# Influence of Auditory Experience on the Outcomes of Children with Hearing Aids: ACCESS Matters

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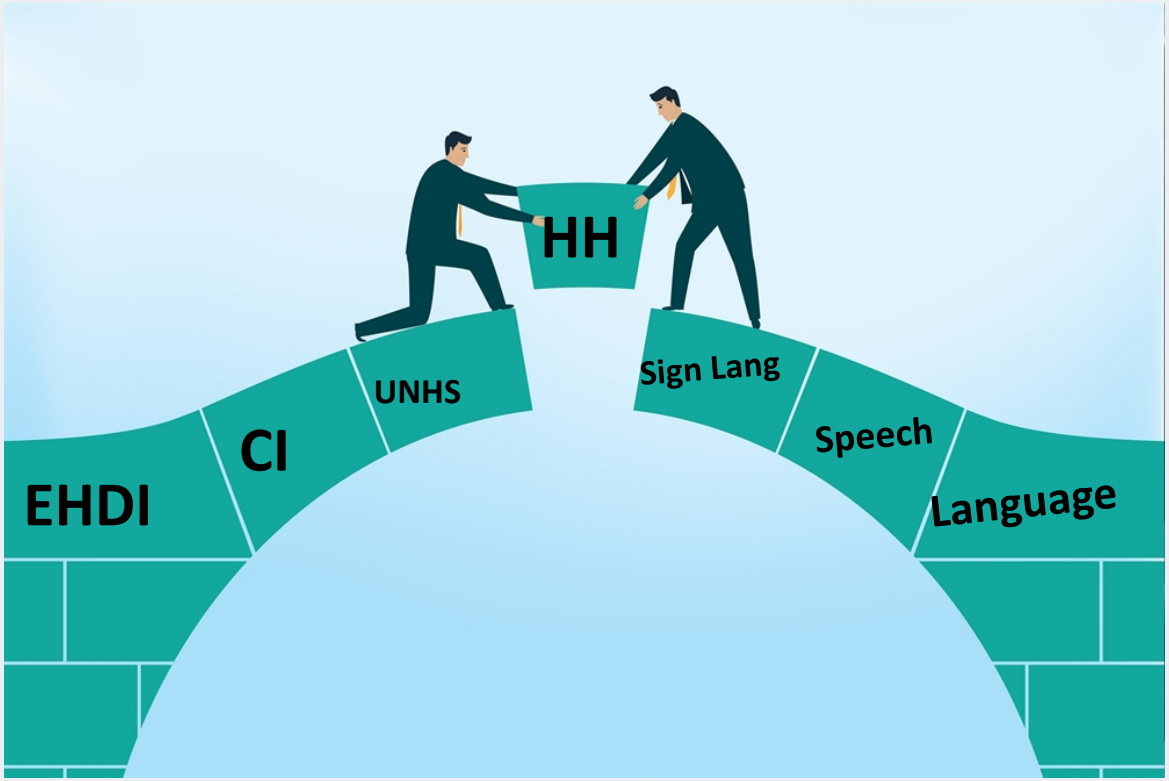
# NIDCD Working Group: Research Gaps




Donahue, *E&H* (2007); Eisenberg et al., *E&H* (2007); Tomblin & Hebbeler, *E&H* (2007)

# Prospective, Multi-site Longitudinal Study

## Need for large, epidemiological sample

-Focused on young children who are HH

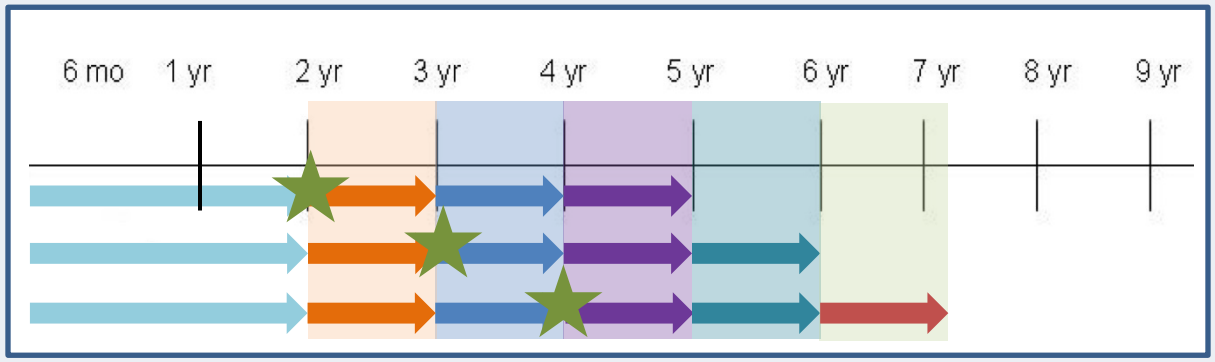
-With early service access

- Are children achieving *expected* outcomes*?*
- What factors influence outcomes?

Outcomes of Children with Hearing Loss

a study of children ages birth to six

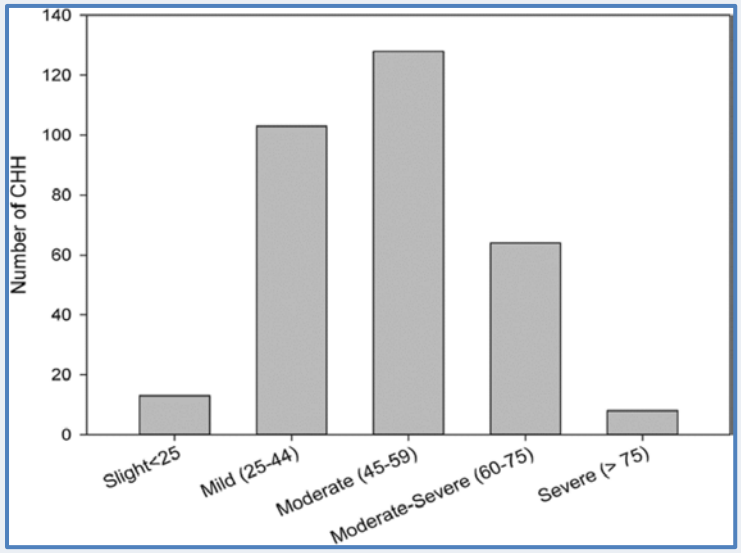
# Accelerated Longitudinal Design

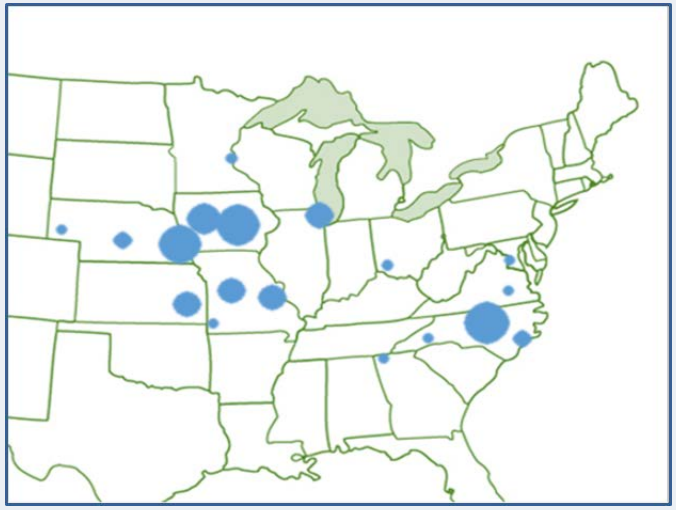



- Inclusion criteria:
  - English spoken in home
  - No significant cognitive or motor delays
  - Permanent bilateral mild to severe HL (25 – 75 dB HL)
  - No cochlear implants

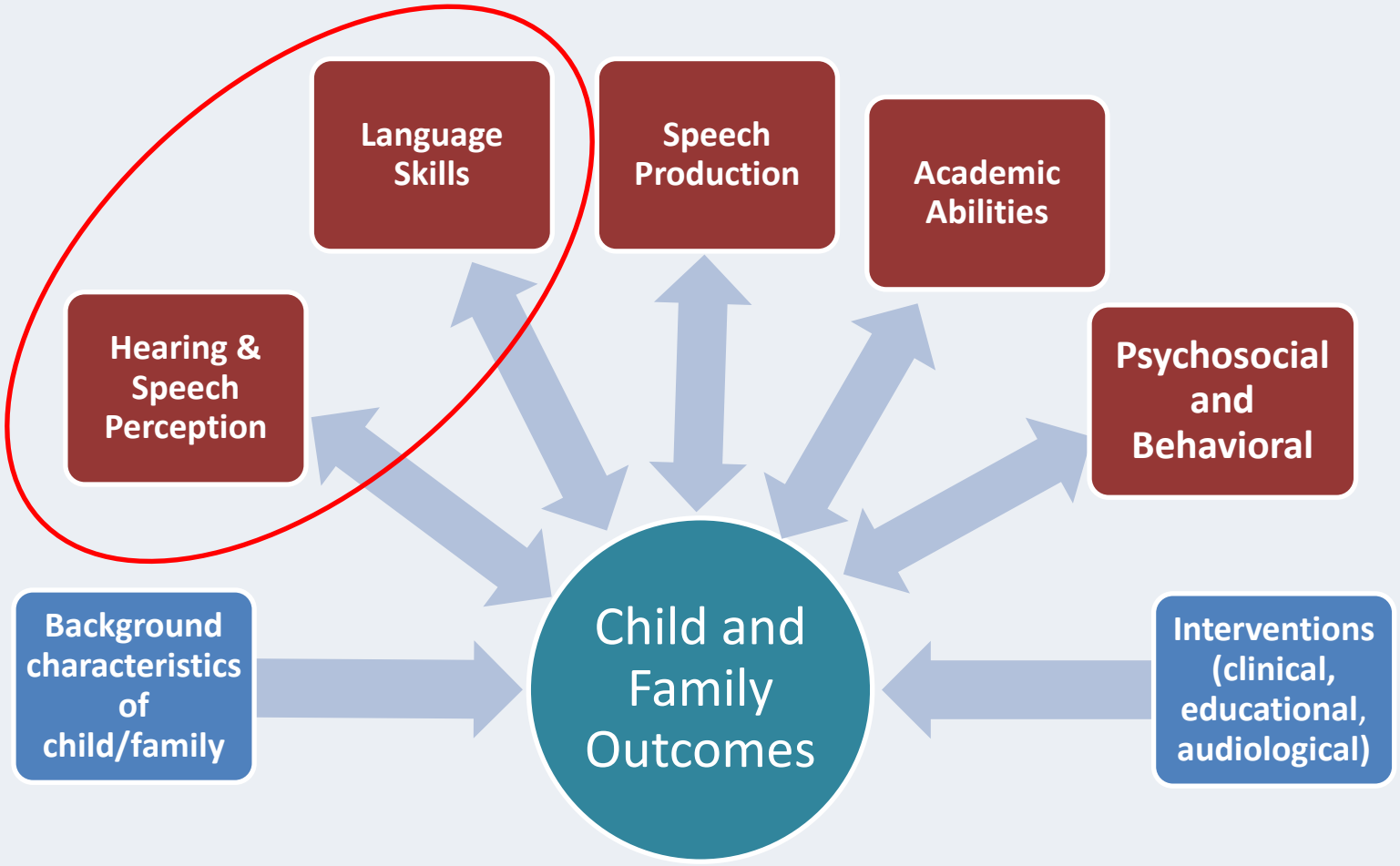
# Participants

| | CHH | CNH | Both Groups |
|---|---|---|---|
| Number | 317 | 117 | Matched on income & maternal education<br>Higher than typical US sample<br>9.78% attrition |
| Gender | 173 male; 144 female | 54 male; 63 female | |
| Hearing | M= 48.88 dB HL<br>7 without amplification<br>76% identified from NHS | < 20 dB HL | |



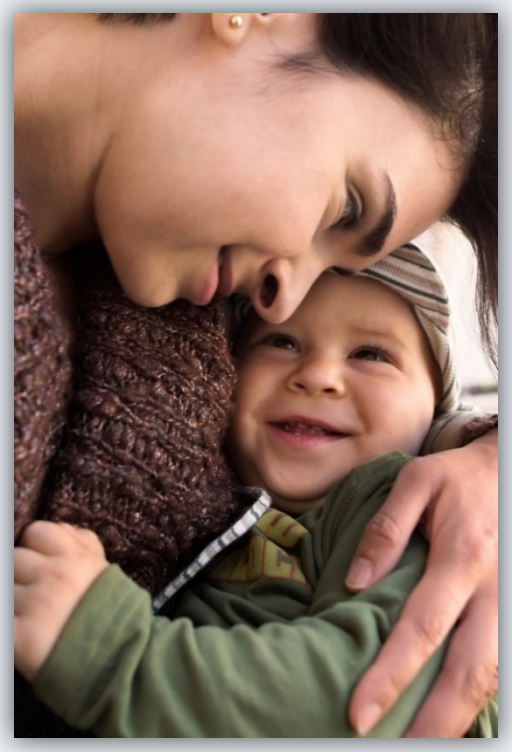
# Comprehensive Outcomes



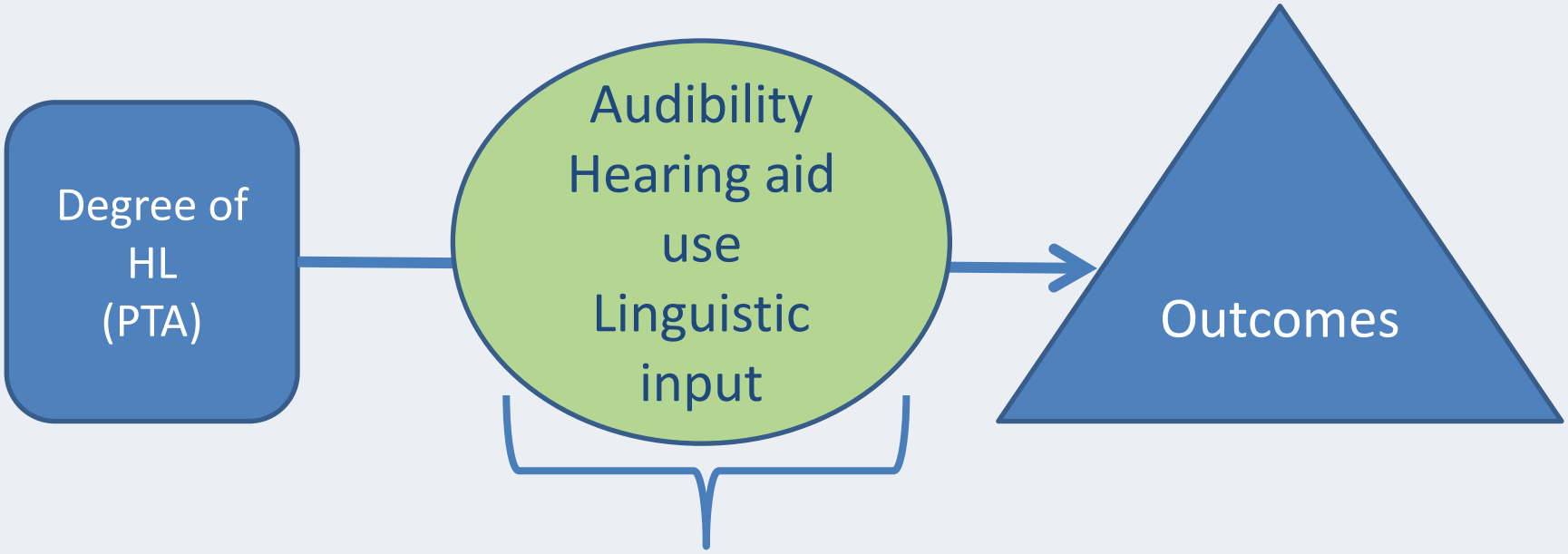

Multiple measures at each age; Derived a **single language score** for each child at each age using Principal Components Analysis (2 to 6 years of age)
Tomblin, et al., *E&H* (2015).

# Access to Linguistic Input

- **Essential for language development in all children**
- **Quality & quantity of exposure matter**
- **Infants use patterns in input to learn**
  - Requires access to acoustic-phonetic properties in the input
  - Constraints on input may reduce learning efficiency



# Proposed Model of Inconsistent Access




Moeller & Tomblin, *E&H* (2015)

# ACCESS: What factors matter?

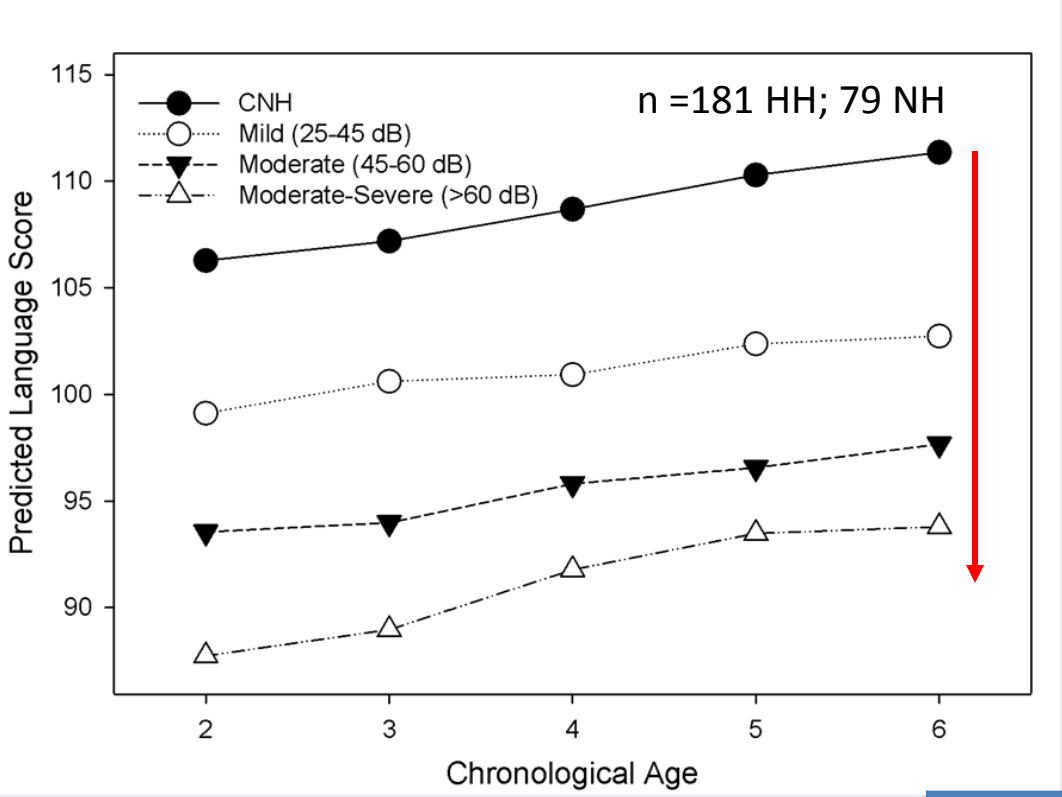
- **A** — **Audibility** is optimized
- **C** — **Carefully fit** and **closely monitored** devices
- **C** — **Consistently worn** devices from early infancy
- **E** — **Environment conducive** to language learning
- **S** — **Selected at-risk areas** of language are a focus
- **S** — **Service provision** is optimized

# ACCESS

What is the evidence?

## AUDIBILITY IS OPTIMIZED

# Developmental Risk Increases with Severity of Hearing Loss

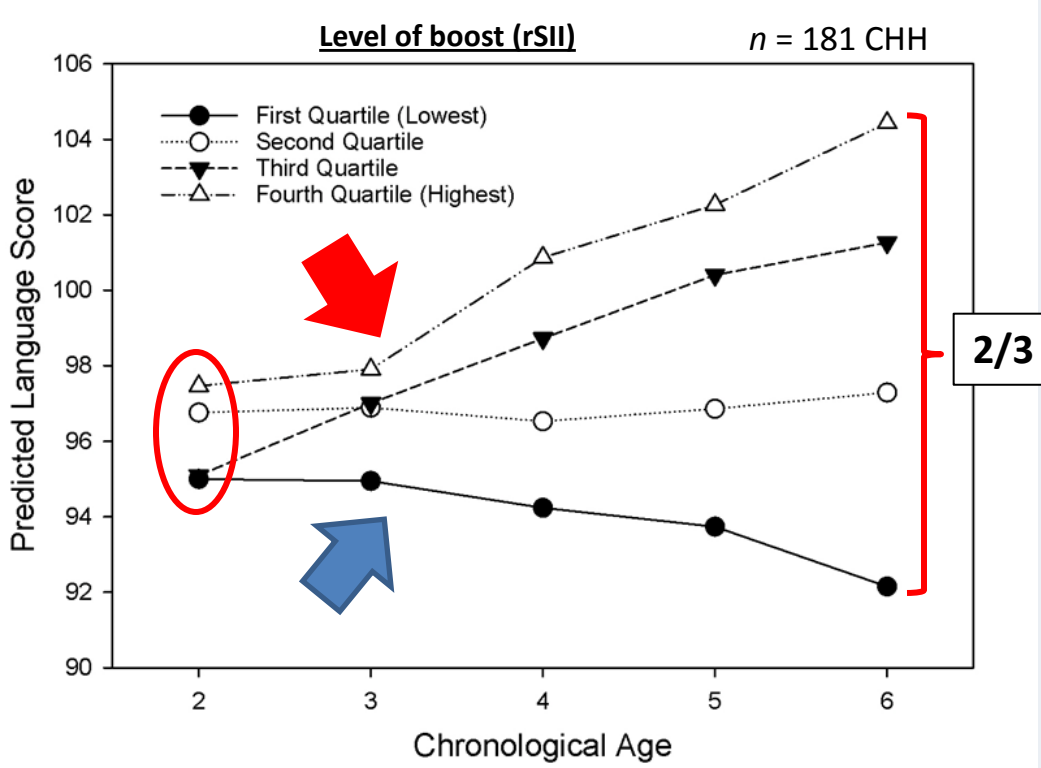



- Systematic relationship between degree of hearing loss and language levels
- All subgroups were significantly different than control group ($p < 0.0001$)

| Predictors | Parameter | *F* value | *p* value |
|---|---|---|---|
| **Maternal education** | | 18.74 | <0.0001 |
| **Age** | 1.0 | 10.62 | 0.001 |
| **Degree of loss (BEPTA)** | -0.32 | 50.72 | <.001 |
| **Age * BEPTA** | 0.0002 | 0 | 0.99 |

Tomblin et al., *E & H* (2015)

# Audibility Contributes to Language GROWTH




- **Quartiles of Aided Benefit**, after controlling for degree of loss
- Audibility did not have an overall effect ($p$ = 0.88), but was **significantly associated with differential growth** ($p$ = 0.009)
- **Benefit holds for mild to severe degrees of HL**
- **Better aided audibility also linked to better word recognition in noise**

**Conclusion: Children who receive the most benefit from HAs show steeper growth in language skills**

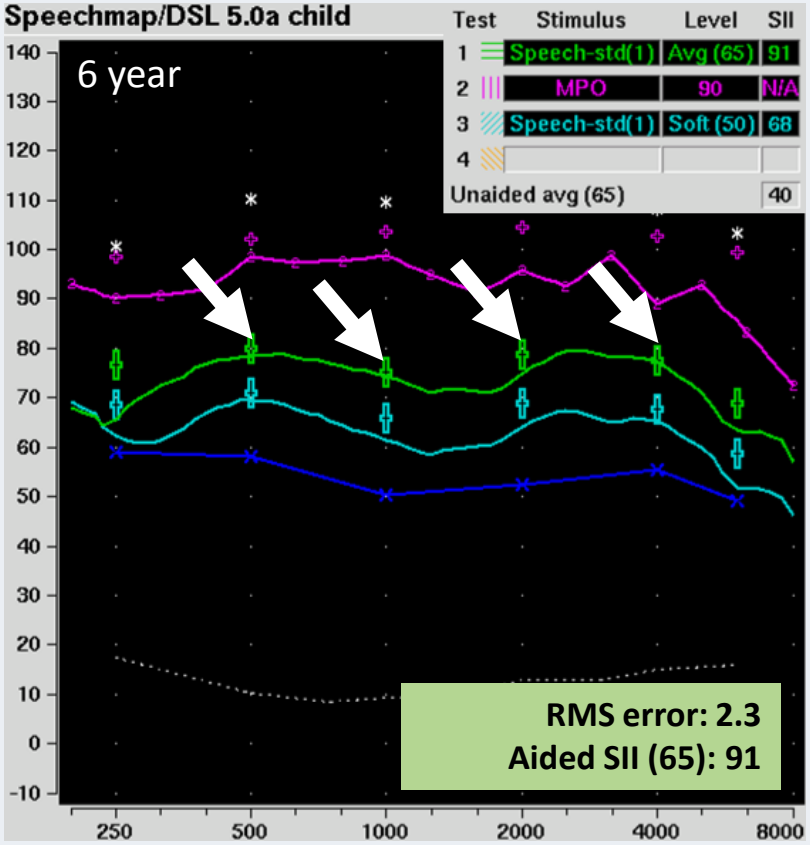
Tomblin, Harrison, Ambrose, Walker, Oleson, & Moeller, *E&H* (2015); McCreery et al., *E &H* (2015)

# ACCESS

What is the evidence?

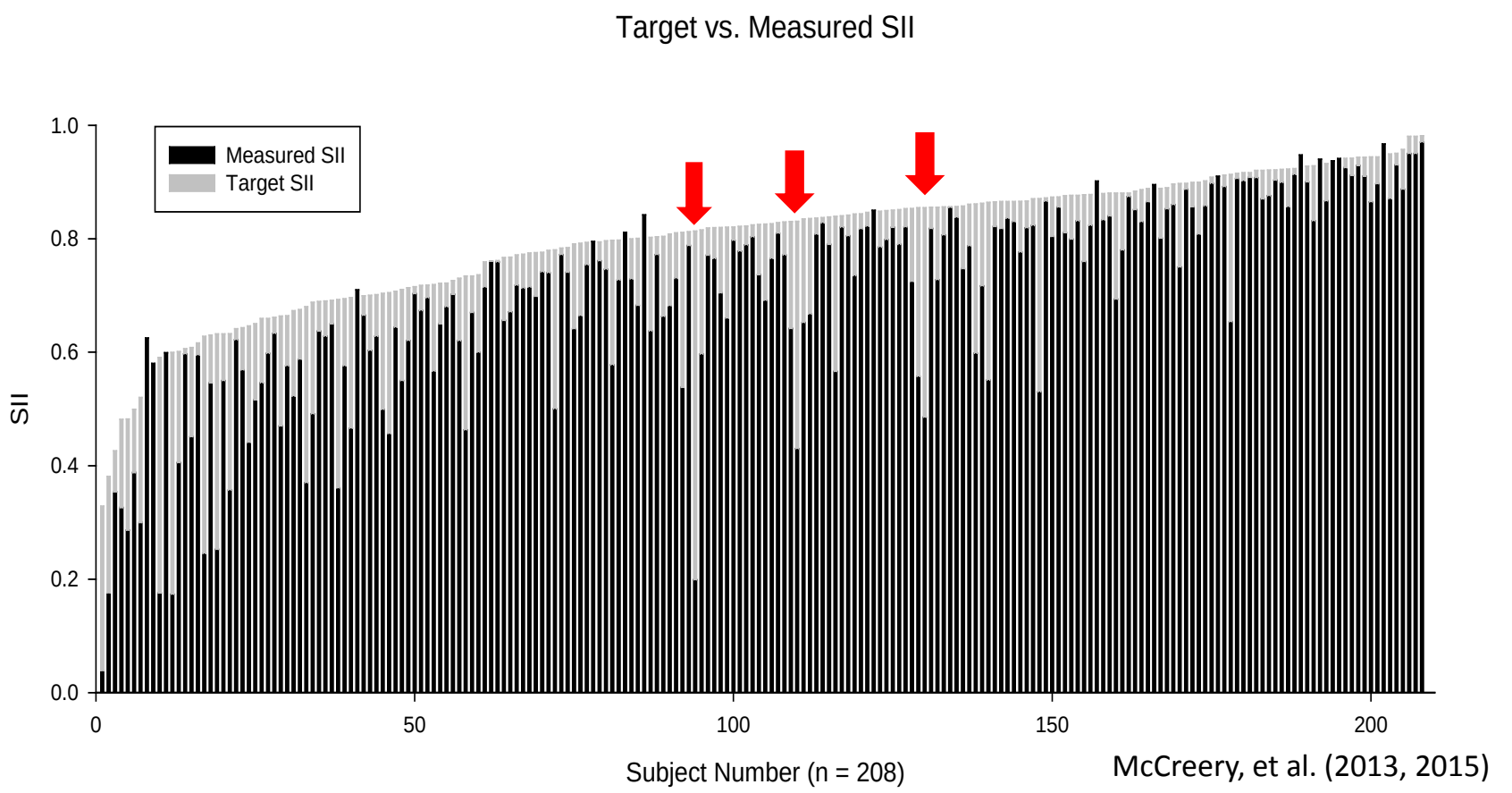
## CAREFULLY FIT AND CLOSELY MONITORED DEVICES

# Better Match to Targets → Better Aided SII




- Fitting compared to DSL targets.
- Calculated RMS error of deviations from target at .5, 1, 2, and 4 kHz.
- RMS error < 5 dB is a good fit.

# Quality of Fit Influences Audibility




Conclusion: Substantial number of HA's could be BETTER fit. This can be improved with best practice and it matters for outcomes.

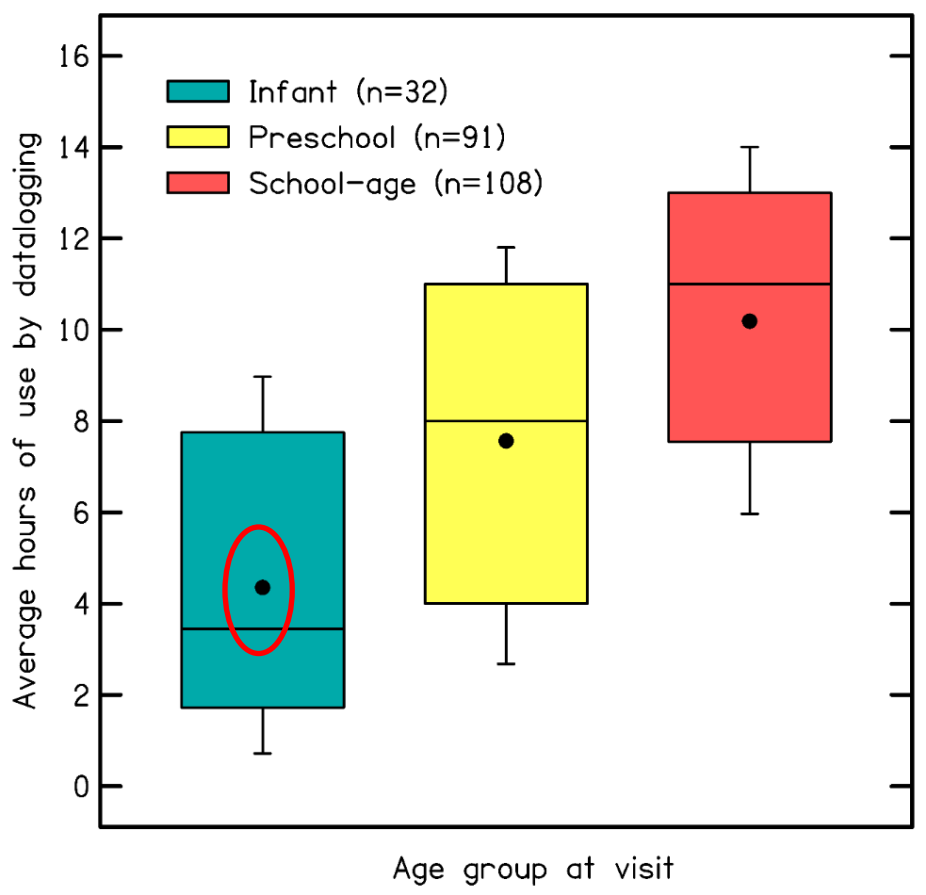
# What Else Accounts for Individual Differences?

ACCESS

What is the evidence?

# CONSISTENTLY WORN DEVICES FROM EARLY INFANCY

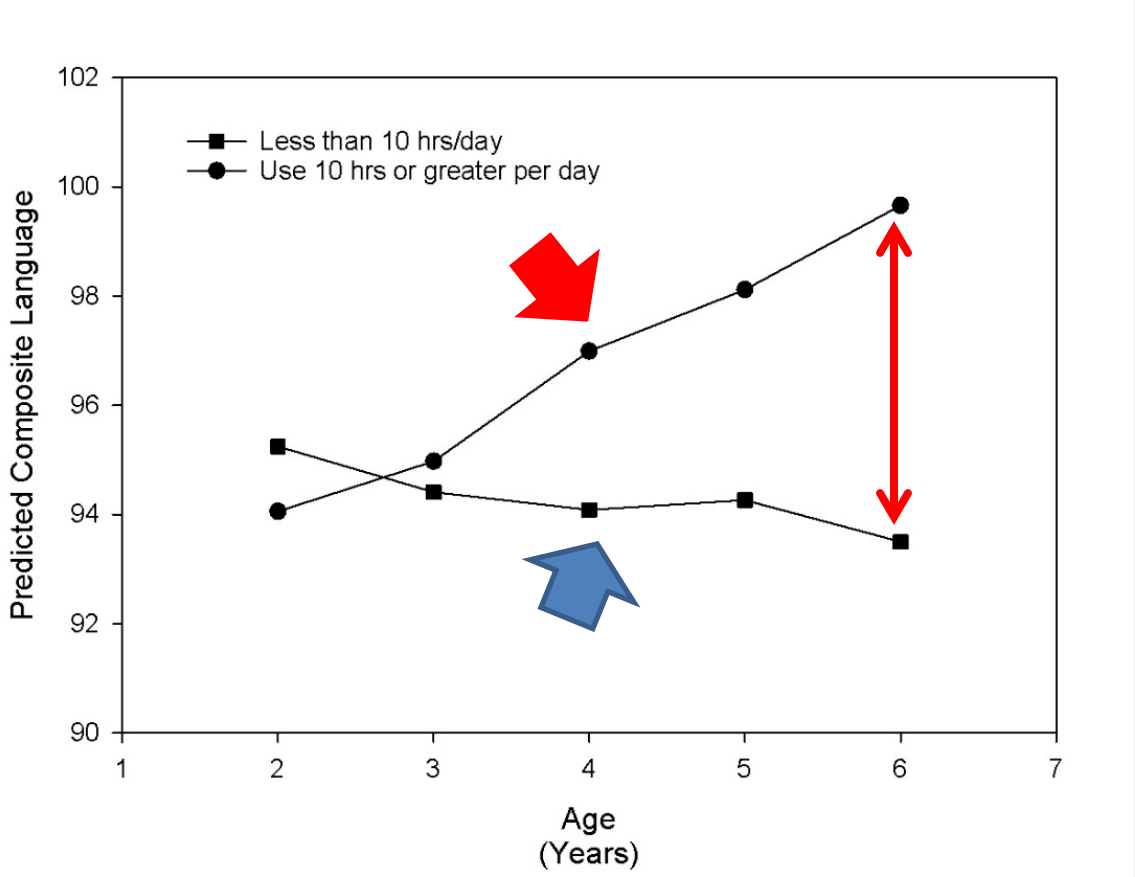
# How Consistently are HAs Worn? (Data Logging by Age Group)




- Maternal education level influential
- Degree of hearing loss influenced use in school-age children

Walker et al., *E & H* (2015)

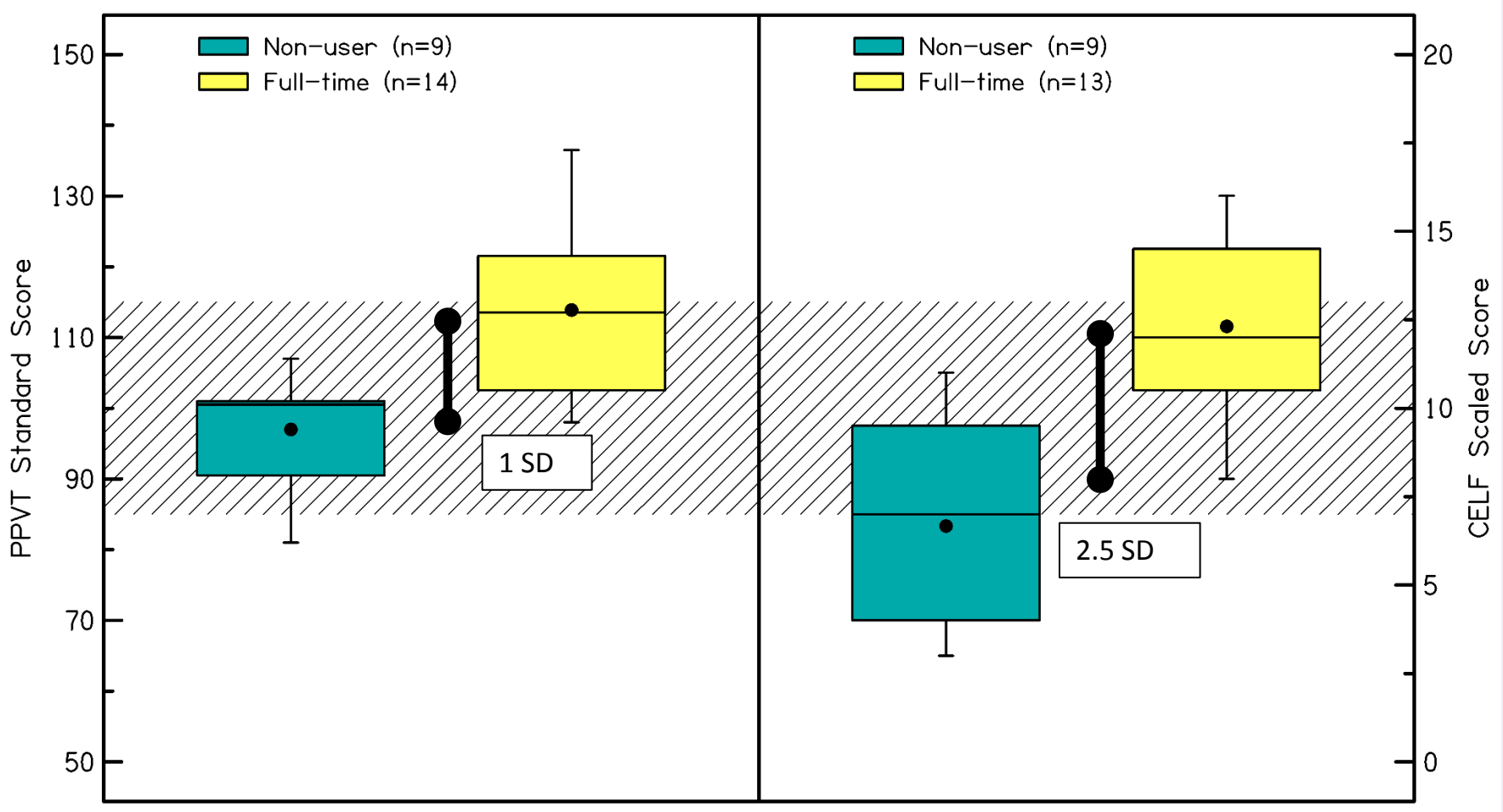
# HA Use Affects Language Growth




Conclusion: Children who wear HAs more than 10 hours/day show steeper growth in language skills than children wearing HAs less than 10 hours/day

Tomblin, Harrison, Ambrose, Walker, Oleson, & Moeller, *E&H* (2015)

# HA Use Reduces Risk in Children with Mild HL




Modified from Walker, et al., *JSLHR* (2015)

ACCESS

What is the evidence?

# ENVIRONMENT IS CONDUCIVE TO LANGUAGE LEARNING

# Conducive Environment

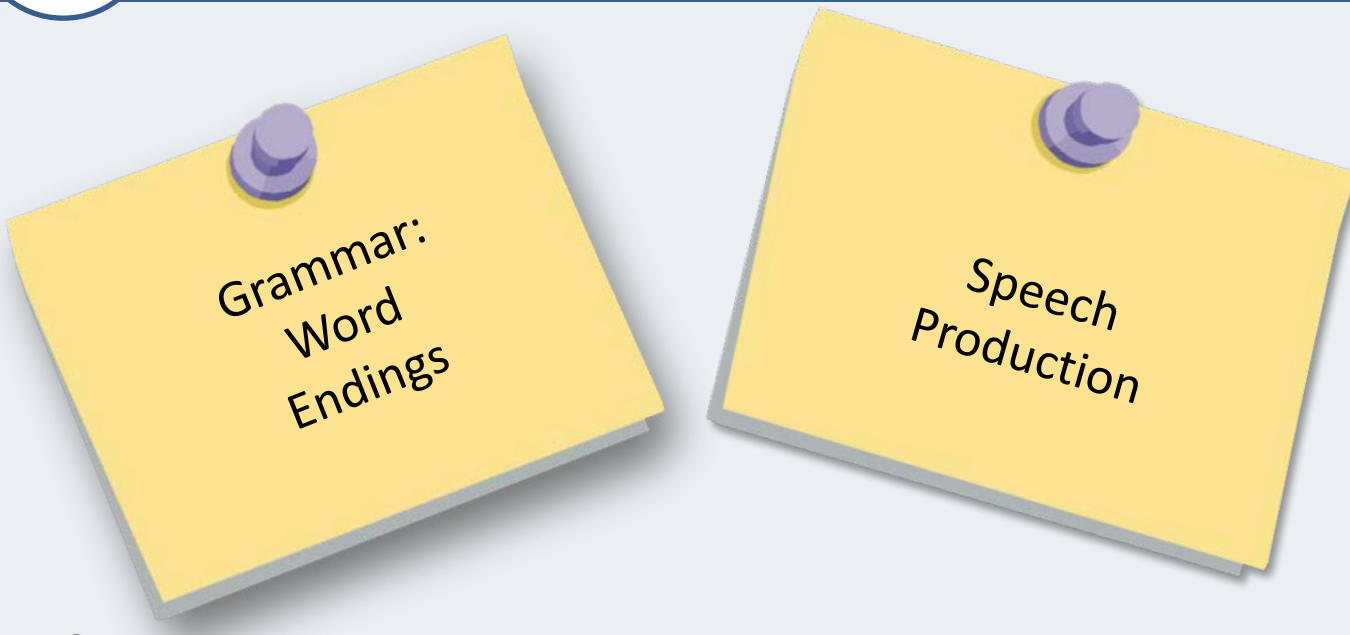
- **Compared parent[illegible] months**
- **CHH exposed to le[illegible]entences**
  - –fewer abstract ideas
  - –more directive statements
- **Use of abstract (higher level) language positively related to language outcomes**
- **Directive use negatively related to outcomes**

I think he is hungry…I wonder what this is.

Say "ball"
Sit down.

Ambrose et al., *E&H* (2015)

ACCESS

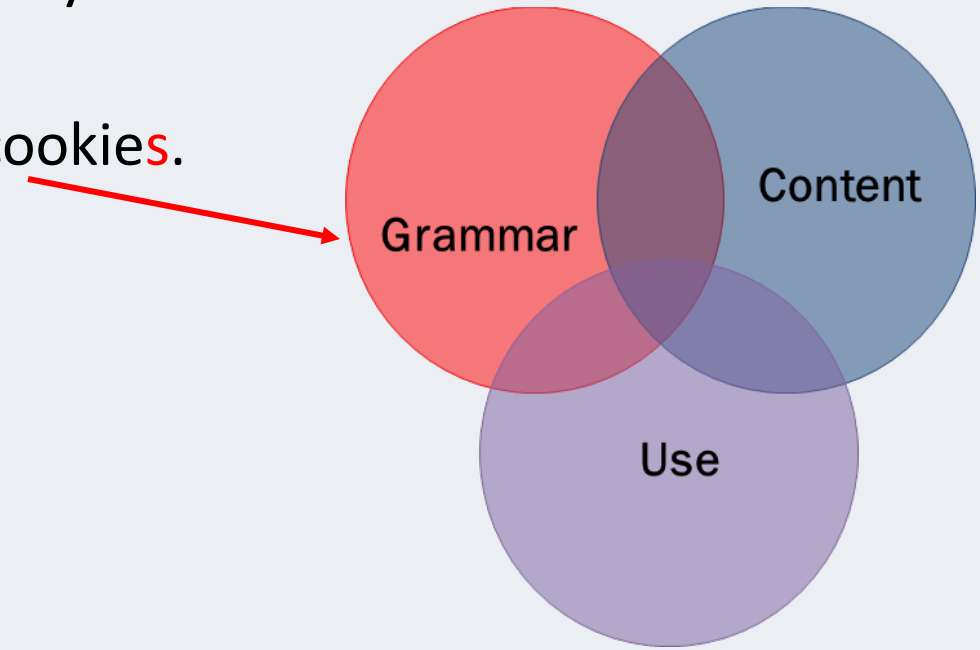



What is the evidence?

# SELECTED AT-RISK AREAS OF LANGUAGE ARE A FOCUS

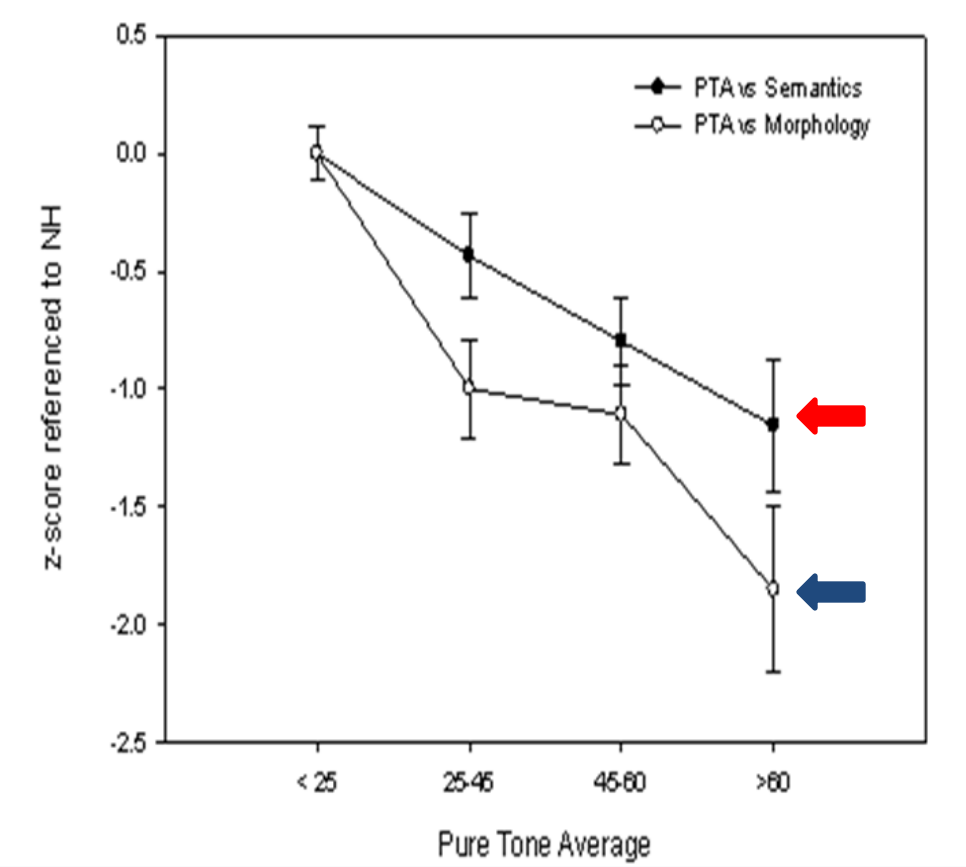
# Differential Vulnerability?

- Greater risk for domains that depend on access to phonetic structure?
  - HL reduces opportunities for perceiving elements that are perceptually subtle
  - She wants more cookies.



# Morphology is at Greater Risk than Vocabulary

*n* = 154 CHH; 69 CNH  Age = 4 years




Basic concepts & vocabulary
versus
Production of word endings

Morphology has a specific relationship with hearing beyond that found for semantic scores.

Conclusion: CHH show differential areas of vulnerability in language development

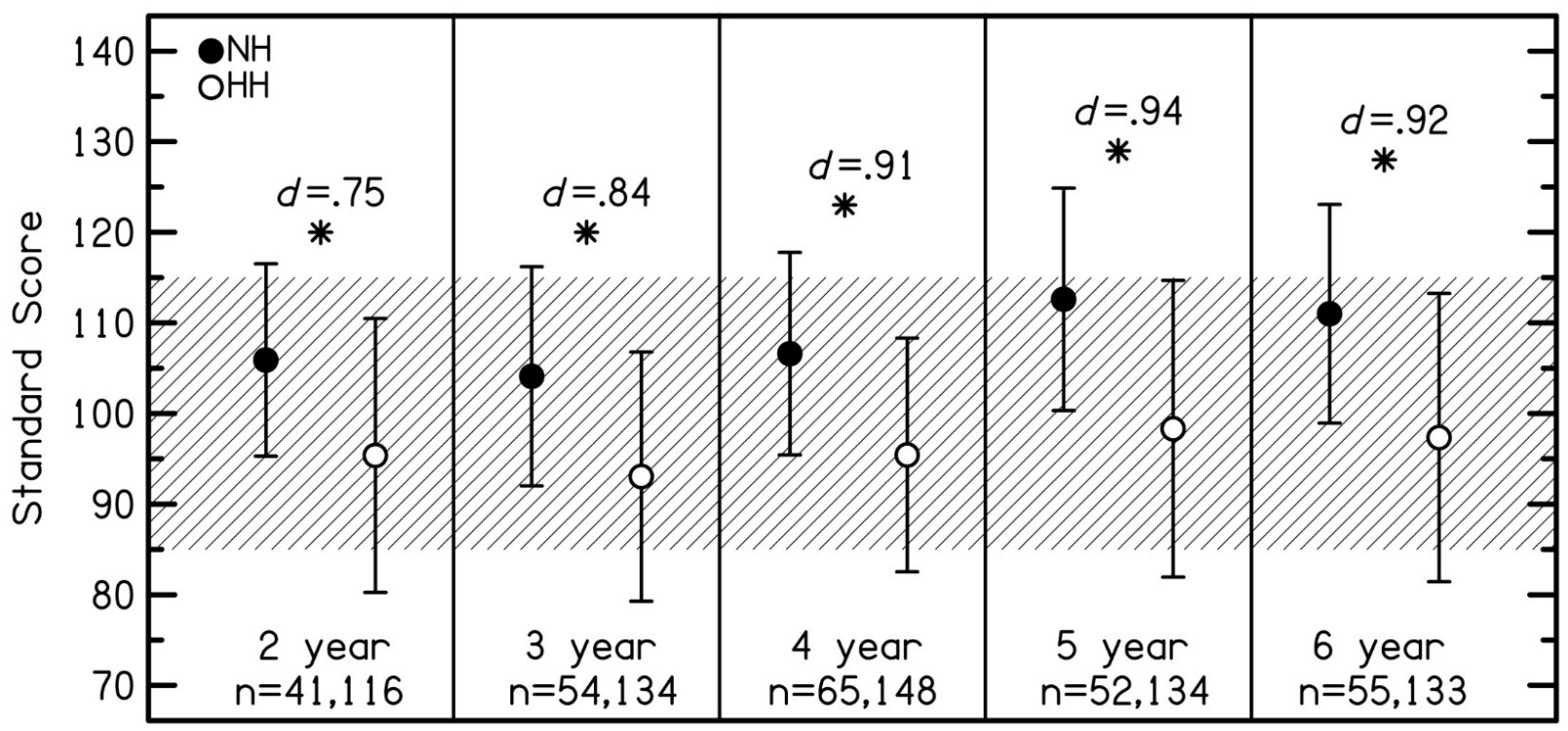
Tomblin, Harrison, Ambrose, Walker, Oleson, & Moeller, *E&H* (2015)

# ACCESS

**What is the evidence?**

## SERVICE PROVISION IS OPTIMIZED

# Risk for Underestimation of Service Needs?




* $p < .0001$ CHH differed significantly from SES-matched age mates.

**Conclusion: CHH are at risk for depressed language development.**

Tomblin et al., *E&H* (2015)

# ACCESS: Summary of Evidence

- **A** **Audibility** influences language growth rates
- **C** **Carefully fit devices** with **low error** optimal
- **C** **Consistently worn devices** - at "head of the pack"
- **E** **Environments** - language rich & responsive beneficial
- **S** **Selected aspects** of language at risk and need emphasis
- **S** **Service provision** research is a priority

# Additional Implications for Practice

**Better audibility yields better language learning rates. Ongoing HA verification is vital. Quality is key!!**

Children with consistent HA use had better language learning rates and auditory outcomes.

Families with infants and those with fewer resources need unique supports to promote HA use.

Families should be encouraged to use responsive rather than directive styles with young children.

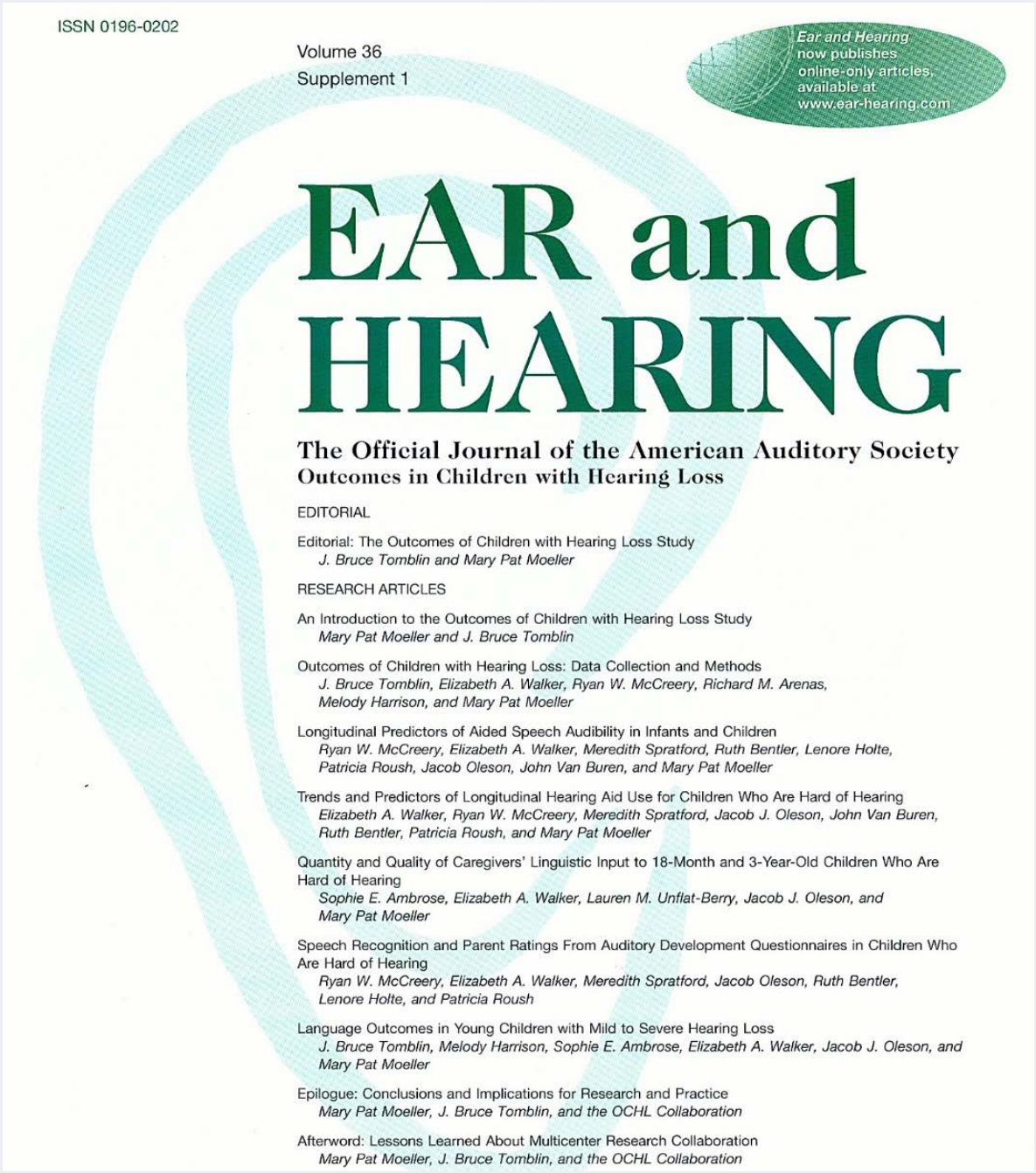
# Future Research Questions

Do preschool delays cascade to affect later academic and social development?

What are other developmental consequences of reduced audibility? What level of audibility is optimal?

How might focused interventions provide protection? Massed exposure?

How do CHH learn in complex listening environments? Focus and fidelity of interventions?



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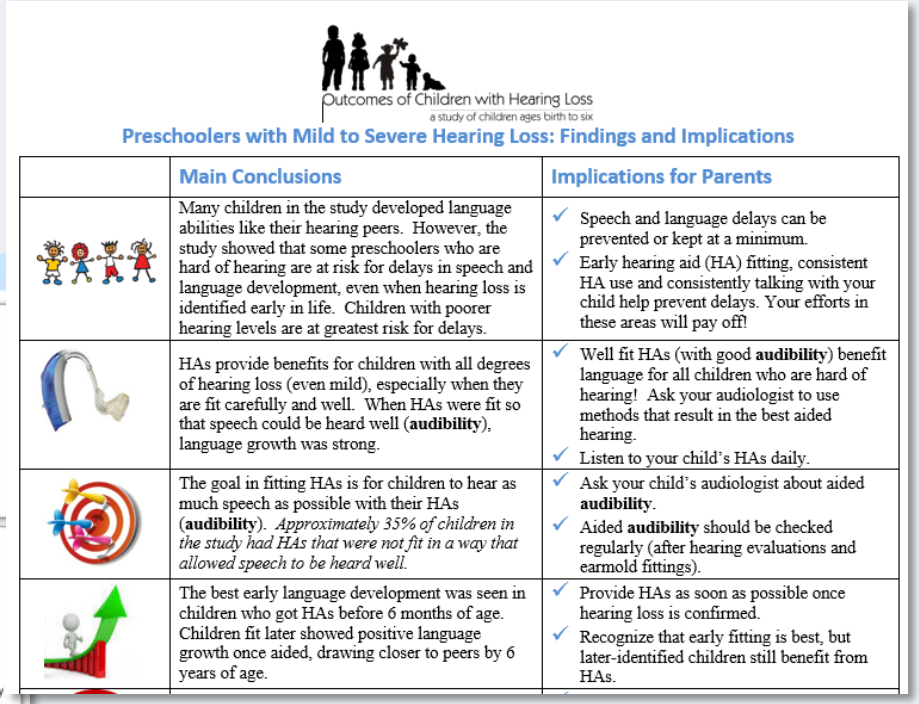
## Outcomes in Children with Hearing Loss



Thanks to the children and families and NIDCD!

# www.ochlstudy.org

Free access to OCHL supplement in Ear & Hearing

Outcomes of Children with Hearing Loss
a study of children ages birth to six

**Preschoolers with Mild to Severe Hearing Loss: Findings and Implications**

| | Main Conclusions | Implications for Parents |
|---|---|---|
| | Many children in the study developed language abilities like their hearing peers. However, the study showed that some preschoolers who are hard of hearing are at risk for delays in speech and language development, even when hearing loss is identified early in life. Children with poorer hearing levels are at greatest risk for delays. | ✓ Speech and language delays can be prevented or kept at a minimum.<br>✓ Early hearing aid (HA) fitting, consistent HA use and consistently talking with your child help prevent delays. Your efforts in these areas will pay off! |
| | HAs provide benefits for children with all degrees of hearing loss (even mild), especially when they are fit carefully and well. When HAs were fit so that speech could be heard well (**audibility**), language growth was strong. | ✓ Well fit HAs (with good **audibility**) benefit language for all children who are hard of hearing! Ask your audiologist to use methods that result in the best aided hearing.<br>✓ Listen to your child's HAs daily. |
| | The goal in fitting HAs is for children to hear as much speech as possible with their HAs (**audibility**). *Approximately 35% of children in the study had HAs that were not fit in a way that allowed speech to be heard well.* | ✓ Ask your child's audiologist about aided **audibility**.<br>✓ Aided **audibility** should be checked regularly (after hearing evaluations and earmold fittings). |
| | The best early language development was seen in children who got HAs before 6 months of age. Children fit later showed positive language growth once aided, drawing closer to peers by 6 years of age. | ✓ Provide HAs as soon as possible once hearing loss is confirmed.<br>✓ Recognize that early fitting is best, but later-identified children still benefit from HAs. |