Evidence Regarding the Effectiveness of Hearing Solutions in Older Adults

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Overview

- Types of Hearing Aid Outcome Measures
- Dimensions of Hearing Aid Outcome
- Explaining Individual Differences in Outcome
- Influence of Technology on Outcomes

Do Hearing Aids Help?

- Yes, but how can this be demonstrated—for the field and for individual patients?
  - "Hearing Aid Outcome Measures"
    - Used to demonstrate or document the benefits of hearing aids to consumers, clinicians, HA manufacturers, and various third-party payers

Hearing-Aid Outcome Measures

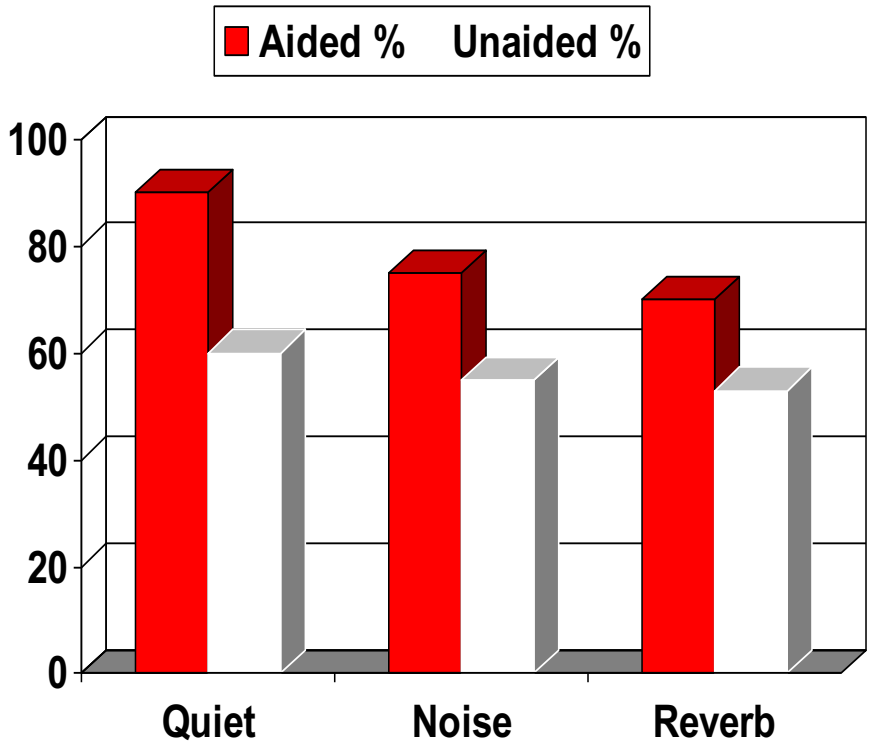
Objective Performance and Benefit

Subjective Benefit

Satisfaction

Usage

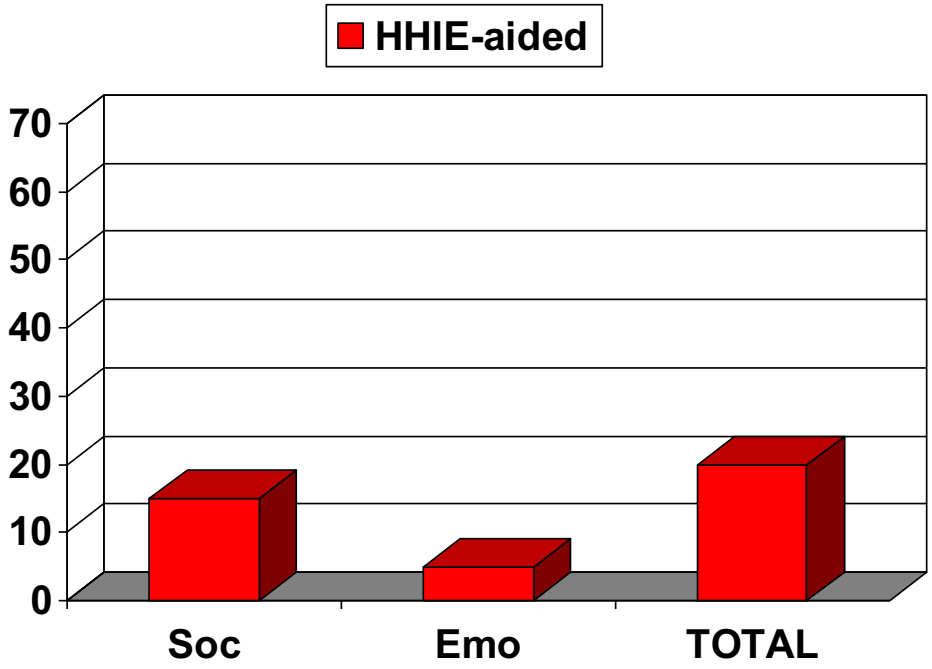
Objective Performance and Benefit



Aided and Unaided Speech Recognition

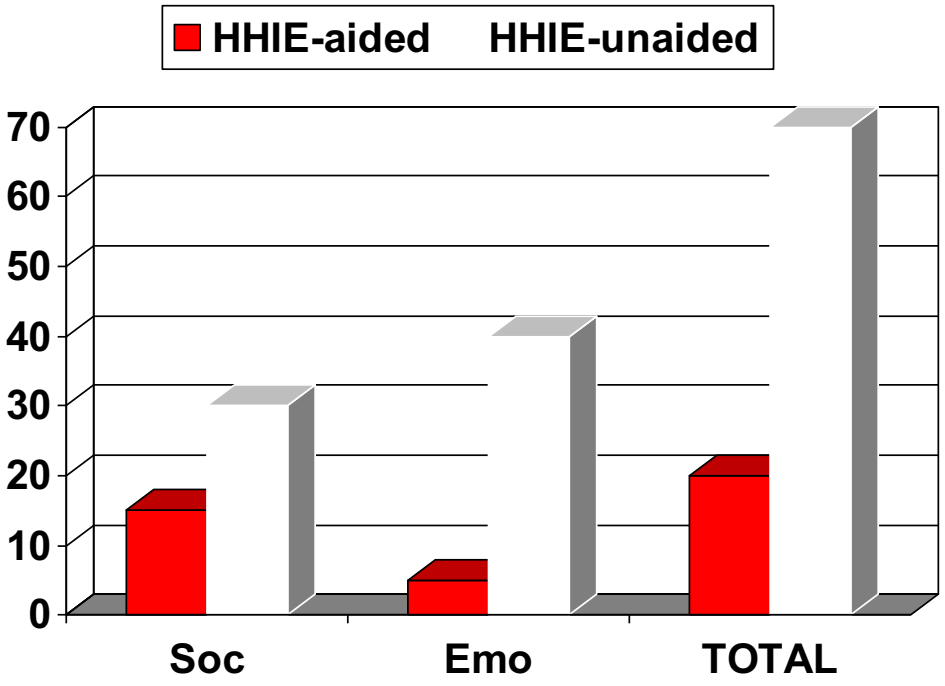
- Materials
  - Syllables, words, sentences
- Listening Conditions
  - Speech Level
  - Background
  - Azimuth

Subjective Performance



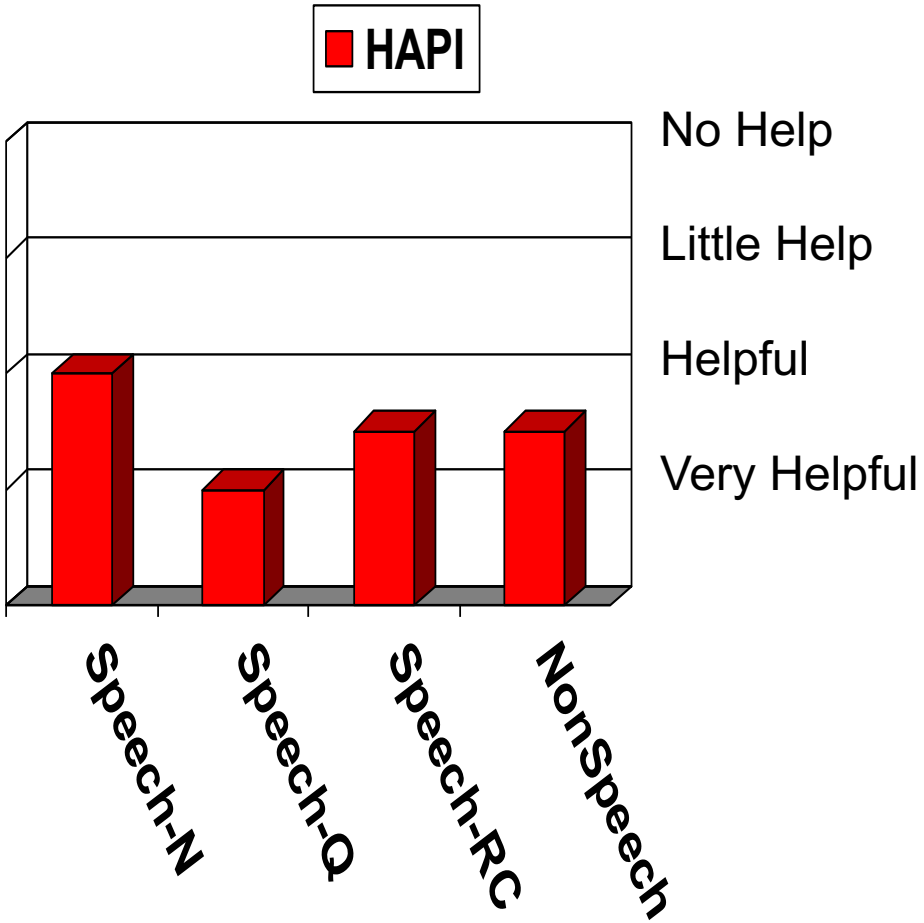
- Subjective Scales
- Aided Assessment
- Examples
  - Sound Quality
    - Gabrielsson et al.
  - Aided Performance
    - PHAP (Cox & Alexander)
  - Hearing Handicap
    - HHIE (Weinstein)

Subjective Benefit



- Subjective Scales
- Assessment of *CHANGE* from Unaided to Aided
- Examples
  - HAPI or SHAPIE
  - Benefit Profiles
    - PHAB, APHAB, COSI
  - Hearing Handicap
    - HHIE

Subjective Benefit



- Self-Report Scales
- Assessment of *CHANGE* from Unaided to Aided or "helpfulness" of HA
- Example
  - HAPI, Hearing Aid Performance Inventory

Example (HAPI)

- You are in a large business office talking with a clerk. There is the usual office noise (e.g., typing, talking, etc.)

  - In this situation, my hearing aid is…

    very helpful helpful very little help
    no help hinders performance N/A

Hearing Aid Satisfaction

Rate your satisfaction with the following ***HA features*** (VS,S,N,D,VD)

- Overall fit/comfort
- Hearing aid size
- Visibility to others
- Ease of adjusting volume
- Whistling/feedback
- Clearness of sound

Rate your satisfaction with the HA in the following ***listening situations***

- Conversation with 1 person
- In small groups
- Outdoors
- In large groups
- Watching TV
- On the telephone

MarkeTrak series, S. Kochkin

Hearing Aid Usage

- Objective Measures
  - “Datalogger”
  - Battery weight
- Subjective Measures
  - single reports of “typical usage”
  - diaries or use “logs”
  - average hours used per day vs. recommended hours

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- **Dimensions of Hearing Aid Outcome**
- Explaining Individual Differences in Outcome
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Many Outcome Measures

- How are they related?
- Do they all measure the same thing?
- Do they interact in a simple or complex manner?
- Are some more important than others?
- ????

Our Approach to Sorting this Out

- Obtain multiple measures of hearing-aid outcome from large numbers of hearing aid wearers at the same time
- Examine associations (correlations) among measures
- Determine if the large set of outcome measures can be reduced to a smaller set (factor analysis)

The IU Studies (IU-1 to IU-4)

KEY COLLABORATORS:

Nathan Amos
Amy Arthur
Nancy Barlow
Gretchen Burk
Carolyn Garner
Lisa Goerner
Dana (Wilson) Kinney
Elizabeth Thompson
+ many students!

Common Features across IU Studies

- Shared set of 11 outcome measures
- Outcome measures completed at 4-6 weeks post-fit
- Strict protocol followed in each study, with many common features across studies
  - Older adults with typical bilateral sloping hearing loss as participants
  - Similar gain targets and real-ear verification
  - Bilateral fits
  - Same core team of clinicians in same clinic

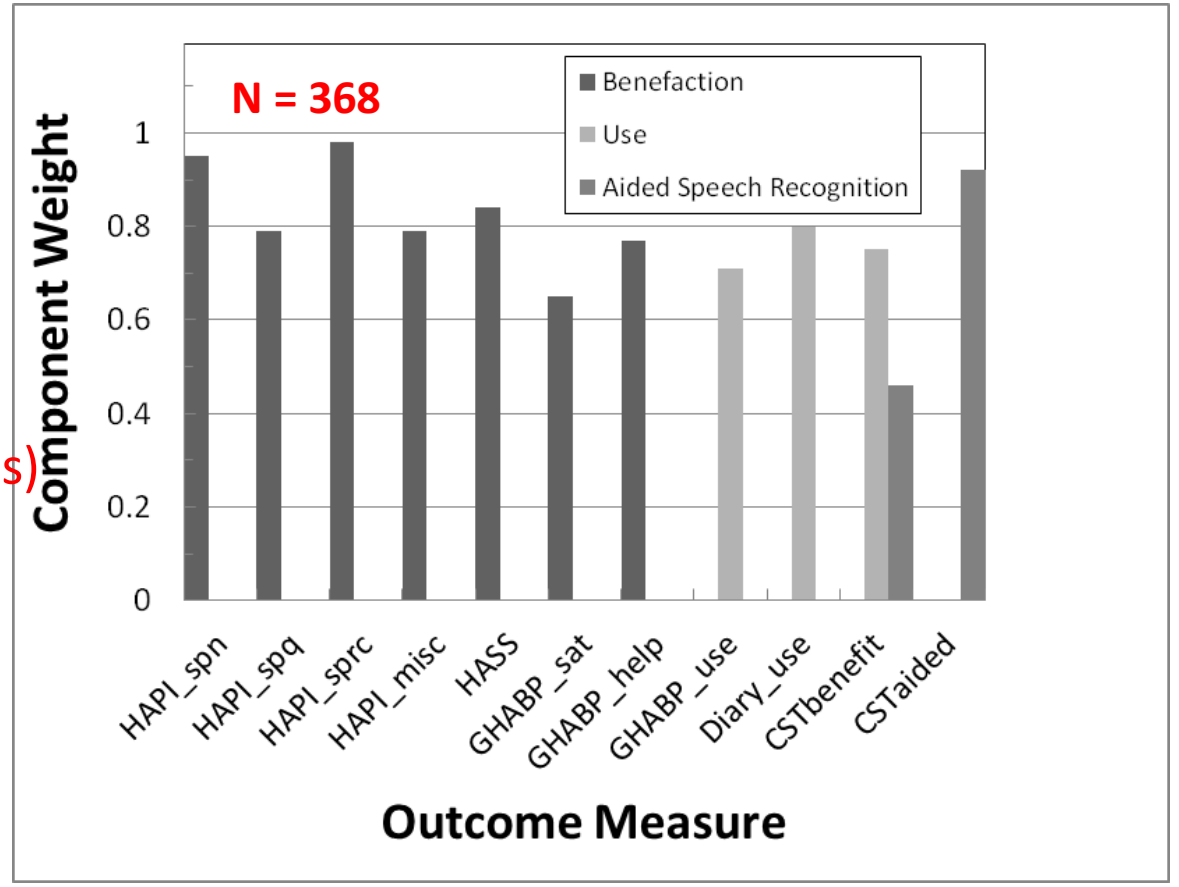
Audiology "Best Practices"

Dimensions of Hearing Aid Outcome

Are all measures needed? NO
(11 measures >>> 3 dimensions)

Relies on correlations and factor analysis

Large subjects/variables ratio needed (e.g., 368/11)



Humes & Krull (2012)

Overview

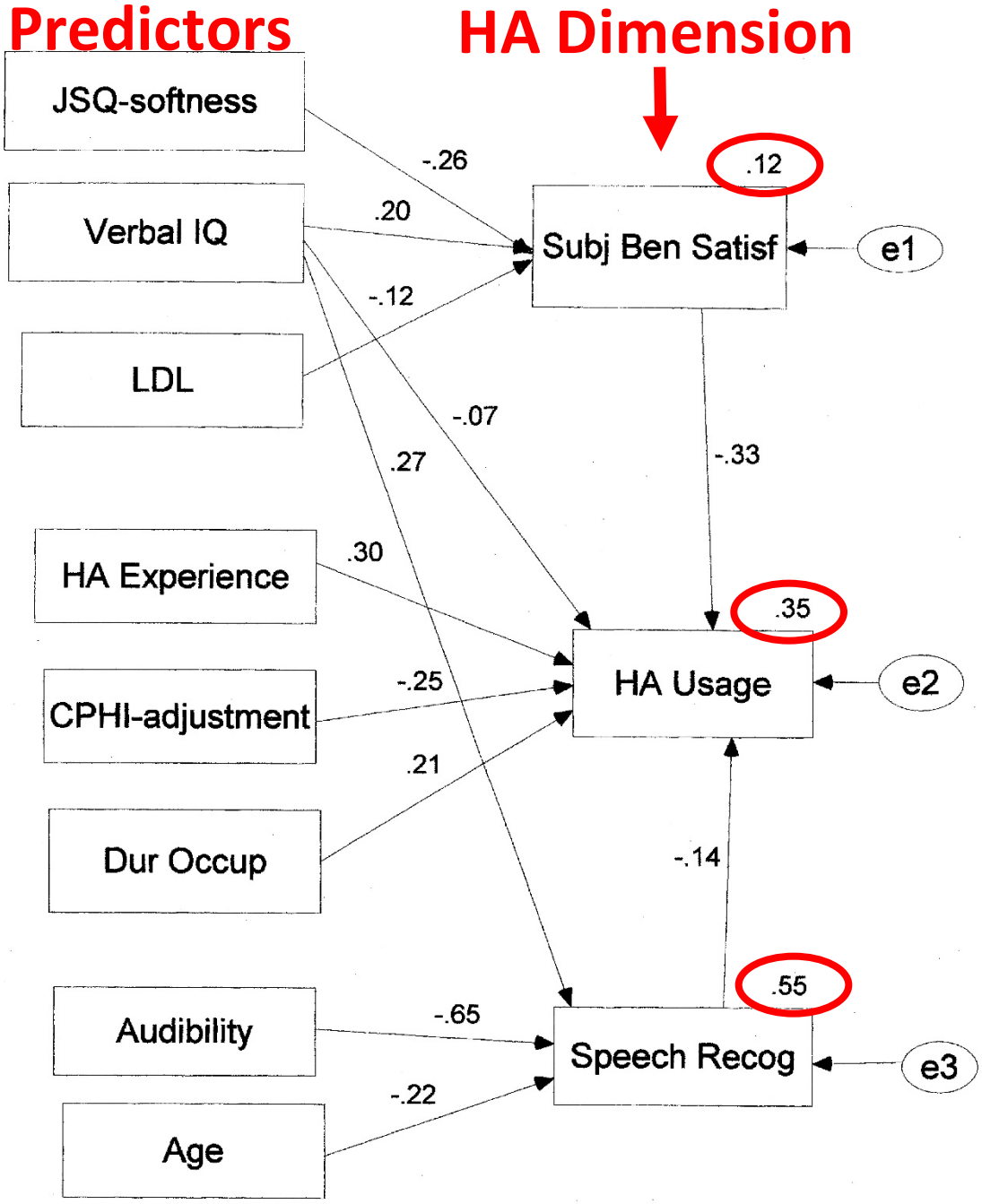
- Types of Hearing Aid Outcome Measures
- Dimensions of Hearing Aid Outcome
- **Explaining Individual Differences in Outcome--***Why* do listeners differ in performance?
- Influence of Technology on Outcomes

SEM Results

IU-1 Study

N=173

Humes (2003)



Re: “Benefaction”: Thorough Reviews in Recent Years

- Wong, Hickson & McPherson (2003)
- Knudsen et al. (2010)
- Singh, Lau & Pichora-Fuller (2015)
  - In addition to review, added two substantial studies of factors related to satisfaction

Singh et al. (2015)

- Study 1: 173 older adults, 55.5% using hearing aids for at least 5 years
- Study 2: 161 middle-aged adults, 35.4% using hearing aids for at least 5 years
- Some minor differences in variables, both predictor and outcome, across studies

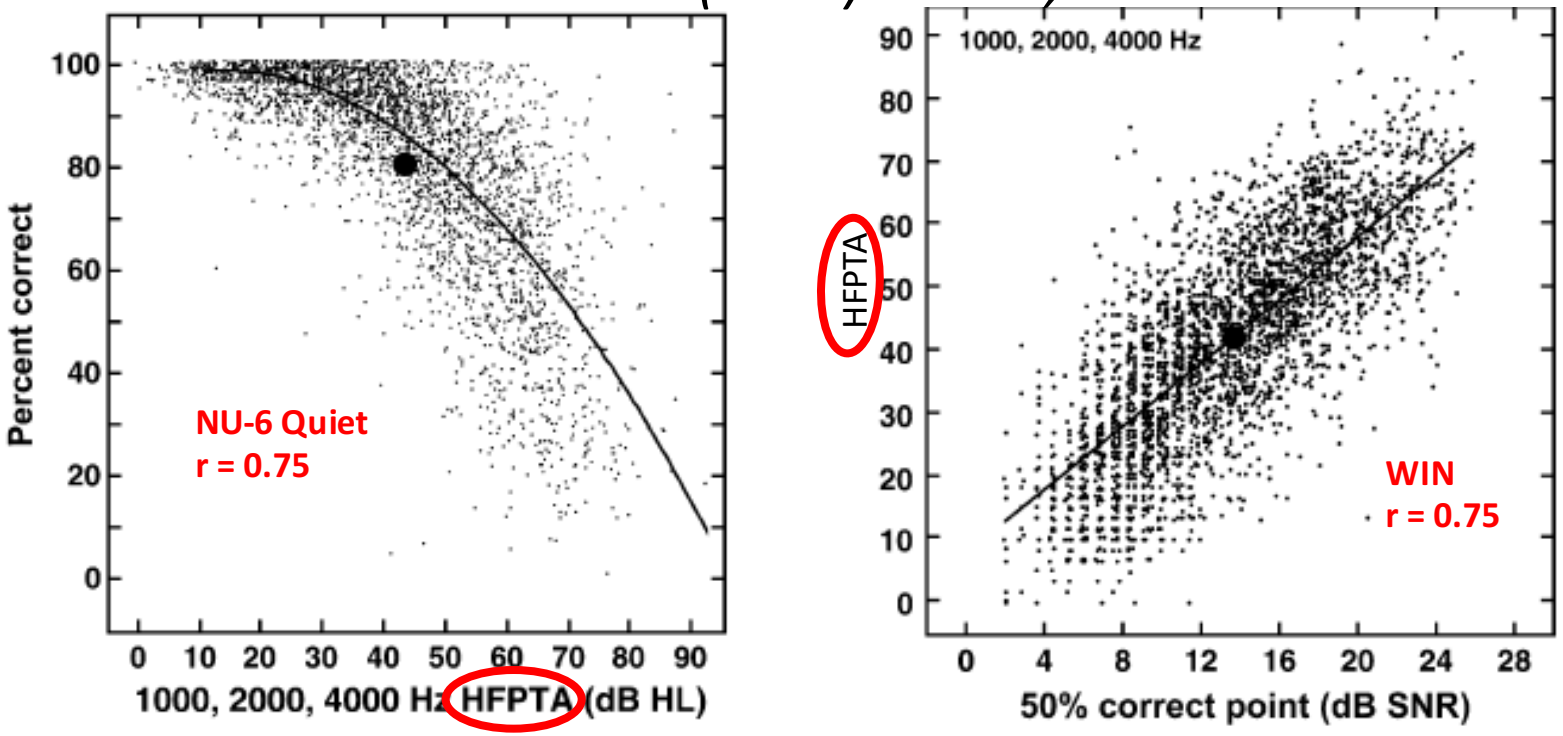
Singh et al. (2015)

- Best predictor in both sa… …ed social support (DUFSS)
  - S1: Total … to DUFSS
  - … …9.25 due to DUFSS
  - …ed predictors across samples
- AP… …included in S2 and correlation with SADL was r = 0.46 – “benefaction” (incl. as predictor in S2)

Despite wide range of variables examined, still only able to account for about 10-25% of variance in benefaction measures

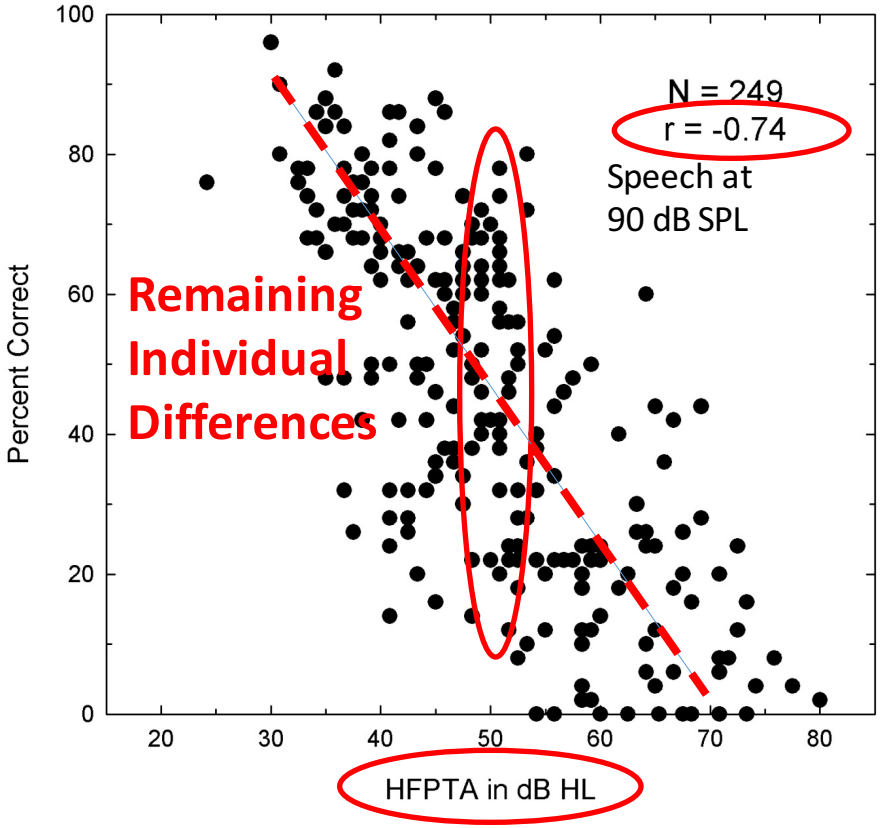
Explaining Individual Differences in Speech Understanding— Unaided and Aided

Unaided Speech Recognition:
Wilson (2011) N = ~3,200



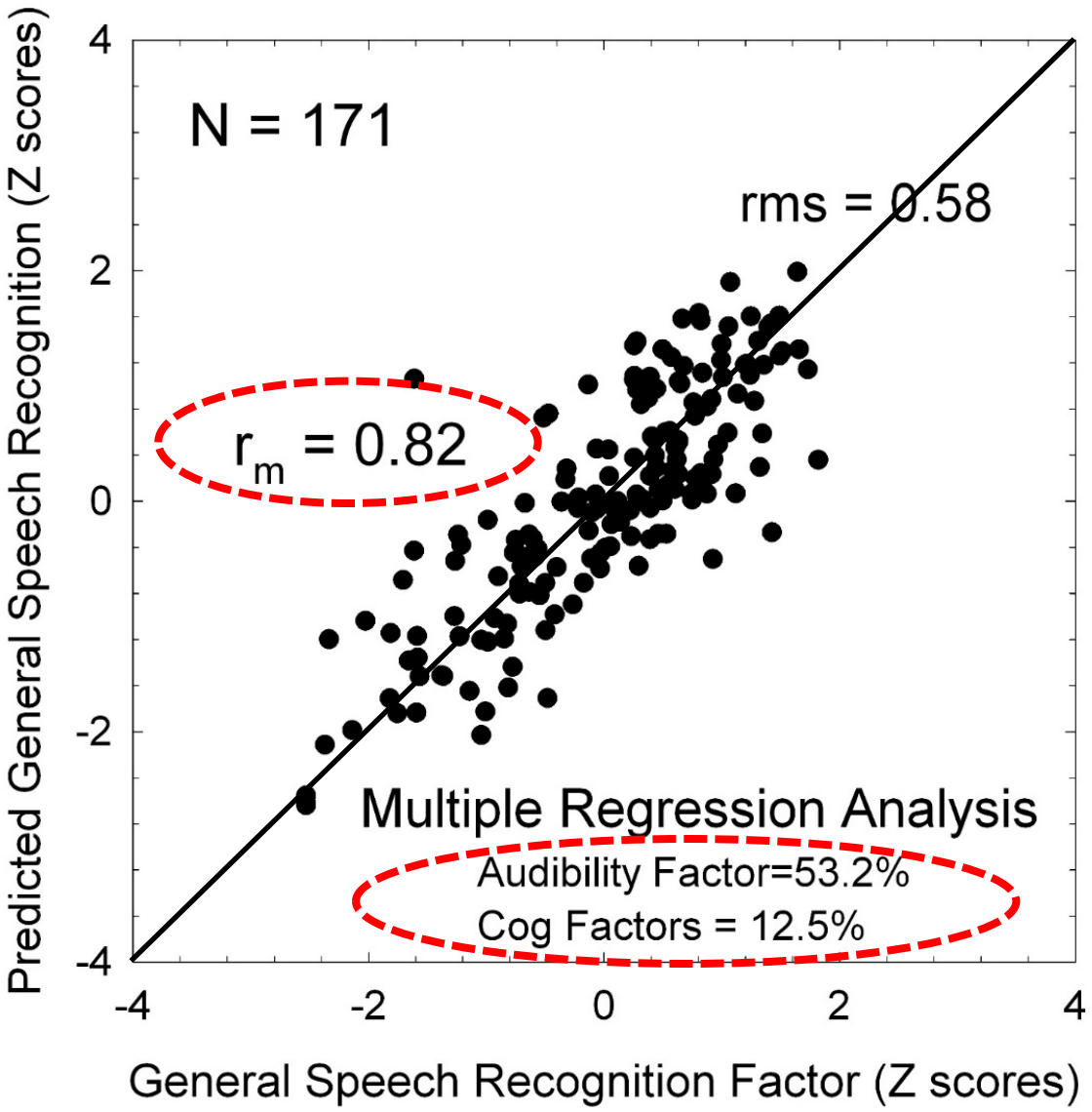
Explaining Individual Differences

Unaided Speech Recognition--Humes (2005) N = 249



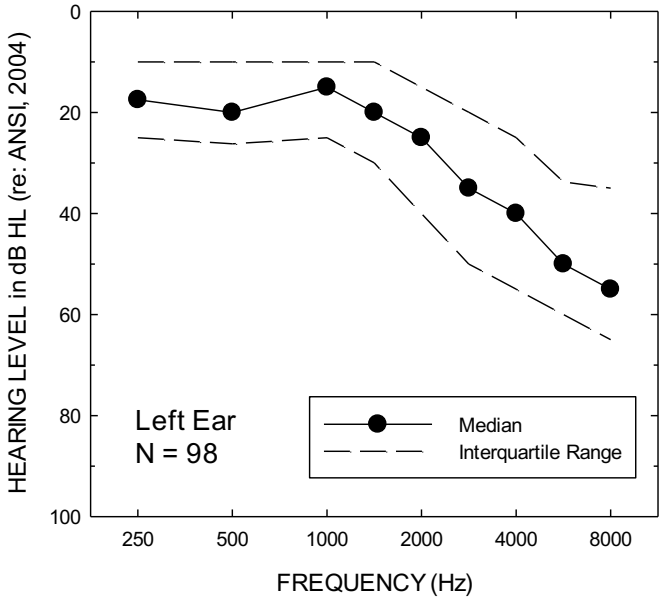
Explaining Individual Differences:

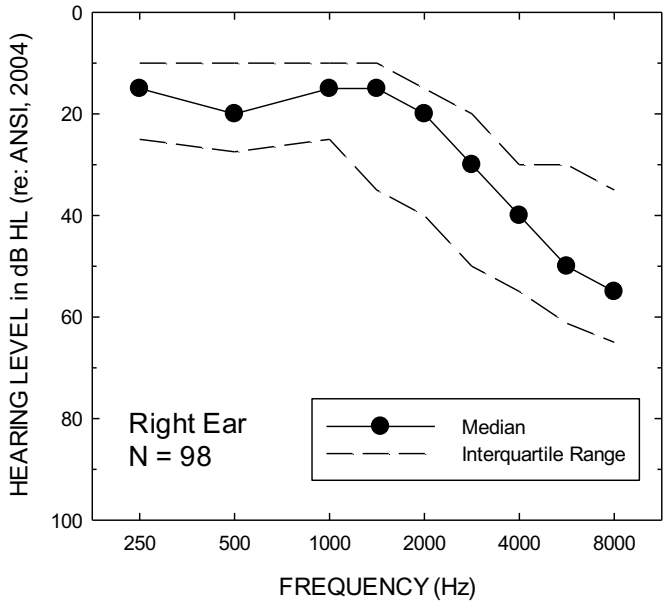
AIDED Speech Recognition



Humes (2002)

Our Most Recent Study of Individual Differences in *Aided* Speech Recognition (Humes, Kidd & Lentz, 2013)





AGE: M = 69.2 y, 60-86 y
50 females;
91 right ears tested;
91 not current HA users (88 never)

Potential Predictor Variables

- Cognitive/Linguistic Measures

  (all tests made use of **visual** stimuli)

  - 3 Measures of Verbal Processing Speed (AQT)
  - 3 Measures of Working Memory Capacity
  - Text Recognition Threshold (TRT)—using text of SPIN-PH sentences

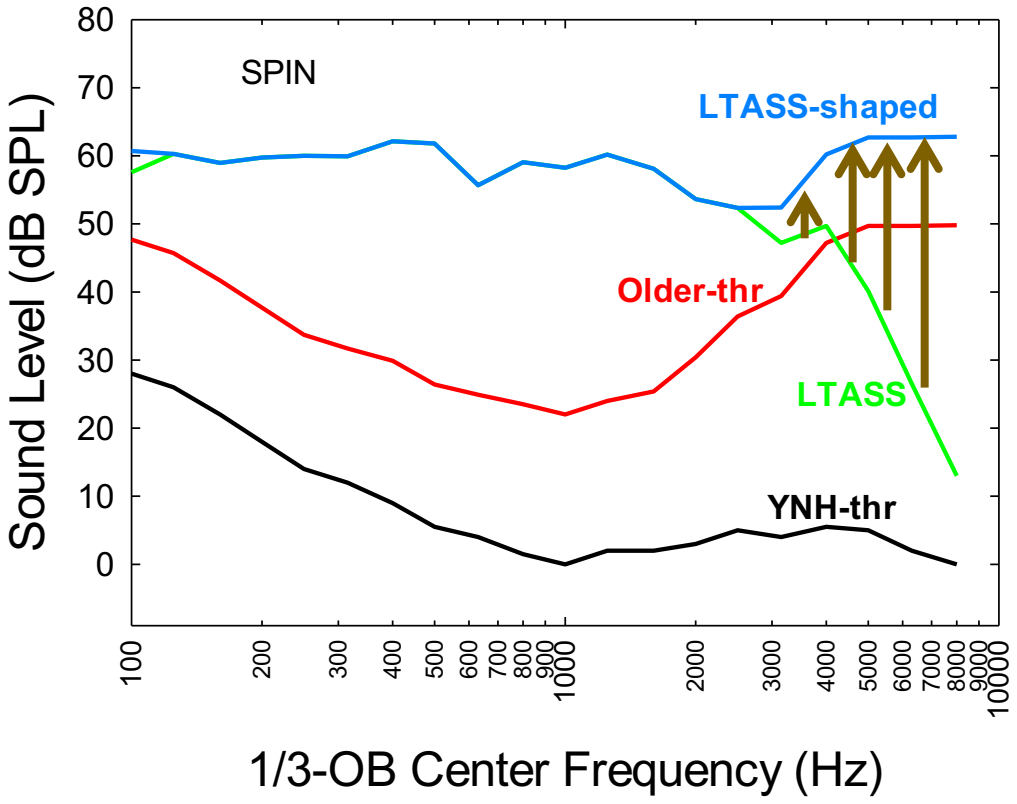
Potential Auditory Predictor Variables

- Psychophysical Measures (14 measures)
  - Modulation Detection and MDI (5)
  - Dichotic Pure-Tone Masking (2)
  - Stream Segregation (3)
  - Informational Masking (“multi-burst masking”) (2)
  - Anisochrony (1)
  - Harmonic Mistuning (1)
  - Except for stream segregation, standard-2AFC, adaptive tracking-7 reversals each, 5 estimates averaged
- Environmental Sound Identification (ESI)

Speech-Understanding Measures

- Coordinate Response Measure (CRM)--85 dB SPL
  - Simultaneous (same target & competing talker, 0-dB SNR)
  - 6 ST Fo separation
  - 6 ST Fo sep, reversed
- Speech Perception in Noise (SPIN)—85 dB SPL
  - Interrupted (8, 19-38 ms “glimpses” per target word; 50% proportion or duty cycle)
  - Babble (+8 dB SNR)
  - Time compressed (50% time compression; PL items only)
- Dichotic Syllable-Sequence Task

Spectral Shaping Applied--SPIN



Quick Summary of Group Differences

- Group means for YNH subjects were generally consistent with prior studies

- In the vast majority of cases (~80%), for auditory measures, older adults did not perform significantly worse than YNH subjects (*including speech understanding*)

Multiple-Reg & Dominance Analysis

- Regression analysis performed
  - Independent Variables (Predictors)
    - Age
    - TRT
    - ESI
    - Cognitive Function
    - Modulation Detection
    - Dichotic Masked Threshold
    - Stream Segregation
    - Informational (Multi-Burst) Masking
    - Hearing Loss

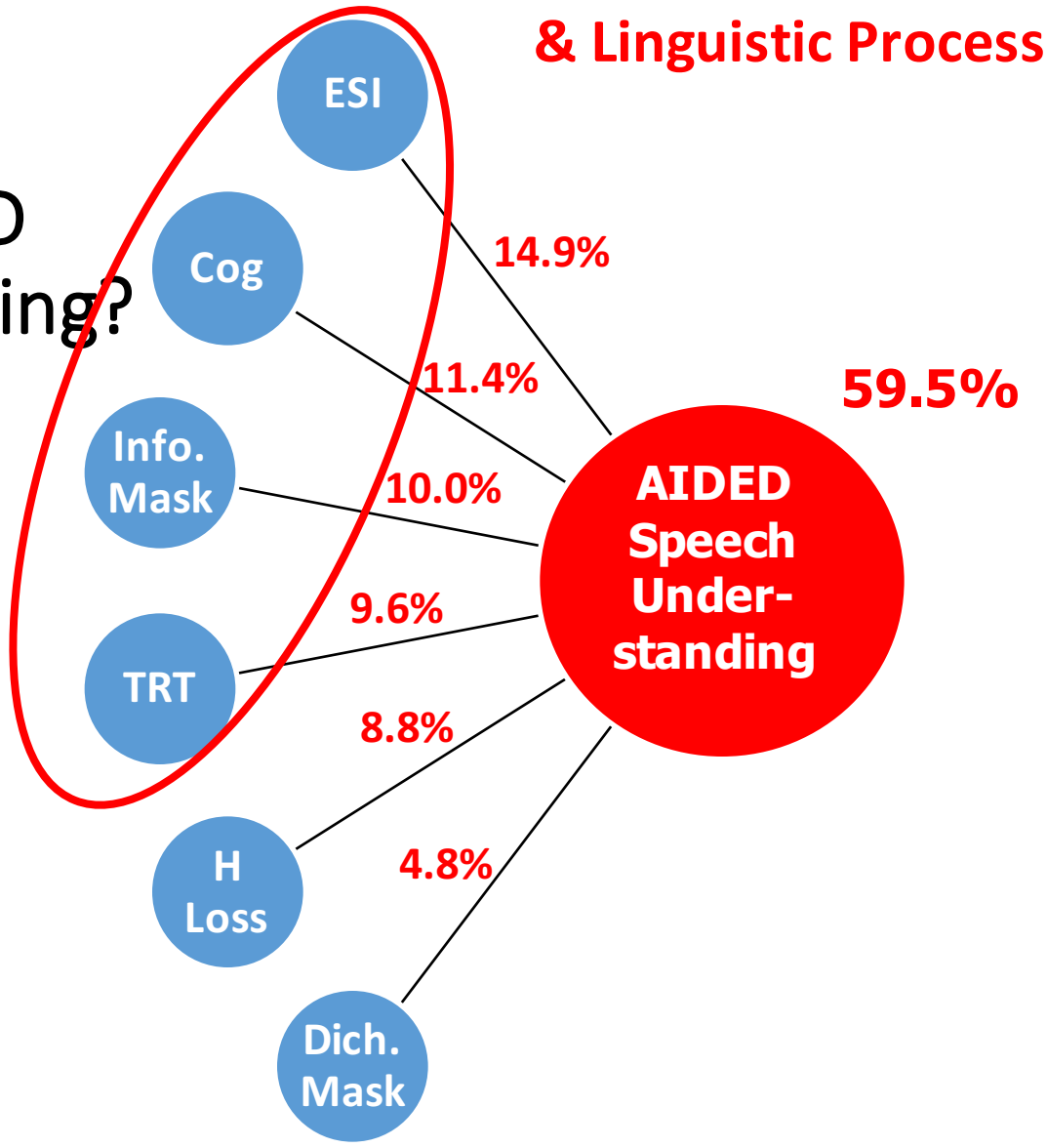
How do differences in THESE measures

  - Dependent Measures
    - Aided Speech Understanding

Explain differences in THIS measure

Regression Analysis:

Why Individual Differences in AIDED Speech Understanding?



Variables NOT Entering:

- Mod Detection
- Stream Segregation
- Age

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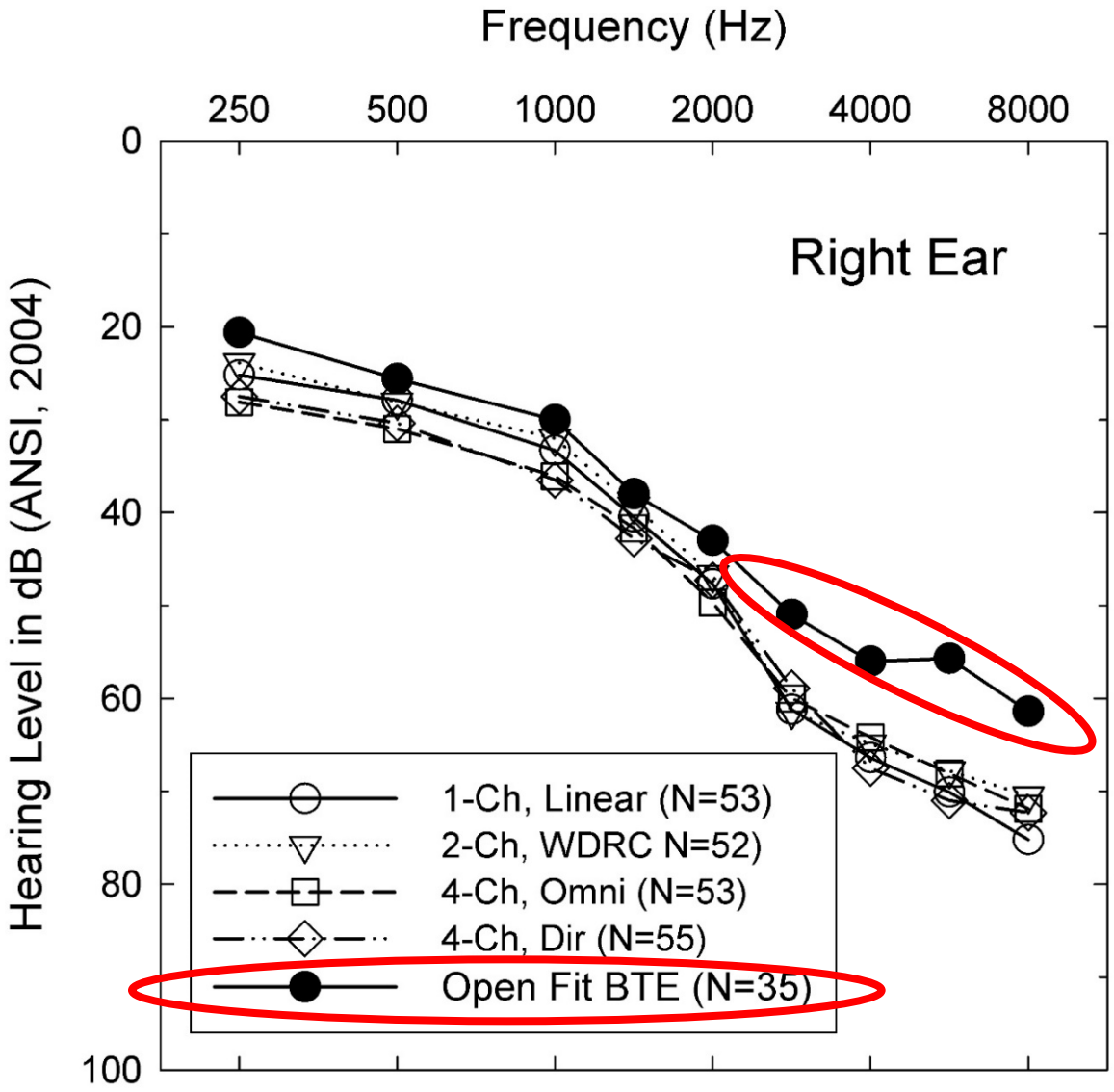
Subject & Technology Characteristics

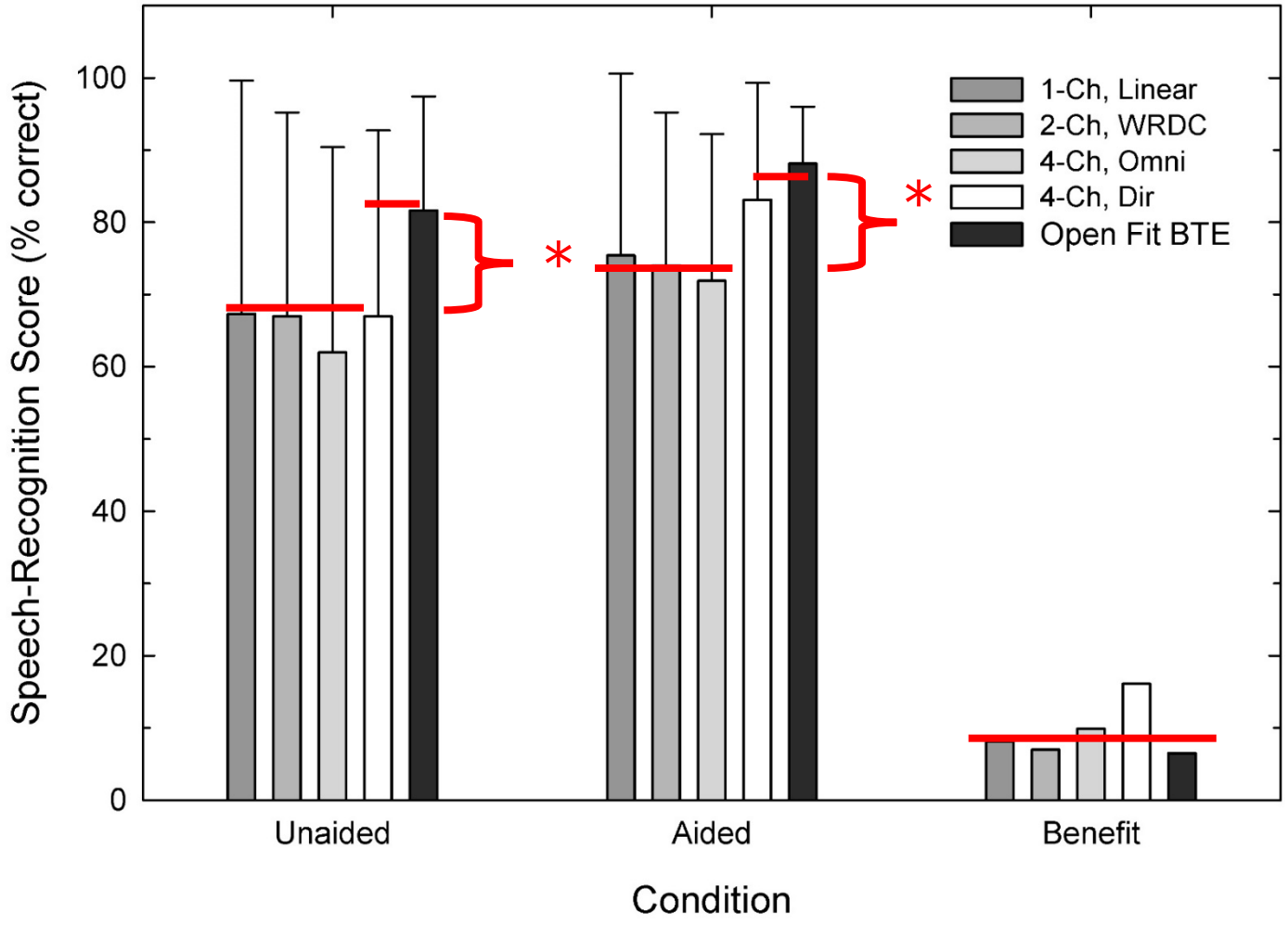
GROUP	N	AGE (M, sd)	BHFPTA*	%MALE	%NEW users
1-Ch, Linear	53	74.0 (6.7) y	48.4 dB HL	66	74
2-Ch, WDRC	52	74.6 (7.0) y	48.3 dB HL	66	74
4-Ch, Omni	53	75.4 (6.4) y	50.3 dB HL	60	67
4-Ch, Dir	56	74.5 (7.6) y	50.9 dB HL	71	71
Open Fit BTE**	35	73.6 (8.0)y	44.0 dB HL	51	80

*BHFPTA = Bilateral pure-tone average at 1000, 2000 and 4000 Hz
**6-channel, WDRC, Directional mic

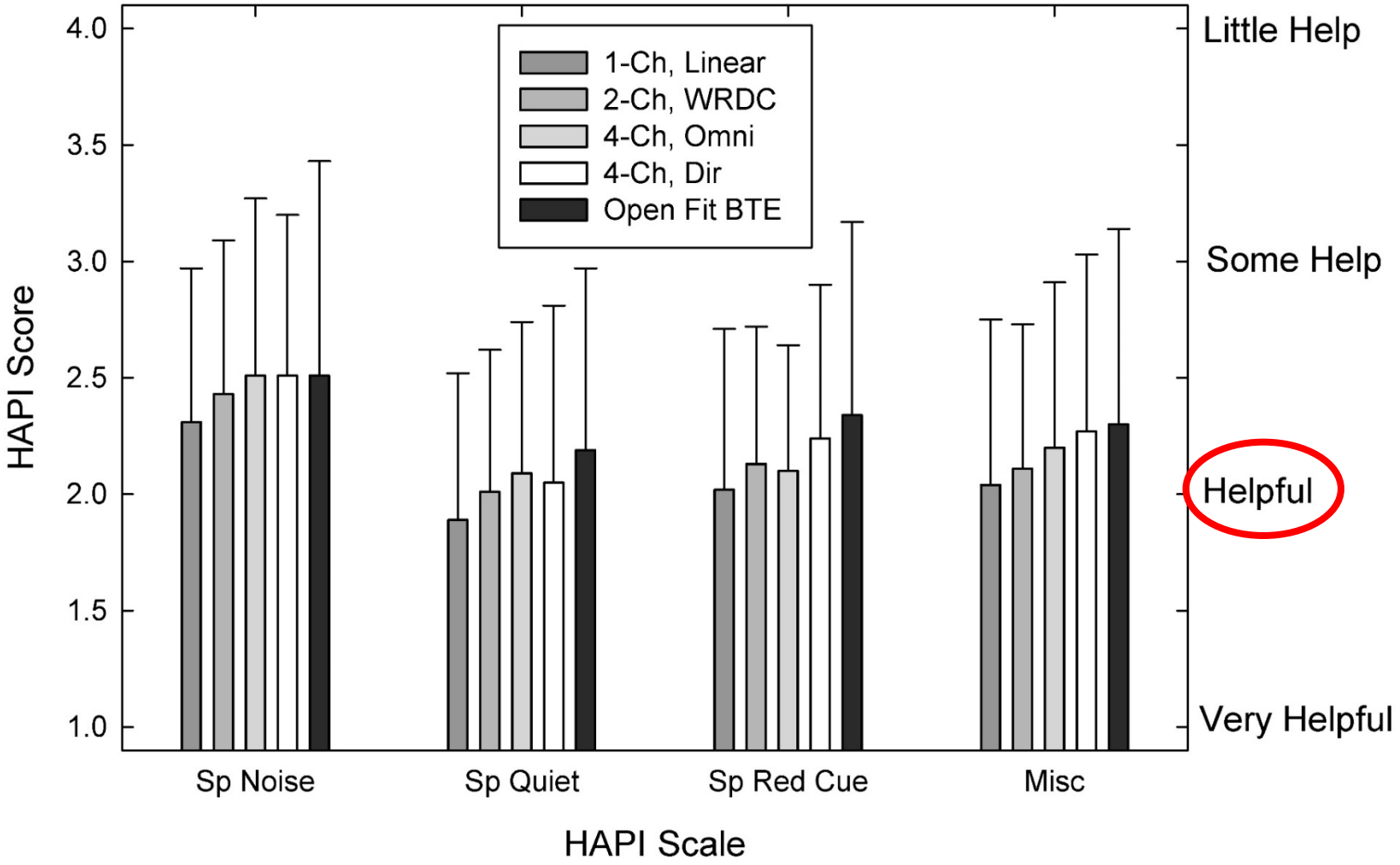
Audiograms


Frequency (Hz)
250
500
1000
2000
4000
8000
0
20
40
60
80
100
Hearing Level in dB (ANSI, 2004)
Right Ear
1-Ch, Linear (N=53)
2-Ch, WDRC N=52)
4-Ch, Omni (N=53)
4-Ch, Dir (N=55)
Open Fit BTE (N=35)

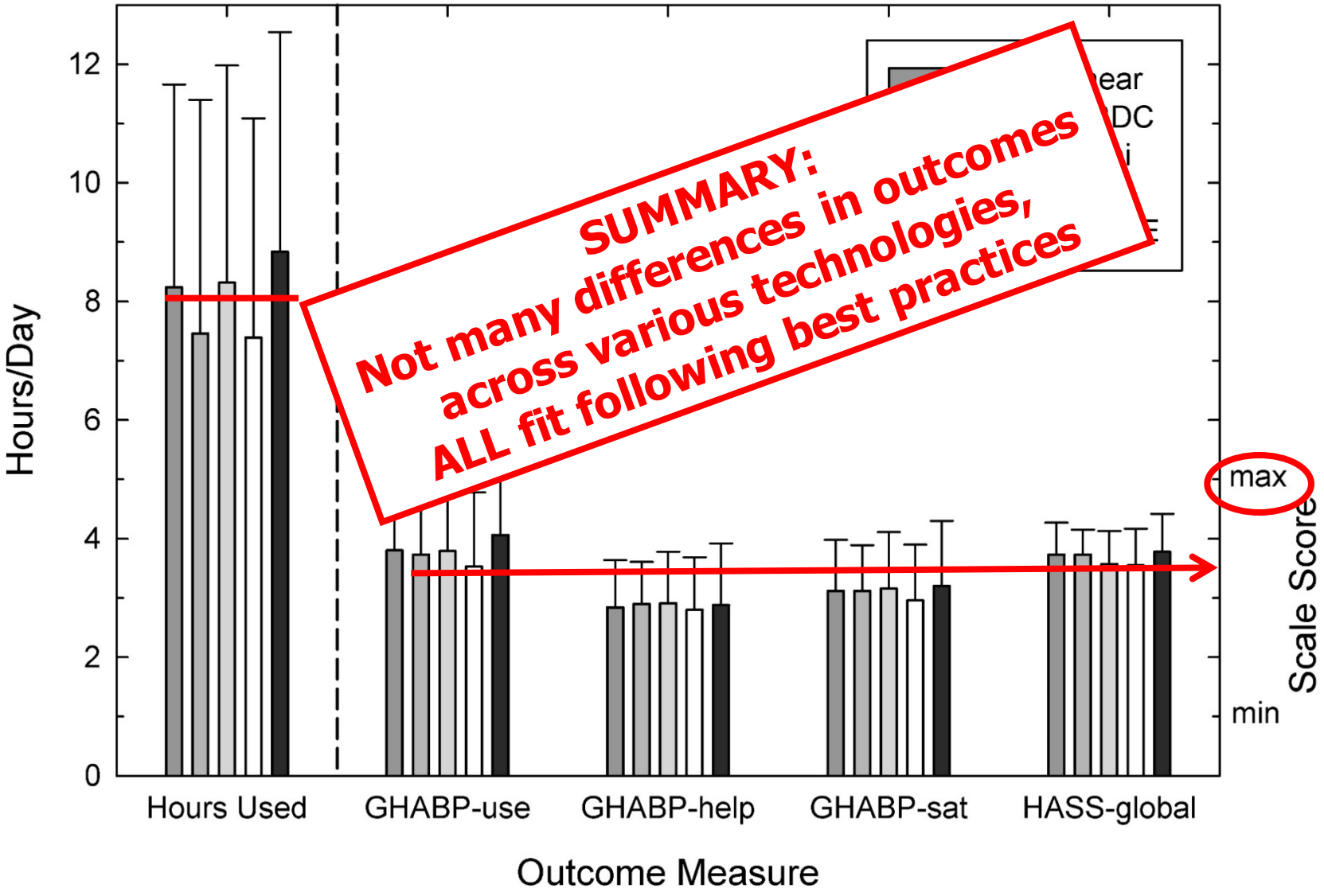
Speech-Recognition Performance (CST)



Hearing Aid Performance Inventory



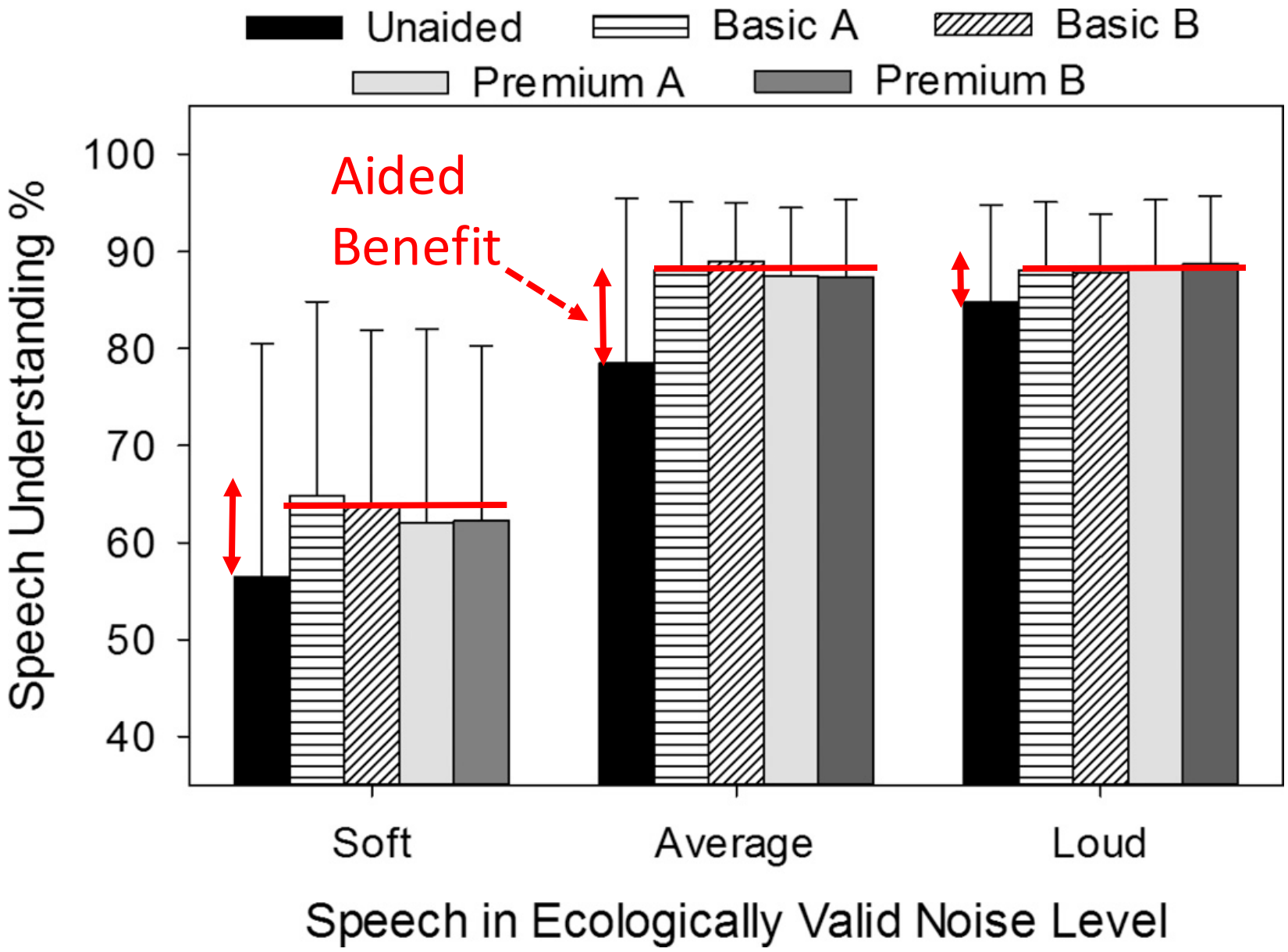
Benefaction and Usage



Johnson, Xu & Cox (2015)

- Outcome domains for lab tests and questionnaires (as used in daily life) from 45 older adults
  - Speech understanding
  - Listening effort
  - Localization
  - Sound acceptability
- Hearing aid fittings
  - Bilateral, with appropriate coupling
  - Fitted using best-practice protocols, starting with NAL targets
  - Features set to manufacturers' recommendations
- Compared "basic" to "premium" technology—2 brands

Feature	Hearing Aids			
	Premium A	Basic A	Premium B	Basic B
Number of compression channels	16	8	20	6
Directional Microphone	Automatic multi-channel adaptive	Automatic single-channel adaptive	Automatic multi-channel adaptive	Automatic single-channel adaptive
Environmental adaptation	more	less	more	less
Binaural data streaming	yes	no	yes	no
Automatic learning of preferred volume	yes	no	yes	no


Unaided
Basic A
Basic B
Premium A
Premium B
Aided Benefit
Speech Understanding %
100
90
80
70
60
50
40
Soft
Average
Loud
Speech in Ecologically Valid Noise Level

Influence of Technology on Outcomes

- When audiology best practices followed, differences in outcomes across technologies are relatively small.

- This appears to be true across a wide range of technologies.

- Shared aspects of “best practices” across studies:
  - Bilateral fits
  - REM used to match Rx targets
  - Counseling and HA orientation included

Acknowledgements

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