Raising the bar for children who wear hearing aids: Improving clinical outcomes

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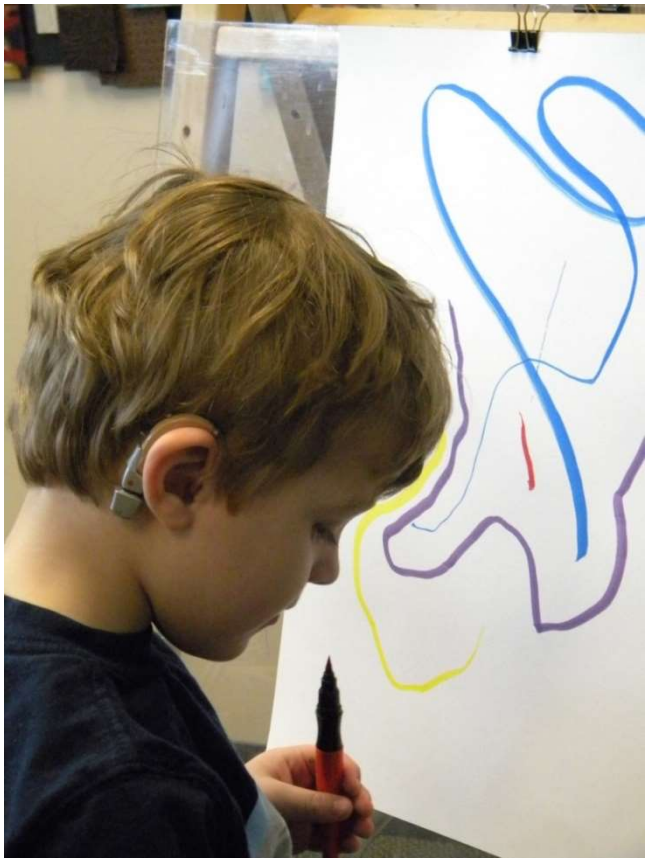
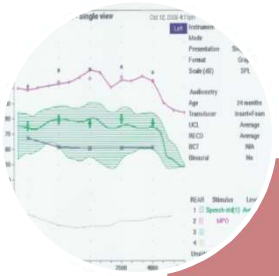
Improving Outcomes for children who wear hearing aids?



Complexity

Emerging research base



What is our reference for “typical”?

Additional disabilities

Heterogeneity

Previous Research

-Duration variables were important

- Naturally-occurring groups of early vs. late
  - Due to emergence of newborn hearing screening
- Do duration variables work as a red flag?

Demographic Factors

Advantages

- Puts findings in context
- Target intervention?

Disadvantages

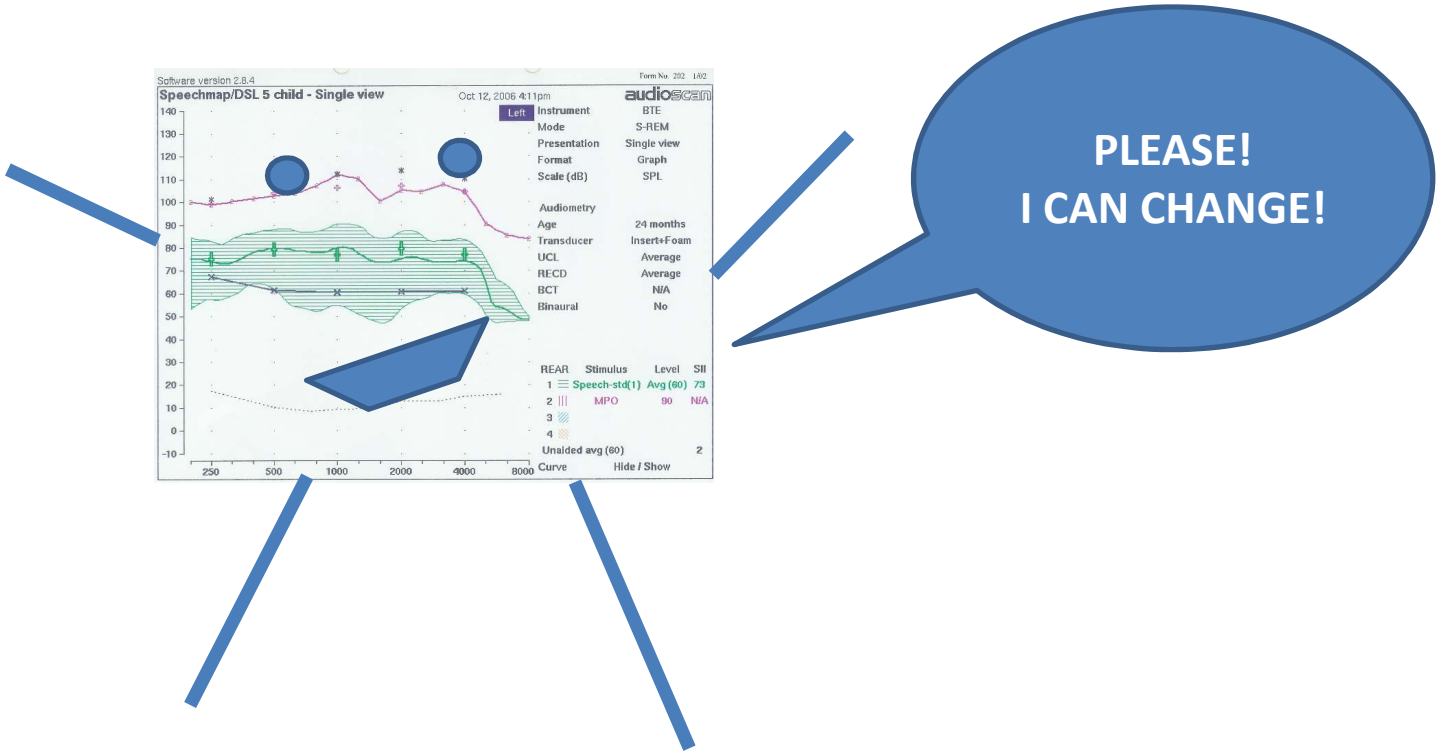
- Not **malleable**
- Assumes demographic groups are homogeneous
  - i.e. Girls, Mild HL, Late ID
- Send a frustrating message to parents/caregivers

Degree of hearing loss

- Red flag? 
  - Not malleable.
  - Wide variance in outcomes for children with the same degree of hearing loss
  - Children with cochlear implants

Requirements for Outcomes

- Must be <u>malleable</u> or <u>actionable</u>

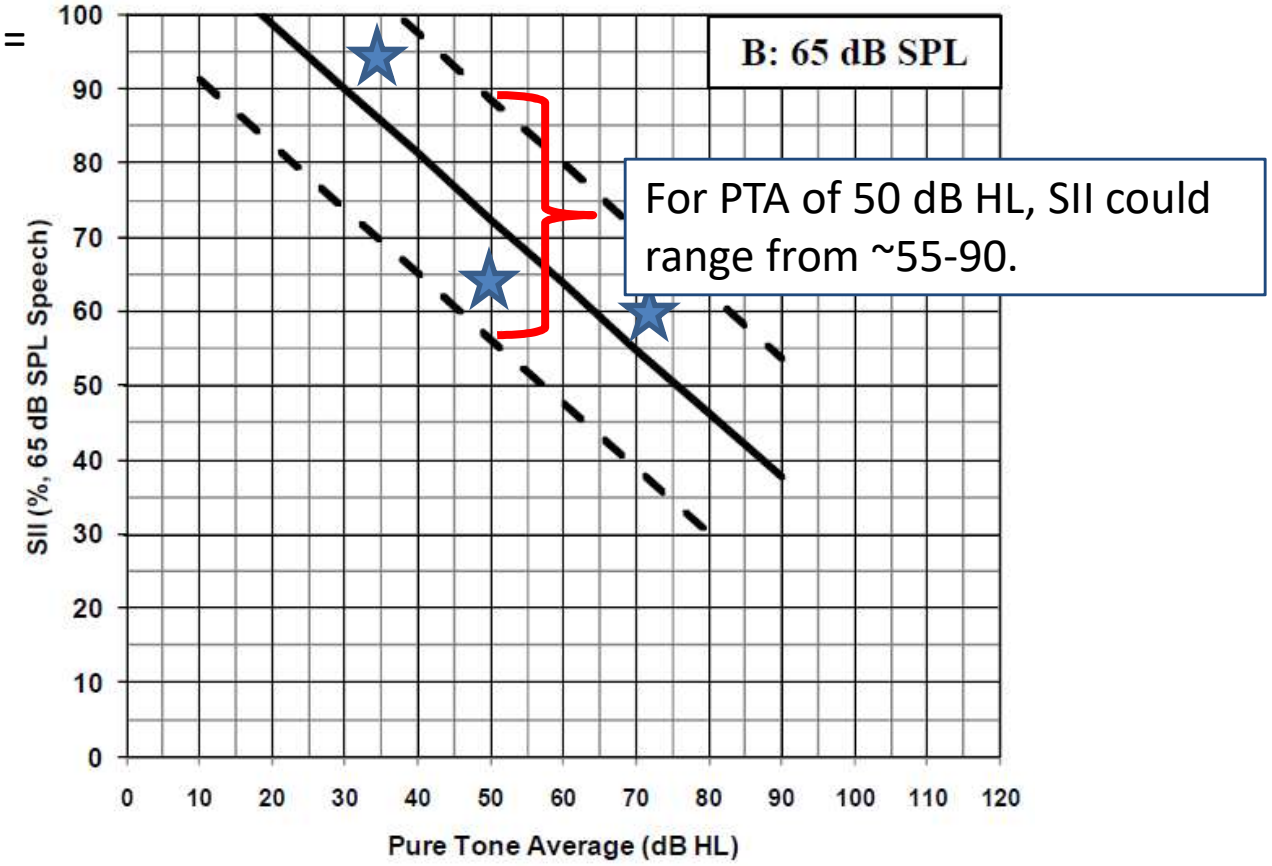


Outcomes

- Aided audibility 
- Hearing aid use 
- Auditory development questionnaires 
  - LittlEARS
  - Parent's Evaluation of Aural/Oral Functioning in Children (PEACH)
  - Speech, Spatial, and Qualities (SSQ)
- Aided speech recognition assessment 

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)

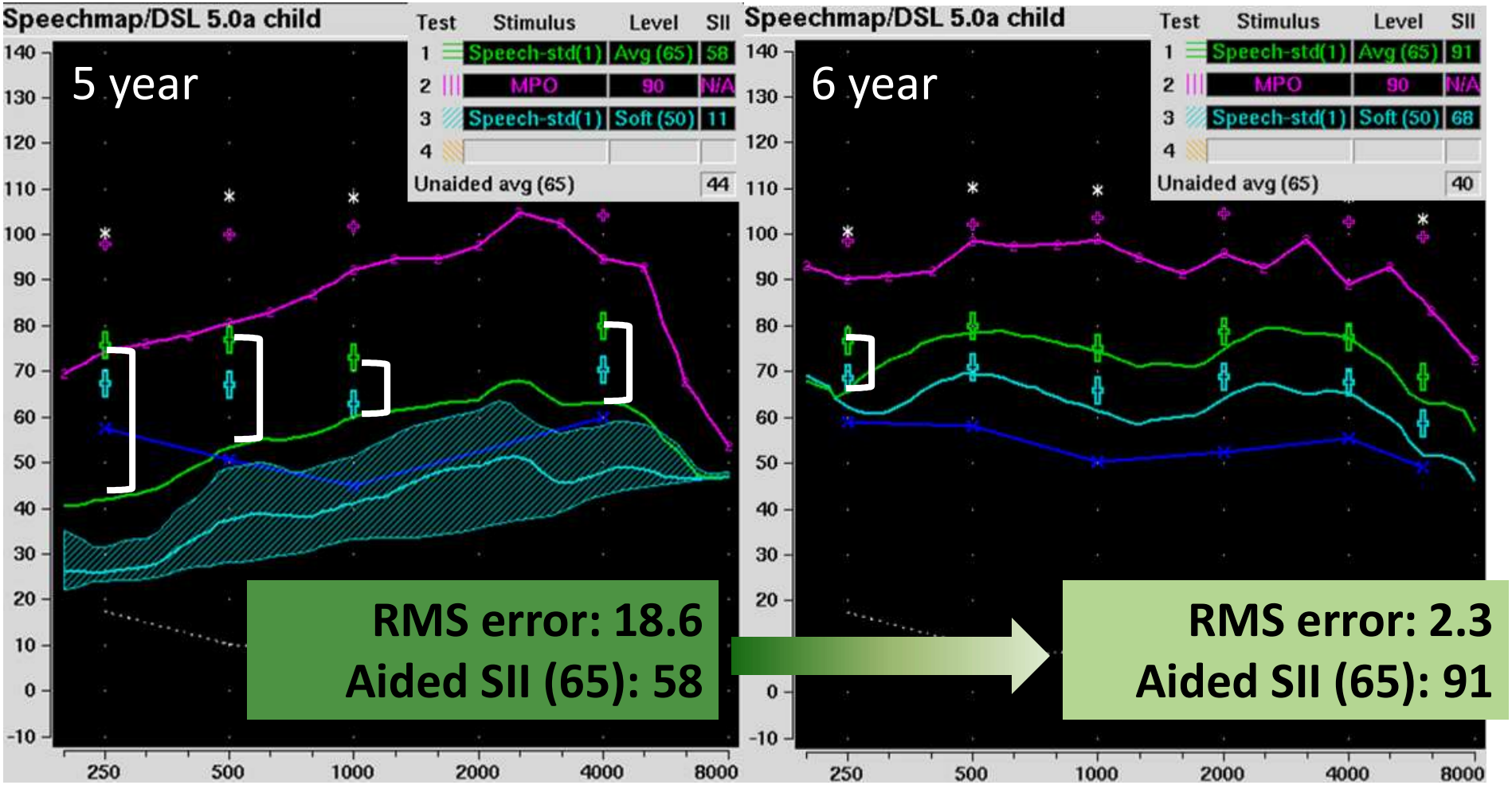
Functional gain (aided soundfield)
RMS error=7.92 dB (SD = 4.67 dB)

McCreery, Bentler, Roush, 2013

What else impacts audibility?

- PTA ($p < 0.001$, $\beta = -0.663$)
- Fit-to-target ($p < 0.001$, $\beta = -0.553$)
  - aka RMS error
    - <5 dB “good fitting”

Better match to targets → better audibility



An ethical dilemma….

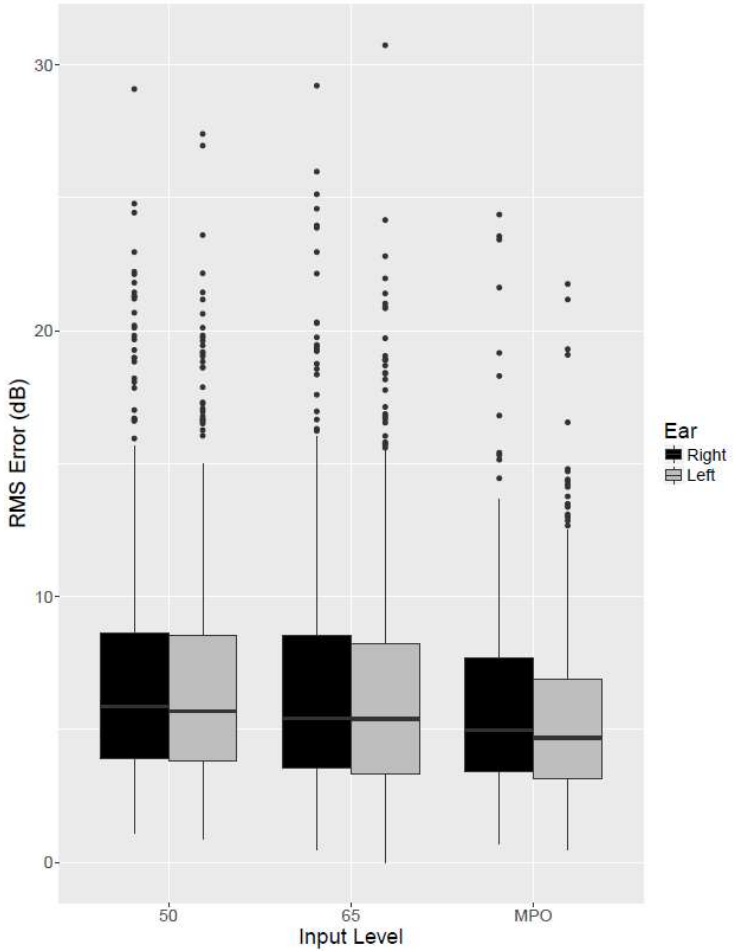
Alter poor fittings?

- Give the child best audibility
- Previous research on audibility is limited because of this issue.

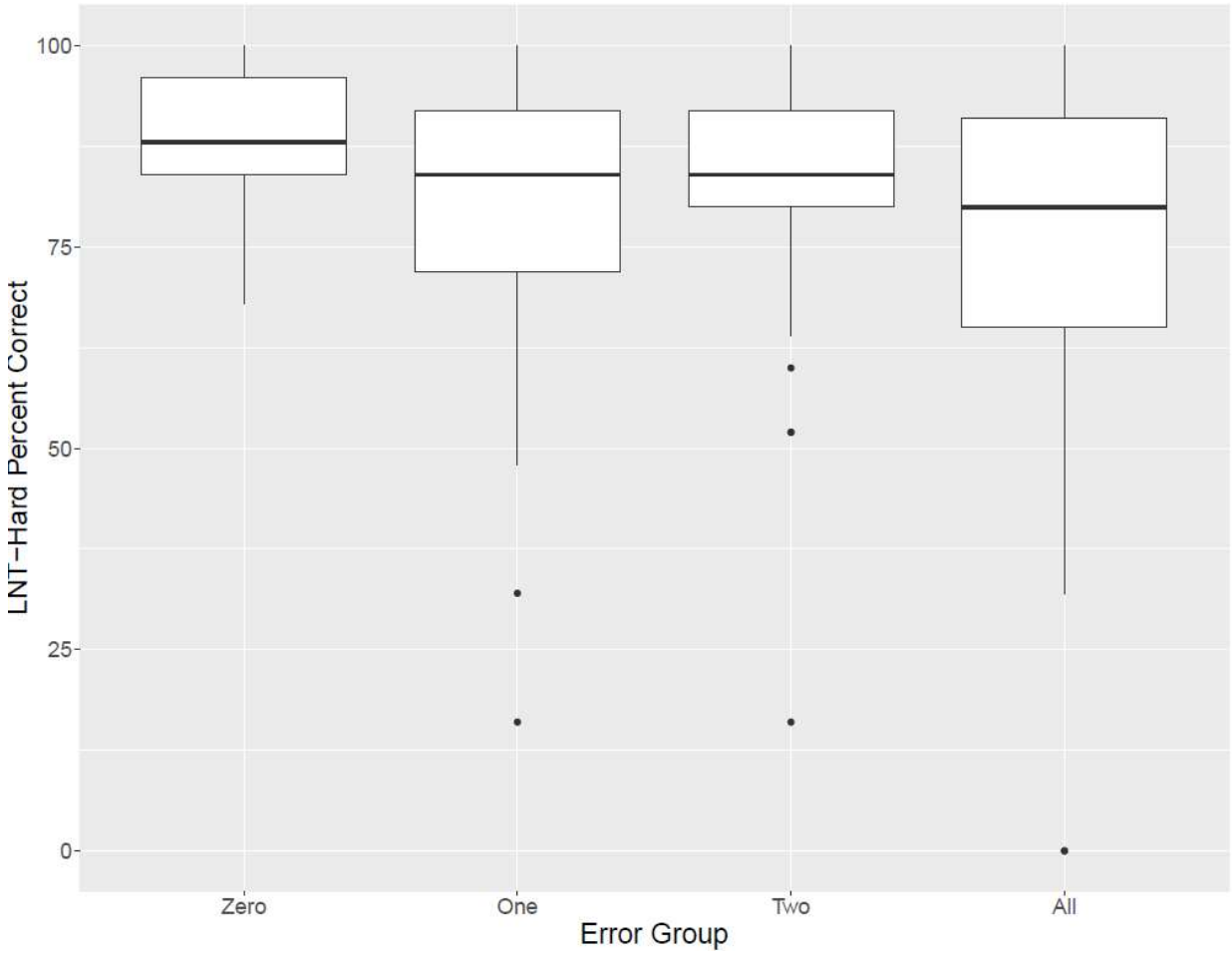
Do not alter poor fittings?

- Allows for examination of the effects of audibility in realistic fittings.
- Are we harming our participants?

RMS error by input level



Effects of errors on speech in quiet



Audibility as a Red Flag

- Children with audibility below average of the normative range for their PTA
  - Ensure audibility for soft, average and loud input levels
- Adjust amplification as the child's hearing or ear canal acoustics change over time

Hearing aid use

- Average number of hours per day that the hearing aid is worn

LSHSS

Research Article

Predictors of Hearing Aid Use Time in Children With Mild-to-Severe Hearing Loss

Elizabeth A. Walker,[a] Meredith Spratford,[b] Mary Pat Moeller,[b] Jacob Oleson,[a] Hua Ou,[a] Patricia Roush,[c] and Shana Jacobs[c]

272 children with hearing aids

Which factors predict daily HA use time in children who are hard of hearing?

How consistently do children wear HAs in different settings?

Are parents accurate at estimating average daily hearing aid use time?

How can we measure amount of daily HA use?

Subjective

Objective

Hearing aid questionnaire

average # of hours per day

consistency of use across contexts: in the car, meal times, book sharing, etc

Hearing aid data logging

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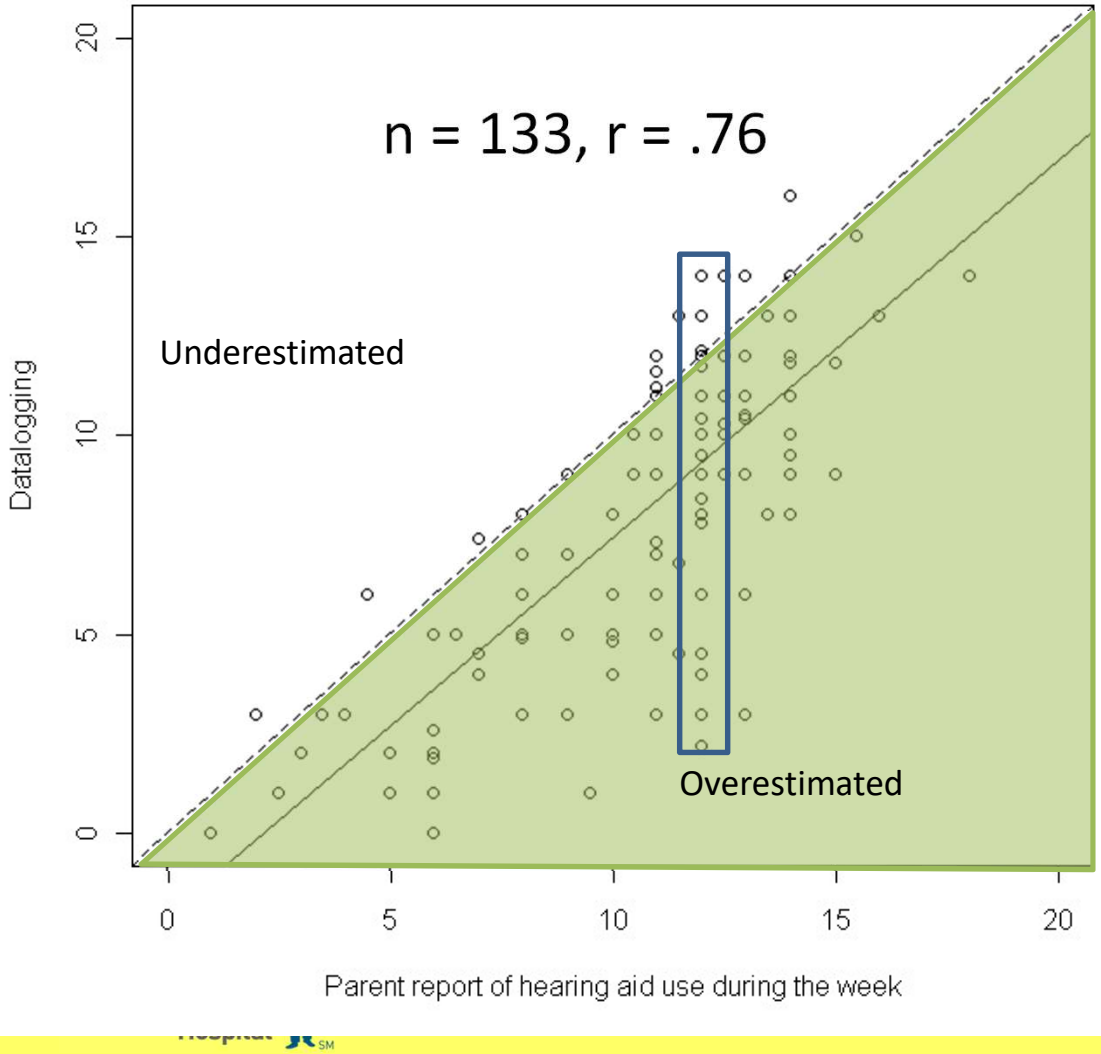
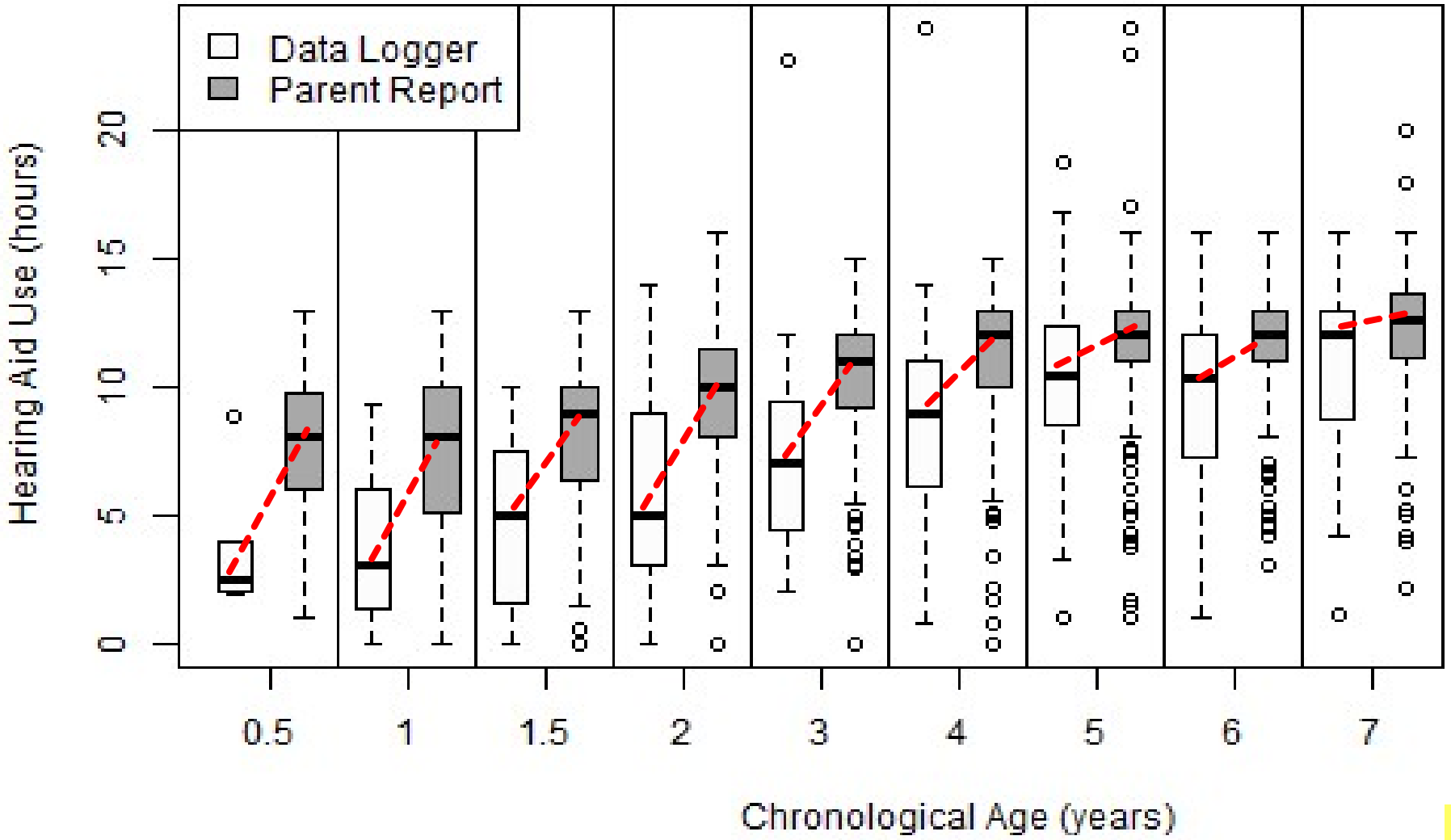
Are parents accurate at estimating daily hearing



- Parent report = 10.84 hours
- Data logging = 8.3 hours
- Average difference = 2.6 hours
- As children get older, parents become more accurate reporters

Walker et al, 2013

As children get older, parents become more accurate reporters



Walker et al., in review

How can we counsel consistency of use?

Find times when initial use is most practical

Communication diary

Datalogging

Emphasize link between auditory stimulation and language

Hearing Aid Use Conclusions

- Hearing aid use is challenging for many families
- Support consistent use
- Clinicians may rely on parental self-report of HA use time as a general estimate of how much the child wears HAs.
  - **Caveat:** HA datalogging and consistency ratings are preferred with parents of younger children when monitoring HA compliance.

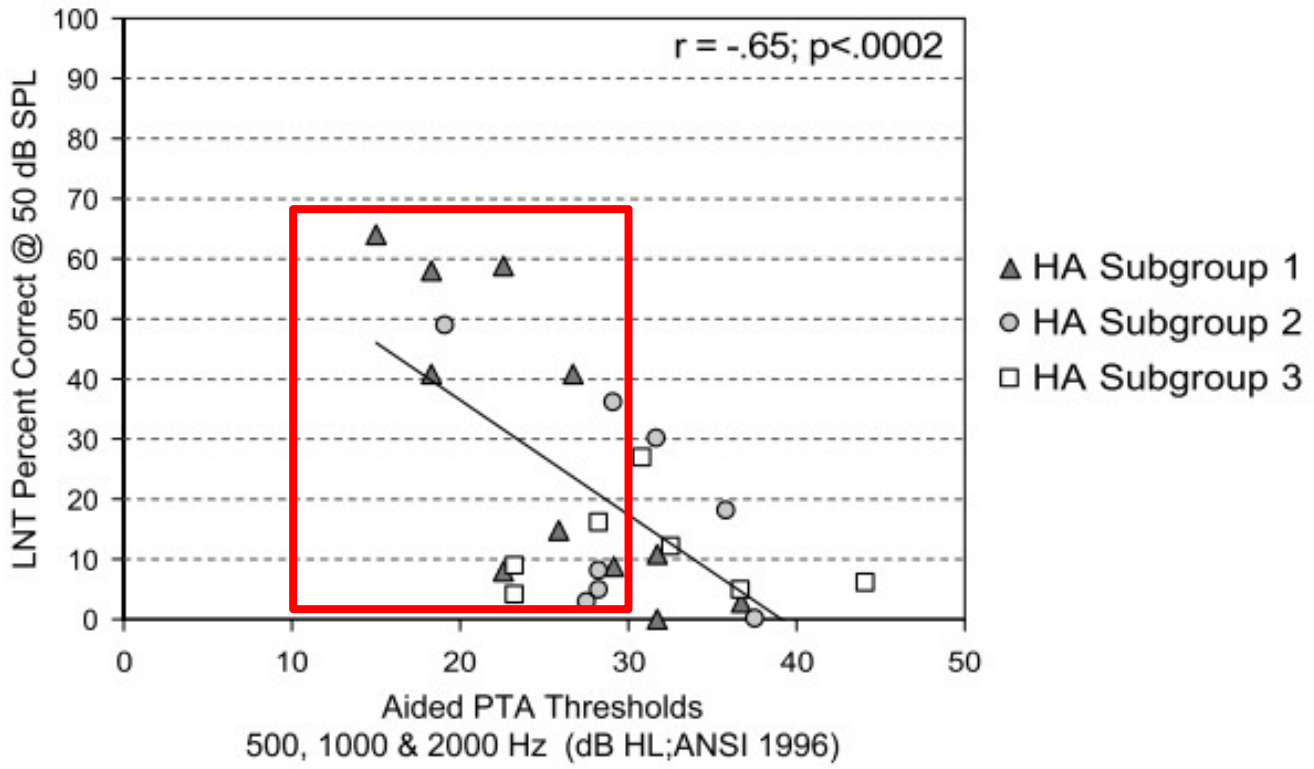
Auditory skills

Soap Box

- Measuring detection for children who have advanced to higher levels of the hierarchy

Aided pure tone average

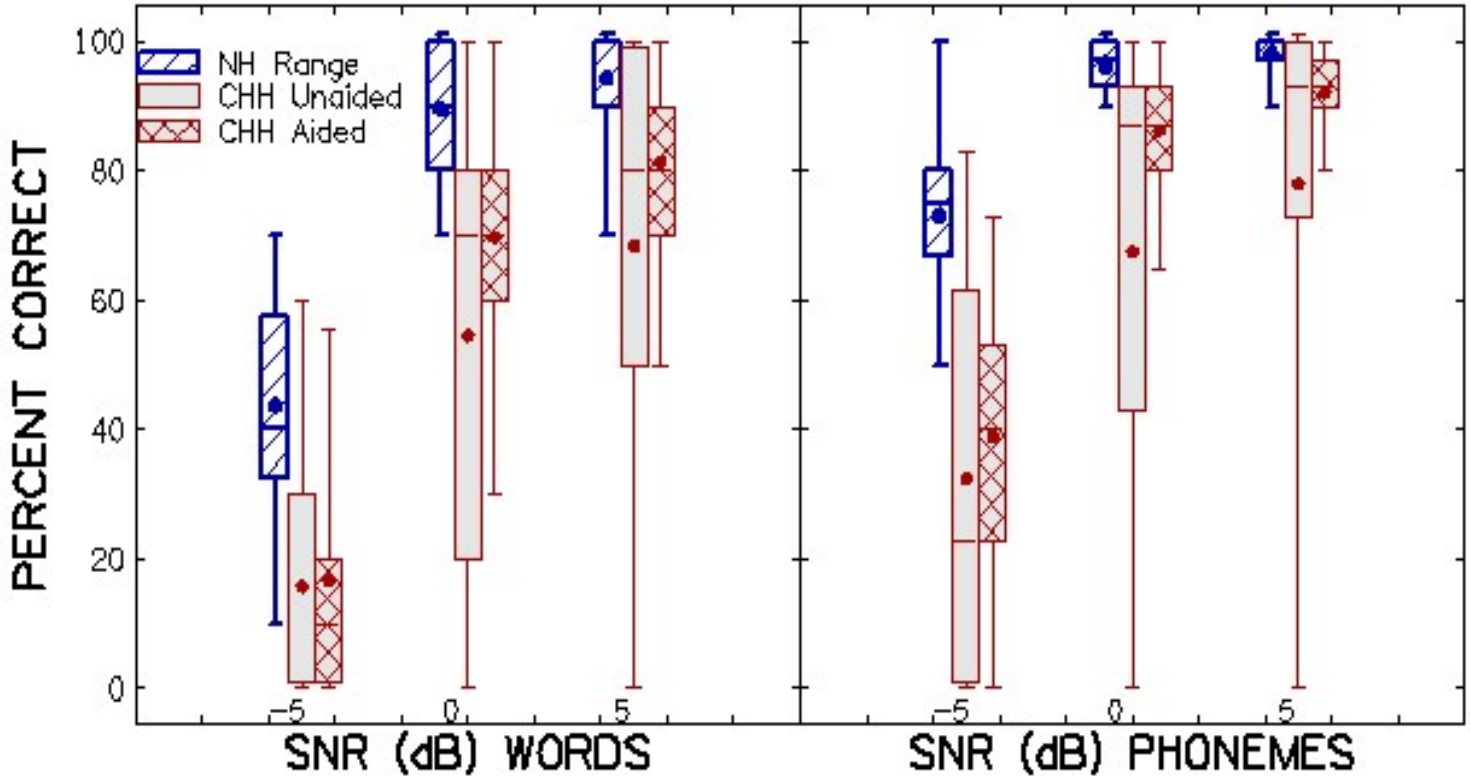
Figure 6. Aided PTA (at 0.5, 1.0, and 2.0 kHz; dB HL) as a function of LNT score (% correct) at the 50 dB SPL presentation level for the 26 children. Linear regression line, *r* value, and significance level are also shown. The symbols are triangles, circles, and squares for Aids 1, 2, and 3, respectively.



What if I love detection?

- See Susan Scollie et al. Ling 6
  - It's speech!
  - It's calibrated!
  - It has important applications
    - Frequency lowering
    - Children with minimal word/phoneme recognition abilities

Computer Assisted Speech Perception Assessment (CASPA)



McCreery et al. 2015

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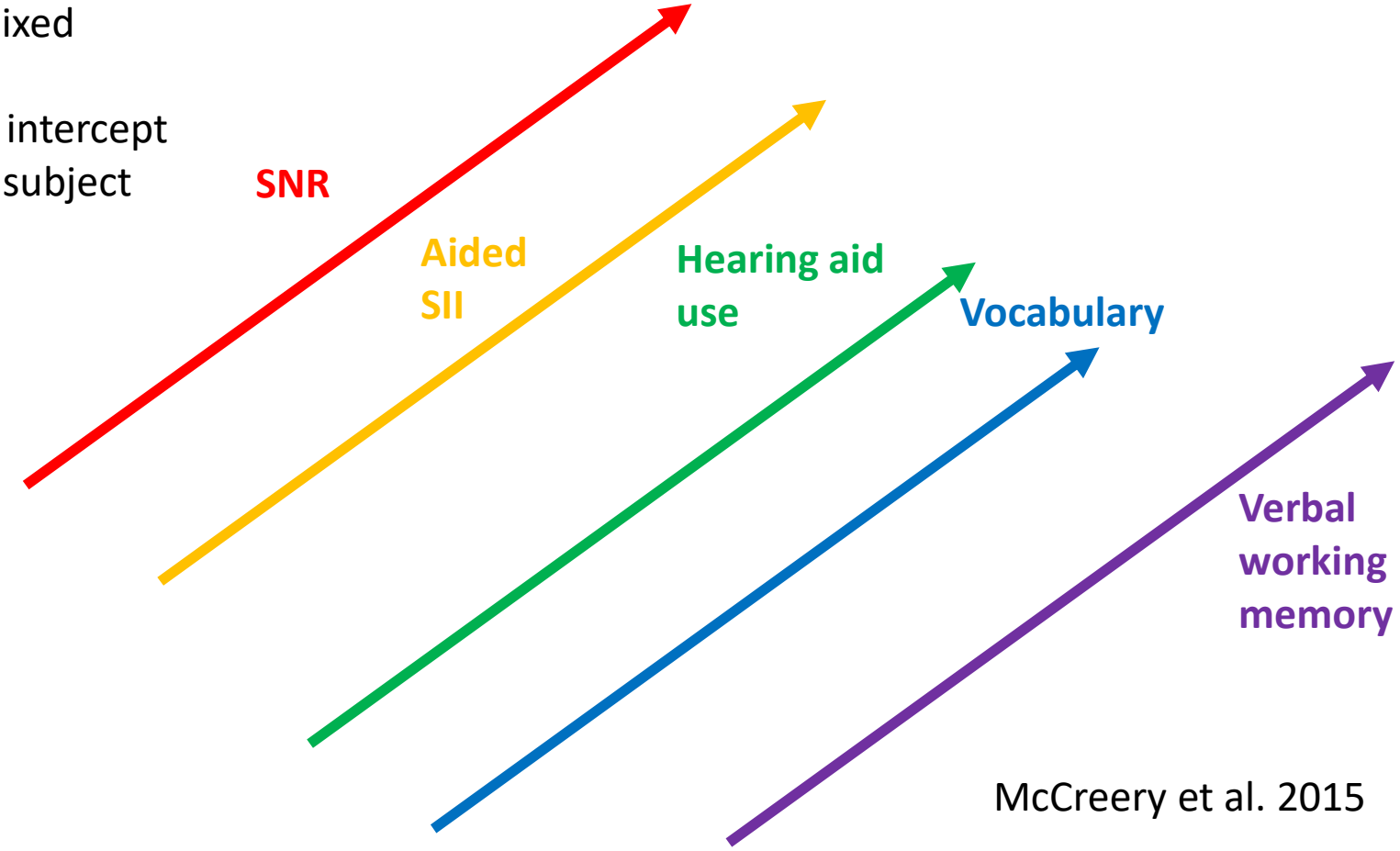
7-9 year-olds

Predictors - CASPA

Linear mixed model
Random intercept for each subject

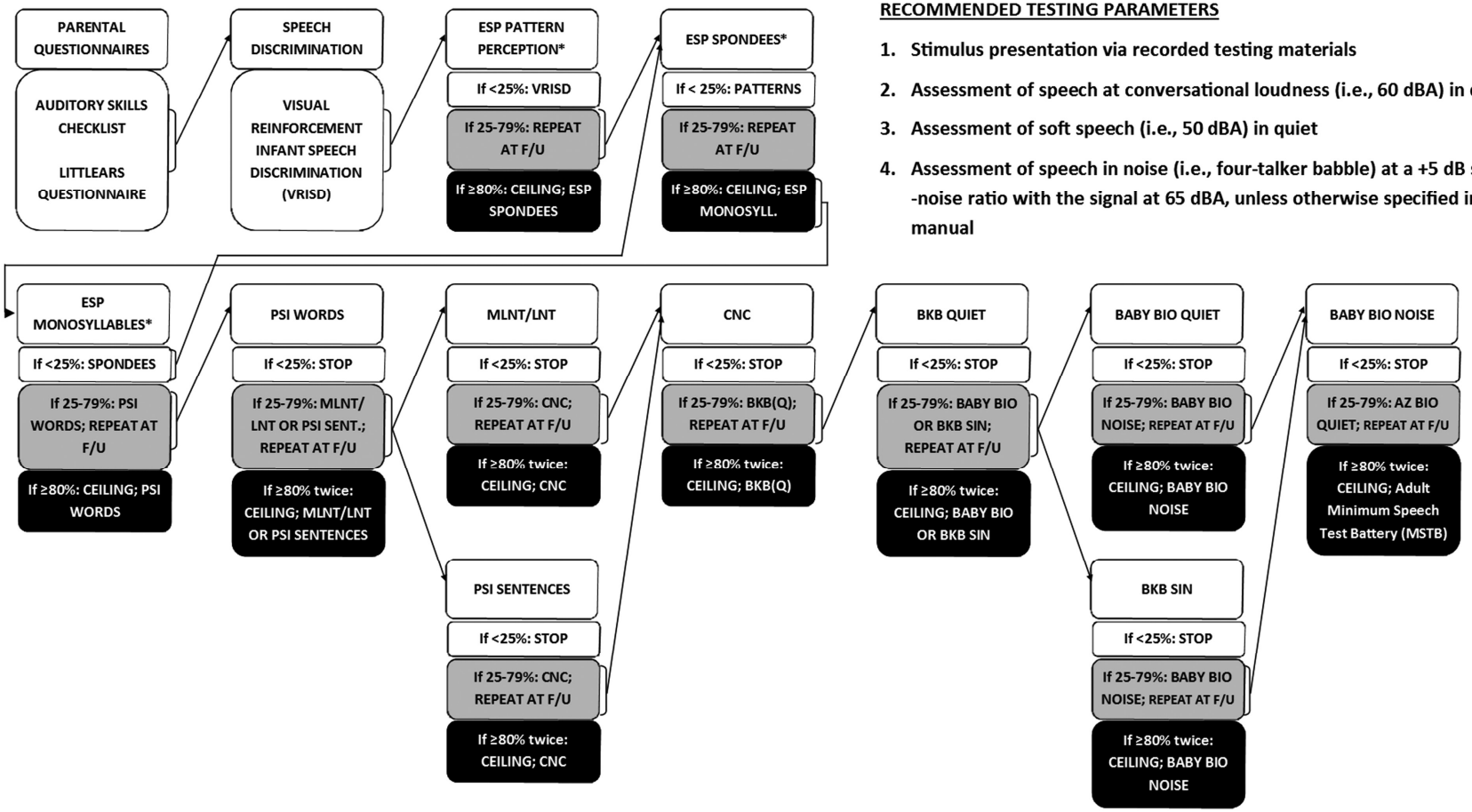


McCreery et al. 2015

Pediatric Minimum Speech Test Battery

- Described by Uhler et al. 2017
- Developed with input from a large number of pediatric audiologists, mostly in North America
- English-based
- Goal of standardizing pediatric speech recognition assessment

Pediatric Minimum Speech Test Battery (PMSTB)



RECOMMENDED TESTING PARAMETERS

1. **Stimulus presentation via recorded testing materials**
2. **Assessment of speech at conversational loudness (i.e., 60 dBA) in quiet**
3. **Assessment of soft speech (i.e., 50 dBA) in quiet**
4. **Assessment of speech in noise (i.e., four-talker babble) at a +5 dB signal-to-noise ratio with the signal at 65 dBA, unless otherwise specified in the manual**

* Clinicians should select the version of the ESP test (i.e., low-verbal or standard version) based on the child's language abilities.

Pediatric MSTB

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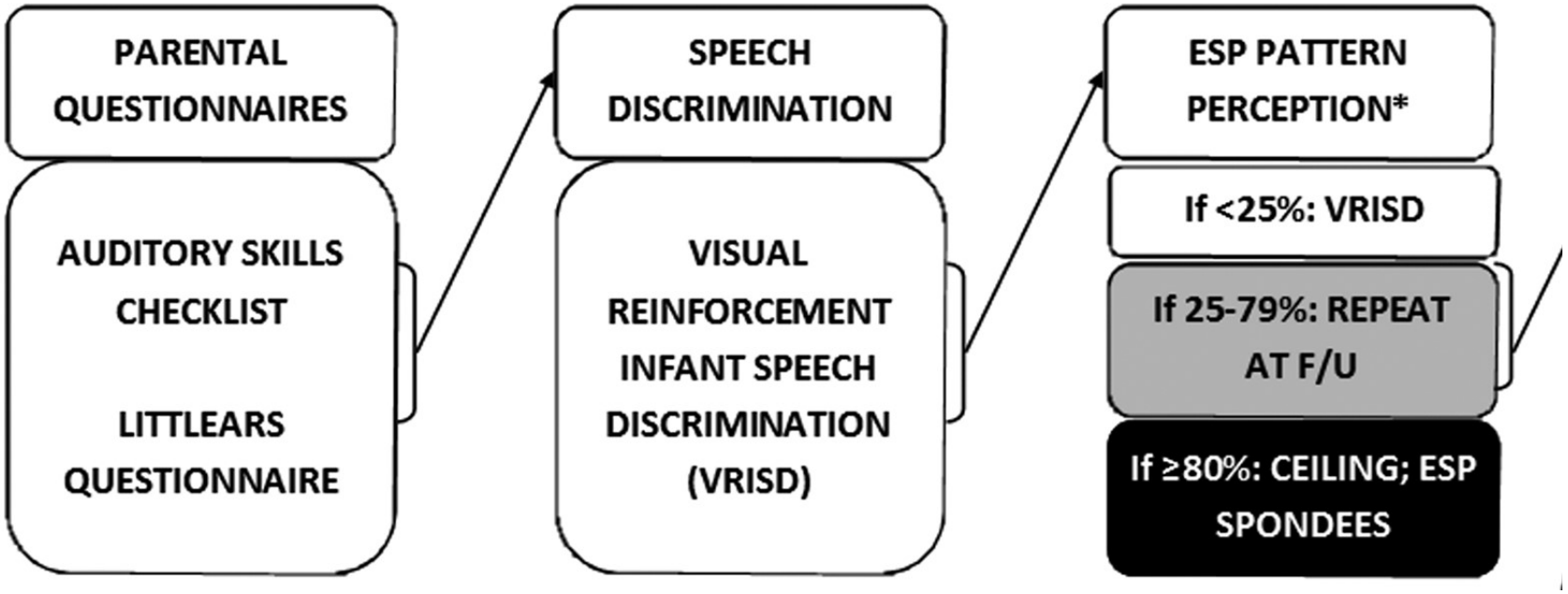
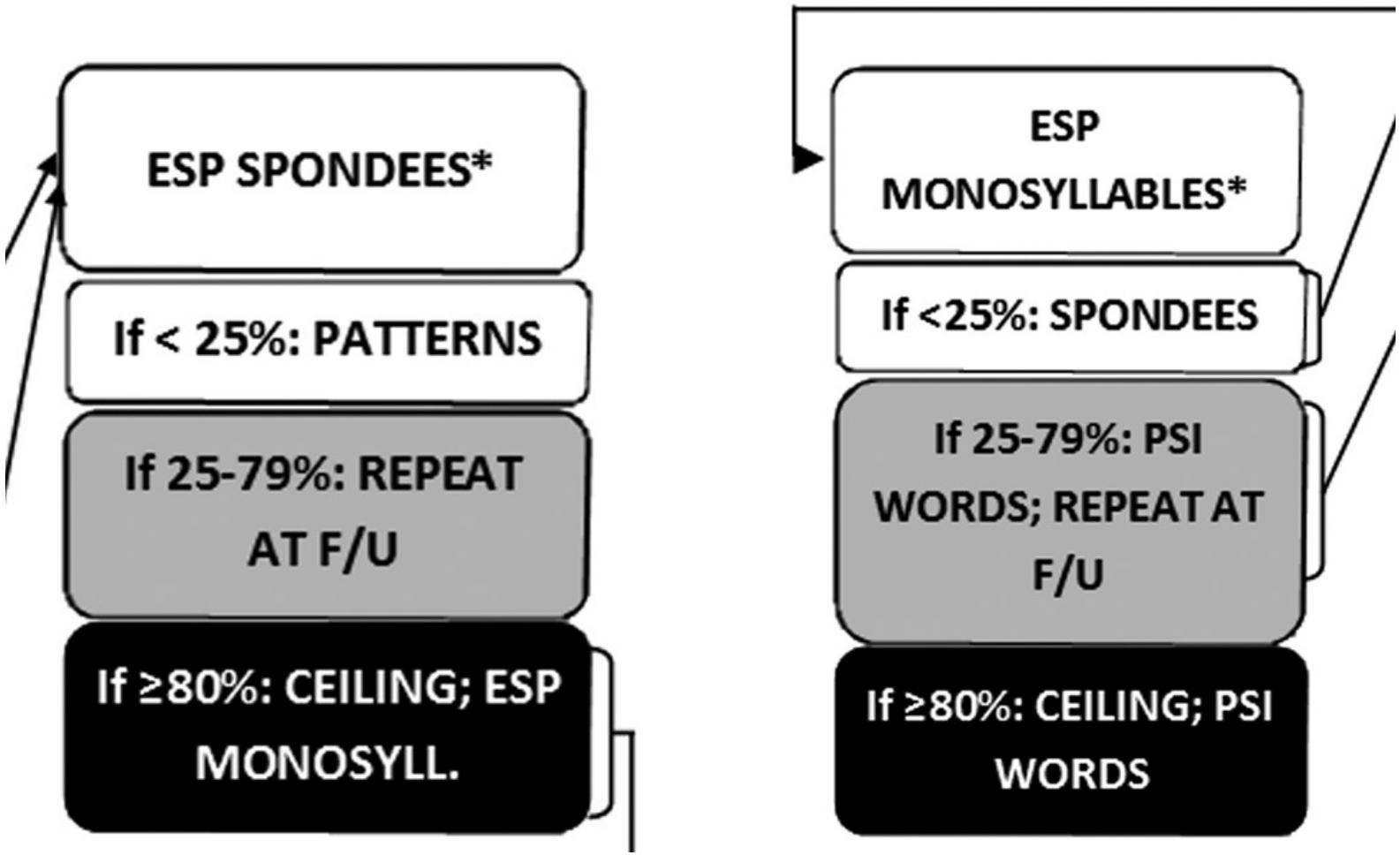
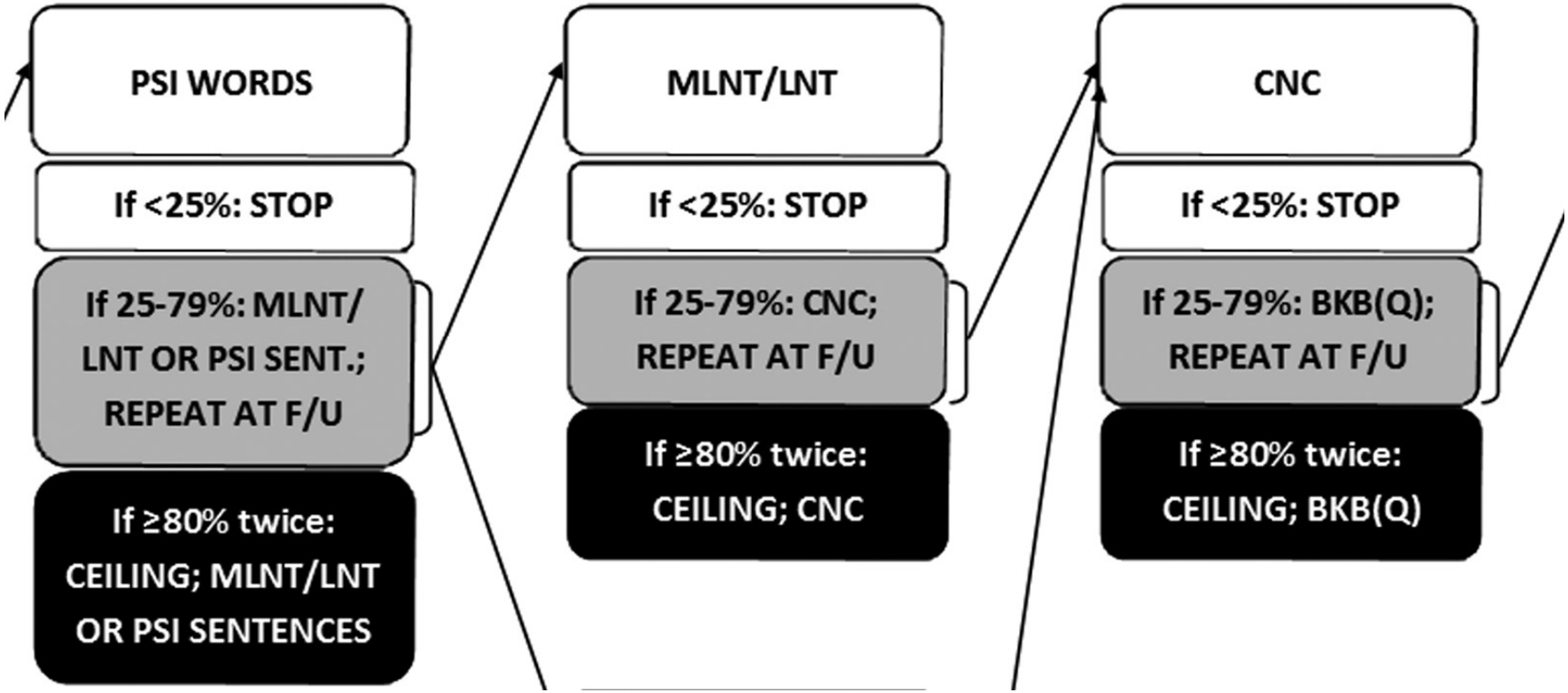
Pediatric MSTB



Pediatric MSTB

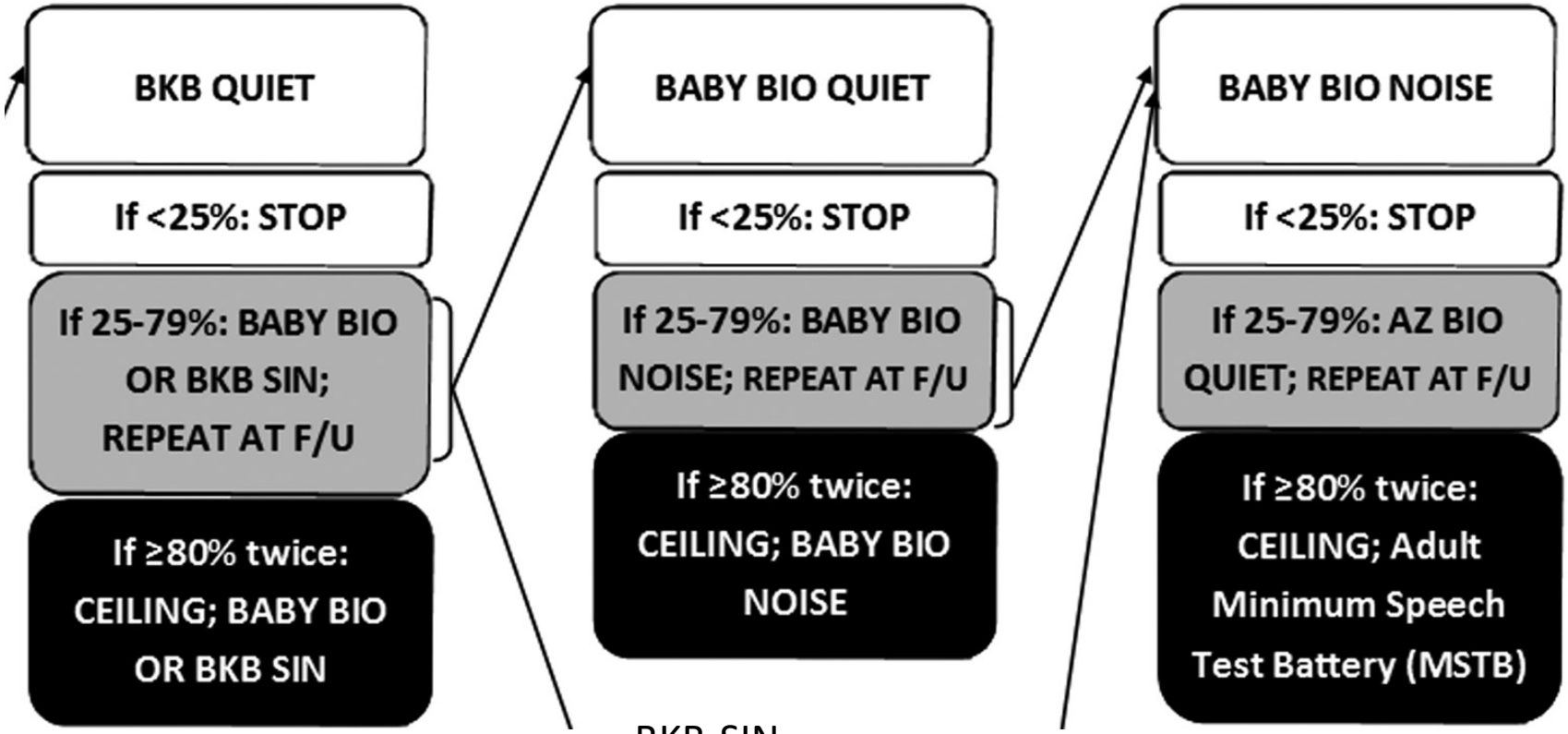


Pediatric MSTB



PSI Sentences

Pediatric MSTB



BKB-SIN

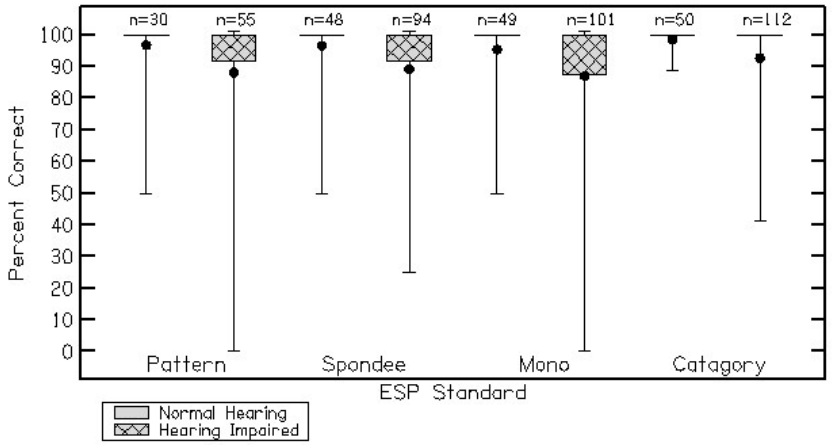
Pediatric MSTB

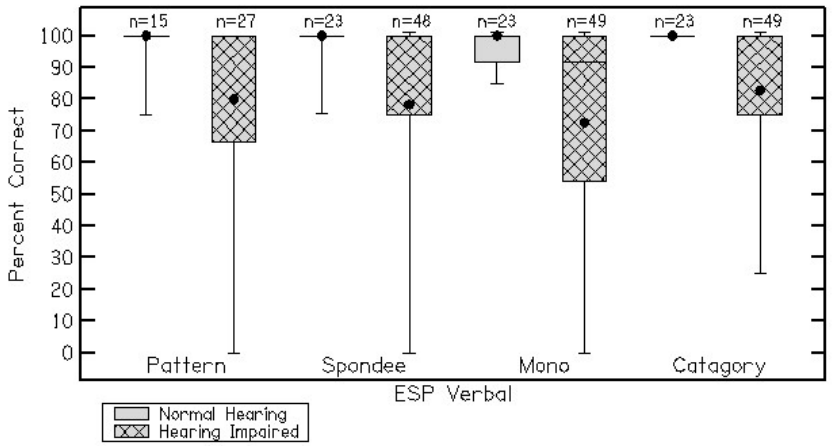
- Advantages
  - Standardized protocol
  - Prescriptive approach to presentation level
  - Could allow development of database due to standardization

Pediatric MSTB

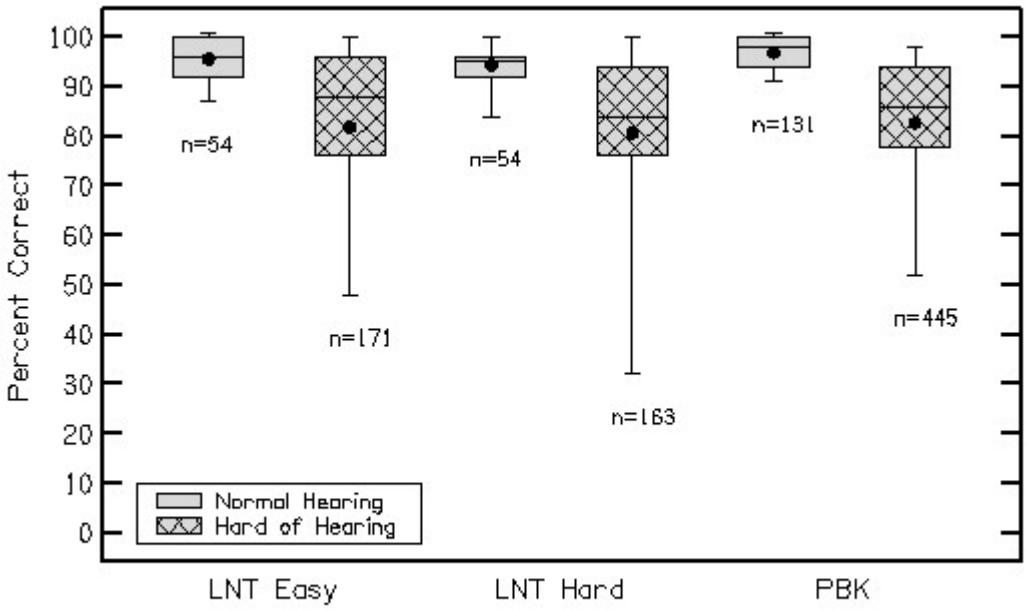
- Disadvantages
  - Only English materials
  - Single presentation level and SNR recommendation unlikely to work for all children with hearing loss.
  - Lots of similar materials presented as different steps.

Pediatric MSTB

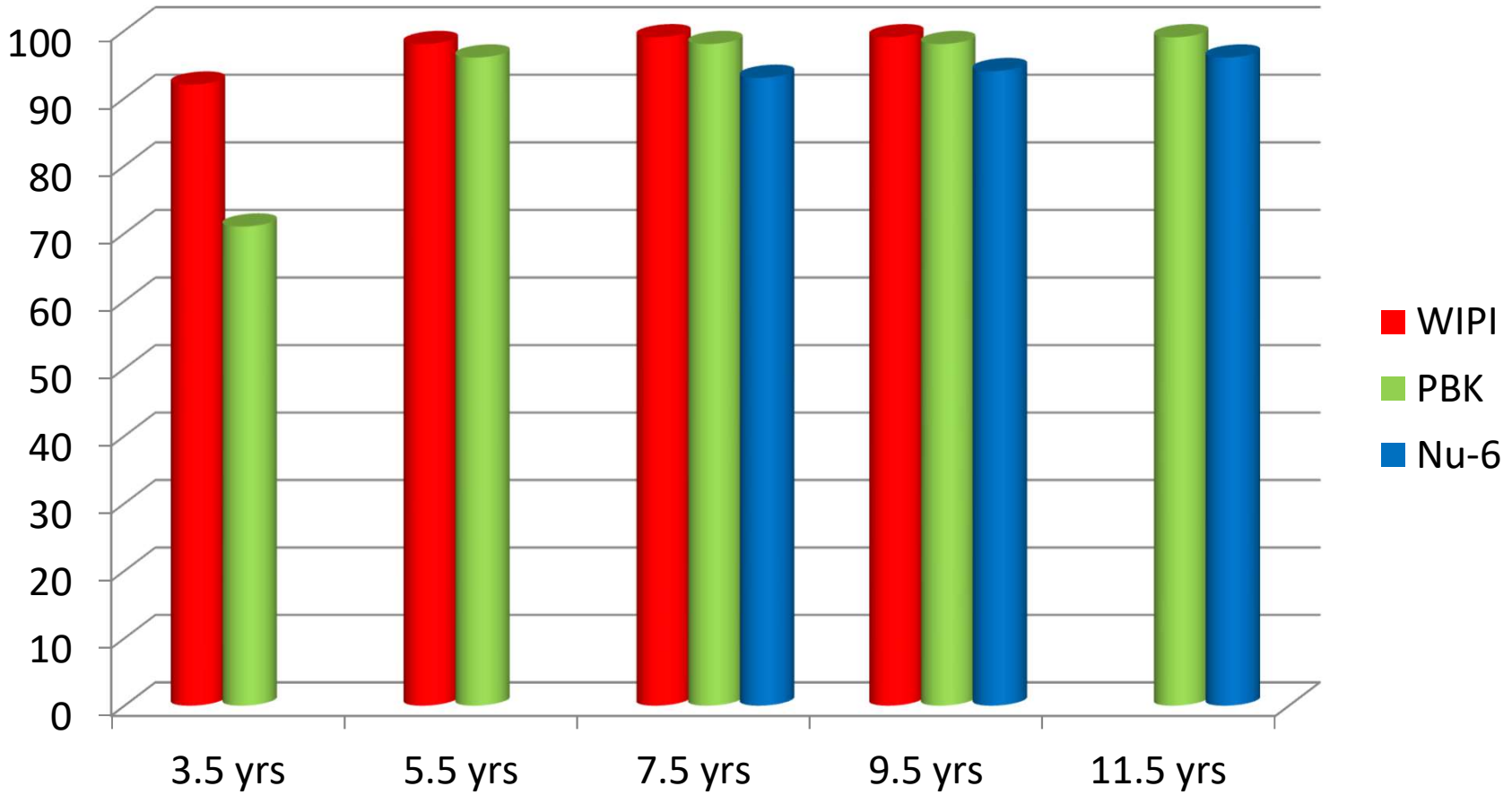




Performance on monosyllabic words in quiet



Comparing Speech Perception Tests



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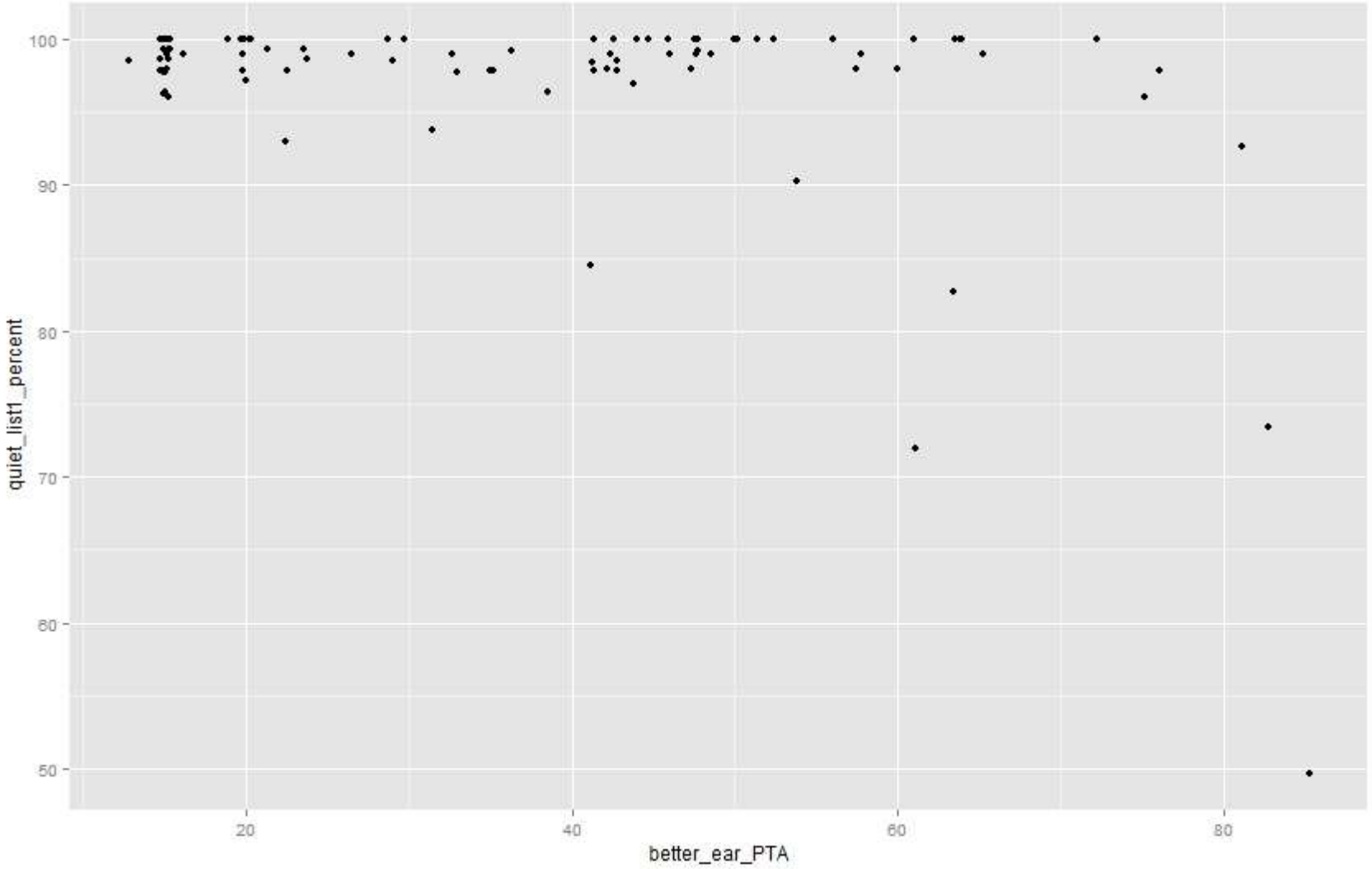
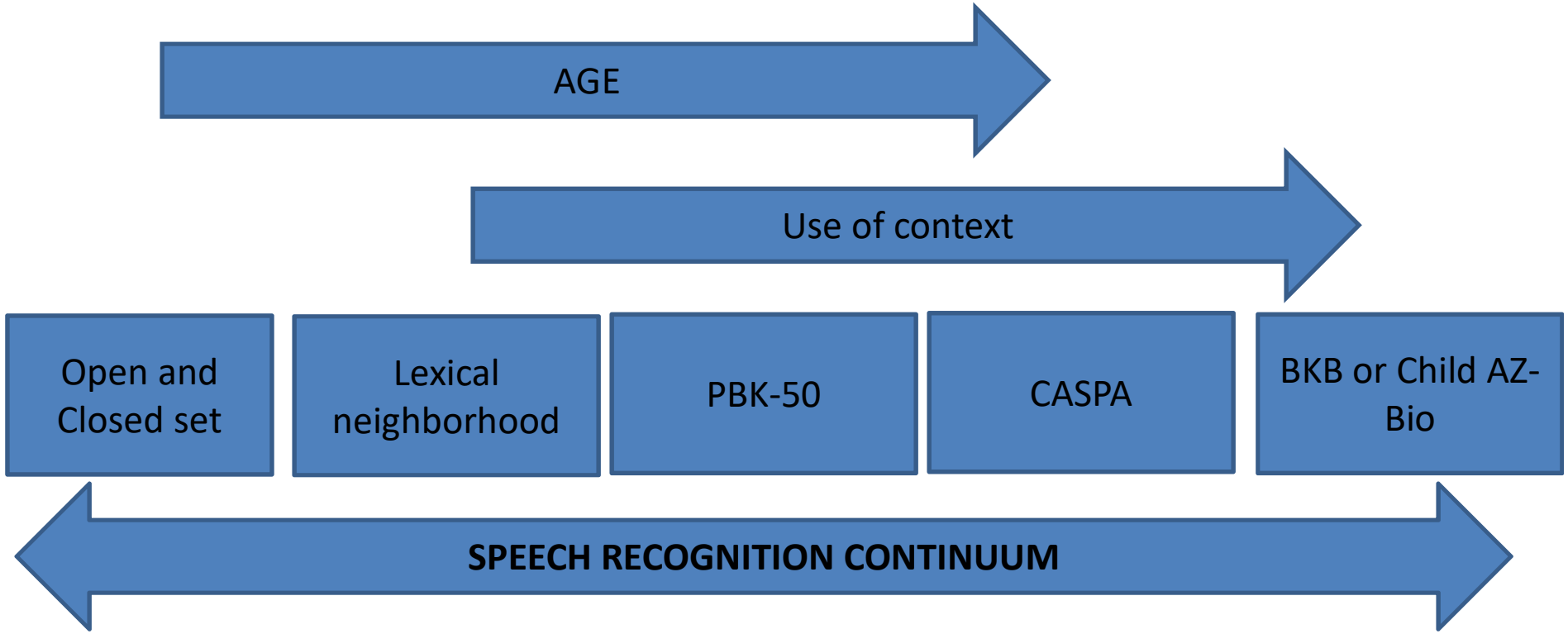
(Sanderson-Leepa & Rintelmann, 1976)

Baby AZ-Bio Sentences in Quiet



Aided Speech Recognition Battery



Open & Closed Set Test (O&C)

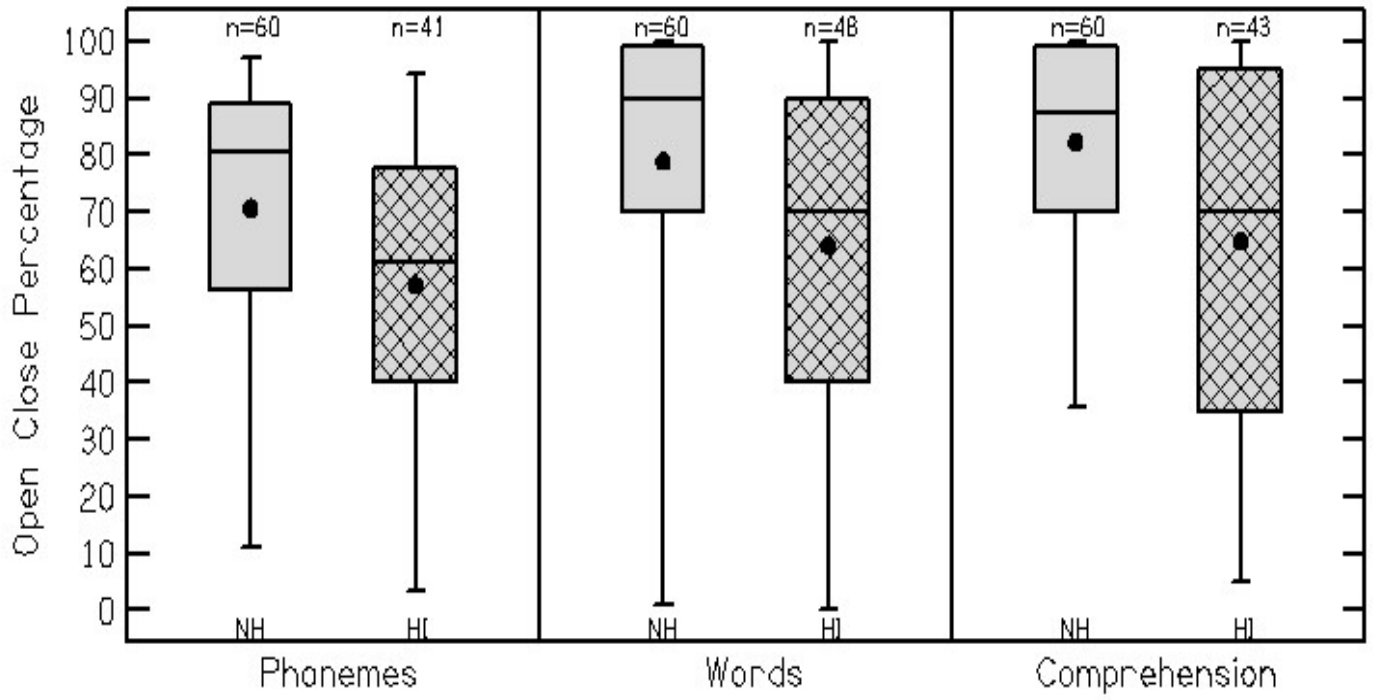
- Developed by: Ertmer, Miller, & Quesenberry,2004
- Appropriate for ages 18 to 24 months
- A measure of perception and production
- 10 items using realistic pictures
- Production followed by picture identification

dertmer@purdue.edu

O&C: Administration

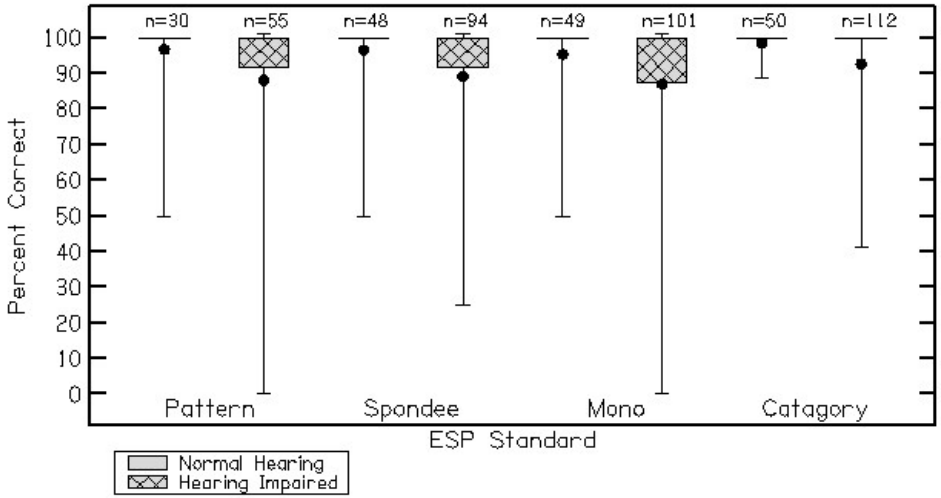
Mom: And “keys”… Child: /tis/… Mom: uh huh, where are they?
Child: /tis/ + point. Mom: very good.

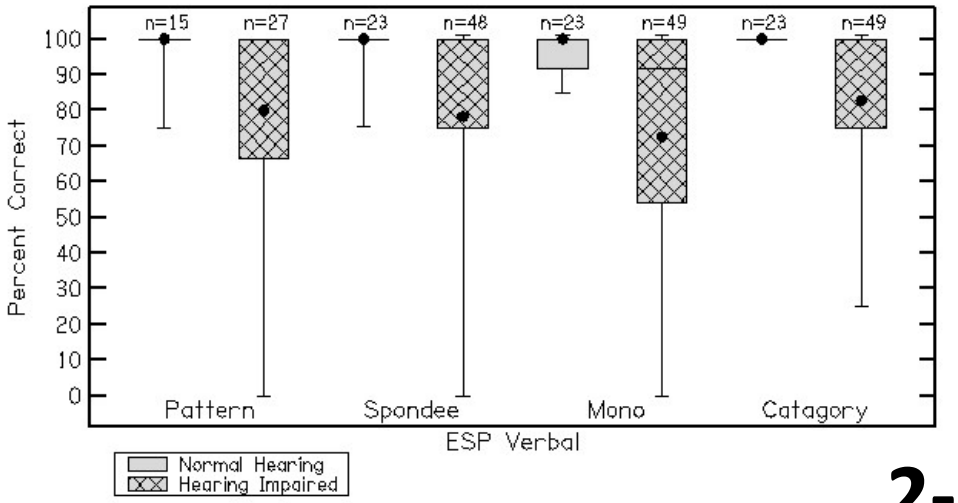
Open and Closed Set Task



2 year-olds

Early Speech Perception Test





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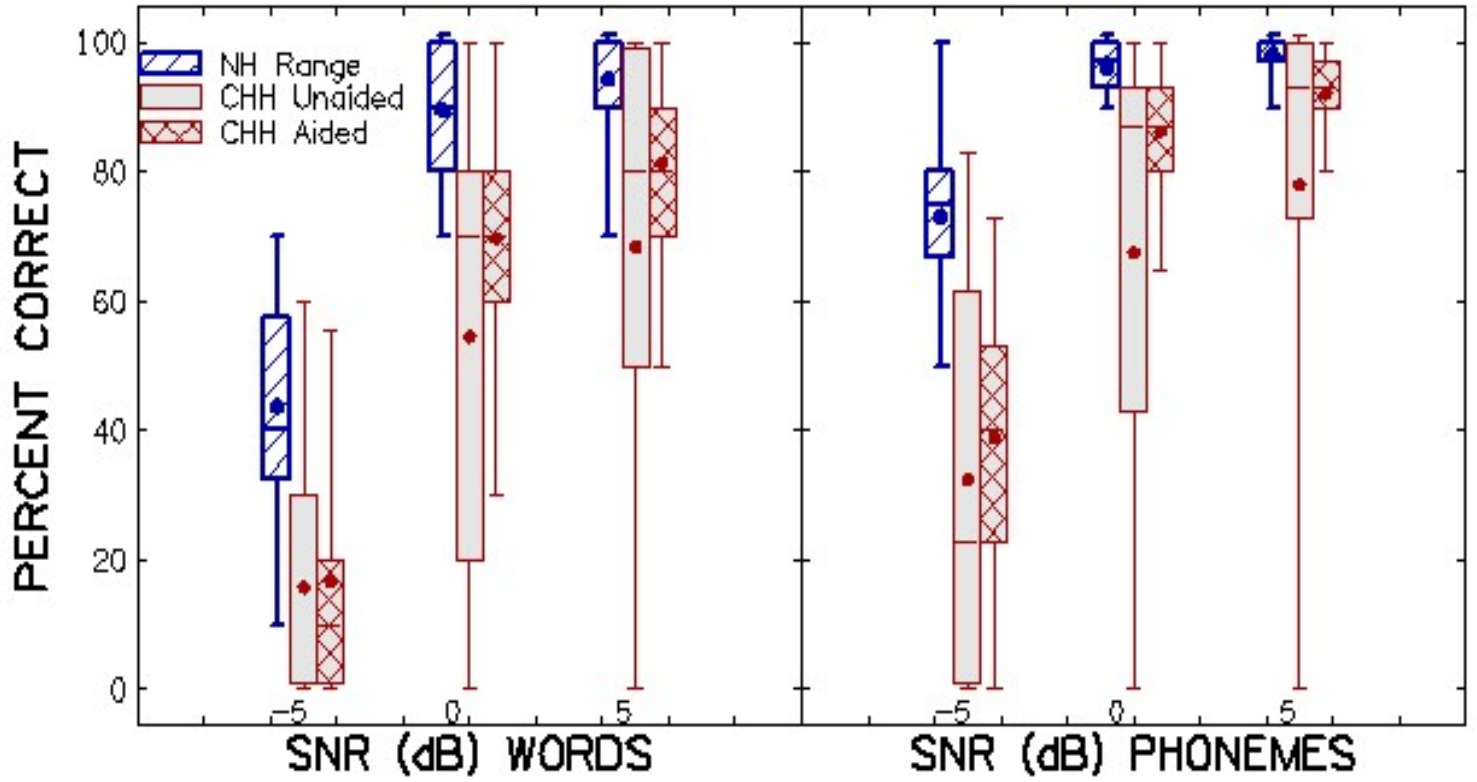
2-3 year-olds

Computer Assisted Speech Perception Assessment (CASPA)



7-9 year-olds

Predictors - CASPA

- Positive predictors
  - Signal-to-noise ratio
  - Hearing status (NH > HoH)
  - Aided (Aided > Unaided)
  - Audibility
  - HA use
  - Language
  - Working memory

Aided speech recognition

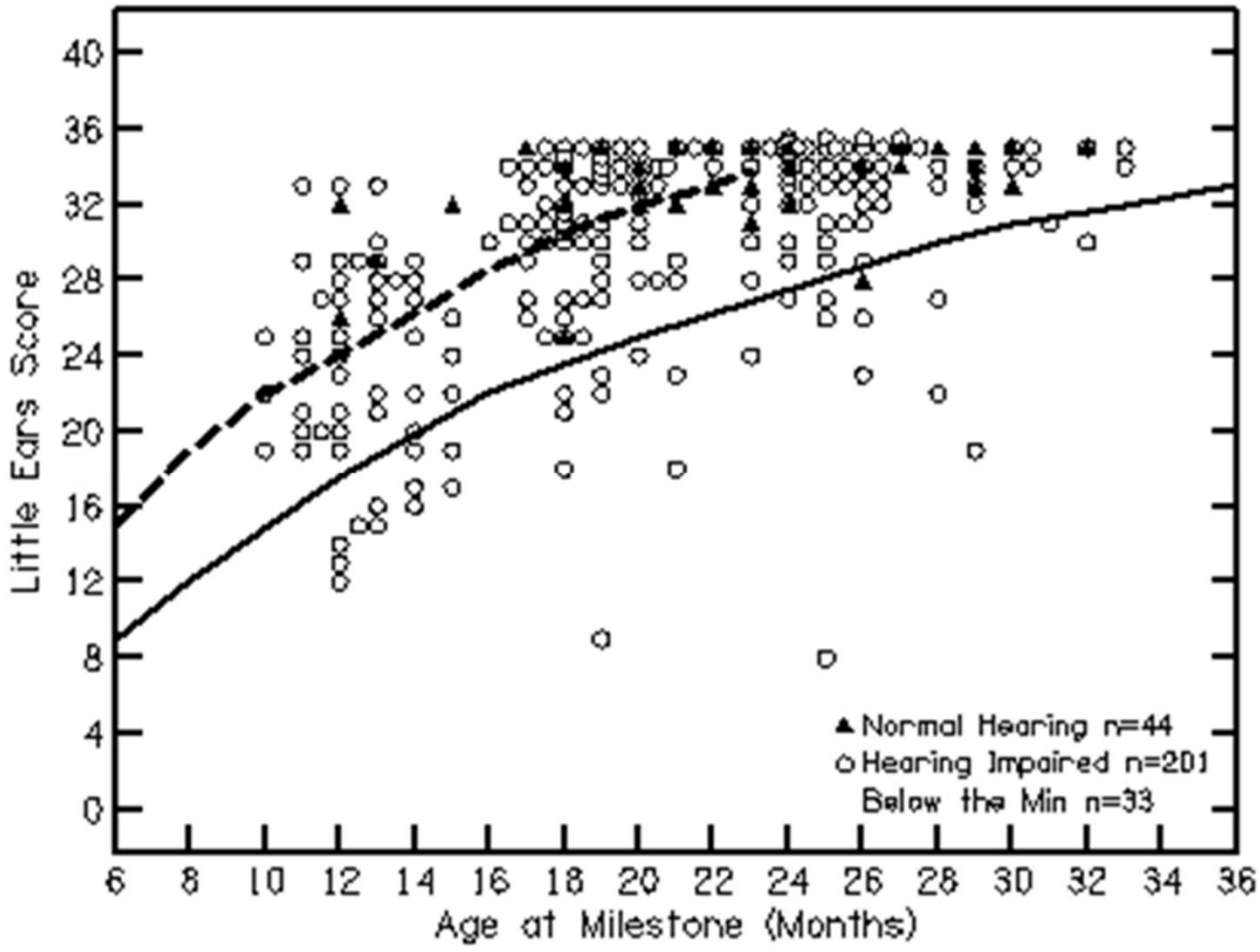
- Compare to outcomes from studies of children who wear hearing aids
- Check aided audibility across input levels

- Auditory development questionnaires
  - LittlEars
  - PEACH

Auditory Development Questionnaires

- LittlEars – 12 months – 2 years
- PEACH – 12 months – 2 years – once 28 on LittlEars
- SSQ – 4, 6, 8 year-olds

LittlEARS


Little Ears Score
40
36
32
28
24
20
16
12
8
4
0
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
Age at Milestone (Months)
▲Normal Hearing n=44
○Hearing Impaired n=201
Below the Min n=33

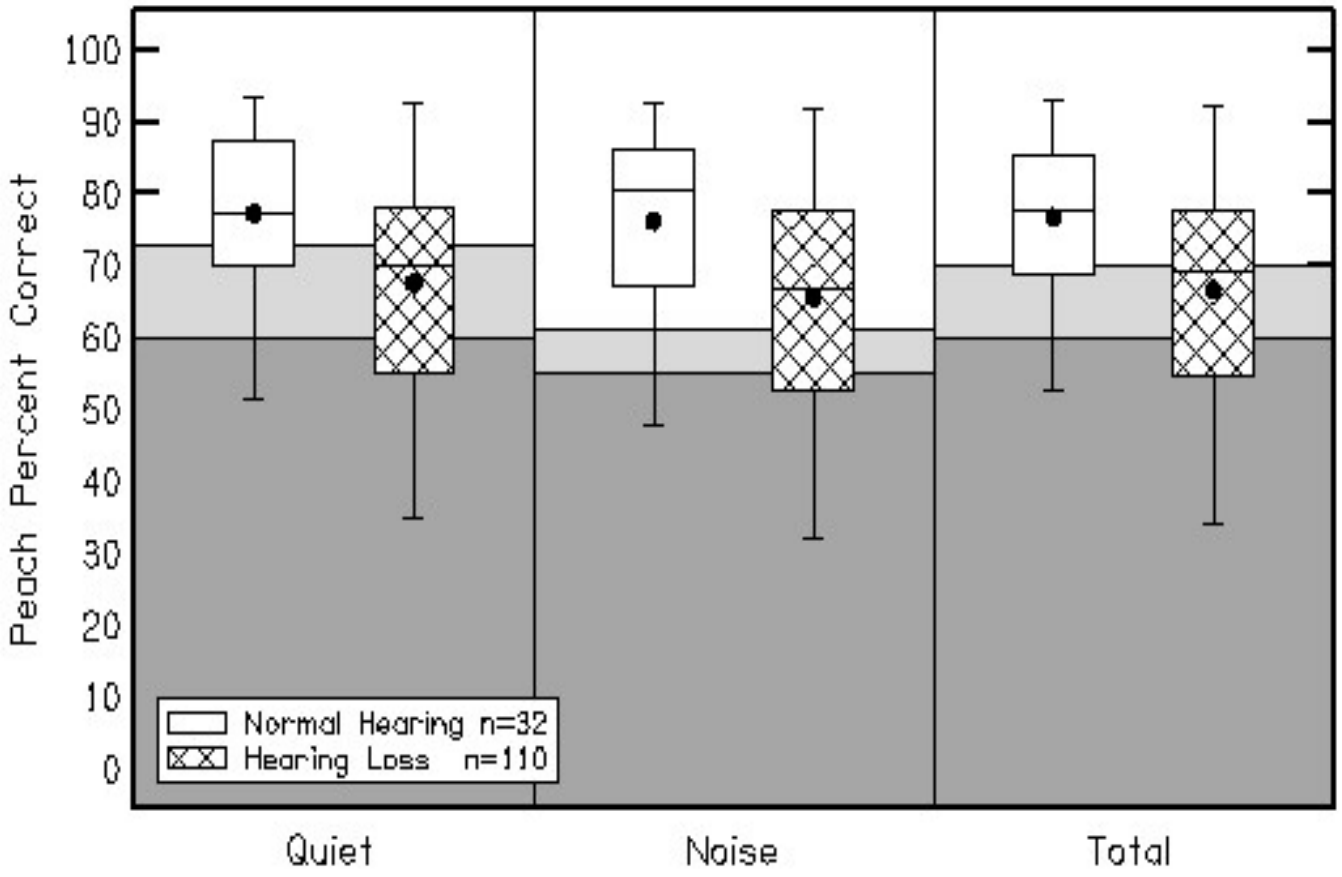
LittlEars Predictors

- Positive predictors
  - Age
  - Audibility
  - Receptive Language
  - Open and Closed Set Speech Recognition
  - Hearing Aid Use
- Not predictive
  - Maternal education

Parents Evaluation of Aural/Oral Performance in Children (PEACH)

- Questionnaire with Quiet and Noise subscales
- Developed by Ching & Hill (2006)
- Part of UWO-PedAMP protocol
- Initiated when subjects had 28 or higher on LittlEars
  - Average age 21 months

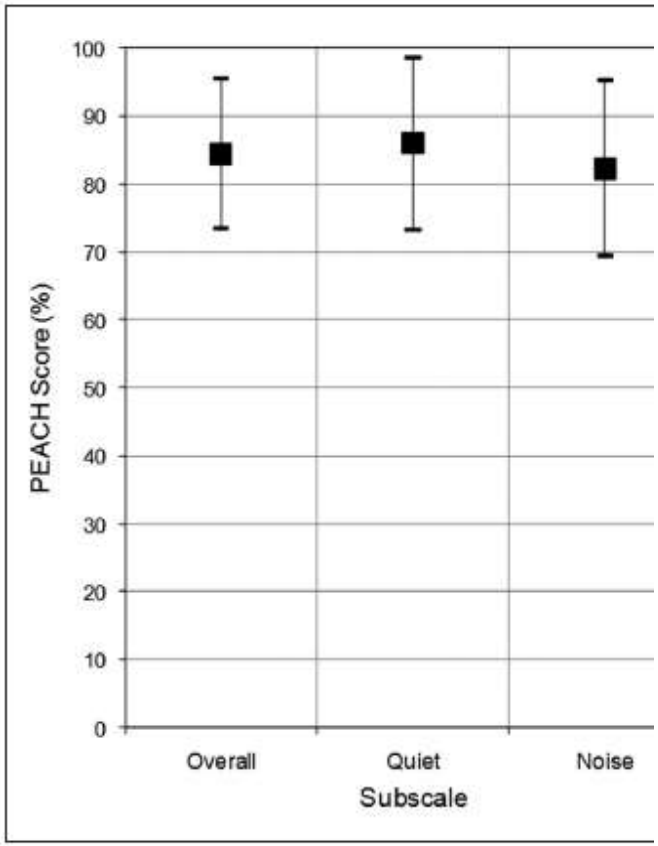
PEACH


Peach Percent Correct
100
90
80
70
60
50
40
30
20
10
0
Normal Hearing n=32
Hearing Loss n=110
Quiet
Noise
Total

PEACH Predictors

- Positive Predictors
  - Audibility
  - Receptive Language
- Not predictive
  - Hearing aid use
  - Maternal education level
  - Open and Closed set speech recognition

PEACH vs. previous studies



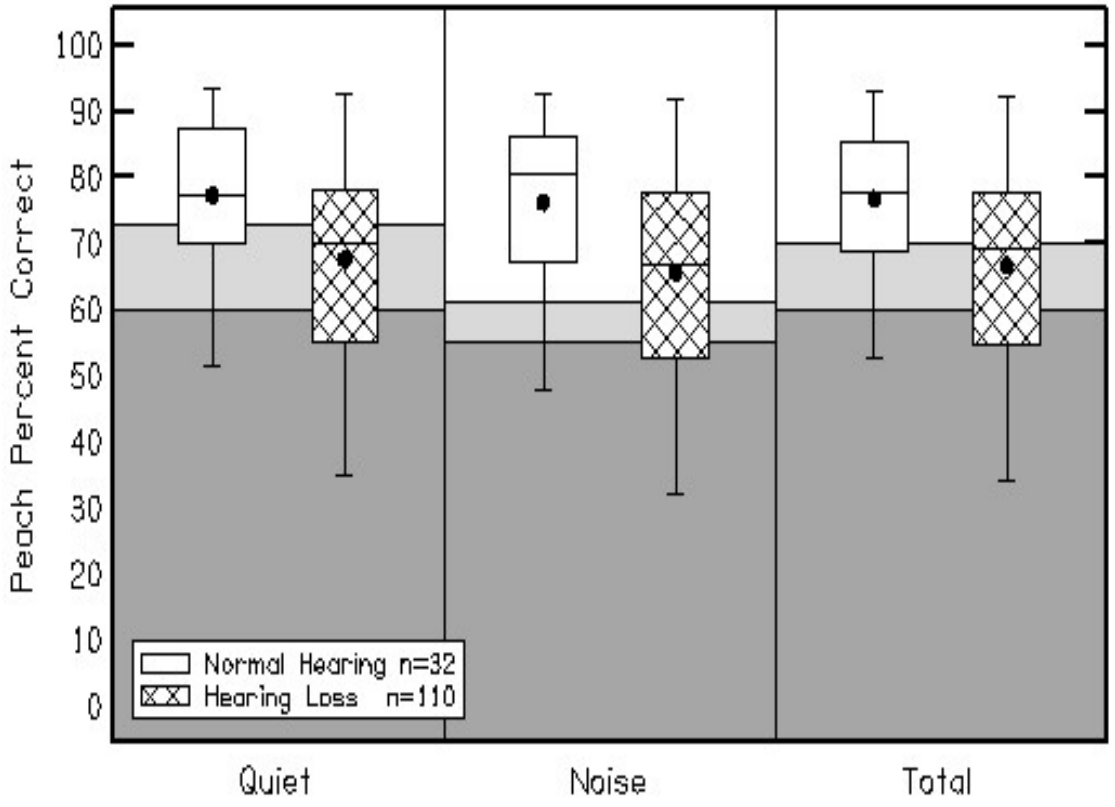


Figure 8. PEACH scores from typically developing, full-term children with hearing aids

Auditory Development Questionnaires

- Reflect auditory variables
- Also reflect language abilities

- LittlEars – performance may be high
- PEACH – consider age of child

When to move to cochlear implantation?

- Reduced or stagnant outcomes despite:
  - Good audibility
  - Consistent hearing aid use
- Shift in candidacy
  - Current: Audiogram
  - Future: Audibility, hearing aid use, and outcomes

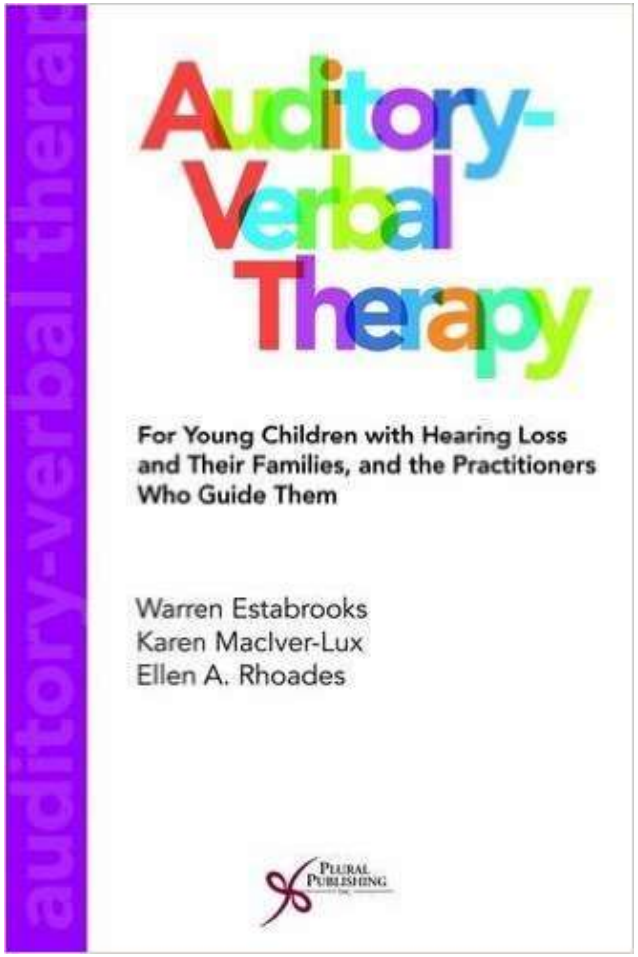
Acknowledgements

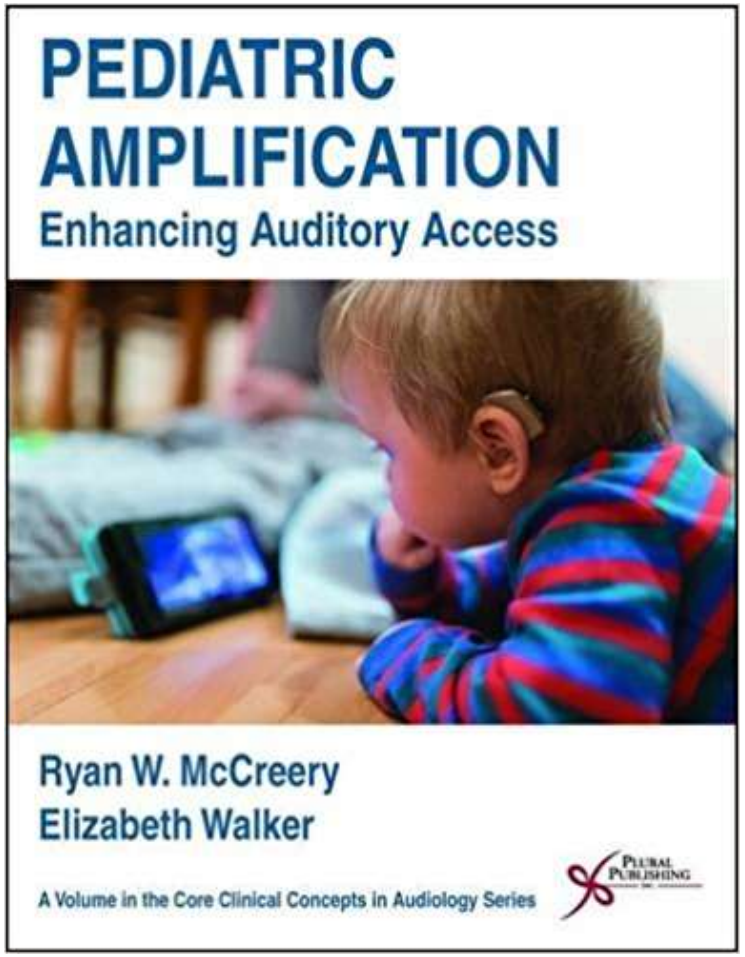
- NIH/NIDCD
  - R01DC013591, R01DC009560
- Collaborators






Shameless Self-Promotion





Thank you!

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