Monitoring Outcomes of Infants & Children Who Wear Hearing Aids

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Western
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for Audiology

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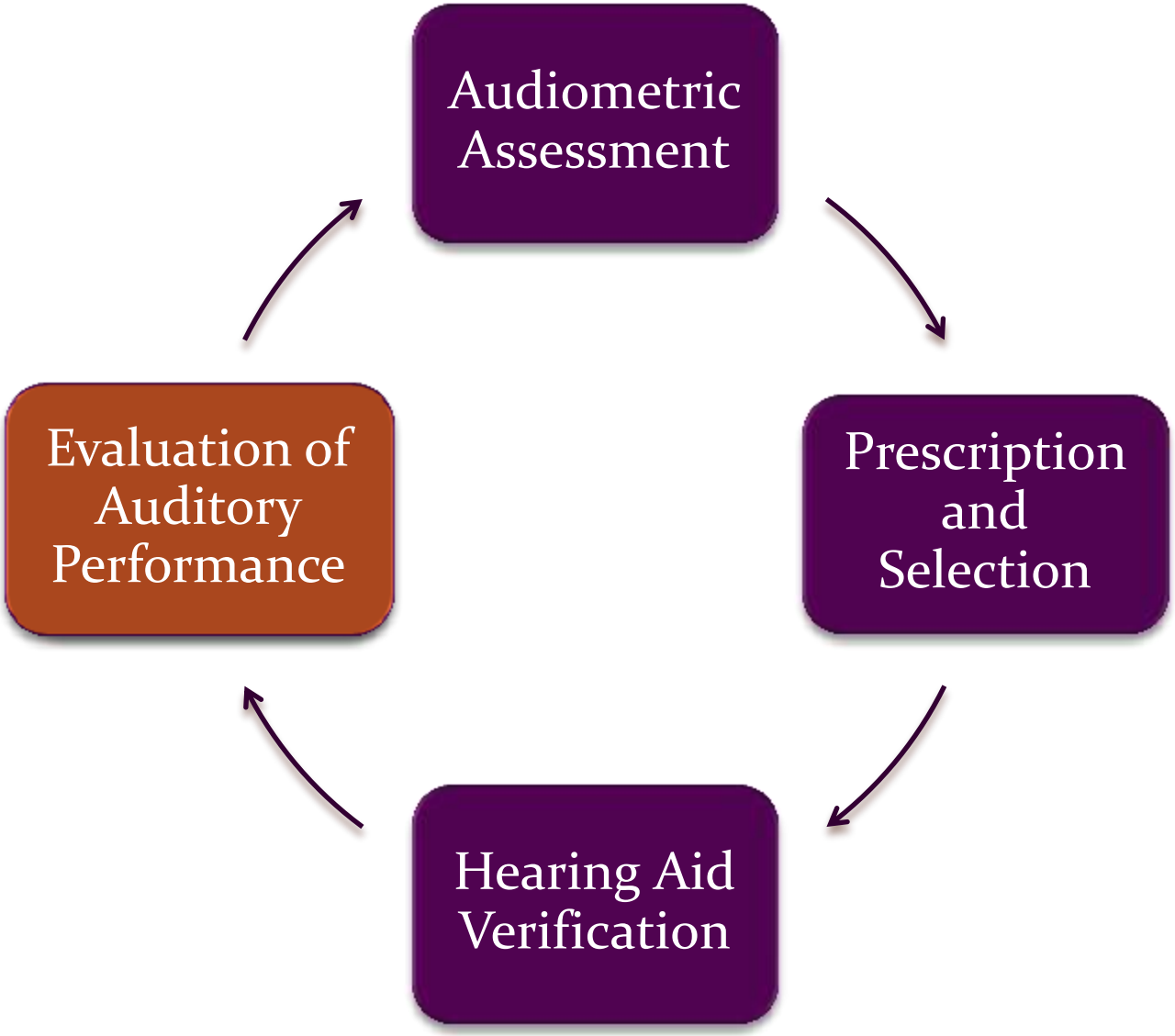
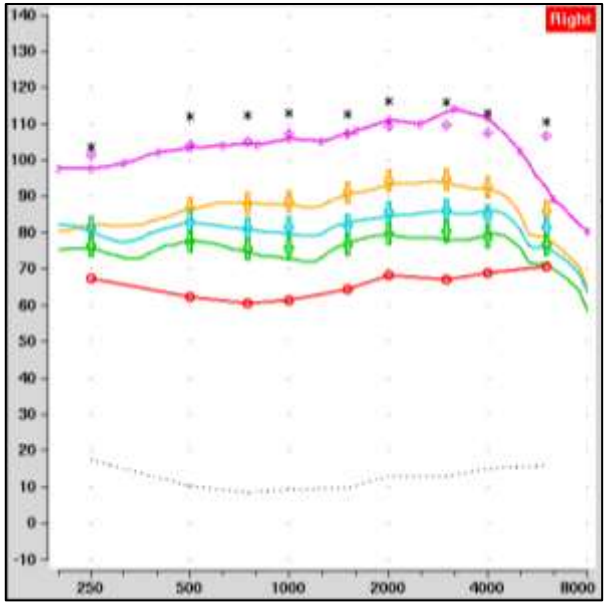
Collaborators:

- Ontario Ministry of Children and Youth Services Infant Hearing Program
- Richard Seewald, Doreen Bartlett, Linda Miller, Anita Kothari
- Martyn Hyde
- April Malandrino, Christine Brown, Frances Richert, Debbie Clench
- Network of Pediatric Audiologists of Canada
- Ontario Ministry of Children and Youth Services Infant Hearing Program
- Danielle Glista

Process of Pediatric Hearing Aid Fitting




Right
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Provision of Hearing Aids

- Suitable technology and evidence-based hearing aid fitting protocols support accurate and safe hearing aid fittings for the pediatric population
  - American Academy of Audiology, 2013
  - Australian Protocol; King, 2010
  - British Columbia Early Hearing Program, 2006
  - Modernizing Children's Hearing Aid Services, 2005
  - Ontario Protocol; Bagatto, Scollie, Hyde & Seewald, 2010

Clinical Need:

Pediatric audiologists who fit young infants with hearing aids need tools to measure the impact of the hearing aid on the child's auditory development

Program Need:

Early Hearing Detection and Intervention (EHDI) programs need tools to assess the overall quality of the program

Considerations for Outcome Evaluation

Target Population: Infants & young children who wear hearing aids

Good Statistical Properties

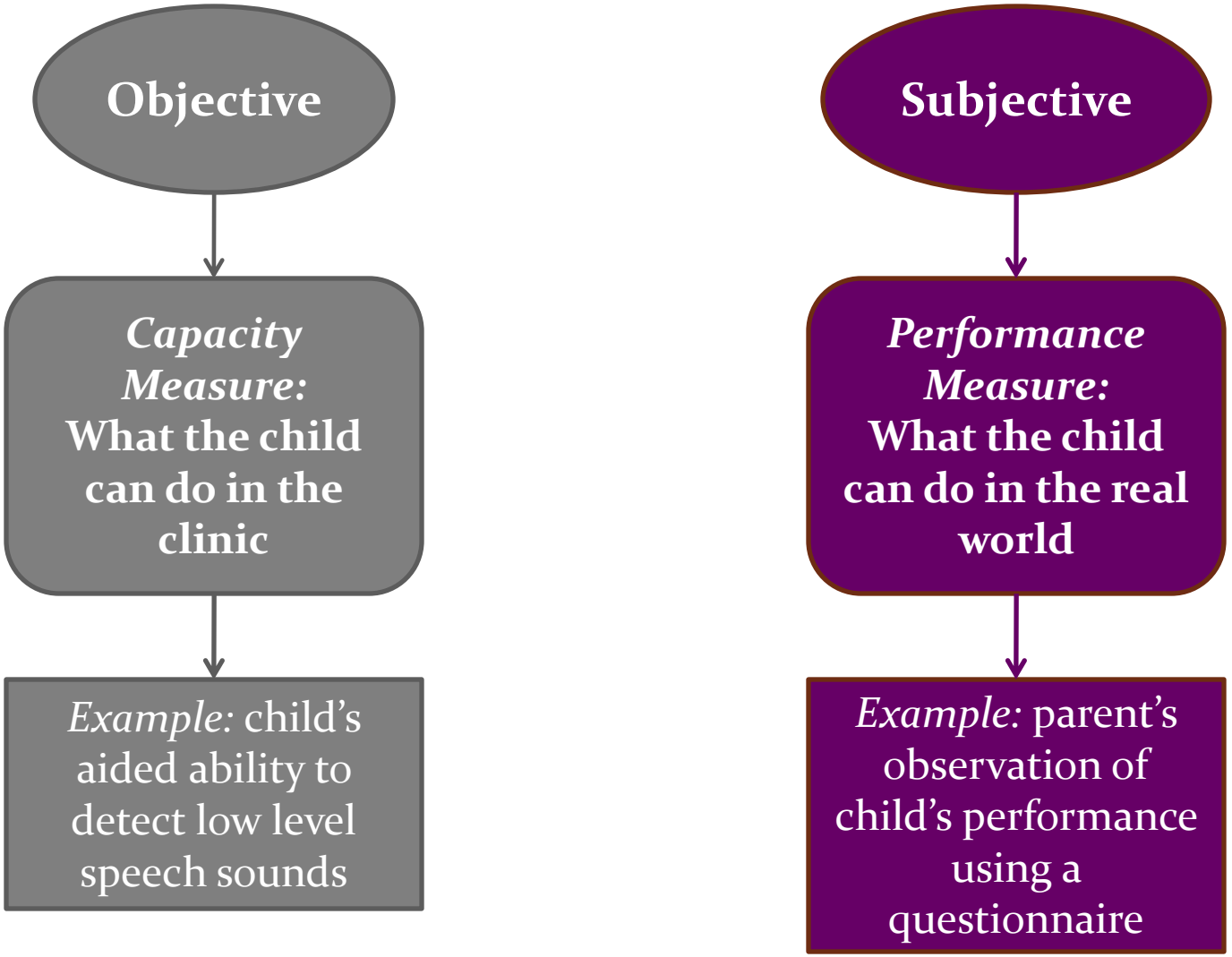
Purpose: Measure the impact of the hearing aid fitting

Clinically Feasible

Administration & Interpretation: By Audiologist

Clinically Meaningful

Types of Outcome Measures



The University of Western Ontario

PEDAMP

Pediatric Audiological Monitoring Protocol

Version 1.0

Marlene Bagatto, Sheila Moodie, Susan Scollie

2010

www.dslio.com

UWO PedAMP Development

- Avoid tools that:
  - are too lengthy or complicated
  - rely on information or scoring by other professionals
  - (e.g., standard language measures)
    - May be implemented in other parts of the Early Hearing Detection and Intervention (EHDI) program

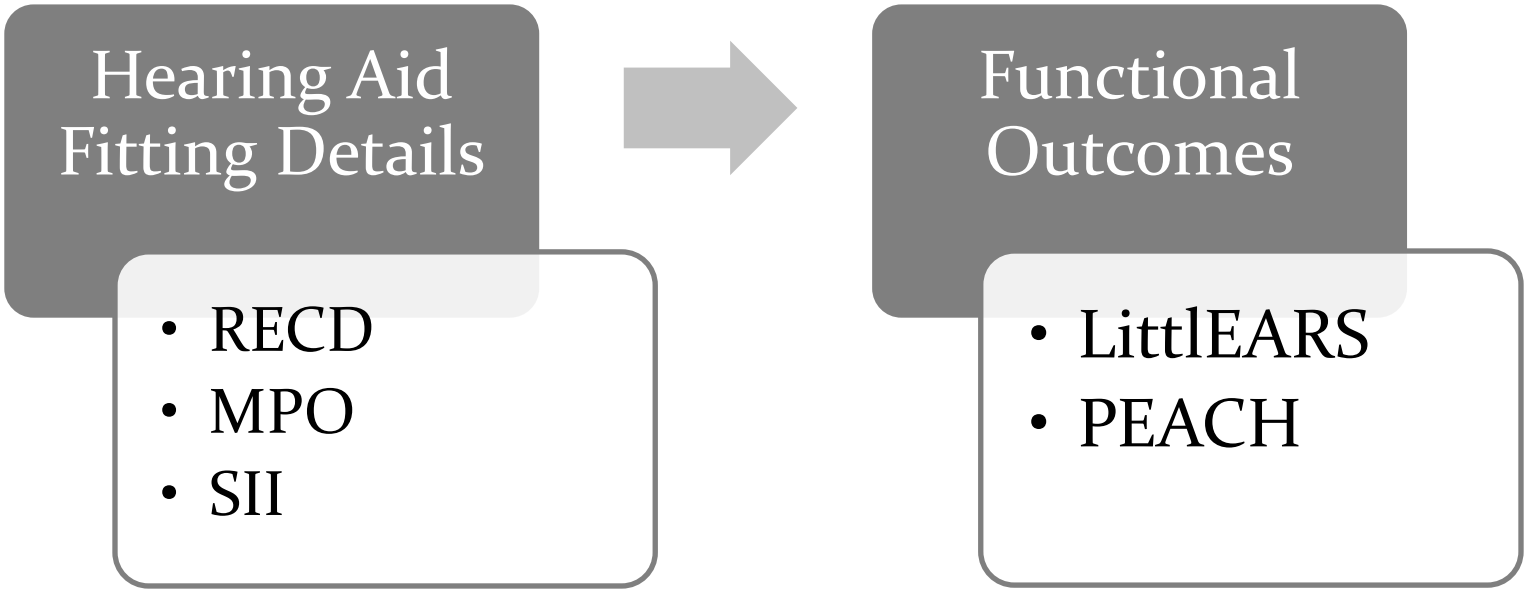
- Include tools that:
  - have good statistical properties
  - have good clinical feasibility and utility
  - support family-centered practice
  - help you collaborate better with others

The University of Western Ontario
PEDAMP
Pediatric Audiological Monitoring Protocol

- Maximize efficiency and interpretation through:
  - Visual tools to permit rapid scoring
  - Data to support interpretation

Contents of the UWO PedAMP

Tool	Purpose	Description
Amplification Benefit Questionnaire	• Acceptance & use of hearing aids • Satisfaction with services	11 items 5 point rating scale
Hearing Aid Fitting Details	• Quality of hearing aid fitting	RECD, MPO, Speech Intelligibility Index (SII)
LittlEARS Auditory Questionnaire ***Tsiakpini et al, 2004***	• Receptive & semantic auditory behaviour • Expressive vocal behaviour	35 items Yes/no response
Parents' Evaluation of Aural/Oral Performance of Children (PEACH) ***Ching & Hill, 2005***	• Communication in quiet & noise • Responsiveness to environment	13 items 5 point rating scale


Hearing Aid Fitting Details
• RECD
• MPO
• SII
Functional Outcomes
• LittlEARS
• PEACH

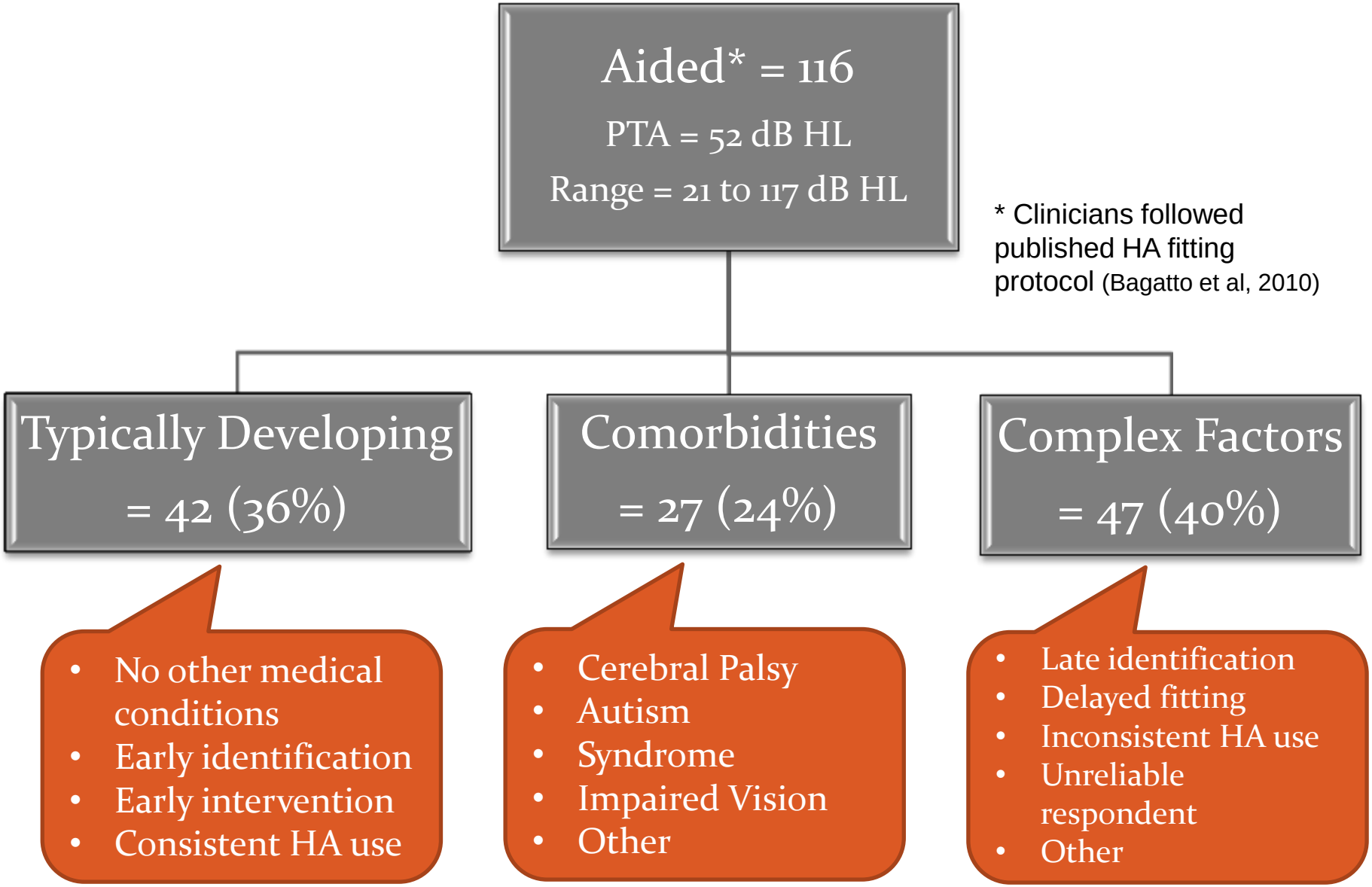
The University of Western Ontario Pediatric Audiological Monitoring Protocol (UWO PedAMP)

Bagatto, Moodie, Malandrino, Richert, Clench & Scollie

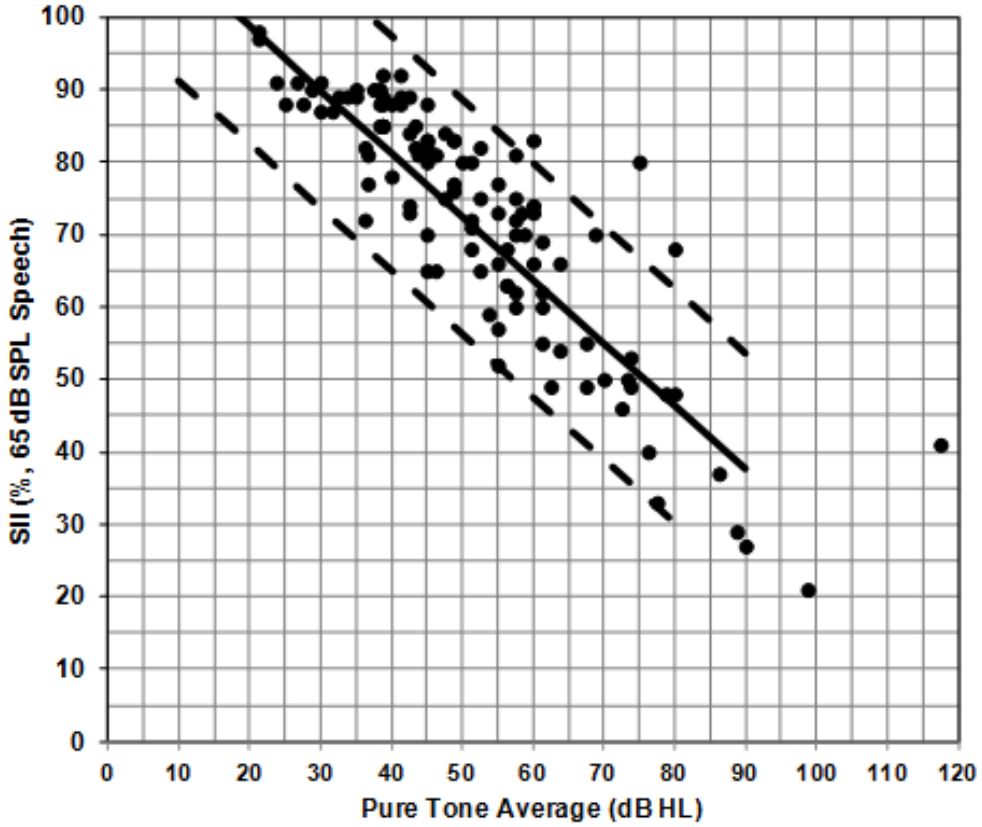
2011

Trends in Amplification
Volume 15(1): 57-76

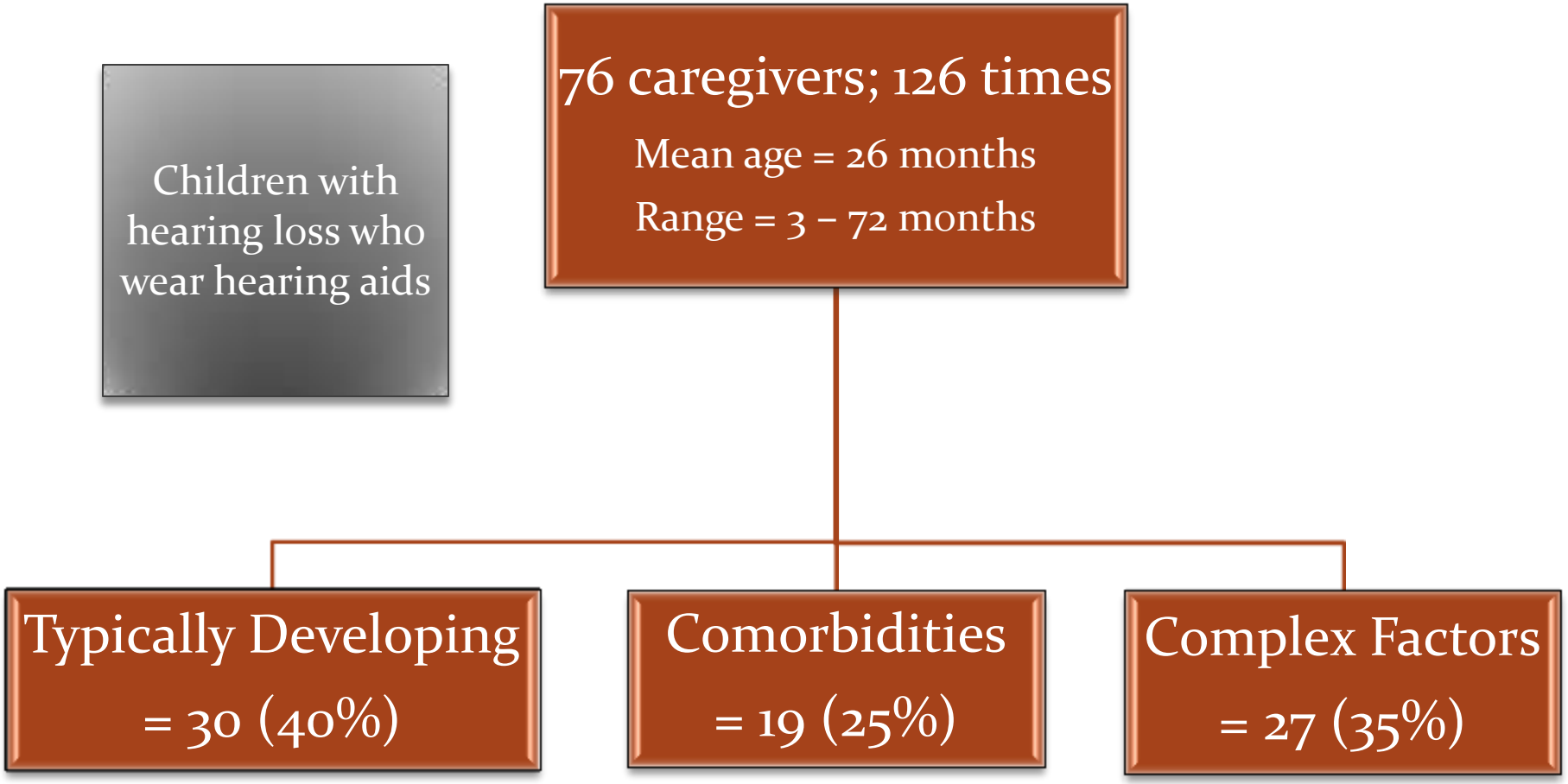
Longitudinal Clinical Observation Study



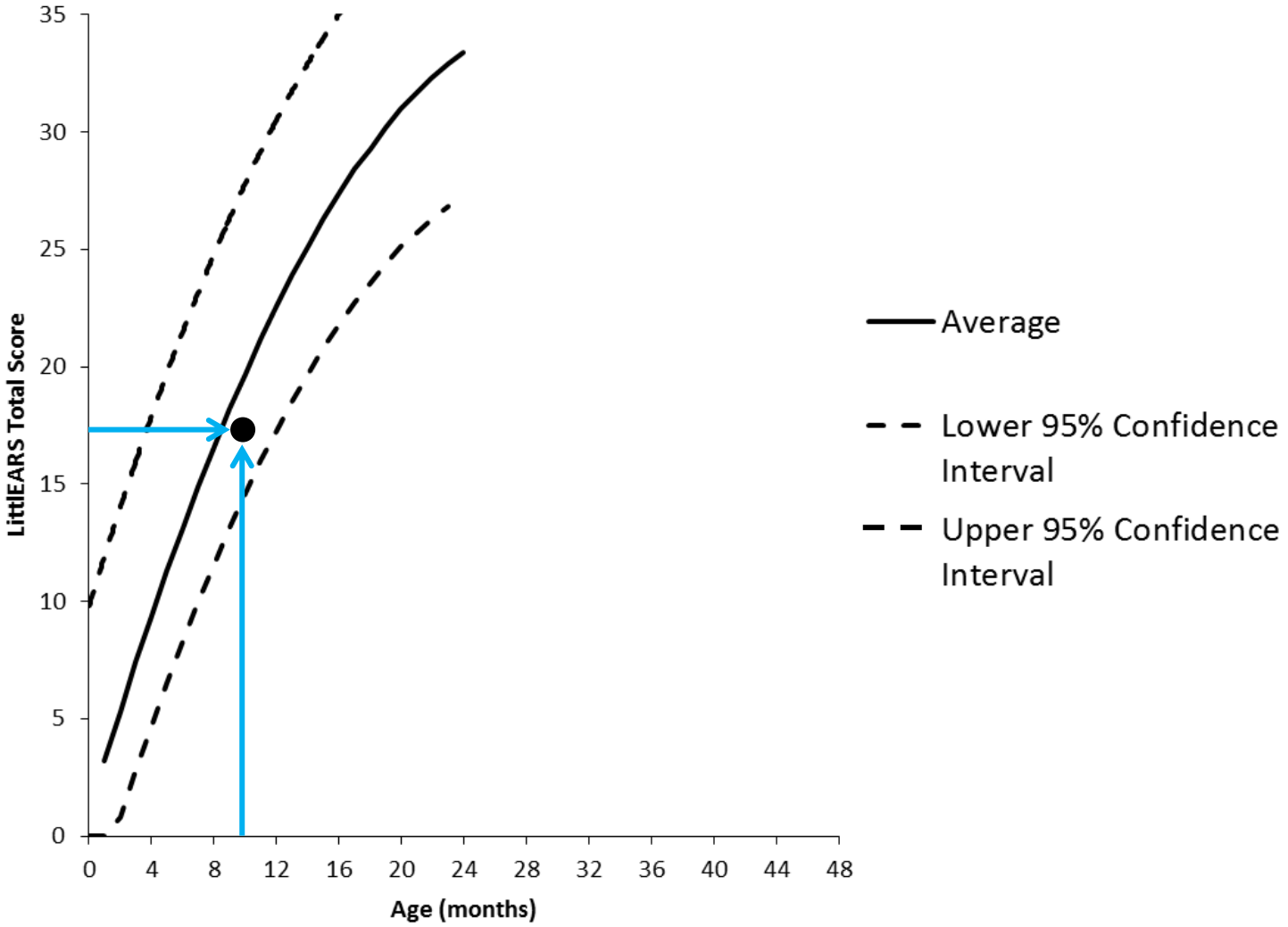
SII Data from Current Study



Administration of LittlEARS

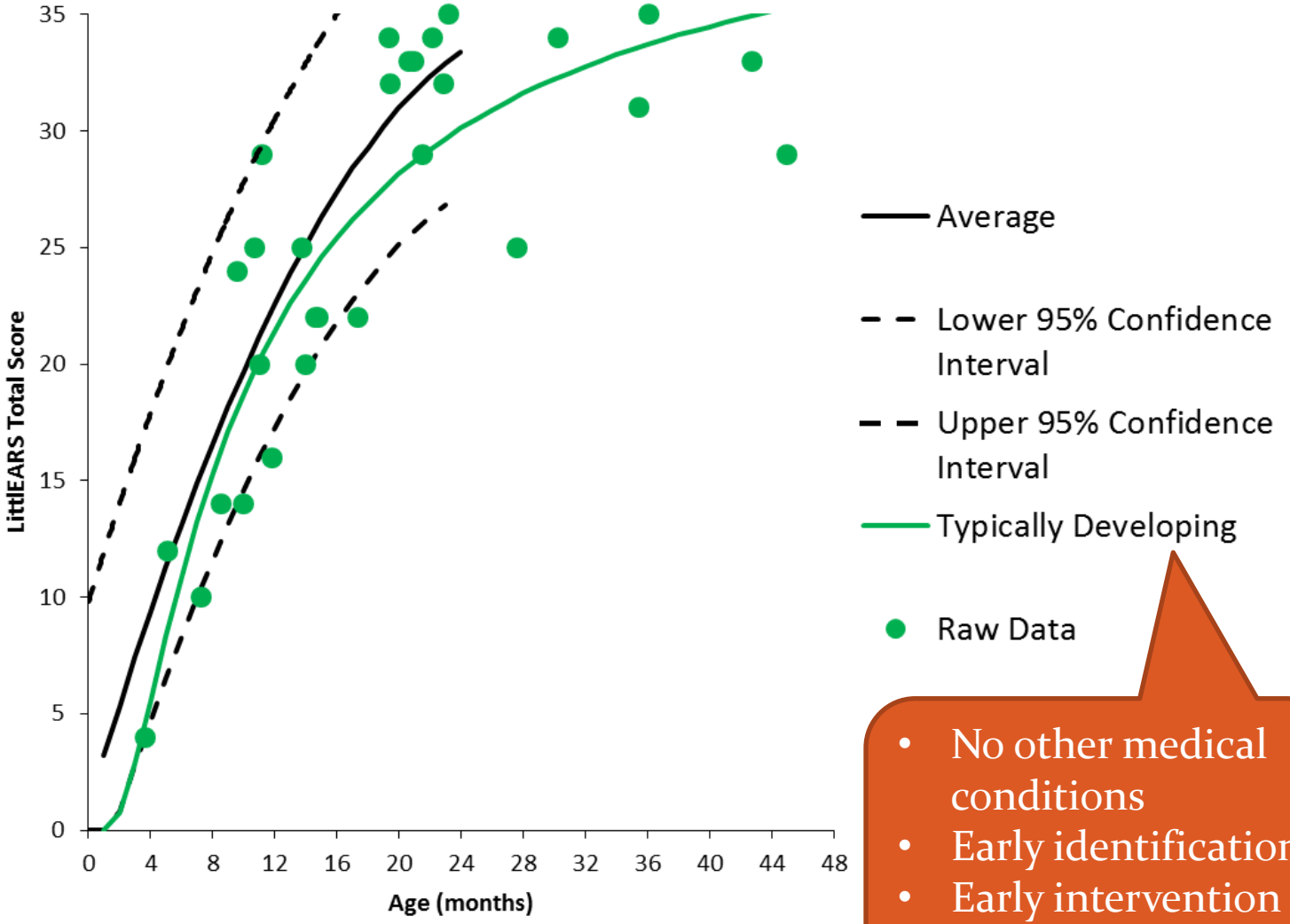


LittlEARS Scoring



Typically Developing Children with Hearing Aids

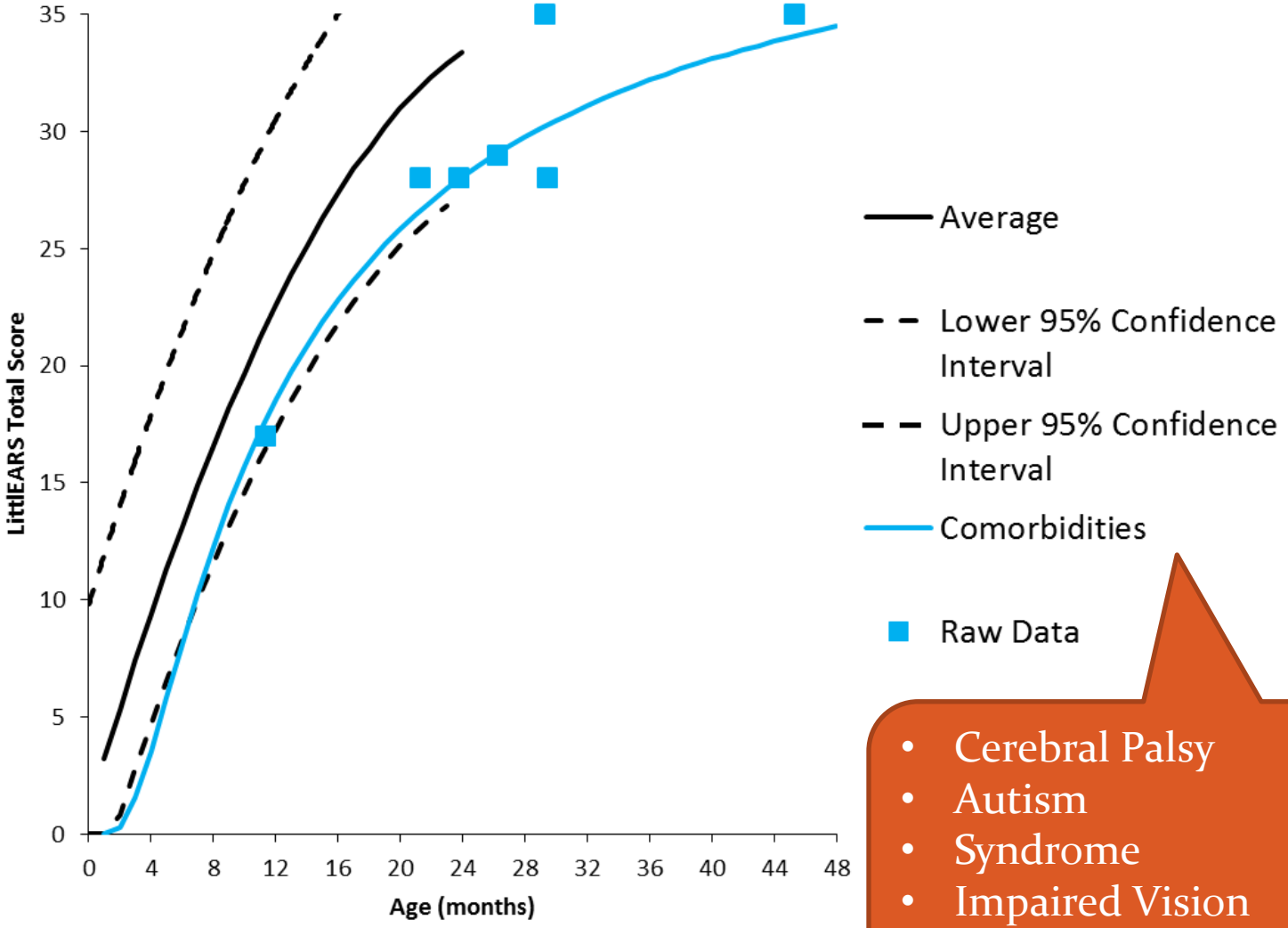
N = 30



- No other medical conditions
- Early identification
- Early intervention
- Consistent HA use

Children with Comorbidities with Hearing Aids

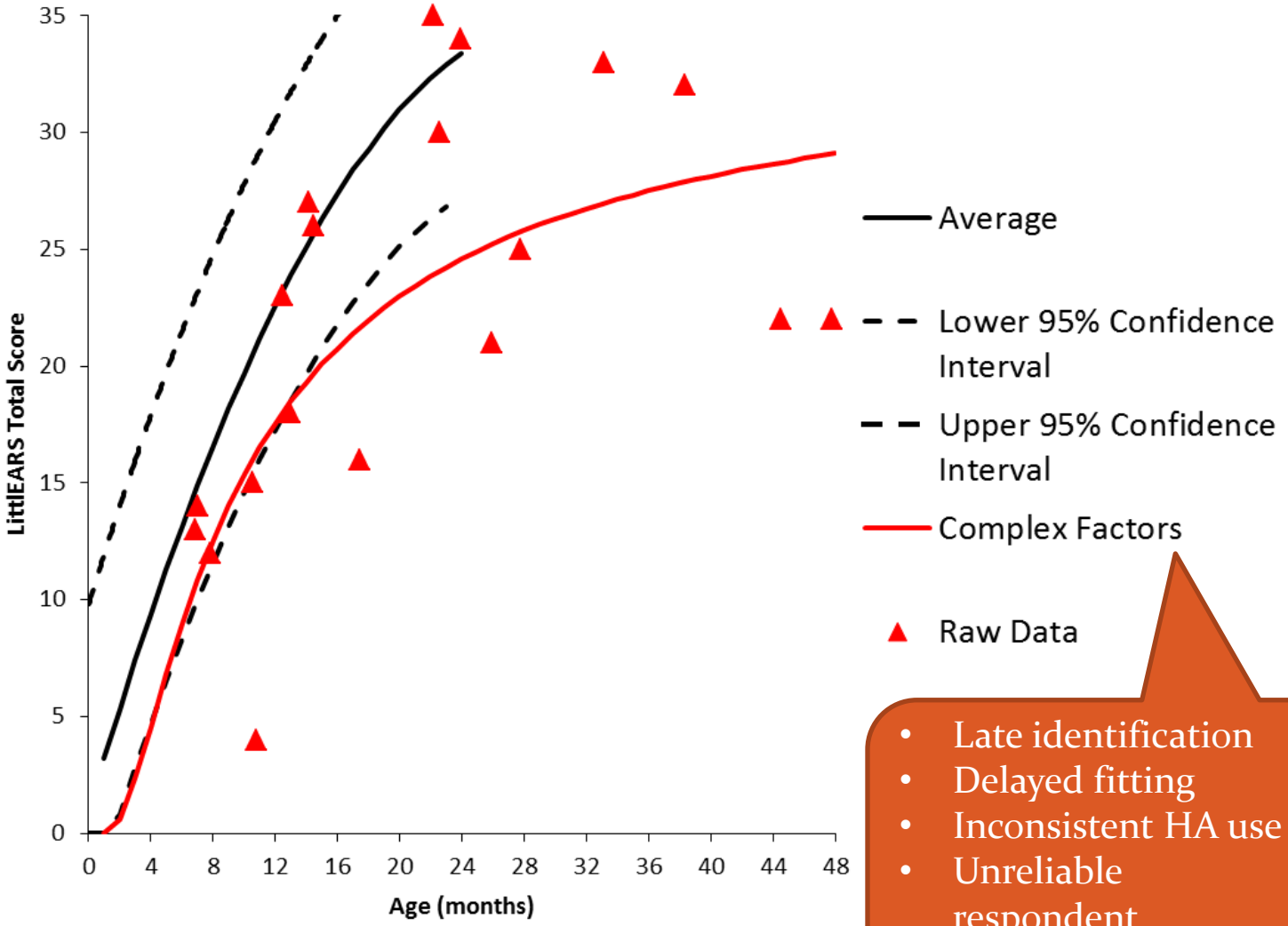
N = 9



- Cerebral Palsy
- Autism
- Syndrome
- Impaired Vision
- Other

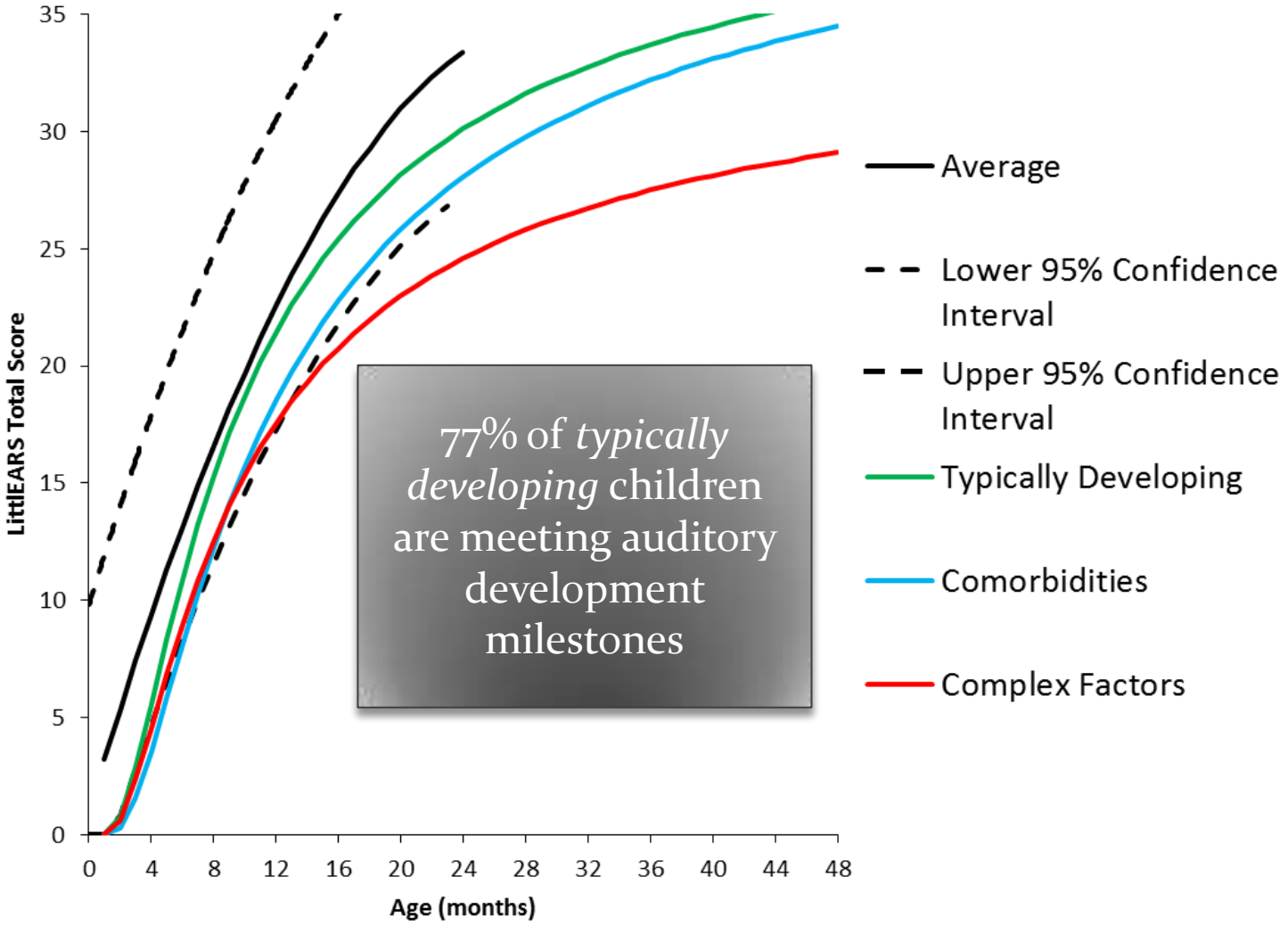
Children with Complex Factors with Hearing Aids

N = 27



- Late identification
- Delayed fitting
- Inconsistent HA use
- Unreliable respondent
- Other

All Profiles of Children with Hearing Aids



LittlEARS Results

- Significant impact of group (i.e., typically developing, comorbidities, complex factors) on LittlEARS scores
  - $p = 0.001$
- Significant impact of overall degree of hearing loss on LittlEARS scores, though not enough data to analyze by subgroup of degree of hearing loss at this time
  - $p = 0.021$

LittlEARS Conclusions

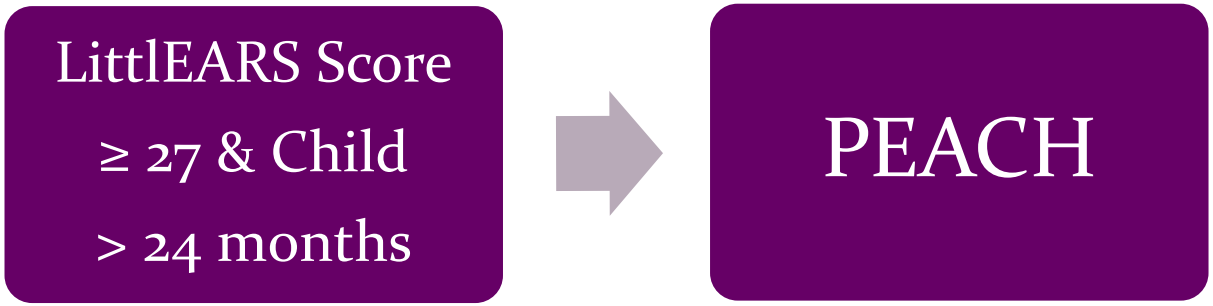
- More data required to further understand special populations (i.e., severe comorbidities, mild/moderate comorbidities, complex factors)

- Majority of typically developing children who have been fitted with hearing aids following an evidence-based protocol are meeting auditory development milestones similar to their normal hearing peers

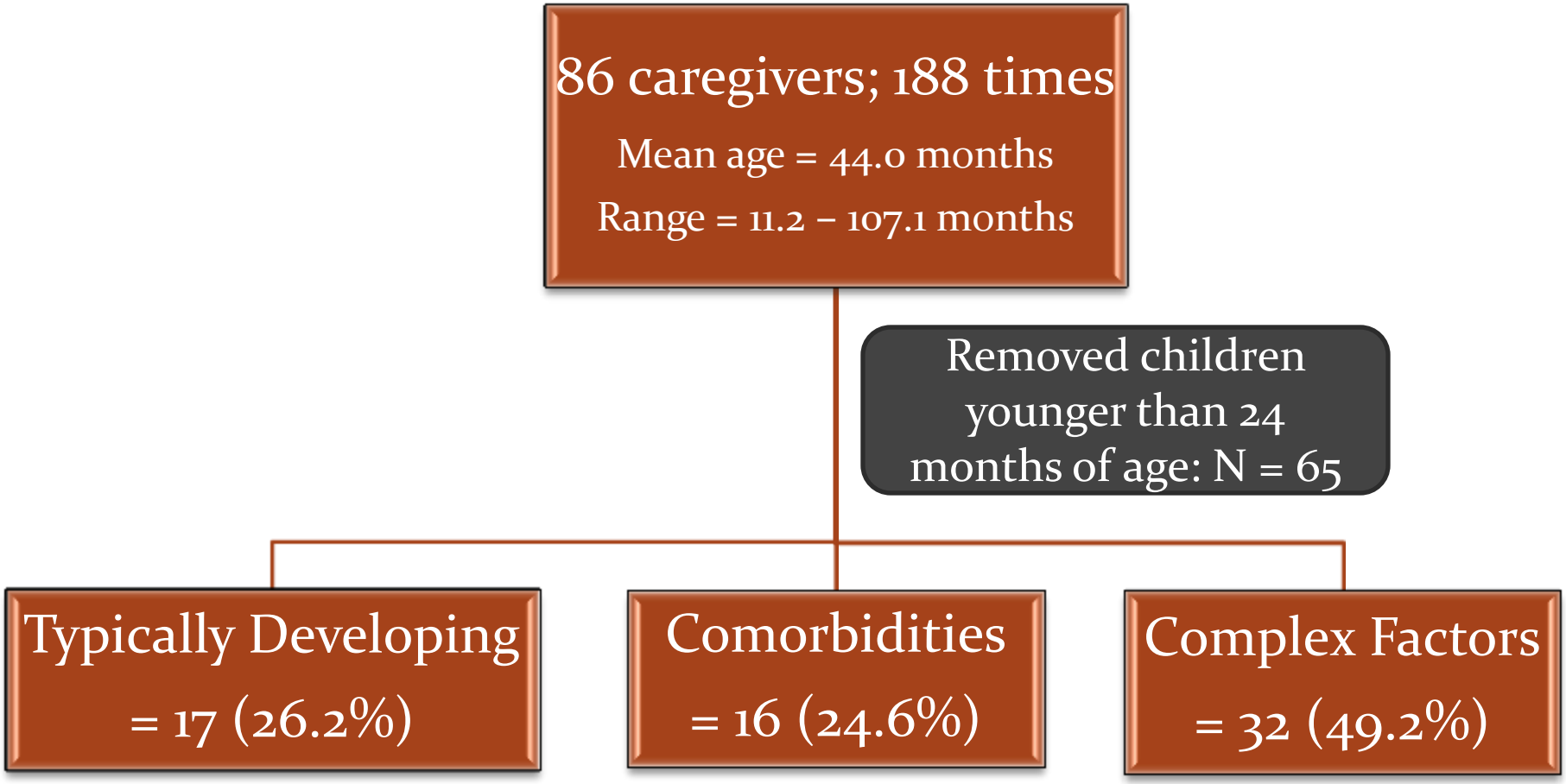
Interpretation

- Provides information regarding the child's auditory development in relation to normal hearing peers
  - Monitoring unaided children
- With repeated administrations provides a description of the child's progress
  - In relation to individual and normal hearing peers
  - Can contribute to the overall profile of the child

Two-Stage Outcome Measurement Process

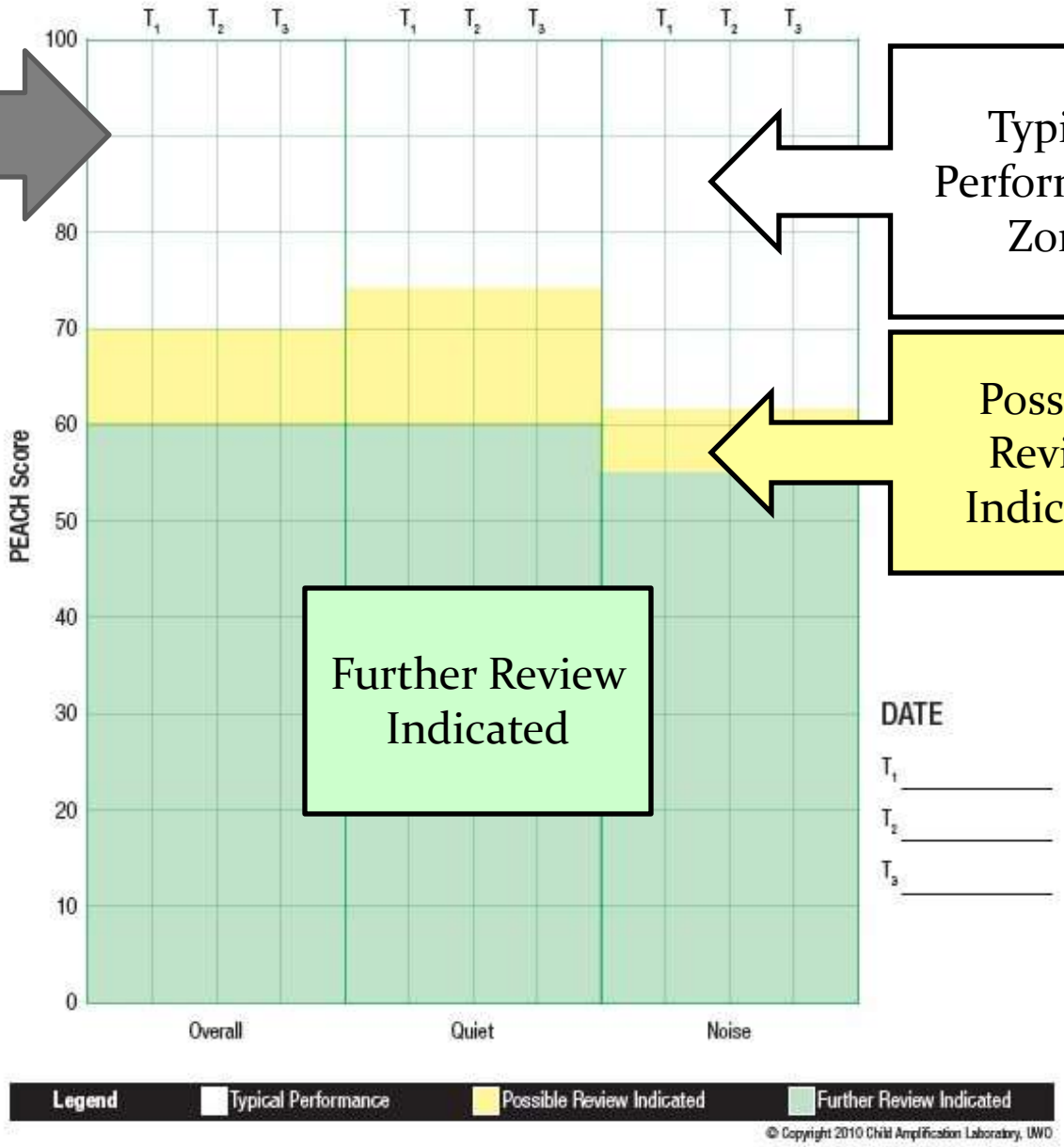


Administration of PEACH



PEACH Scoring

Normal hearing children perform here (90%) by 3 yrs (Ching & Hill, 2005).

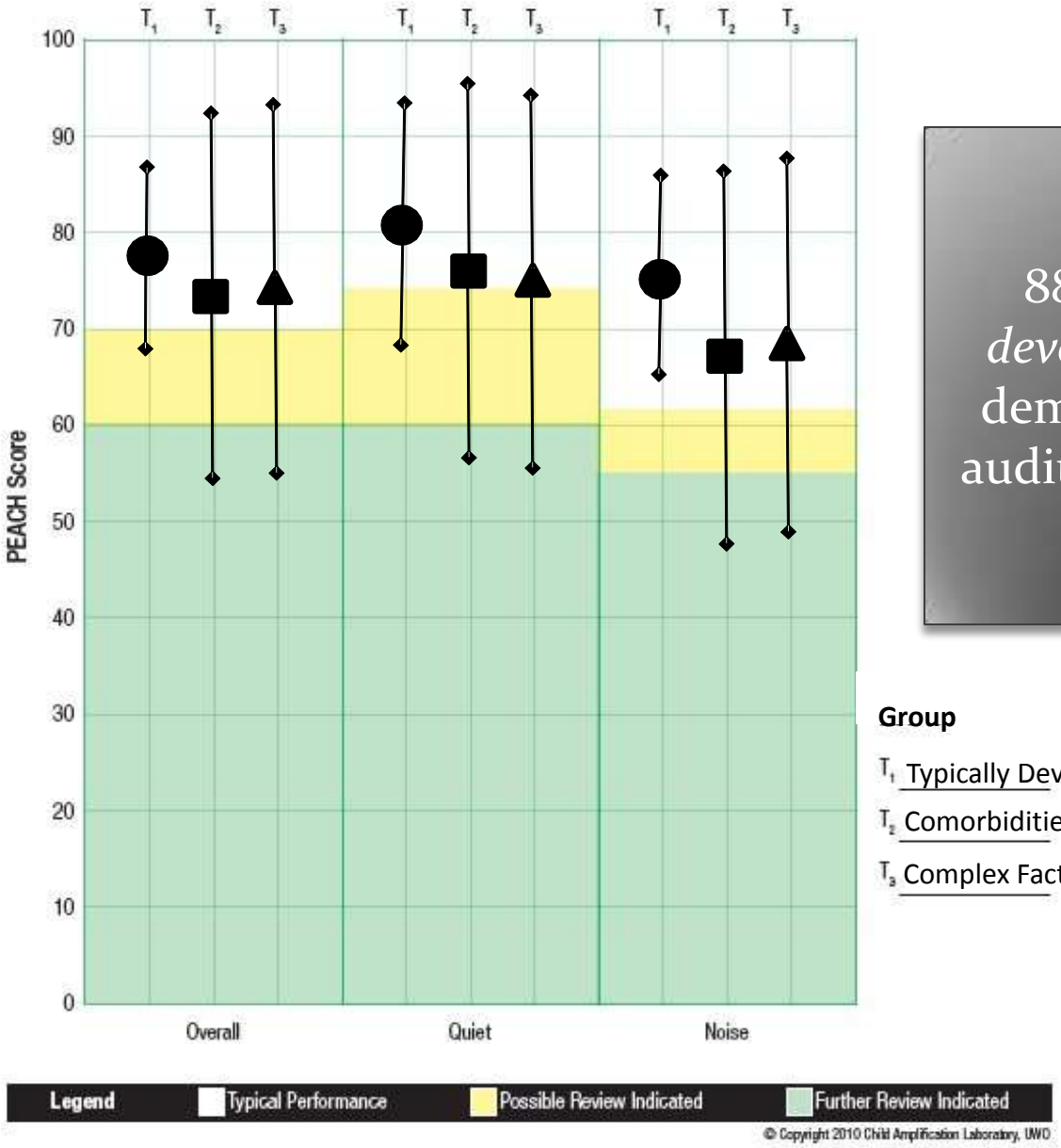


Typical Performance Zone

Possible Review Indicated

Further Review Indicated

PEACH Scores for Children with Hearing Aids



88% of *typically developing* children demonstrate typical auditory performance

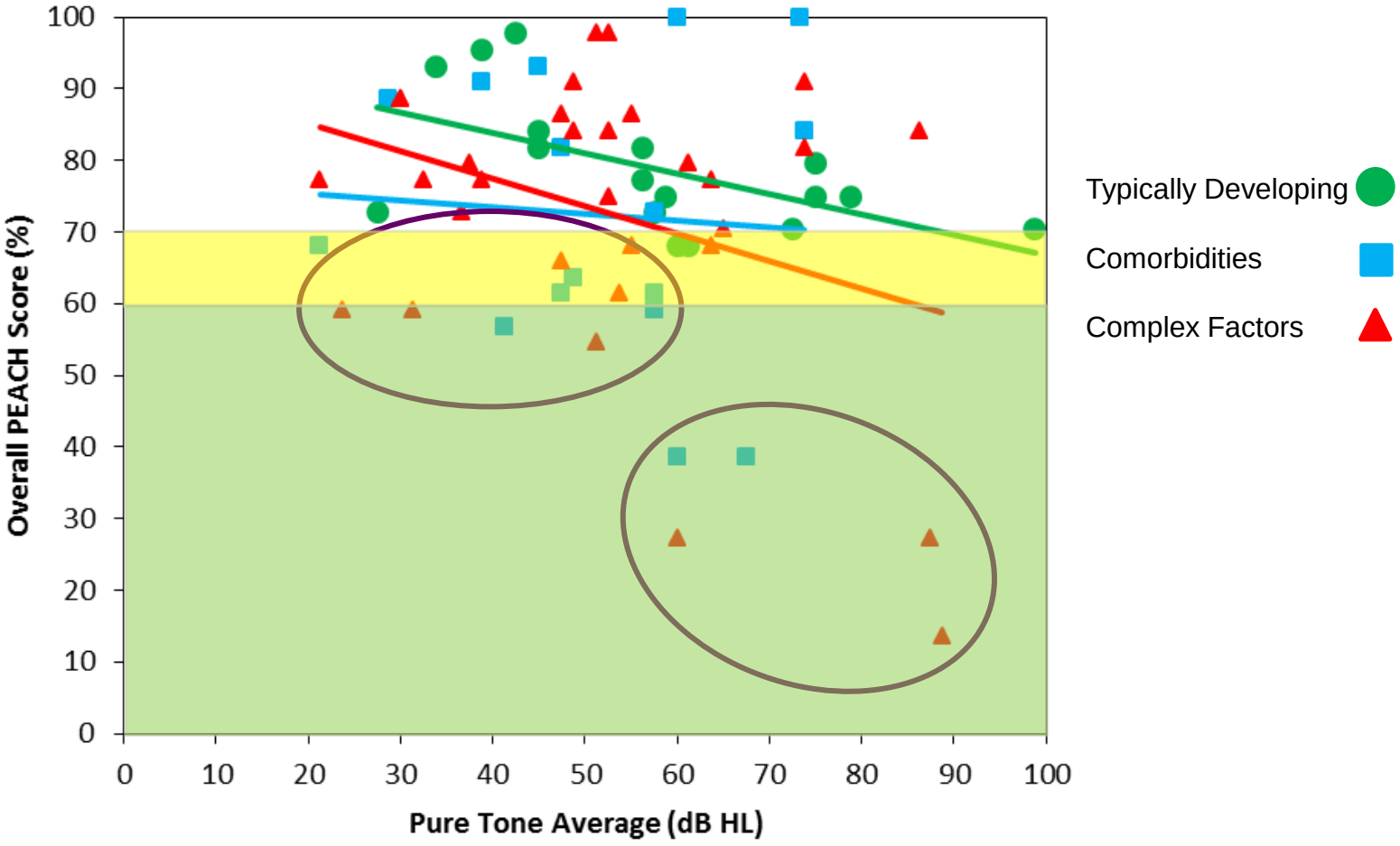
Group

T_1 Typically Developing

T_2 Comorbidities

T_3 Complex Factors

Significant Effect of Degree of Hearing Loss



PEACH Results

- Significant effect of age on PEACH scores (p = 0.026)
  - Supports administration guideline to administer LittlEARS until ceiling score reached and child is >24 months of age
- Degree of hearing loss impacts PEACH scores
  - As hearing loss increases, PEACH scores decrease
  - Group effect by hearing loss level yet to be determined
- No effect of group on PEACH scores yet
  - $p > 0.05$

PEACH Conclusions

- Majority of typically developing children who are fitted with hearing aids following an evidence-based protocol show typical auditory performance

- Children with comorbidities and complex factors have lower scores than typically developing children
  - Further data collection required to characterize scores for these subgroups

Study Outcomes

- Typically developing children with hearing aids demonstrate good auditory development and performance when evidence-based hearing aid fitting protocols are followed

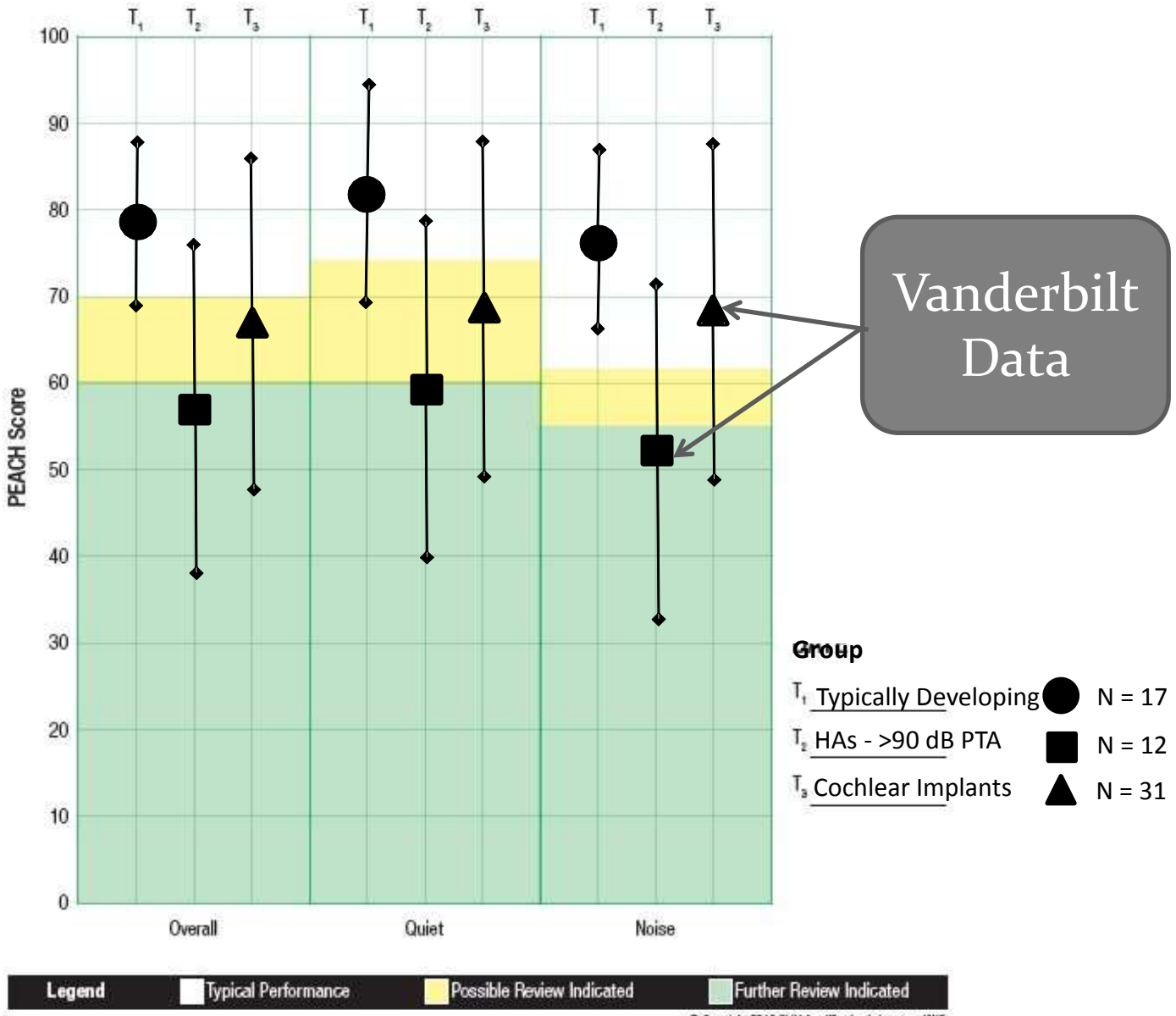
- Children with comorbidities or complex factors related to hearing aid use show poorer performance than those who are typically developing

- Further data is required to characterize the performance of special populations
  - By group
  - By degree of hearing loss
  - Outcomes over time

Further Research

- Collaboration with Vanderbilt University
  - Rene Gifford, Andrea Hedley-Williams, et al.
- Data from specific groups:
  - children who wear hearing aids
  - children who wear cochlear implants
- To better understand outcomes for each group

PEACH Scores for Children with Hearing Aids & Cochlear Implants



Advantages of Subjective Outcome Measures

- Families become good observers of their child's auditory behaviours in the real world
- Families develop a shared language with the clinician
- Can be conducted with children who have complex needs
- No special equipment required
- Available in several languages
  - Use interpreter if needed

Objective Outcome Measures

Ling 6 Detection

Scollie et al, 2012

UWO Plurals

Glista et al, 2012

The Ling 6 Sounds

- /m/, /u/, /a/, /i/, /ʃ/, and /s/
  - These span the speech frequencies

- Originally proposed for live voice use by therapists:
  (see Ling, 1989 for more detail)
  - Probe whether child can detect all sounds
  - Probe whether child can discriminate the sounds
  - Do these prior to every therapy session
    - Protects against running a therapy session during a period of hearing aid malfunction, etc.

In Current Practice

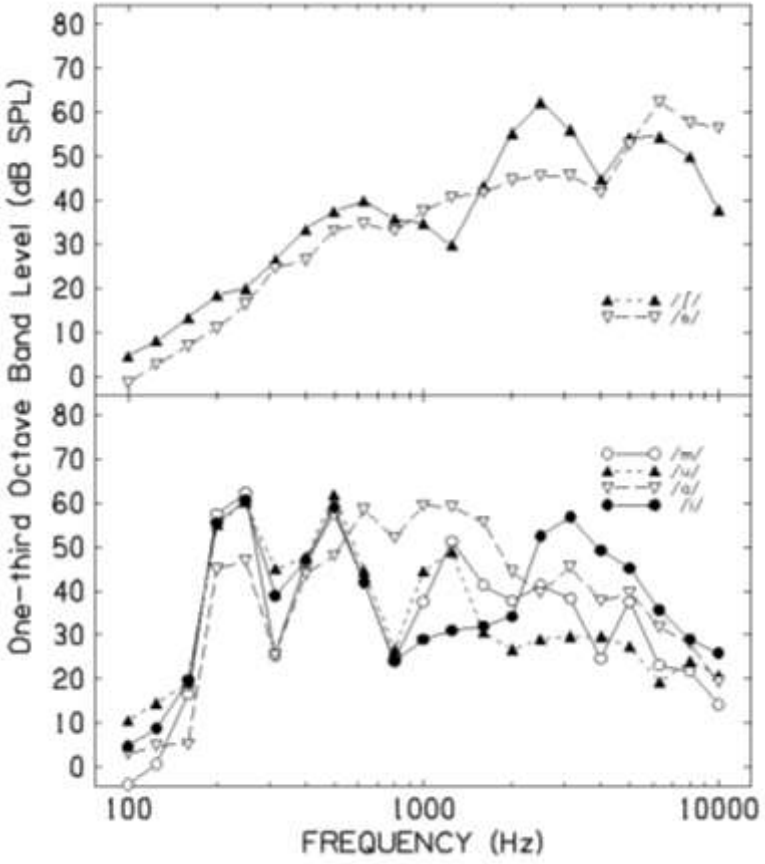
Suggested Use	Details
Aided detection task for infants who wear hearing aids	Confirm reception of sound Demonstrate efficacy to parents Not discrimination or identification
To determine if hearing aid bandwidth/dsp provides access to all 6 Ling sounds	Effects of extended bandwidth or frequency lowering Glista et al., 2009; Wolfe et al., 2010; Wolfe et al., 2011
Aided detection task to provide information about device function for fittings that cannot be verified using real ear measurement	Cochlear implants Bone conduction systems Bass-Ringdahl, 2010; Davidson, et al., 2009; Tharpe, Fino-Szumski, & Bess, 2004; Hodgetts, Hakansson, Hagler, & Soli, 2010

A specific tool: Ling 6 (HL)

Scollie et al, 2012

- Pre-recorded female utterances of each sound
- Norms for detection in dB HL in sound field
- Scoring corrections, a score sheet, and a CD

- Normally hearing listeners:
  - Detect the sounds between – 10 and 10 dB HL
  - Have average test-retest reliability of 1 – 2 dB and a range of test re-test of one to two step sizes



Score Sheet

Normal range

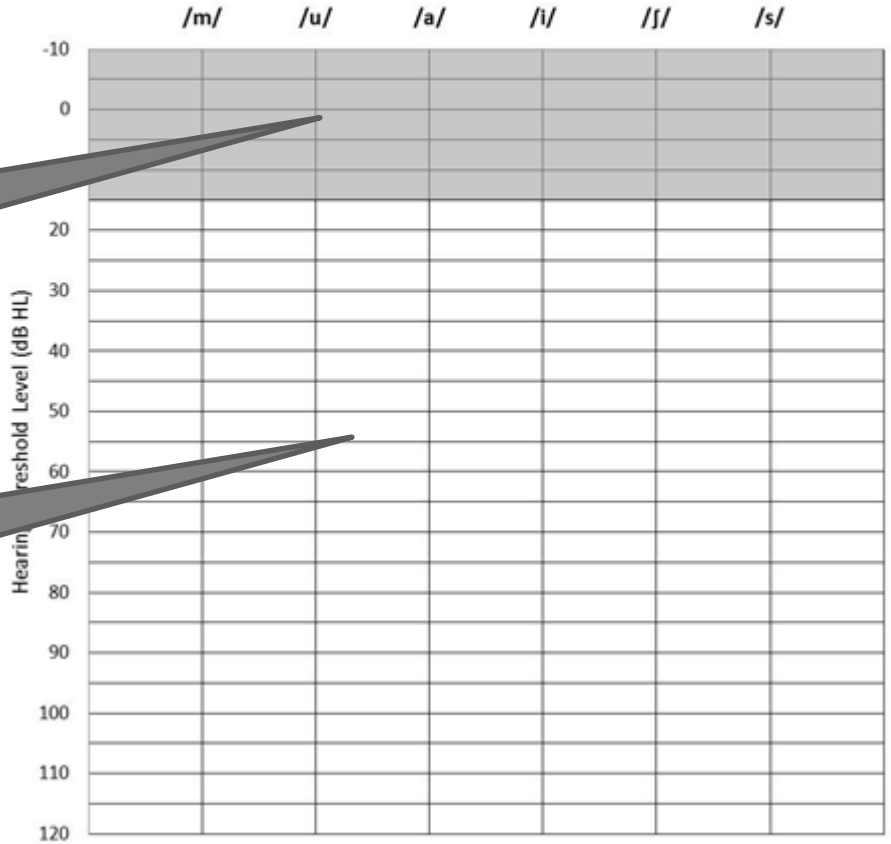
Plot (un)aided thresholds as you would on an audiogram.

Ling-6(HL) Scoring Sheet

Name: _____ D.O.B: _____
Date: _____ Respondent: _____
Notes on testing conditions: _____

Test method:	❑Standard	❑CPA	❑VRA	
Reliability:	❑ Good	❑ Fair	❑ Poor	
Test type:	❑Aided	❑Unaided	❑CI	❑ Bone conducted ❑ BAHA
Masking (unaided ear)?	❑n/a	❑ Yes	❑ No	

Plot the corrected threshold values in dB HL below.



Grey region shows the normal hearing range.
Values assume binaural sound field testing at zero degrees azimuth.

Sample Case

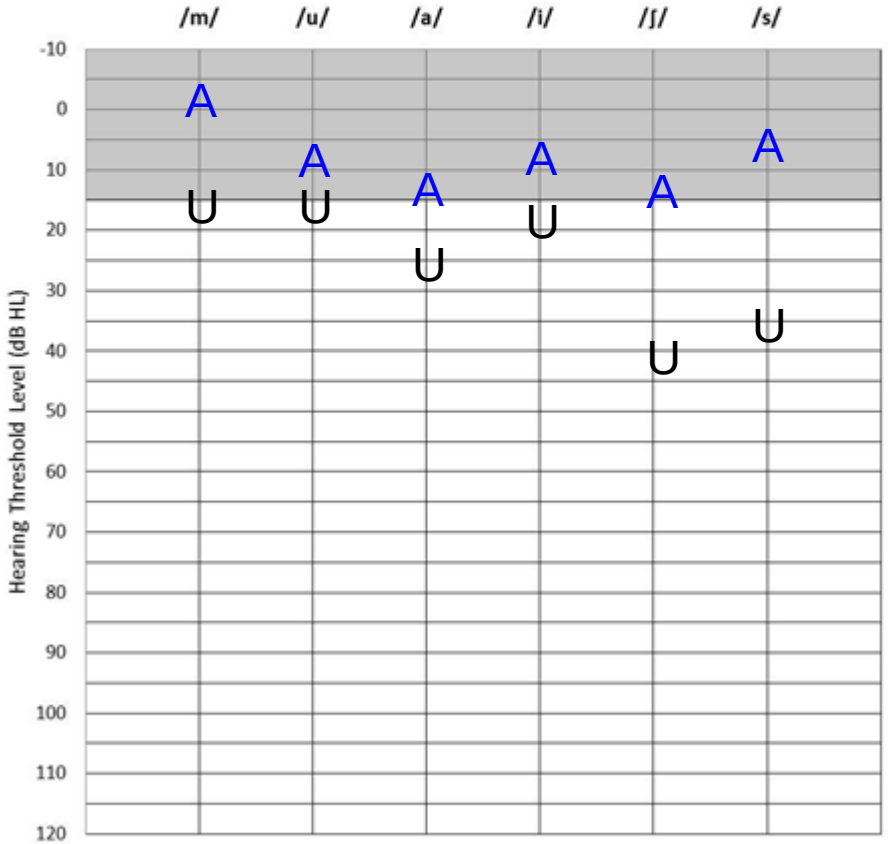
- Age 3 yrs 6 mos
  - Moderate SNHL bilaterally
- Fitting: DSL v5.0
- Standard audiometry, good reliability on Ling6

Ling-6(HL) Scoring Sheet

Name:_____ D.O.B:_____
Date:_____ Respondent:_____
Notes on testing conditions:_____

Test method: ❑Standard ❑CPA ❑VRA
Reliability: ❑ Good ❑ Fair ❑ Poor
Test type: ❑Aided ❑Unaided ❑CI ❑ Bone conducted ❑ BAHA
Masking (unaided ear)? ❑n/a ❑ Yes ❑ No

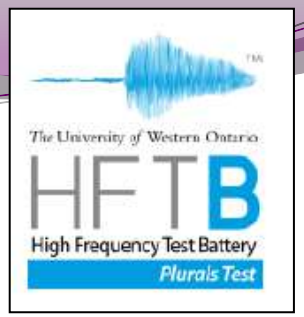
Plot the corrected threshold values in dB HL below.



Grey region shows the normal hearing range.
Values assume binaural sound field testing at zero degrees azimuth.

The UWO Plurals Test

Glista et al, 2012



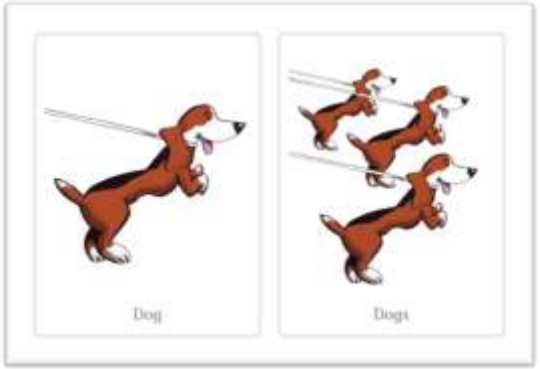
- Developed to be similar to a research task used in evaluating hearing aid bandwidth at Boys Town Stelmachowicz, Pittman, Hoover, & Lewis, 2002

- Nouns in singular & plural form at a high SNR
  - The task is to hear the word-final fricative
  - Sensitive to high frequency audibility

- UWO version uses 15 nouns: ant, balloon, book, butterfly, crab, crayon, cup, dog, fly, flower, frog, pig, skunk, sock and shoe
  - Pre-recorded, calibrated, available on a CD with scoring and interpretation guidelines

Administration

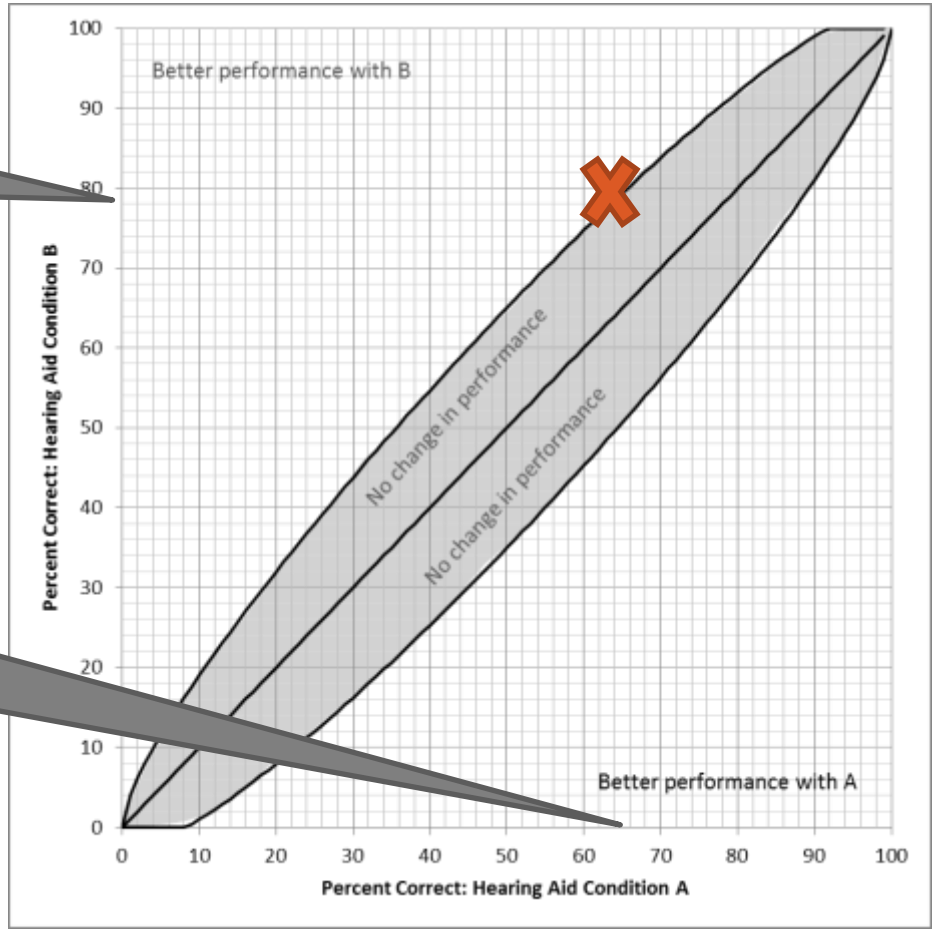
- Present at an overall level of about 55 dB(A)
  - This represents speech at a slightly soft level
- A background noise is built-in
  - Ten randomized lists are provided
- Use picture flip cards to administer using a pointing response
  - This is helpful if the child's own productions of the word would be unclear
  - Tip: pre-sort the cards into the correct random order for the list(s) you will use



Scoring & critical differences

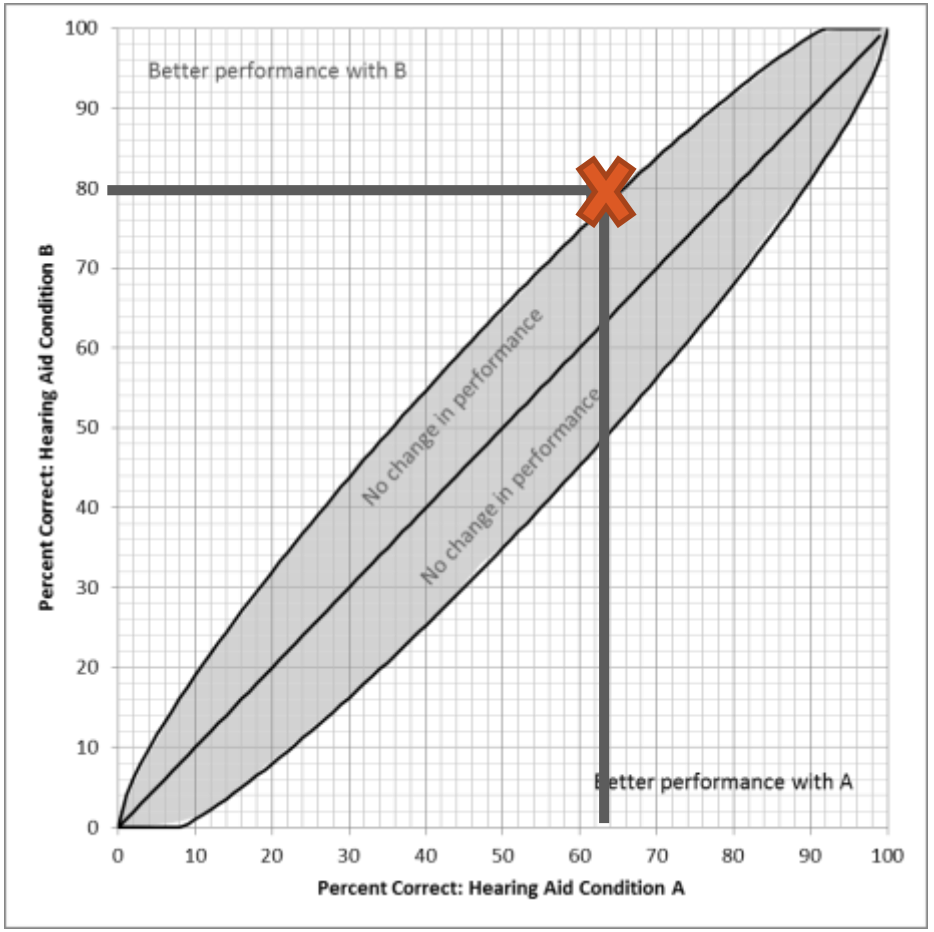
Aided test #2, after re-adjusting: 79% correct

Aided test #1: 64% correct



Scoring & critical differences

- The plotted score falls outside the shaded region and is therefore significantly better
- The re-adjustments improved the score significantly
- Note that this test does not assess correct speech sound identification



Review of Tests

- Ling 6 (HL) can assist in determining if a hearing aid fitting provides access to all 6 sounds
  - Potential for use with young children and infants
  - Further research is being conducted to determine impact across multiple listening conditions (e.g., with insert earphones and at different azimuths)

Review of Tests

- UWO Plurals Test is sensitive to differences in aided audibility of high-frequency bandwidth
  - Limited to use with children and adults
  - Can help determine performance differences across hearing aid fittings that differ in the highs (e.g., frequency lowering)

- Both tests are limited to measuring speech sound detection and do not tell you about speech recognition or discrimination

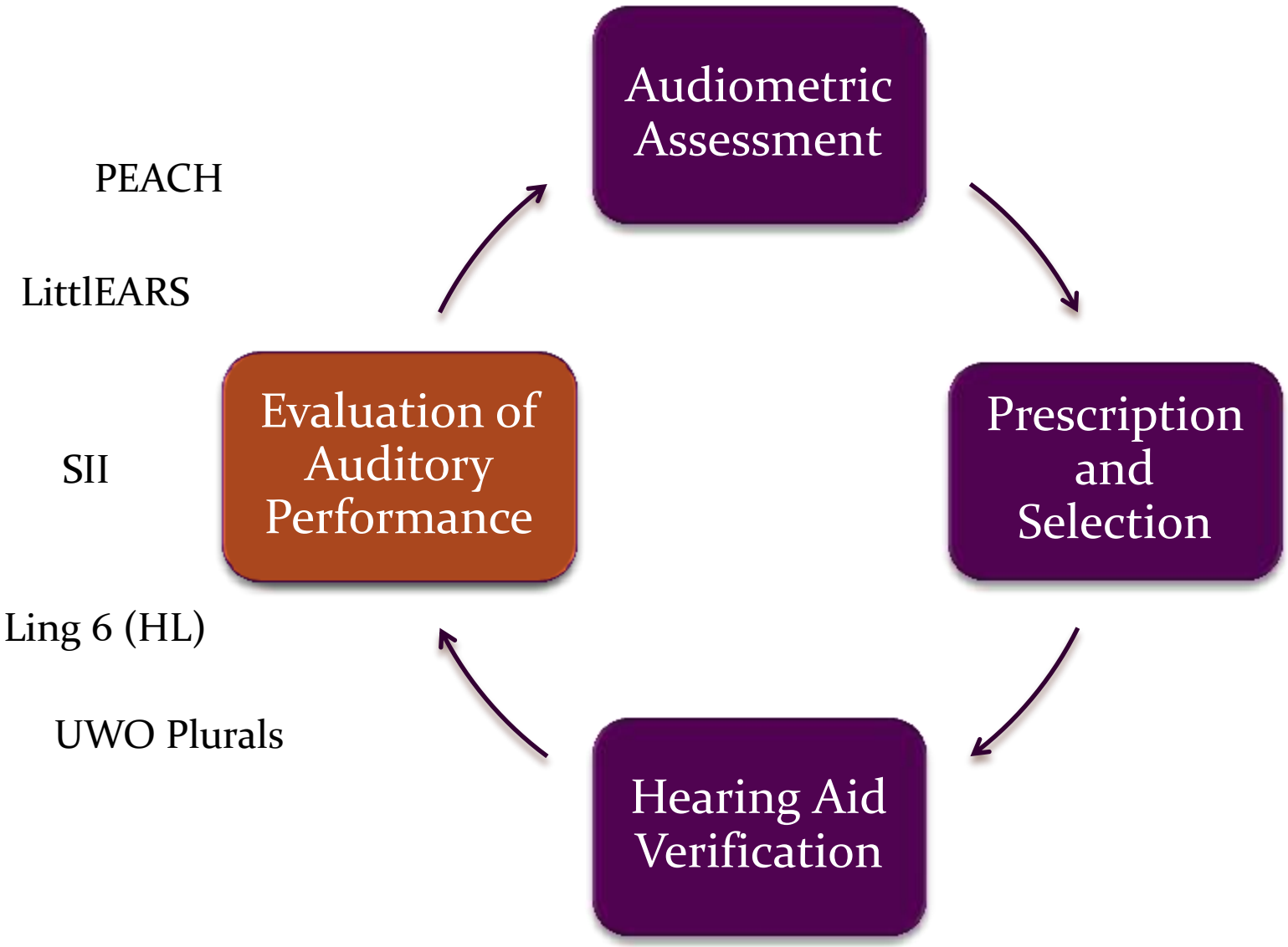
Advantages of Objective Outcome Measures

- Direct measure of child's hearing in aided and unaided conditions
  - Demonstrations to the family
- Most clinics already have the needed equipment
- Useful to combine with subjective measures to give comprehensive description of outcome

Importance of Outcome Evaluation

- Patients
  - Track and monitor
  - Involve parents – result: good observers
  - Shared language
- Audiologists
  - Way to measure impact of hearing aid fitting
  - Improve efficiency and effectiveness of service delivery
  - Improve communication with families and professionals
- EHDI
  - Measure how program is doing
  - Helps describe patterns that affect children within the program

Process of Pediatric Hearing Aid Fitting



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