
  - Clinicians should be aware that the effect of noise management strategies may be more related to the hearing aid manufacturer selected than the technology tier level used
    - Why aren’t these values available?
    - Should this be a factor in hearing aid selection?

Questions?

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Hearing Aid Fittings

The Effect of Hearing Aid Tier Level on Objective and Subjective Outcome Measures

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In Progress, 2018
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Background

- Tier-Levels in Hearing Aid Fittings
  - Challenge
    - Choice of hearing aid technology level
  - Limited Research
    - Directly comparing basic to premium hearing aids
    - Studies generally find little to no difference
      - Between Tier Levels
        - Objective or subjective measures
        - Group data
        - Individual preferences unclear

Background

- Impact of Technology Level on Outcomes in Daily Life I-III
  - Cox et al (2016), Johnson et al (2016, 2017)
    - Fit 45 adults using standard procedures
    - 4 Hearing Aids
      - Brand A: basic & premium devices
      - Brand B: basic & premium devices
    - Outcomes
      - Speech Understanding & Listening Effort
      - Localization
      - Patient's Perspective

Background

- Speech Understanding & Listening Effort
  - Lab testing, questionnaires, diaries
    - Only premium superiority for 1 brand
      - Listening effort for loud speech (70 dB, 0 SNR)
- Localization
  - Lab testing, questionnaire (SSQ)
    - High Hz and low Hz filtered speech
    - Quiet and in noise
  - Premium superiority: high Hz/ quiet

Background

- Patient's Perspective
  - Subjective data
    - Quality of life, questionnaire, preference
  - No difference between basic & premium on any measure
- Over-Arching Theme
  - *"No evidence to suggest that premium-feature devices yielded better outcomes than basic-feature devices."*
  - *"If evidence suggests the patient cannot detect that premium features yield improvements over basic features in daily life, what is the responsibility of the provider in recommending hearing aid technology level?"*

Background

- What about the Individual?
  - *"It is reasonable to assert that the patient's perspective is the gold standard for determining whether one type of hearing aid is better than another for that patient in the particular circumstances of his/her world."*

Background

- Individual Preference
  - 42 of 45 noted a preference
    - 12 basic
    - 9 premium
    - 21 basic for one brand and premium for the other brand
  - Preference Strength
    - 46% minimal to negligible difference
    - 54% described as definite preference
    - ***"some participants gave notably better scores to premium-feature devices whereas others gave notably better scores to basic-feature devices"***

Background

- Why do some notice benefit from premium aids?
  - *"It would be of interest to determine whether these results are examples of measurement error or whether they represent individuals with specific characteristics that point to robust superior performance with one of the two feature levels."*

Background

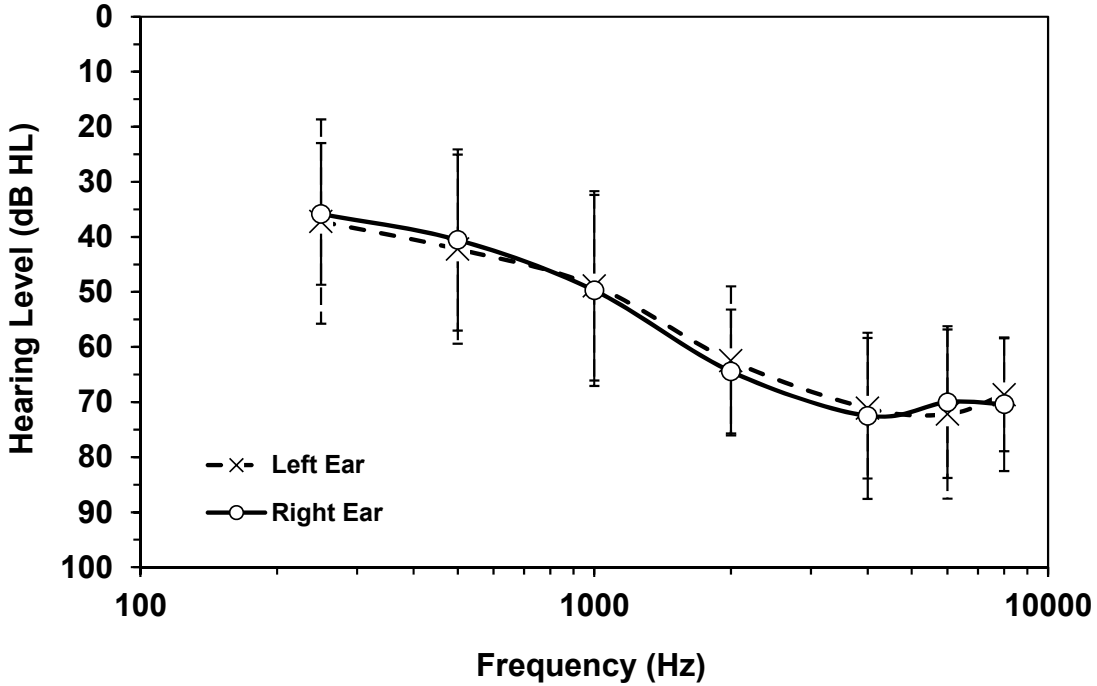
- Why do some notice benefit from premium aids?
  - Demand of listening environments?
    - Vary across patients
    - Activity level of patients
    - Would challenge of listening environments be sensitive to technology level?
  - Noise Acceptance?
    - Related to hearing aid use
    - Not measured in previous studies
    - Would noise acceptance be sensitive to technology level?

Purpose

- Environment & Noise Acceptance
  - Are either factors in determining preference for technology level
- Purpose
  - To determine if the demand of the listening environment and/or acceptable noise level is related to preferred technology level

Methods

- Participants
  - 18 adults (10 males)
  - Sensorineural loss
  - Current hearing aid user
    - Mid technology level

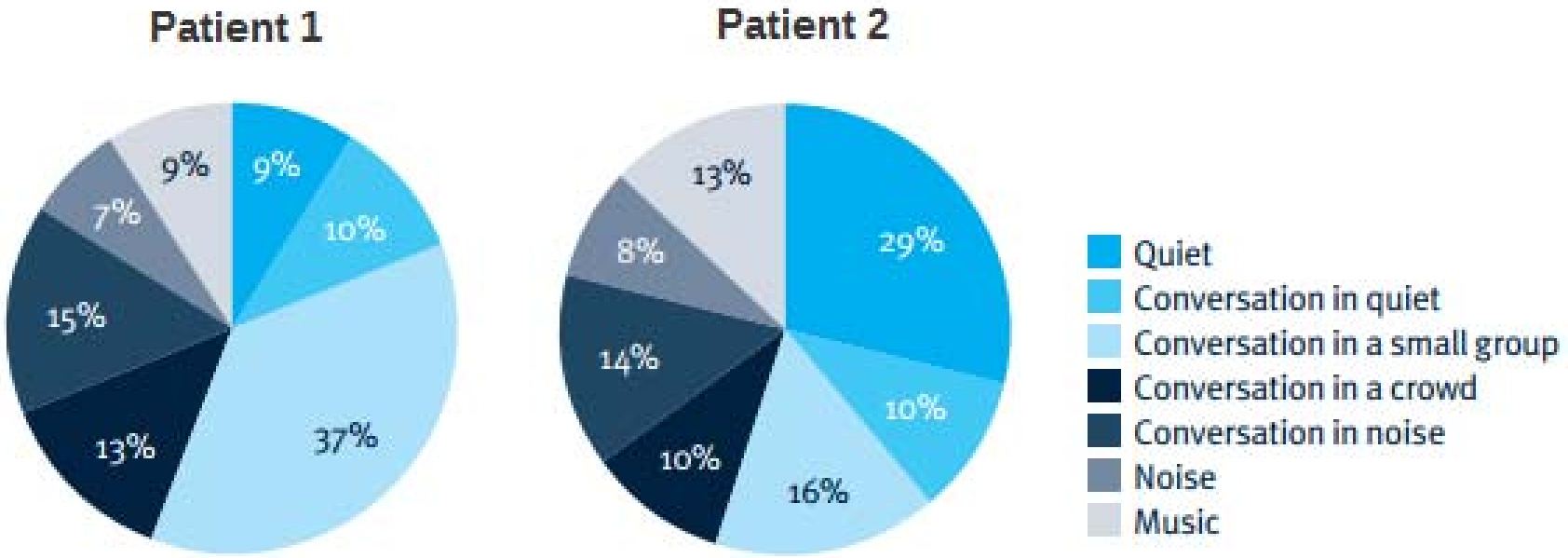


Methods

- Hearing Aids
  - Unitron Flex (Tempus Platform)
    - Basic: T Moxi Fit 600
    - Premium: T Moxi Fit Pro
  - Same two Flex devices for each trial
    - Just re-programmed
    - Slimtube and dome coupling used mimicked each participant's current setup
  - Programs & Features
    - Basic: adapts for 3 listening environments
    - Premium: adapts for 7 listening environments

Methods

- Log It All
  - Data-logging feature
    - Captures information for 7 listening environments
      - Conversation in quiet*
      - Conversation in small group
      - Conversation in crowd
      - Conversation in noise*
      - Quiet*
      - Noise
      - Music
  - * covered in Basic



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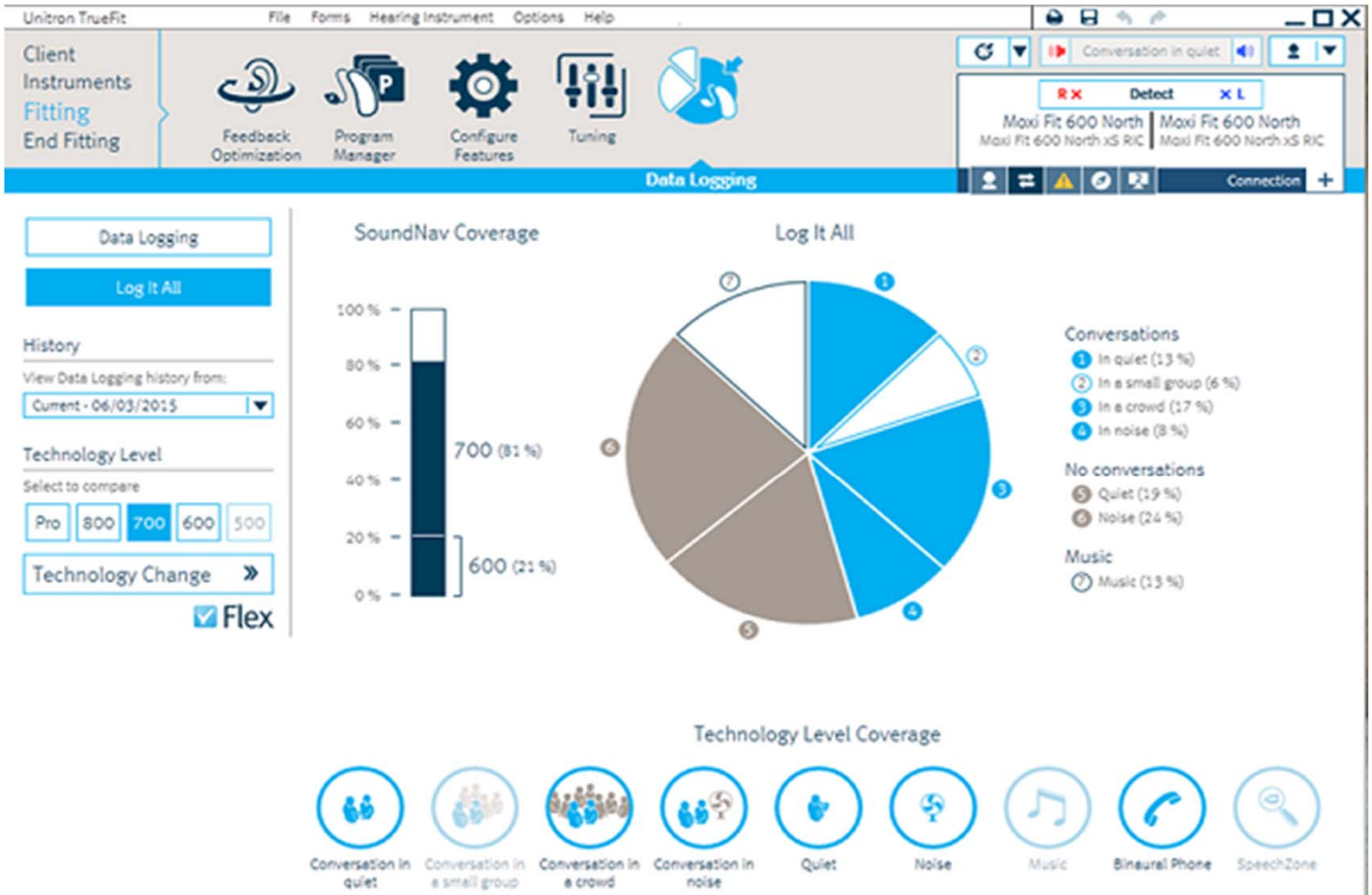

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Instruments
Fitting
End Fitting
Patient Insights
Overview
Usage
Patient Ratings
Lifestyle
R
Detect
L
T Moxi Now Pro
T Moxi Now Pro xS RIC
T Moxi Now Pro
T Moxi Now Pro xS RIC
Connection
History
View history from:
Current - 2017-12-04
Technology Level
Select to compare
700
800
Pro
Technology Change
Flex
Show Comparative Listening Data
T Moxi Now Pro
SoundNav (7 Environments)
SpeechPro - 42 %
Speech Locator
Speech Focus
Dynamic Spatial Awareness
Personalized Spatial Awareness
Sound Conductor
Adaptive Directionality (Multiband)
Binaural MyMusic
Binaural Phone
Typical Weekly Listening Environments
Conversations
No conversations
Music
In quiet
In a small group
In a crowd
In noise
Quiet
Noise
Music
10 %
(8 hours)
11 %
(9 hours)
19 %
(15 hours)
23 %
(18 hours)
11 %
(9 hours)
14 %
(11 hours)
11 %
(9 hours)

Methods

- Hearing Aid Fitting
  - Verification
    - National Acoustics Laboratory-Nonlinear 2
    - Audioscan Verifit Open (speech at 55, 65, 75 & MPO)
    - Match targets using a criteria of +/- 6 dB from 500 – 4000 Hz
  - 2 Trial periods
    - 2 weeks each (counterbalanced)
      - Basic (T-600)
      - Premium (T-Pro)
  - Single blind design

Methods

- Laboratory Evaluations
  - Conducted after each trial period
    - Speech: 0 degrees azimuth @ 65 dB SPL
    - Noise: 0 and 180 degrees azimuth (level dependent on test)
  - Measurements
    - Pascoe's High Frequency Word List
    - Quick Speech-in-Noise Test (Quick SIN)
    - Acceptable Noise Level (ANL)
    - Hearing in Noise Test (HINT)

Methods

Log It All

- Conversation in quiet
- Conversation in small group
- Conversation in crowd
- Conversation in noise

Laboratory Measures

- Pasoce's HFWL
- Quick SIN (4 talker babble)
- ANL (12 talker babble)
- HINT (spectrally matched)

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Methods

- Satisfaction Rating, SSQ-12, Log it All
  - Conducted after each trial period

Rating		Speech in Quiet	Speech in Small Group	Speech in Large Group	Music
Very Unsatisfied	1				
Unsatisfied	2				
Neutral	3		✓	✓	
Satisfied	4	✓			✓
Very Satisfied	5				

- Overall Preference, Importance
  - Conducted after final trial period

Results: Speech in Noise

Speech Perception Measure	Premium	Basic	Benefit	p value
Pascoe's HFWL	84% (14)	80% (16)	4%	0.067
Quick SIN	8 dB(4)	10 dB (7)	2 dB	0.075
Hearing in Noise Test	5 dB (4)	7 dB (5)	2 dB	0.127
Acceptable Nosie Level	1 dB (2)	4 dB (3)	3 dB	***0.037***

Means and standard deviations

Significant effect for ANL

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Satisfaction Ratings & SSQ-12

Subjective Measure	Premium	Basic	Benefit	p value
Speech in Quiet	4.5 (.7)	4.4 (.7)	.1	0.495
Speech in Small Group	4.0 (.9)	3.8 (.9)	.2	0.361
Speech in Large Group	3.2 (1.3)	2.6 (1.4)	.6	0.069
Music	4 (1.1)	3.8 (1.1)	.2	0.421
SSQ-12	6.3 (2.1)	6.2 (2.3)	.1	0.735

Means and standard deviations

No hearing aid effect for any subjective measure

- speech in large group approaching significance

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Preference & Importance Ranking

- Overall Preference
  - Premium = 10
  - Basic = 7
  - None = 1
  - Not significant
    - p = 0.467
- Importance Ranking
  - Small group more important than music
  - Top ranks not significant

Importance Factor	Ranking	Top Ranks
Speech in Quiet	2.5 (1)	5
Speech in Small Group	1.7 (.6)	7
Speech in Large Group	2.3 (1.1)	4
Music	3.3 (.9)	1

Log it All Percentages

Listening Environment	Premium	Basic	Difference
Conversation in Quiet*	12	16	-4
Conversation in Small Group	20	19	1
Conversation in Crowd	5	5	0
Conversation in Noise*	11	11	0
Quiet*	38	37	1
Noise	7	7	0
Music	7	5	2
Total Coverage	100 %	64%	36%

Significant correlation between trials for each environment

Significant difference in total coverage

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A Closer Look…

- Re-Group Data
  - Overall Preference (wash out?)
  - Log it All “Gap”
    - Basic aids covered an average of 64%
      - 36% gap in coverage
      - Gap range was 22 – 51%
        - Median gap was 36.5%
    - Would larger gaps in coverage suggest
      - More demanding listening environment
      - Better candidate for Premium devices

Group by Overall Preference

	Premium				Basic		
Objective Data	**Premium**	**Basic**	**Benefit**		**Premium**	**Basic**	**Benefit**
Pascoe's HFWL	86%	82%	4%		87%	88%	1%
Quick SIN	8 dB	11 dB	**3 dB**		5 dB	6 dB	-1 dB
HINT	6 dB	7 dB	1 dB		4 dB	5 dB	-1 dB
ANL	1 dB	3 dB	**2 dB**		2 dB	2 dB	0 dB

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Group by Overall Preference

	Premium				Basic		
Subjective Data	**Premium**	**Basic**	**Benefit**		**Premium**	**Basic**	**Benefit**
Speech Quiet	4.6	4.3	.3		4.8	5	.2
Speech Small Group	4.2	3.4	.8		4.2	4.8	.6
Speech Large Group	3.4	2.1	1.3		3.7	4.1	.4
Music	4.3	3.7	.6		4.4	4.7	.3
Average	4.1	3.3	.8		4.3	4.7	.4
SSQ-12	6.4	5.8	.6		7.7	8.1	.4
Log it All	100%	64%	36%		100%	64%	36%

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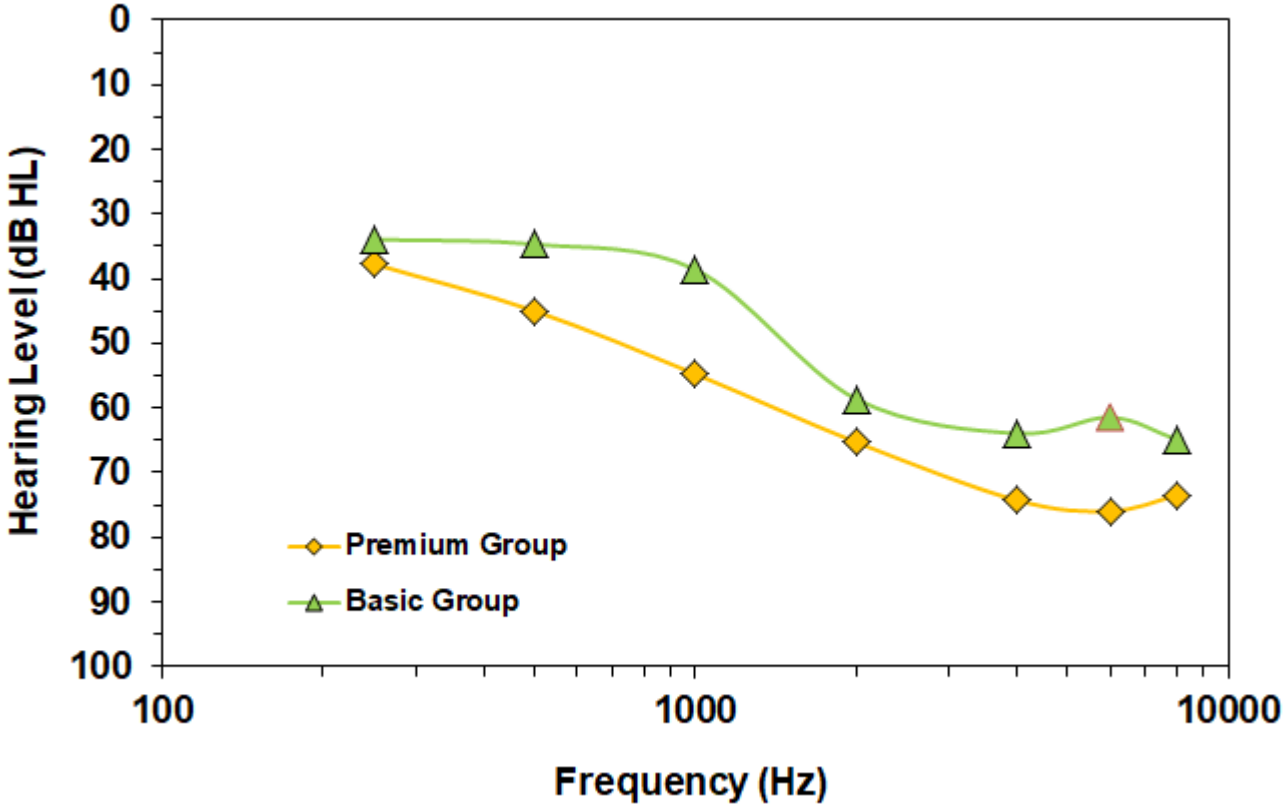
Group by Overall Preference



Basic Group
- 51 dB HL
- 1-4 kHz 54 dB HL

Premium Group
- 61 dB HL
- 1-4 kHz 64 dB HL

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Group by Log it All Gap

	Low Gap				High Gap		
Objective Data	**Premium**	**Basic**	**Benefit**		**Premium**	**Basic**	**Benefit**
Pascoe's HFWL	80%	77%	3%		87%	84%	3%
Quick SIN	9 dB	11 dB	2 dB		6 dB	9 dB	**3 dB**
HINT	6 dB	7 dB	1 dB		5 dB	7 dB	2 dB
ANL	1 dB	1 dB	0 dB		2 dB	5 dB	**3 dB**

Low Gap = 22 – 36%

High Gap = 37 – 51%

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Group by Log it All Gap

	Low Gap				High Gap		
Subjective Data	**Premium**	**Basic**	**Benefit**		**Premium**	**Basic**	**Benefit**
Speech Quiet	4.4	4.4	0		4.7	4.3	.4
Speech Small Group	4.0	3.7	.3		4.1	3.9	.2
Speech Large Group	3.8	3.2	.6		3.2	2.2	1.0
Music	4.1	4.0	.1		3.9	3.7	.2
Average			.25				.45
SSQ-12	7.0	6.8	.2		5.6	5.5	.1
Preference	4	4	0		6	3	3

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What does any of this mean?

- Group Analysis (N = 18)
  - Basic vs. Premium
    - Similar performance for almost every measure
  - ANL
    - ANL was the only measure sensitive to technology level
    - Significantly better for Premium devices
- Agreement
  - Findings agree with previous research

What does any of this mean?

- Overall Preference
  - Basic Group
    - Similar performance between devices on all measurements
  - Premium Group
    - Improved performance with Premium devices
      - Quick Sin
      - ANL
      - Satisfaction ratings
    - Greater degree of hearing loss

What does any of this mean?

- Log it All
  - Low Gap Group
    - Similar performance between devices on all measurements
  - High Gap Group
    - Improved performance with Premium devices
      - Quick Sin
      - ANL
      - Satisfaction ratings
      - Overall preference

Clinical Implications?

- ANL & Log it All
  - May assist with selecting technology level
- Log it All
  - As the “gap” coverage increases
    - Better candidate for premium devices
    - “gap threshold” is unclear
- ANL
  - As the ANL increases
    - Better candidate for premium devices
    - “ANL threshold” is more clear

Clinical Implications

- ANL
  - Participants were current hearing aid users
    - Good ANL values
    - Effects may be larger in those with poorer ANL values
  - ANL affected by
    - Speech level
    - Noise management strategies
  - Not used in previous studies
  - Could the ANL be a good tool for selecting tier level?

Patient Profile

ANL value	Log it All Gap	Technology Level
Low (<5 dB)	Low (< 36.5%)	Basic
Low (< 5dB)	High (> 36.5%)	Flex Trials
High (> 5 dB)	Low (< 36.5%)	Flex Trials
High (> 5 dB)	High (>36.5%	Premium

Closing Remarks

- Modern Hearing Aids
  - Changing vs. Improving
    - Better devices should lead to increased use rates
  - Technology Gap vs. Price Gap
    - Inverted over time
  - Amazing Features
    - Cost-benefit analysis
    - Who benefits and who doesn't
  - Match Game
    - Can ANL and/or Log it All help?

Questions?

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CEU Question #4

- Coupler testing in the lab indicated the performance of digital noise reduction differed significantly across ____.
  1. Manufacturers
  2. Tier levels
  3. Manufacturers & Tier levels
  4. None of the above

  Answer: 1. Manufacturers

CEU Question #5

- Which measurement was sensitive to performance differences between hearing aid tier levels?
  1. APHAB
  2. SSQ-12
  3. HINT
  4. ANL

  Answer: 4. ANL

Thank you for listening!

My email: pplyler@uthsc.edu