# Audibility-Based Hearing-Aid Candidacy for Children with Ryan McCreery – 1 pm ET

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Academie canadienne d'audiologie ACA
Entendus. Compris.

CAA Webinar

# Audibility-Based Hearing-aid Candidacy for Children

**Ryan McCreery, PhD**
**Boys Town National Research Hospital**

**Dec 1st, 2020**

CAA Canadian Academy of Audiology Heard. Understood.
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Canadian Academy of Audiology is a professional association dedicated to enhancing the role of audiologists as primary hearing health care providers through advocacy, education and research.

# Melissa Polonenko - Host

Melissa Polonenko is the past Co-Chair of the CAA Science and Education Committee and is a Clinician Scientist. Currently she is a postdoctoral associate at the University of Rochester Medical Center.

She will be moving to the University of Minnesota to start as an Assistant Professor in the Speech-Language and Hearing Sciences department. Melissa completed her PhD at the University of Toronto in the Cochlear Implant Lab at SickKids Hospital in Toronto.

# Speaker: Ryan McCreery

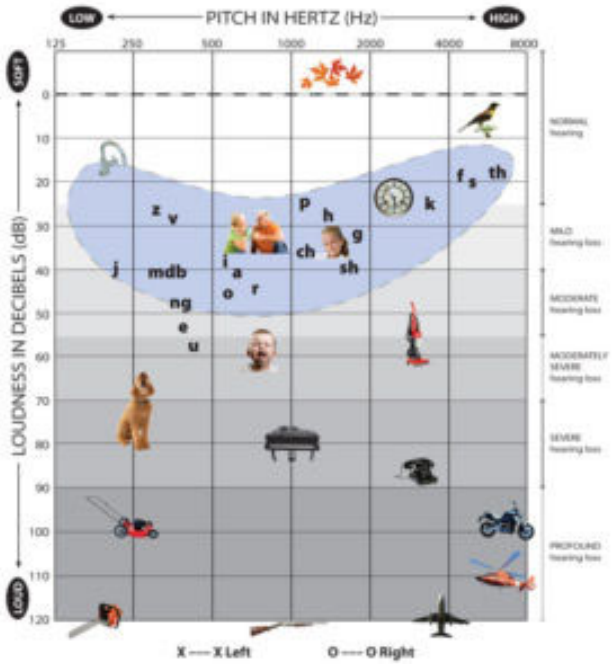
Ryan McCreery is the Director of Research and Director of the Audibility, Perception, and Cognition Laboratory at Boys Town National Research Hospital in Omaha, NE.

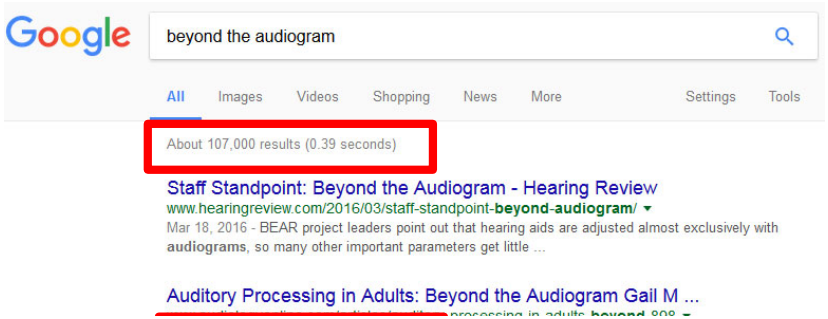
Ryan provides strategic leadership to the 6 centers and 26 laboratories that comprise the BTNRH research program. His NIH-funded research examines the effects of hearing loss and cognitive development on speech perception in children with typical hearing and children with hearing loss.

# Audibility-based hearing aid candidacy for children with hearing loss

Ryan McCreery, Ph.D.
Director of Research
Boys Town National Research Hospital
Ryan.McCreery@boystown.org

# In defense of the audiogram






# KEY CONCERN:
# The audiogram does not predict outcomes with hearing aids

# The audiogram is not perfect

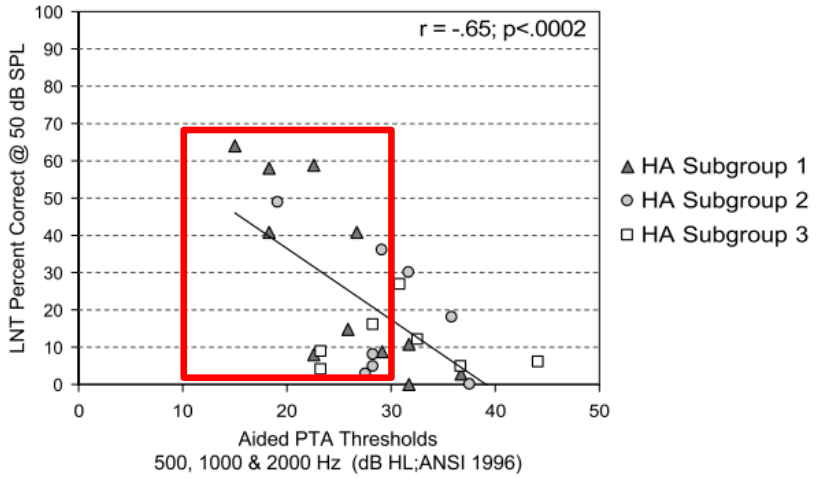
- Pure tone detection task
- Discrete frequency
- Unaided
  - Does not reflect performance with hearing aids
  - Fitting quality varies
- Characterized as an average of mid-frequencies
  - Pure tone average (PTA)

# Findings are mixed between PTA and outcomes

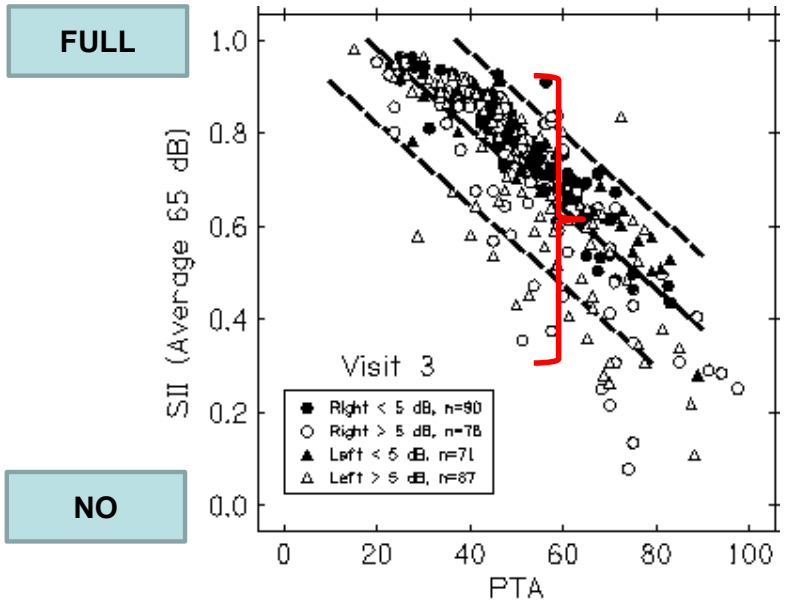
| | |
|---|---|
| Fitzpatrick et al., 2007 | Davis et al., 1986 |
| Wake et al., 2005 | Moeller, 2000 |
| Delage & Tuller, 2007 | Ramkalawan & Davis, 1992 |
| | Gilbertson & Kamhi, 1995 |

# Limitations for predicting speech recognition

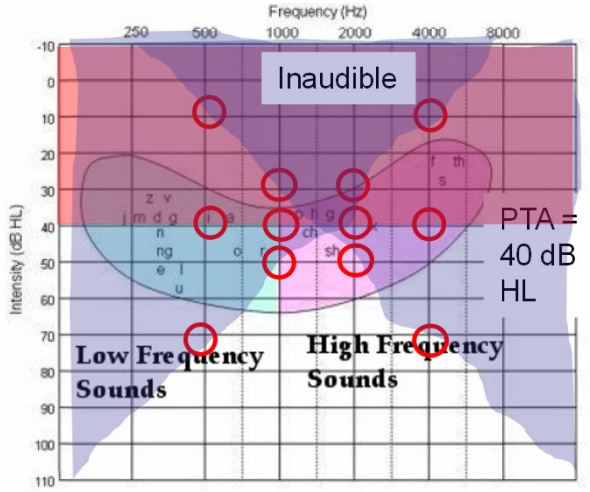
**Figure 6. Aided PTA (at 0.5, 1.0, and 2.0 kHz; dB HL) as a function of LNT score (% correct) at the 50 dB SPL presentation level for the 26 children. Linear regression line, *r* value, and significance level are also shown. The symbols are triangles, circles, and squares for Aids 1, 2, and 3, respectively.**



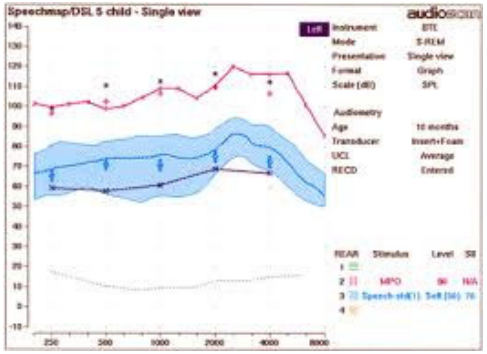
# Problems with Pure Tone Average (PTA)



# What does PTA not tell us?

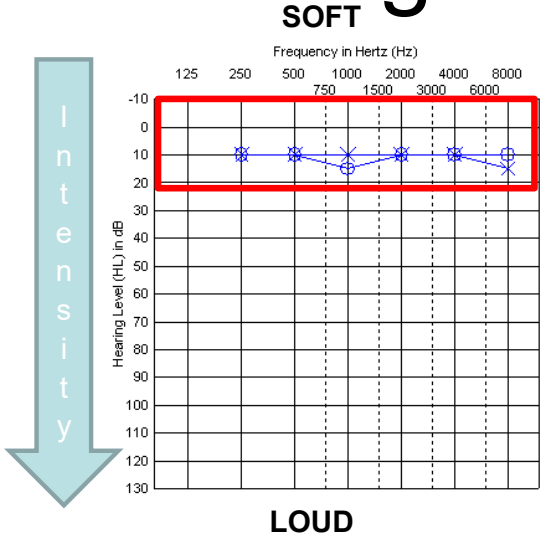



How different configurations may impact speech understanding



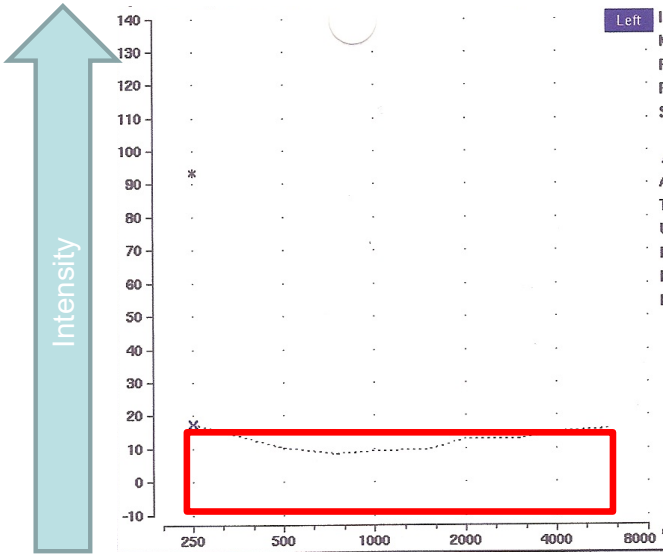

How patient will perceive speech with hearing aids (aided audibility)

# Audiogram

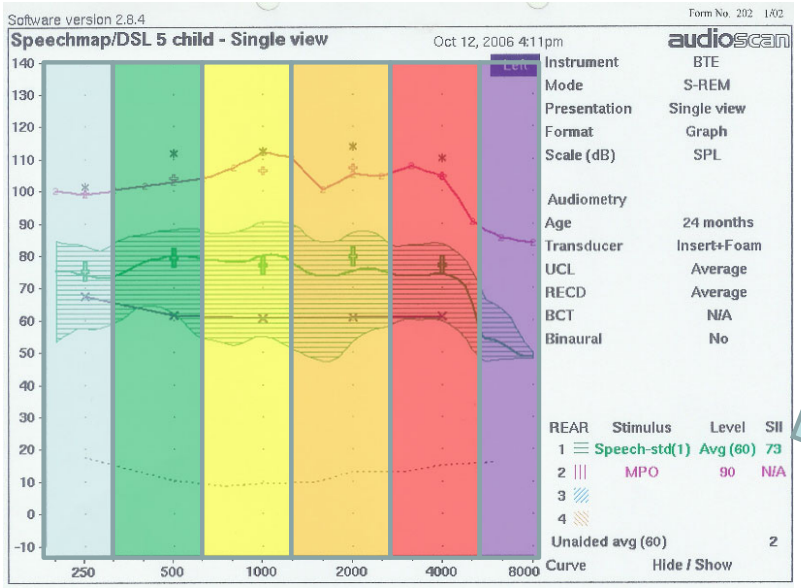



X – Left ear
O – Right ear

# SPL-o-gram


Intensity
Left
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
250
500
1000
2000
4000
8000

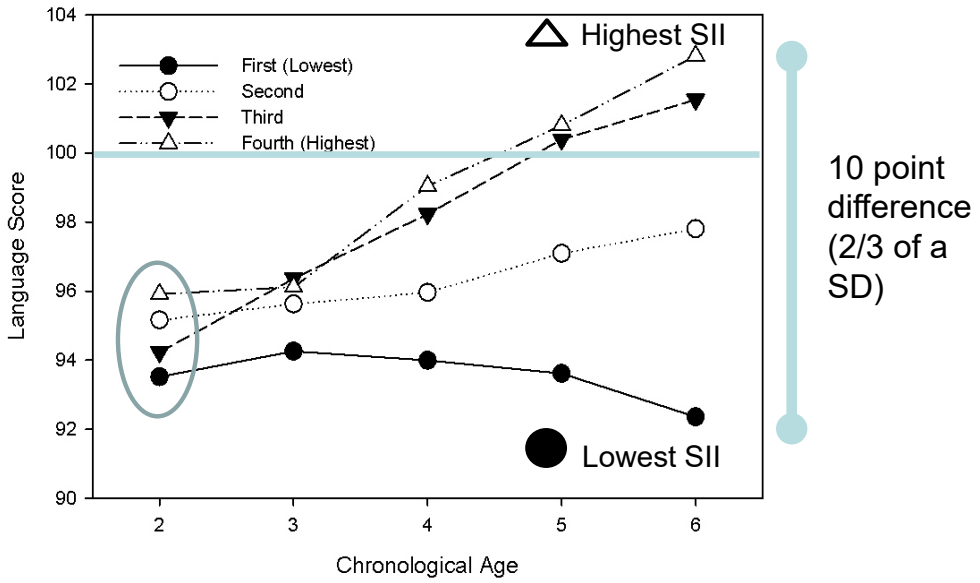
# SPL-o-gram SII Snapshot




For each band – Audibility x FIW = weighted audibility

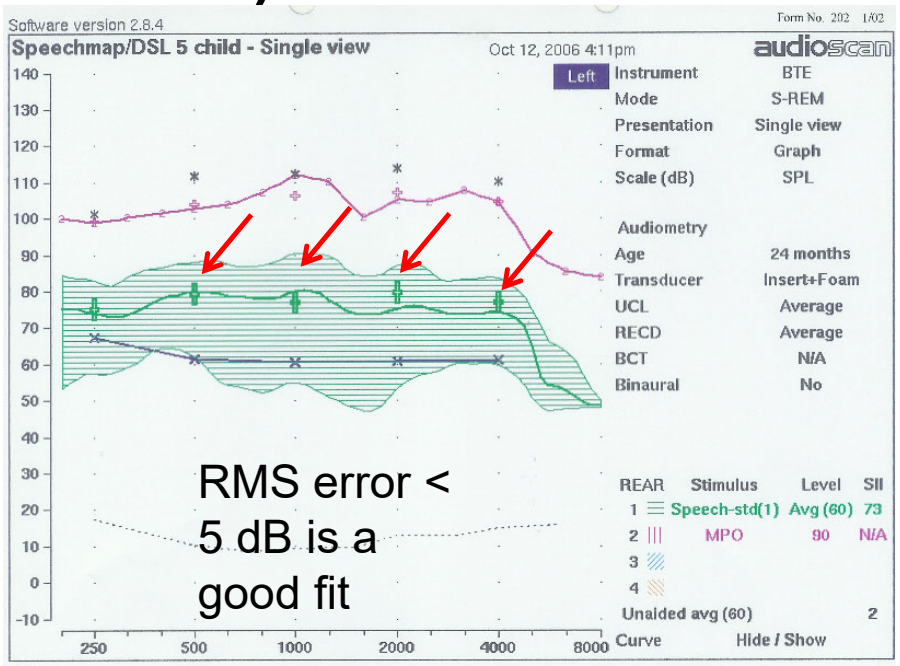
SII = Sum of weighted audibility of all frequency bands

# Language scores as a function of audibility




Tomblin et al., 2015

# Target vs. Actual (RMS error)

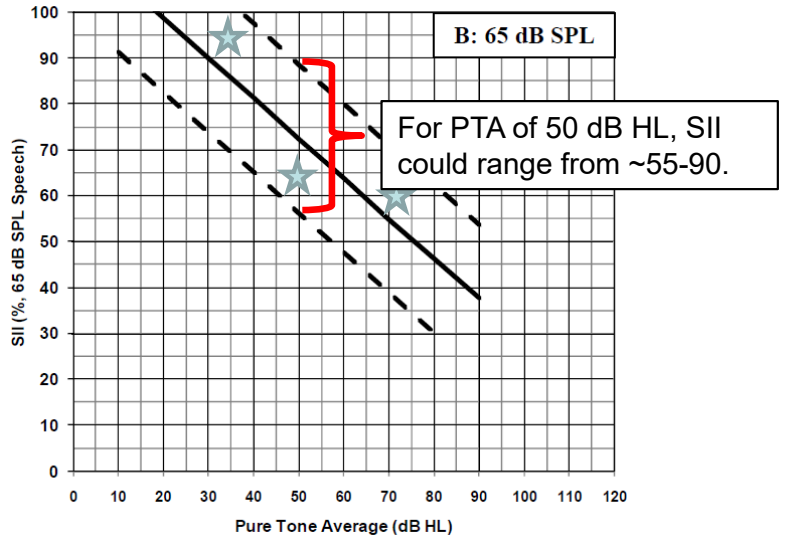



Fitting data compared to DSL targets

Calculate RMS error of deviations from target at 5., 1, 2, and 4 kHz

# Confidence intervals for SII when hearing aids are fit appropriately

Below dashed line = poor fit




Bagatto, et al., 2011

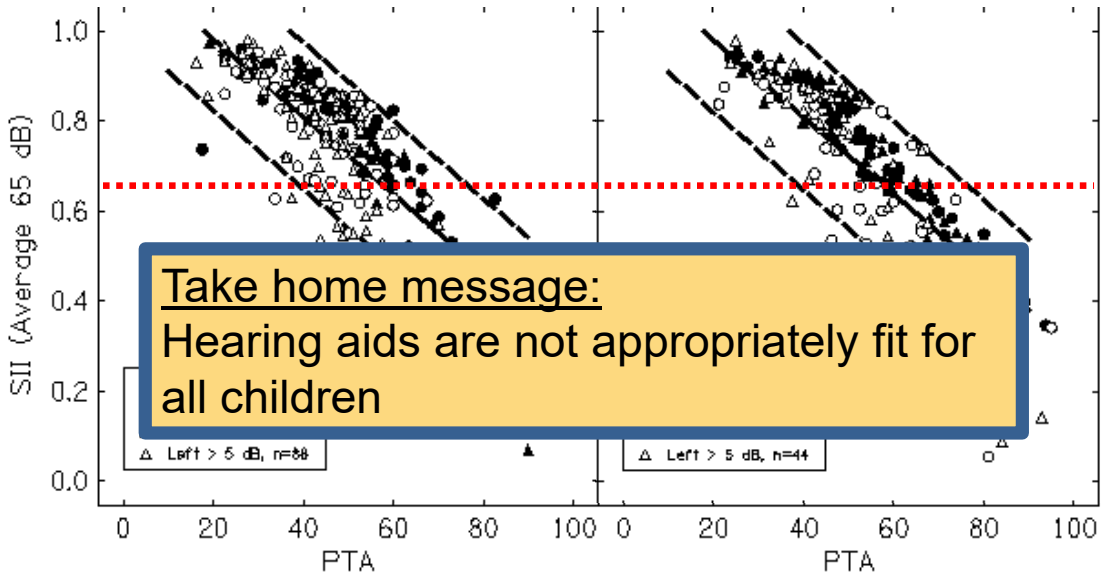
# Accuracy of Verification methods

Probe microphone real ear measures
RMS error= 5.67 dB (SD = 3.95 dB)

Functional gain (aided soundfield)
RMS error=7.92 dB (SD = 4.67 dB)

McCreery, Bentler, Roush, 2013

# Actual Hearing aid fit quality




Take home message:
Hearing aids are not appropriately fit for all children

McCreery, et al., in preparation

# Aided audibility vs. PTA

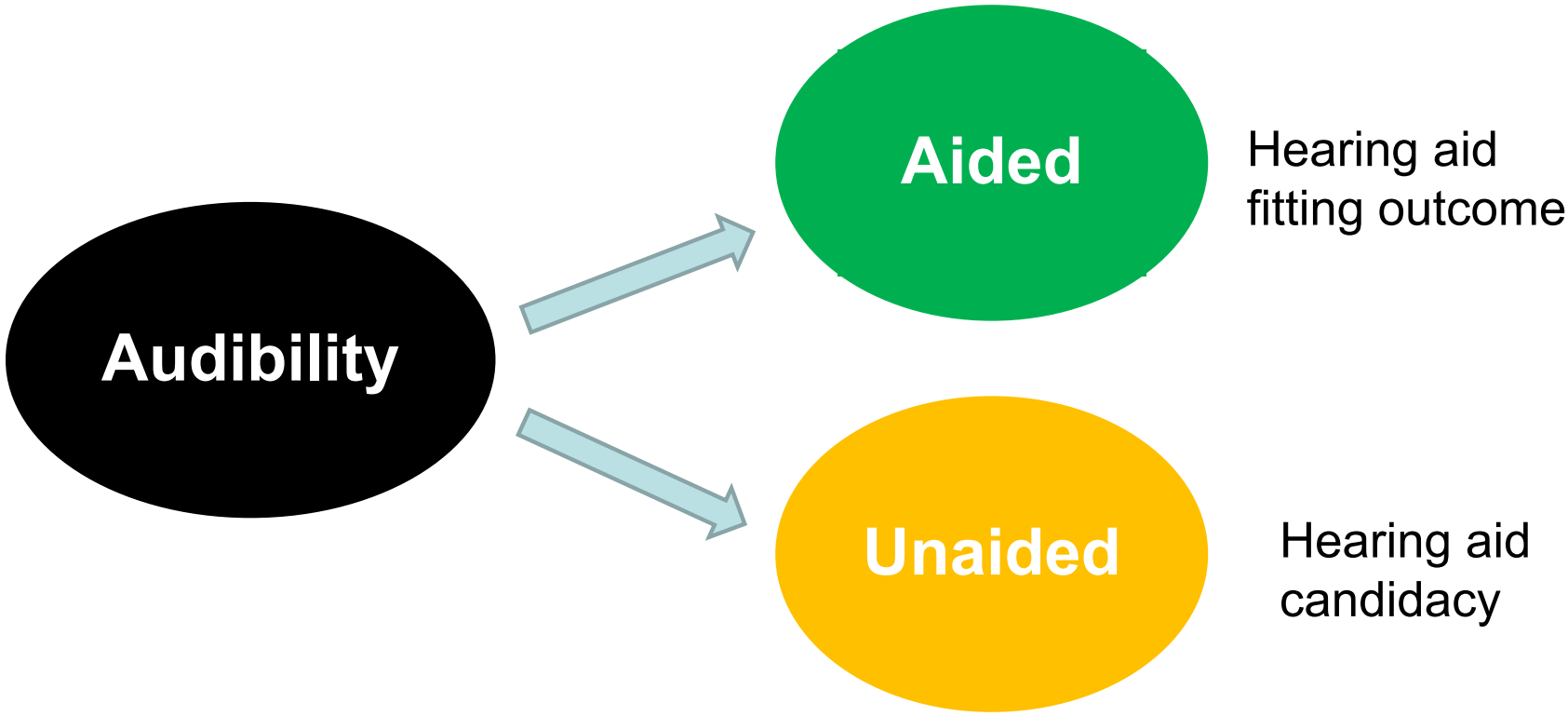
**Speech intelligibility index**

- Measured with speech
- 100-10,000 Hz
- Unaided or aided
- Reflects configuration
- Quality of hearing aid fitting
- Calculated automatically

**Pure tone average**

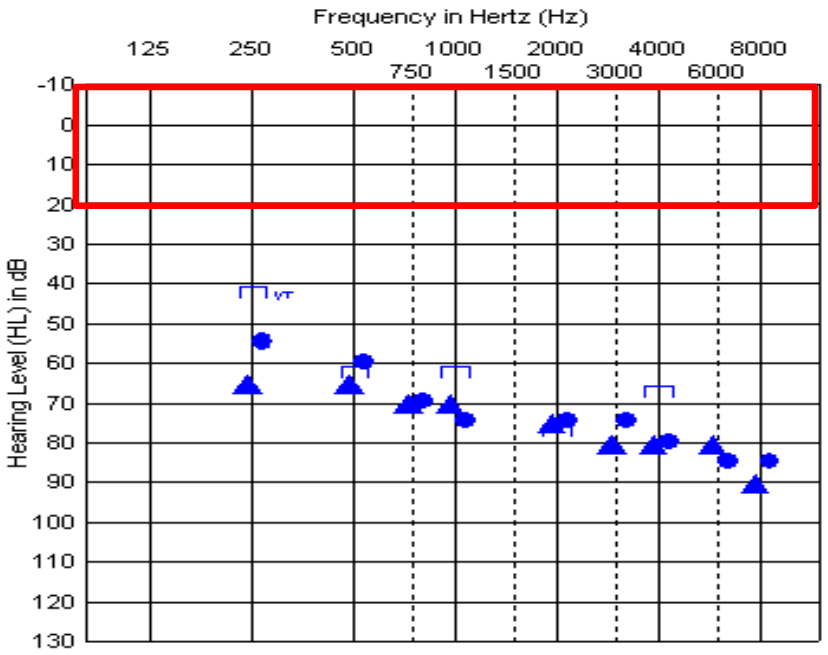
- Measured with pure tones
- 500 – 2000 Hz/4000 Hz
- Unaided or aided*
- Blind to configuration
- Does not reflect quality of hearing aid fitting
- Calculated manually

# Audibility

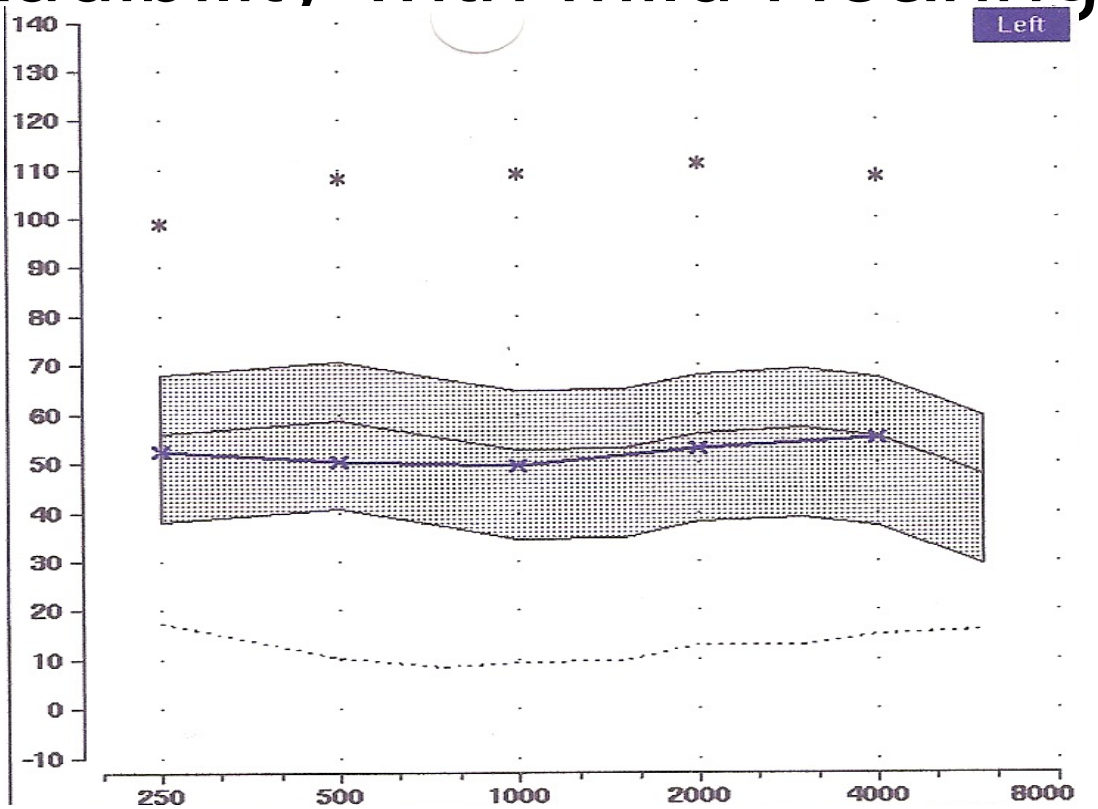

Audibility
Aided
Hearing aid fitting outcome
Unaided
Hearing aid candidacy

# Hearing Thresholds

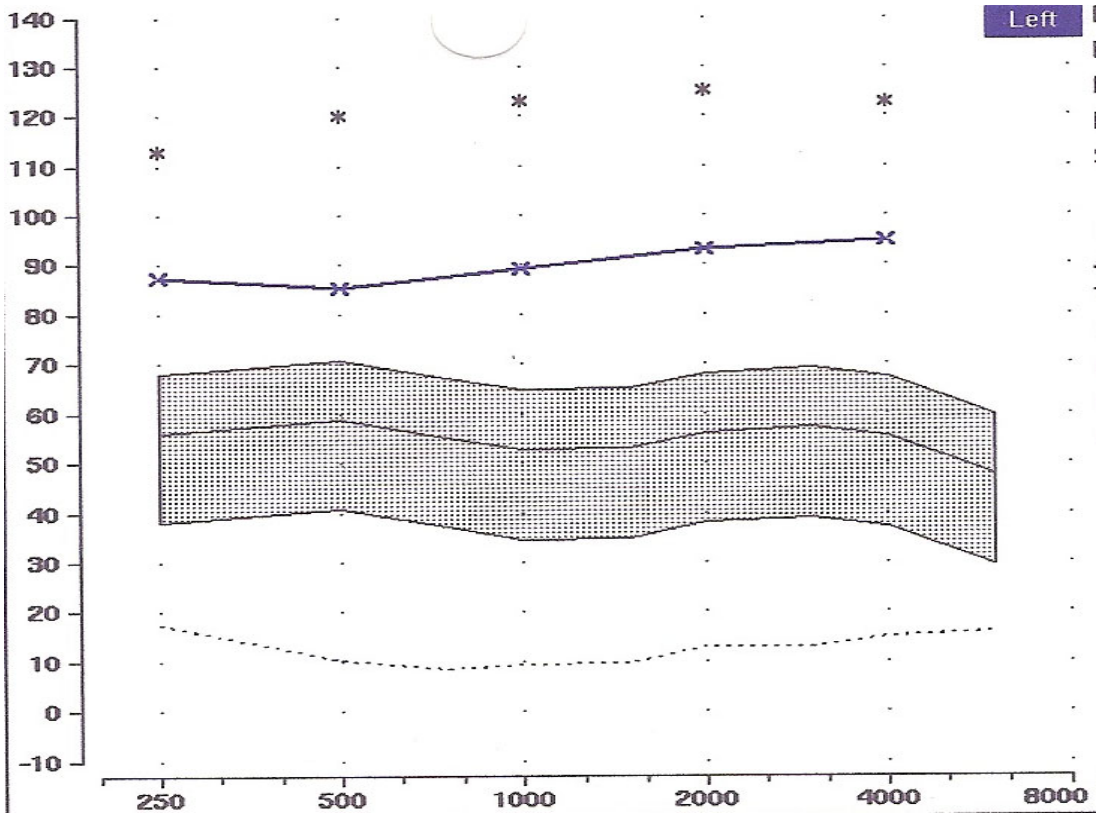
- Hearing loss results in loss of audibility for speech and other important sounds.
- Greater hearing loss = more limited audibility



# Audibility with Mild Hearing Loss



# Audibility with Severe Hearing Loss



# Hearing aid candidacy

- Audibility

  How does ear canal acoustics influence diagnostic assessment?

  How does the hearing loss impact audibility?

# Infants are not average adults: Implications for audiometric testing

*By Richard C. Seewald and Susan D. Scollie*

October 1999 • Vol. 52 • No. 10

## Acoustic mechanisms that determine the ear-canal sound pressures generated by earphones

Susan E. Voss

*Eaton-Peabody Laboratory, Massachusetts Eye and Ear Infirmary, 243 Charles Street, Boston, Massachusetts 02114, Speech and Hearing Sciences Program, Harvard–M.I.T. Division of Health Sciences and Technology, Cambridge, Massachusetts 02139, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, and Department of Otolaryngology, Massachusetts Eye and Ear Infirmary, 243 Charles Street, Boston, Massachusetts 02114*

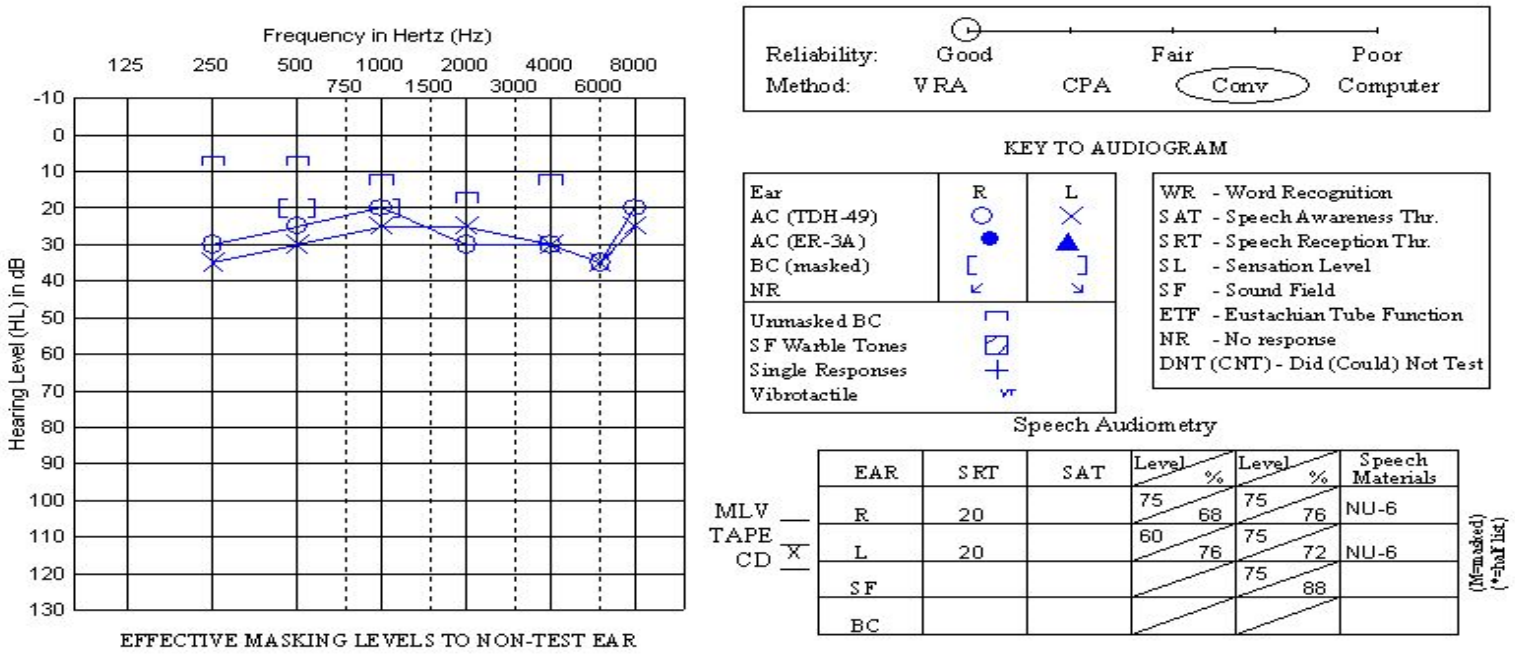
John J. Rosowski

*Eaton-Peabody Laboratory, Massachusetts Eye and Ear Infirmary, 243 Charles Street, Boston, Massachusetts 02114, Department of Otolaryngology, Massachusetts Eye and Ear Infirmary, 243 Charles Street, Boston, Massachusetts 02114, and Department of Otology and Laryngology, Harvard Medical School, Speech and Hearing Sciences Program, Harvard–M.I.T. Division of Health Sciences and Technology, Cambridge, Massachusetts 02139*

J. Acoust. Soc. Am. **107** (3), March 2000

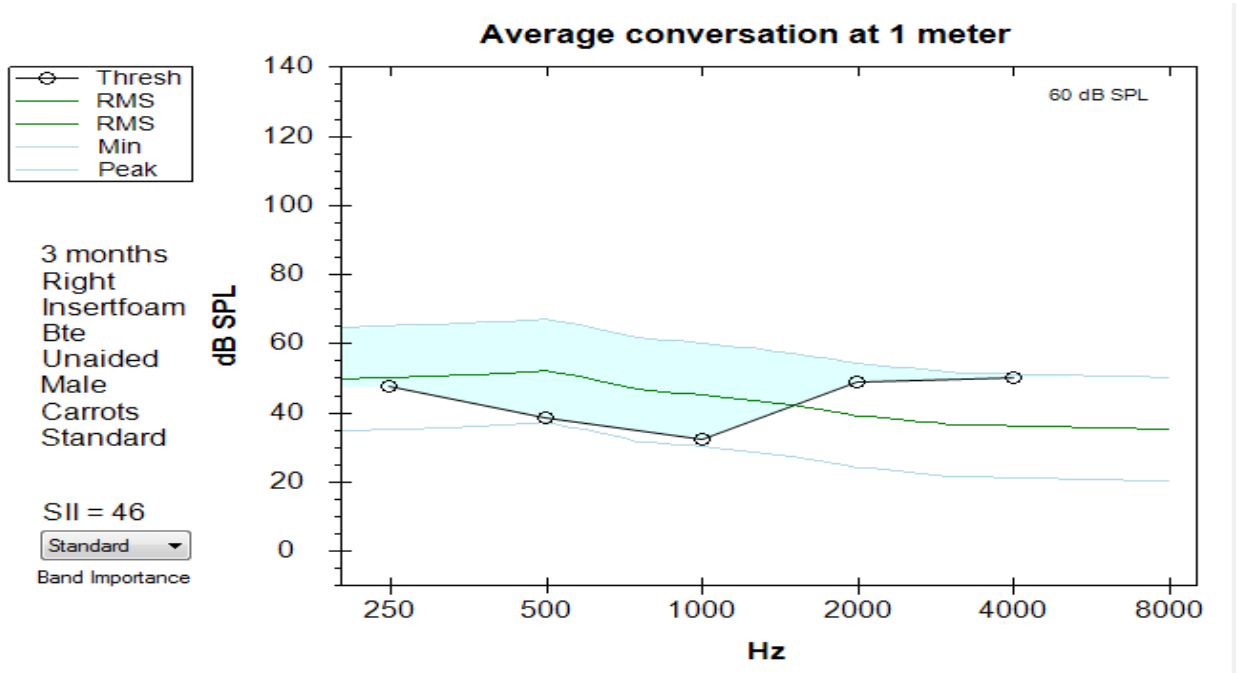
# Hearing aid candidacy

- Audiogram method



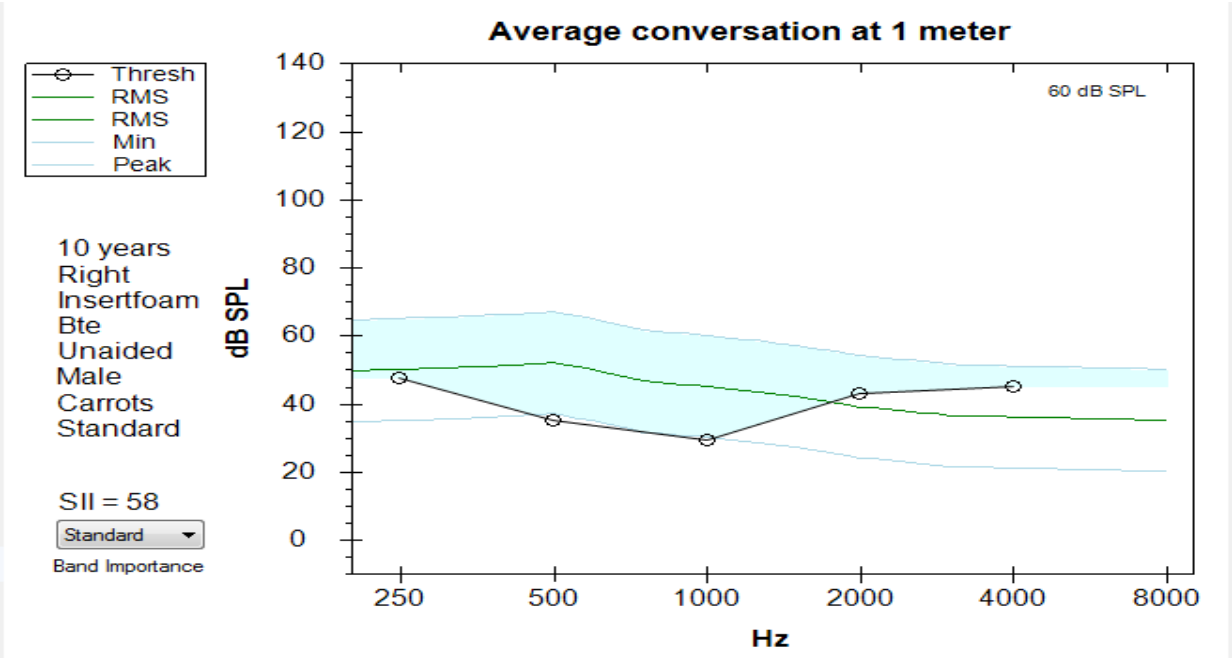
# Hearing aid candidacy

- Audibility method – 3 month-old



# Hearing aid candidacy

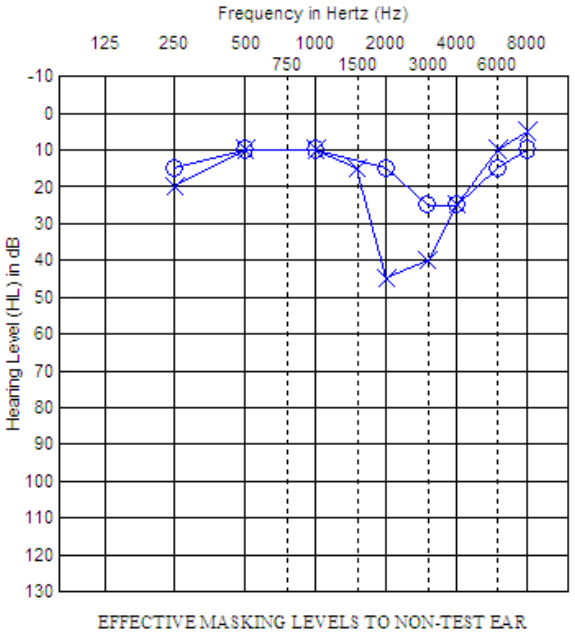
- Audibility method – 10 year-old



# Why do thresholds change?


We know the RECD affects hearing aid measurements, but how do they affect thresholds??

# Audiogram in HL




- Inserts / ABR transducer
  - Calibrated referenced to a 2 cc coupler

# Ear canal growth


Effective stimulus level will decrease as the ear canal volume increases

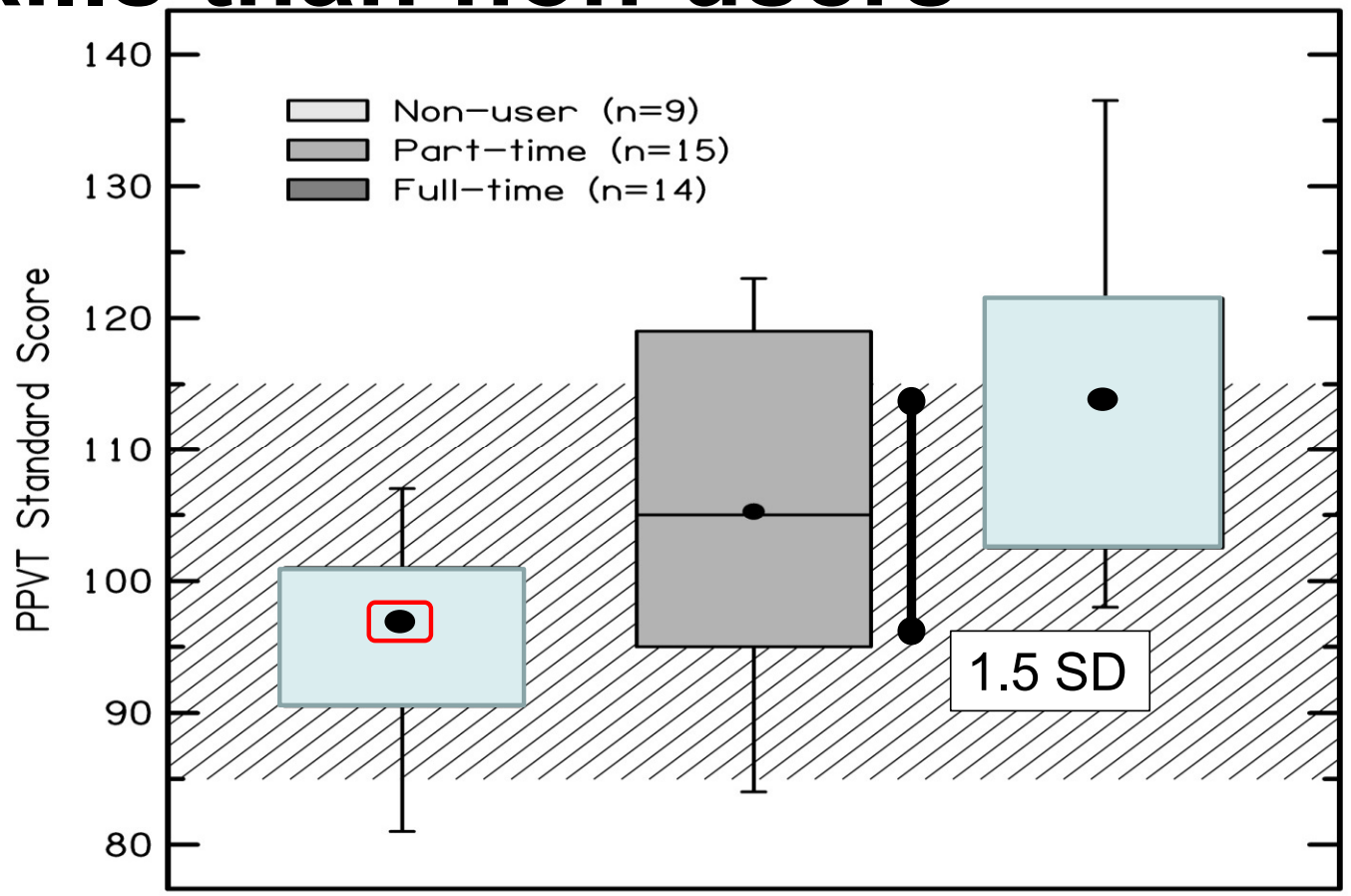
In dB HL, thresholds will appear to be worse over time as ear canal grows

# Are there differences in outcomes for children with mild hearing loss, as a function of amount of hearing aid use?

- Vocabulary
- Articulation
- Grammar
- Phonological processing
- Speech recognition in noise

# Full-time HA users had better vocabulary skills than non-users

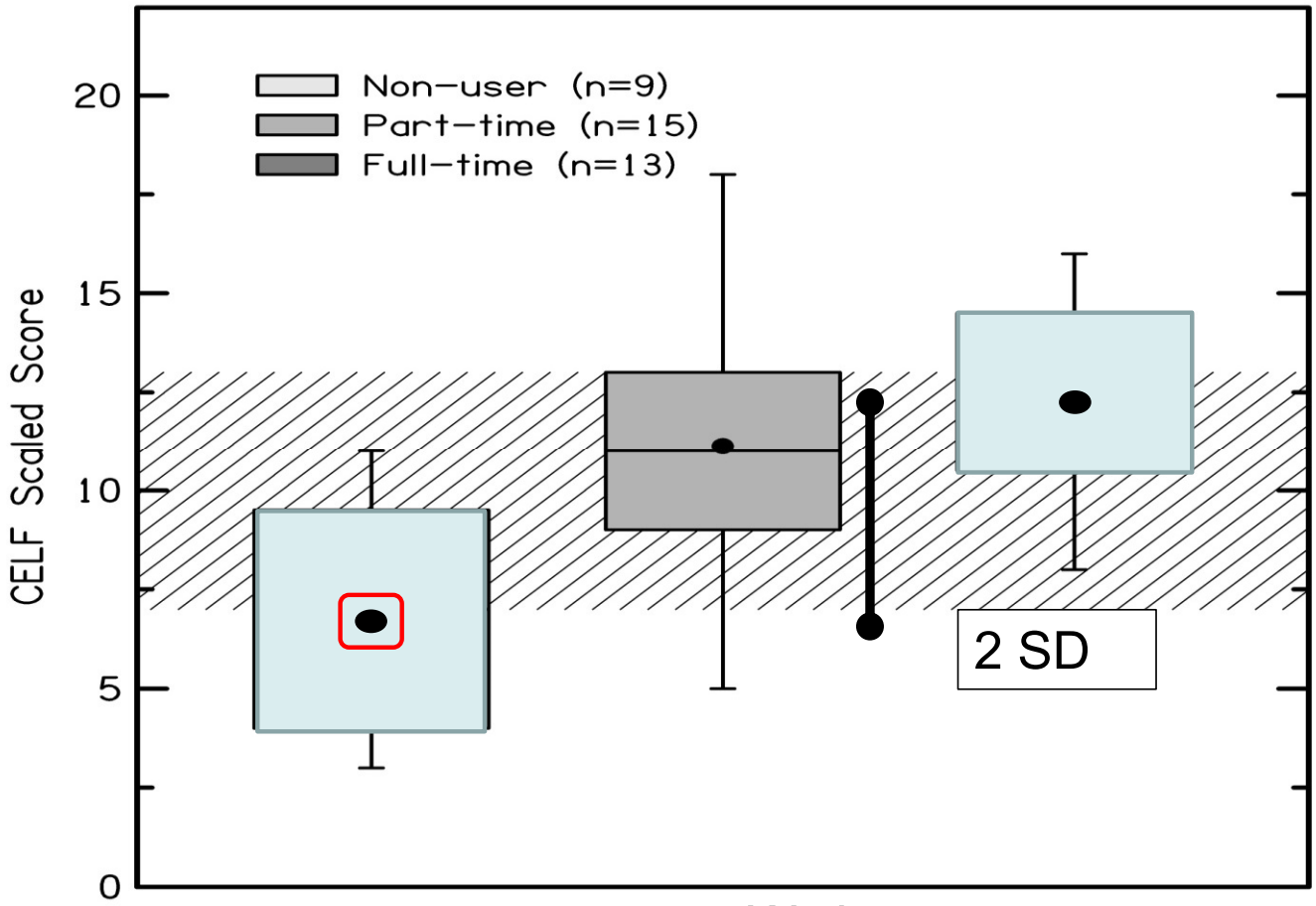
$\eta^2$= .25
Full-time > non-users




Walker et al.,

# Full-time HA users had better morphosyntactic skills than non-users

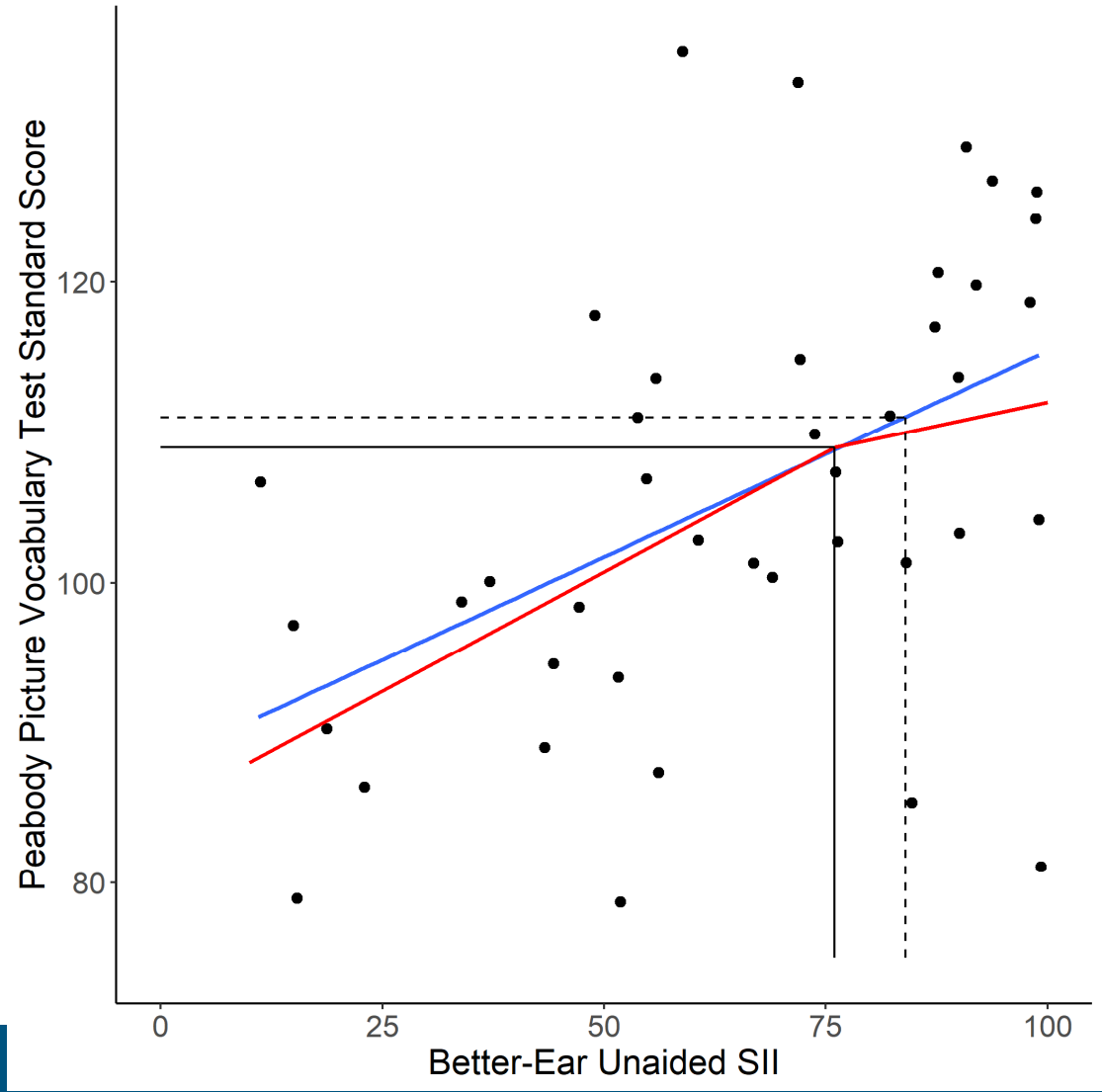
$\eta^2$= .40
Full-time, part-time > non-users

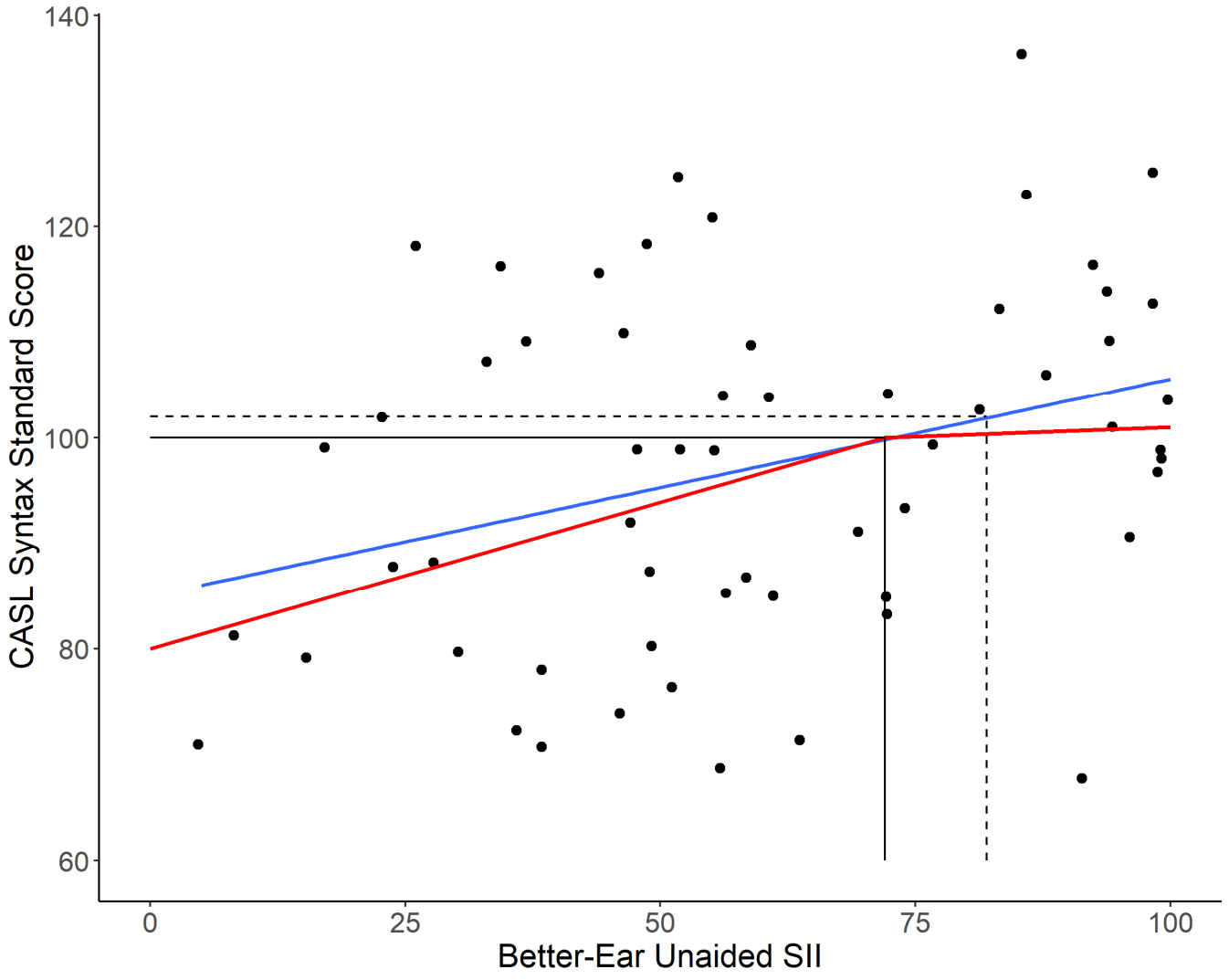


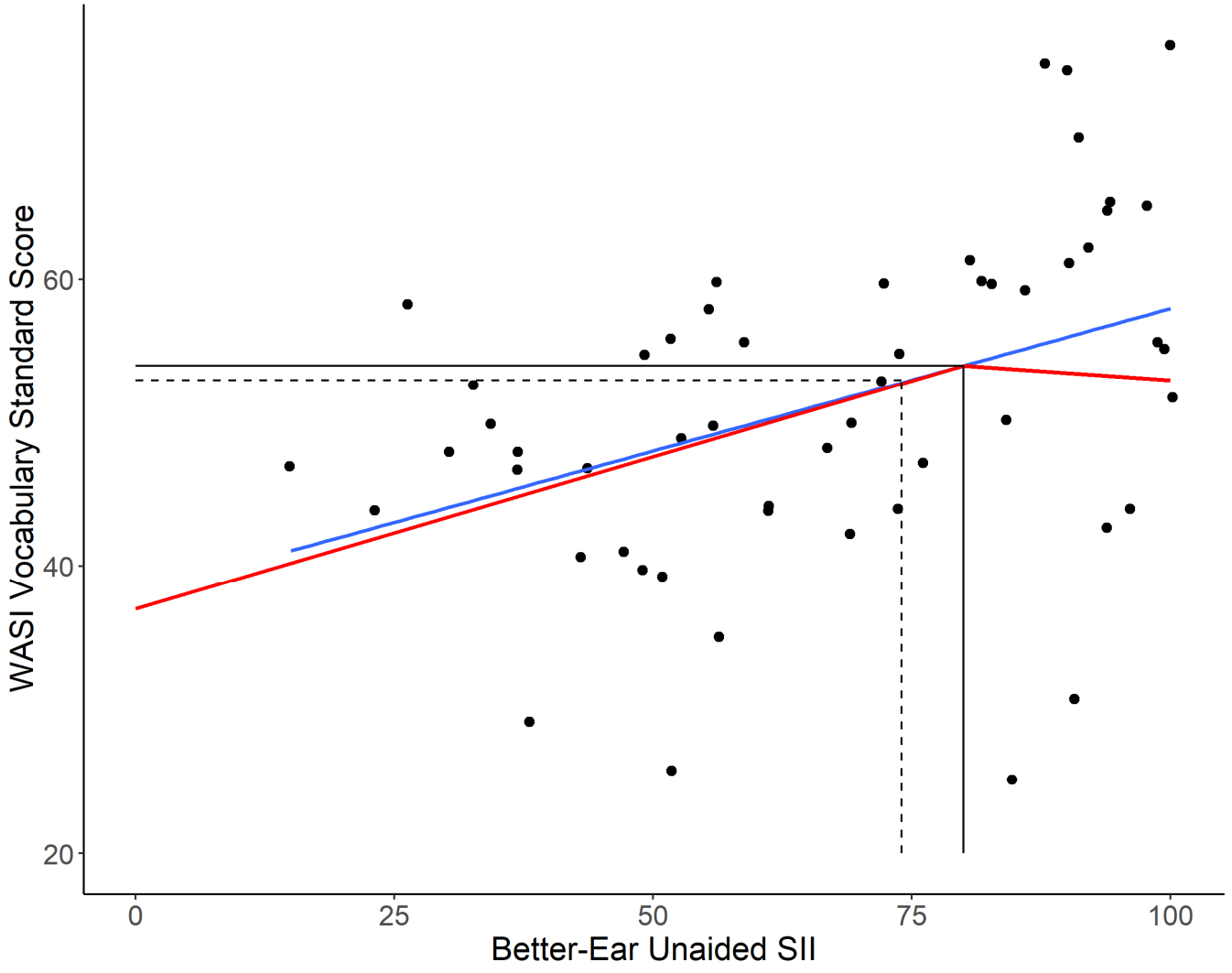

Walker et al.,

# What are we missing?

- How did we decide children with SII < or = 80 should get hearing aids?
- Compared two different criteria
  - Level = 50$^{th}$ percentile for children with normal hearing
  - Iterative piecewise regression
    - Finds point in unaided SII where relationship between SII and language changes


Peabody Picture Vocabulary Test Standard Score
120
100
80
0
25
50
75
100
Better-Ear Unaided SII

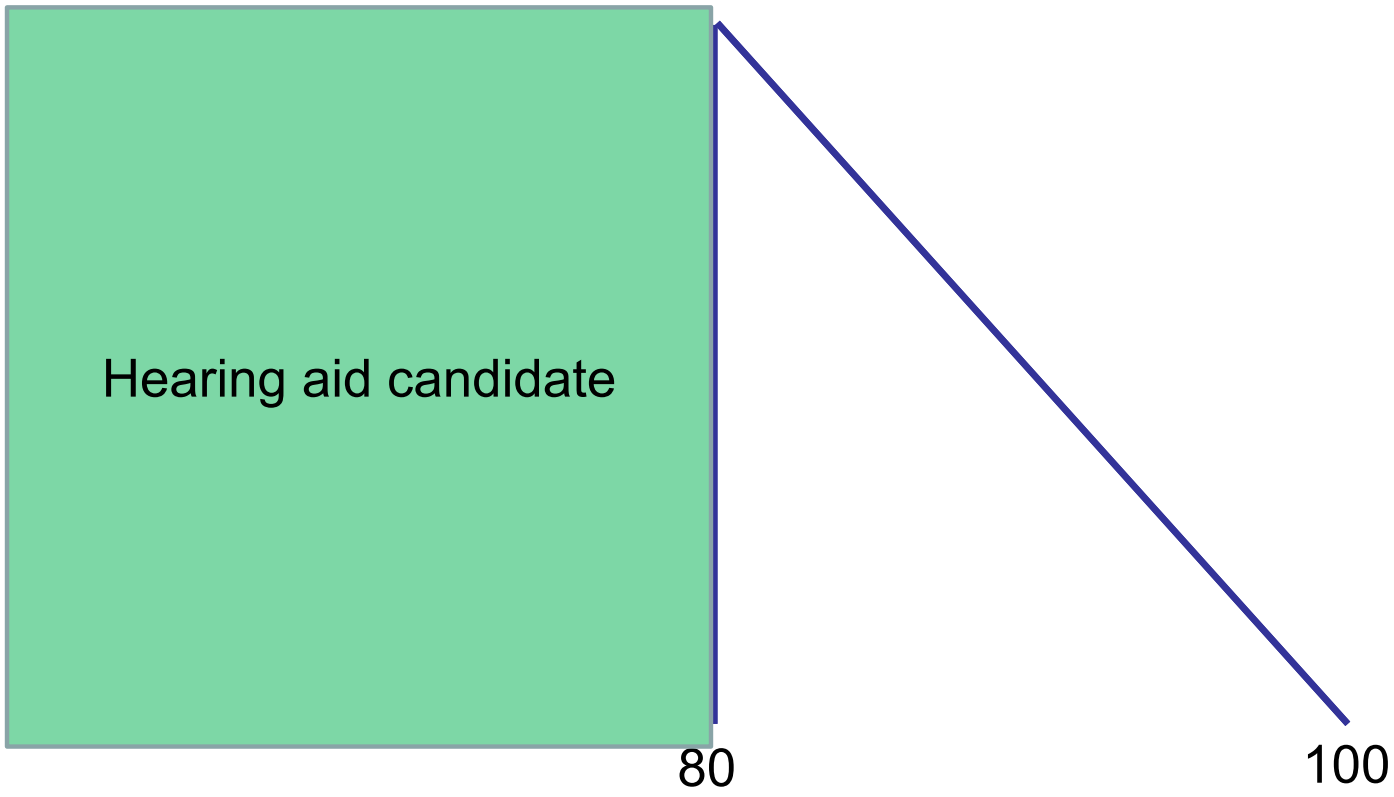

CASL Syntax Standard Score
140
120
100
80
60
0
25
50
75
100
Better-Ear Unaided SII


WASI Vocabulary Standard Score
60
40
20
0
25
50
75
100
Better-Ear Unaided SII

# Convergence

- Both criteria suggested a break-point around unaided SII = 80 across three language outcomes

# Unaided SII Criterion



# Unaided SII Criterion

**PTA-based criterion**

- Did not reflect effects of ear-canal acoustics
- Not based on language outcomes data
- Not easy to quantify impact of hearing on audibility

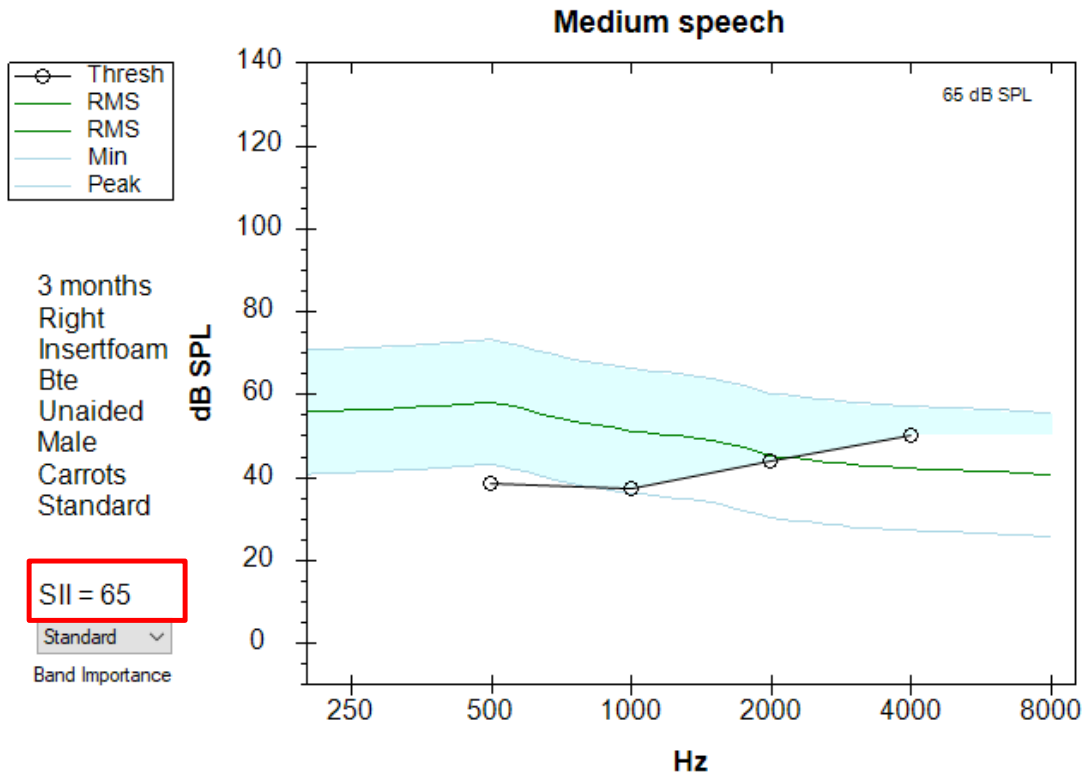
**Unaided SII criterion**

- Reflects effects of ear-canal acoustics on thresholds
- Based on language outcomes data
- Quantifies impact of hearing on audibility

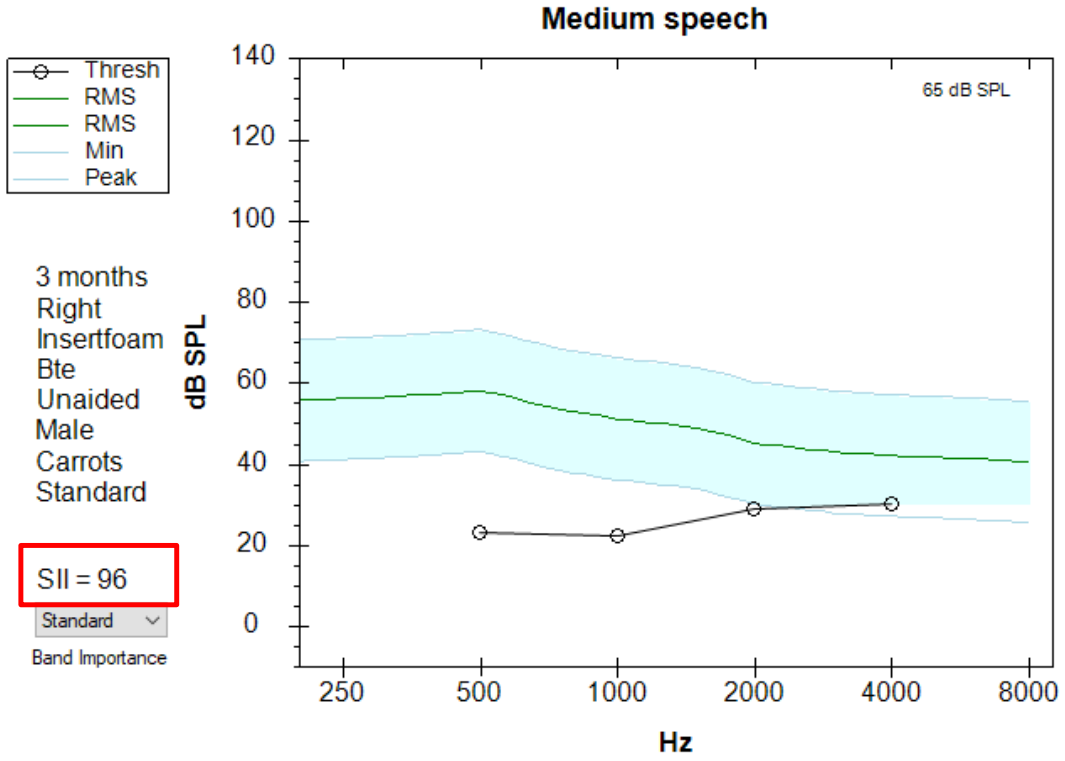
# ABR “normal” vs. normal hearing

- Normal ABR levels = ~25 dB nHL
- For unaided audibility estimates
  - Enter 10 dB HL for any thresholds = normal ABR
  - Enter actual dB eHL (corrected) for elevated thresholds.

# Normal entered as 25 dB nHL

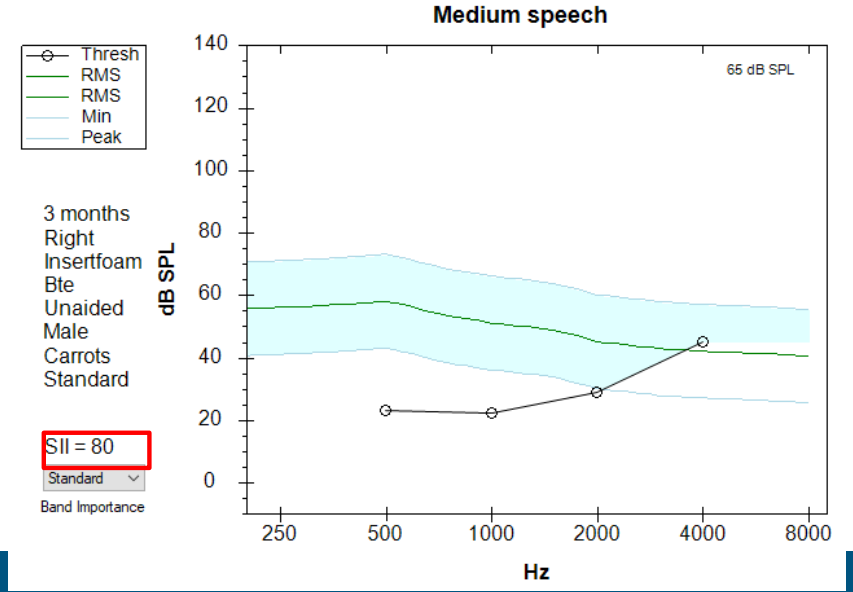


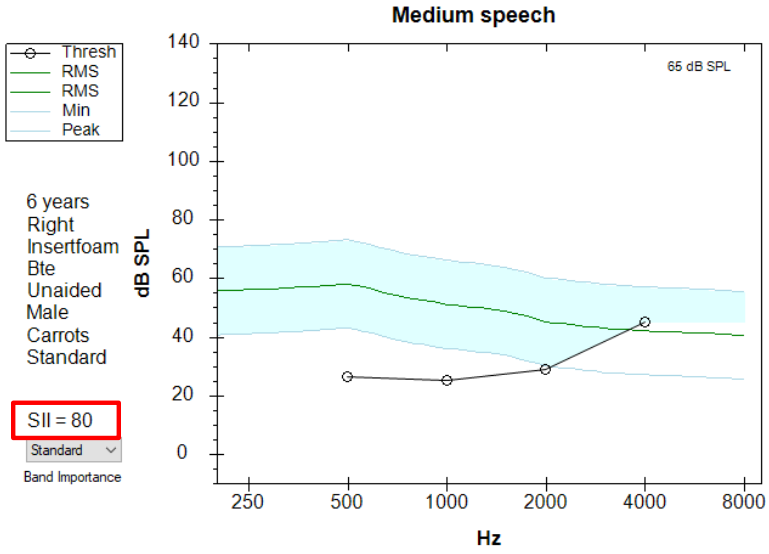
# Normal entered as 10 dB HL



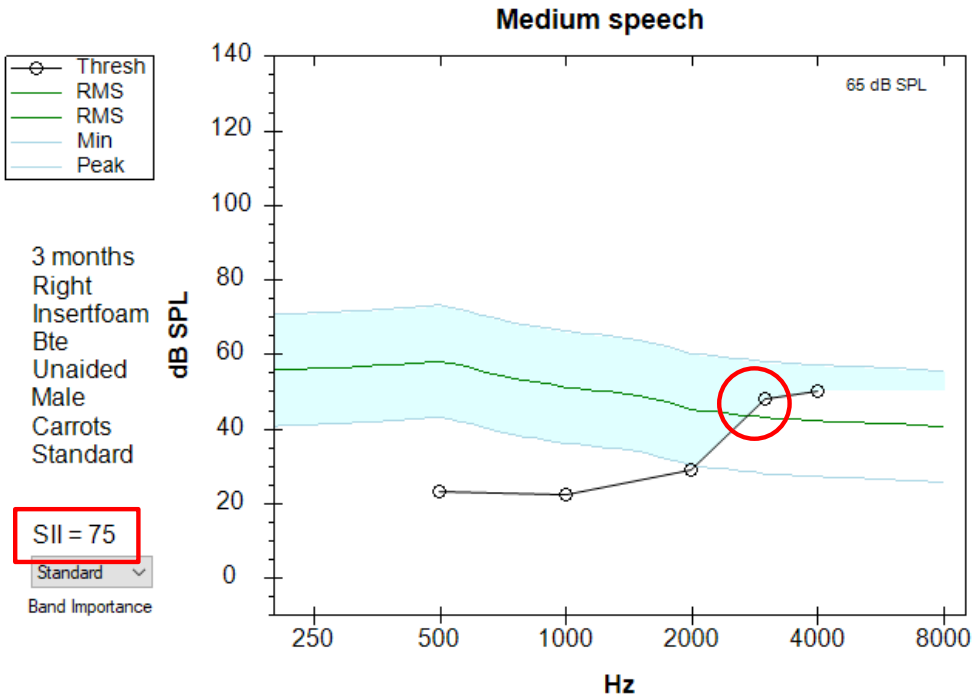
# Borderline Example

| | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz |
|---|---|---|---|---|
| Audiometry | 10 | 10 | 10 | 25 |



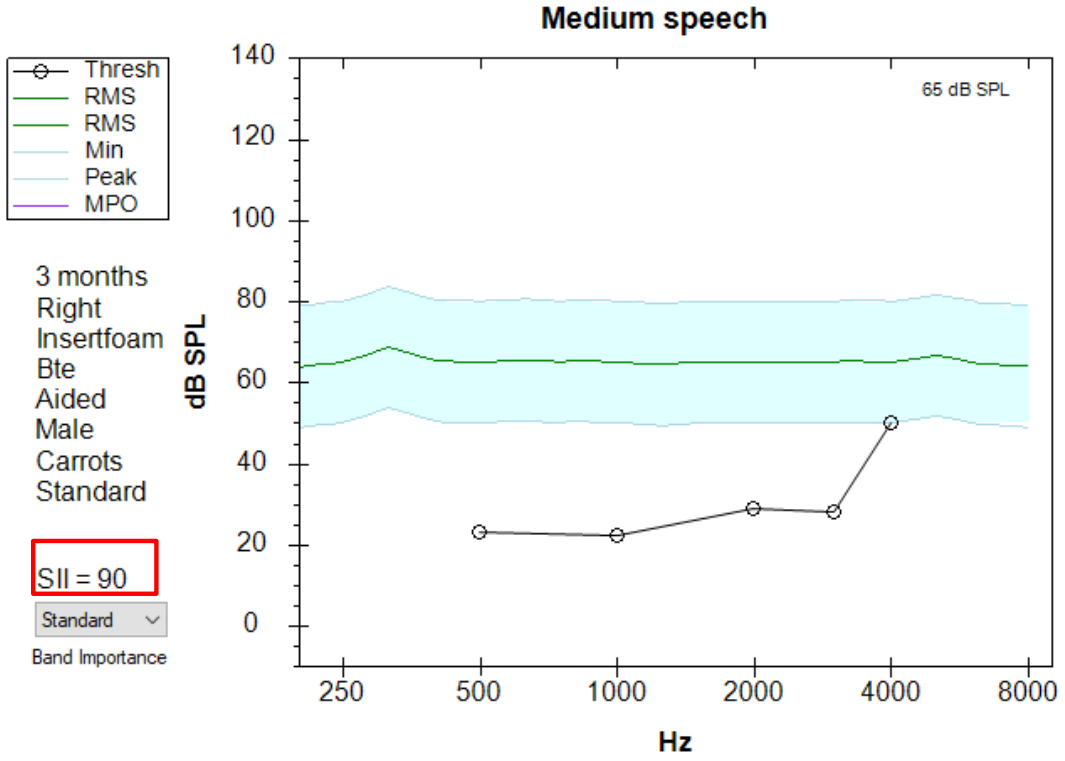



# Borderline – What to do?




DPOAEs – Absent at 3 kHz- 8 kHz
Present at 1.5-2 kHz

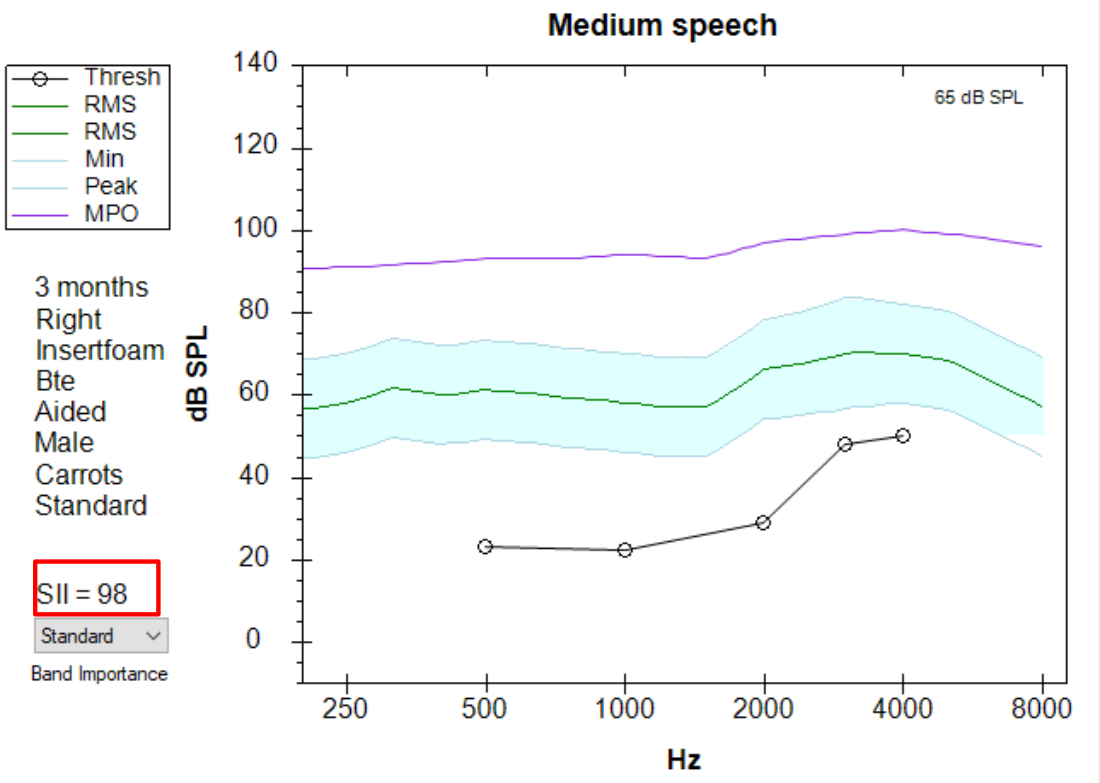
# Borderline – What to do?




DPOAEs – Present at 3 kHz- 8 kHz

Present at 1.5-2 kHz

# Borderline- What do do?




Look at aided

# Practice Pattern Issues

- I don’t have Verifit in my clinic to estimate SII
  - SHARP (Situational Hearing Aid Response Profile)
  - Counsel without SII

# Counselling Approach

- Non-dispensing Audiologist
  - Explain:
    - Audibility and why it is important for language
    - How even small disruptions in audibility can affect communication
    - Refer patient to fitting audiologist to assess impact of loss on audibility

Thank you!

# Questions?

Ryan McCreery - Speaker

Melissa Polonenko - Host

Contact

- CanadianAudiology.ca
- Contact@CanadianAudiology.ca
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