

Children who are Hard of Hearing: Still Forgotten?

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A Sound Foundation Through Early Amplification
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Children who are “Hard of Hearing”

- Characteristics of children who are HH:
 - Hearing levels in the mild through moderately severe range
 - Use hearing aids rather than CIs
 - Reliant on spoken language for functional communication (Jamieson, 2010)
- Described by Julia Davis as “Our Forgotten Children”



Why Called “Forgotten Children?”

- Underestimation of needs
- Lack of training of classroom teachers, school psychologists, and administrators
- Little is known about
 - outcomes and academic achievement
 - problems faced in classrooms
 - extent of support services & impact
- Poorly monitored amplification

Any of these true today??

Background

- 30,000 children < age 6 have mild-to-severe, persistent bilateral hearing loss
- Paucity of research on outcomes of HH children
 - Reflect a belief that HL does not place these children at risk?
- NIDCD Working Group in 2006 identified research gaps & needs
 - Ear & Hearing, 2007

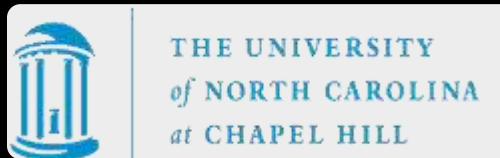
OCHL Study: Aims

- To describe the characteristics of:
 - children and families
 - intervention services
 - factors associated with service variations

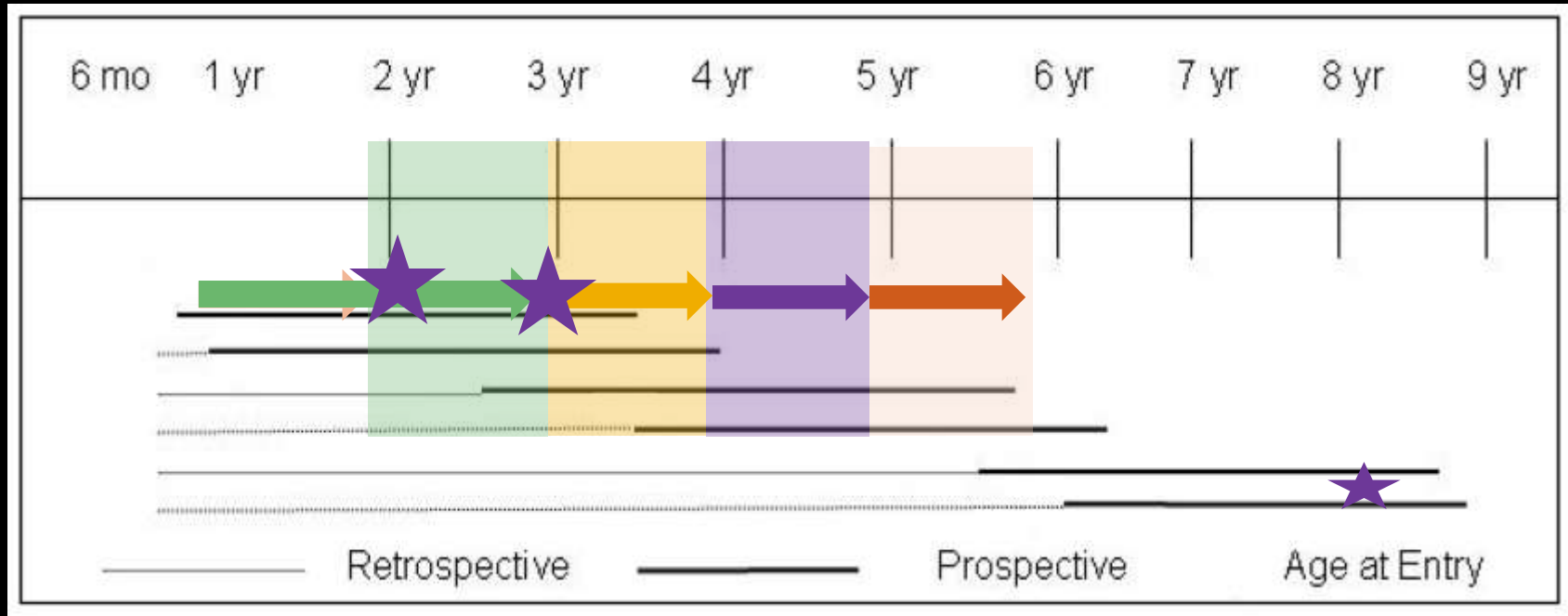
- To measure a range of:

Supported by NIDCD R01 DC009560
backgrounds

- To explore:
 - how variations in child & family factors & intervention characteristics relate to functional outcomes



Accelerated Longitudinal Design

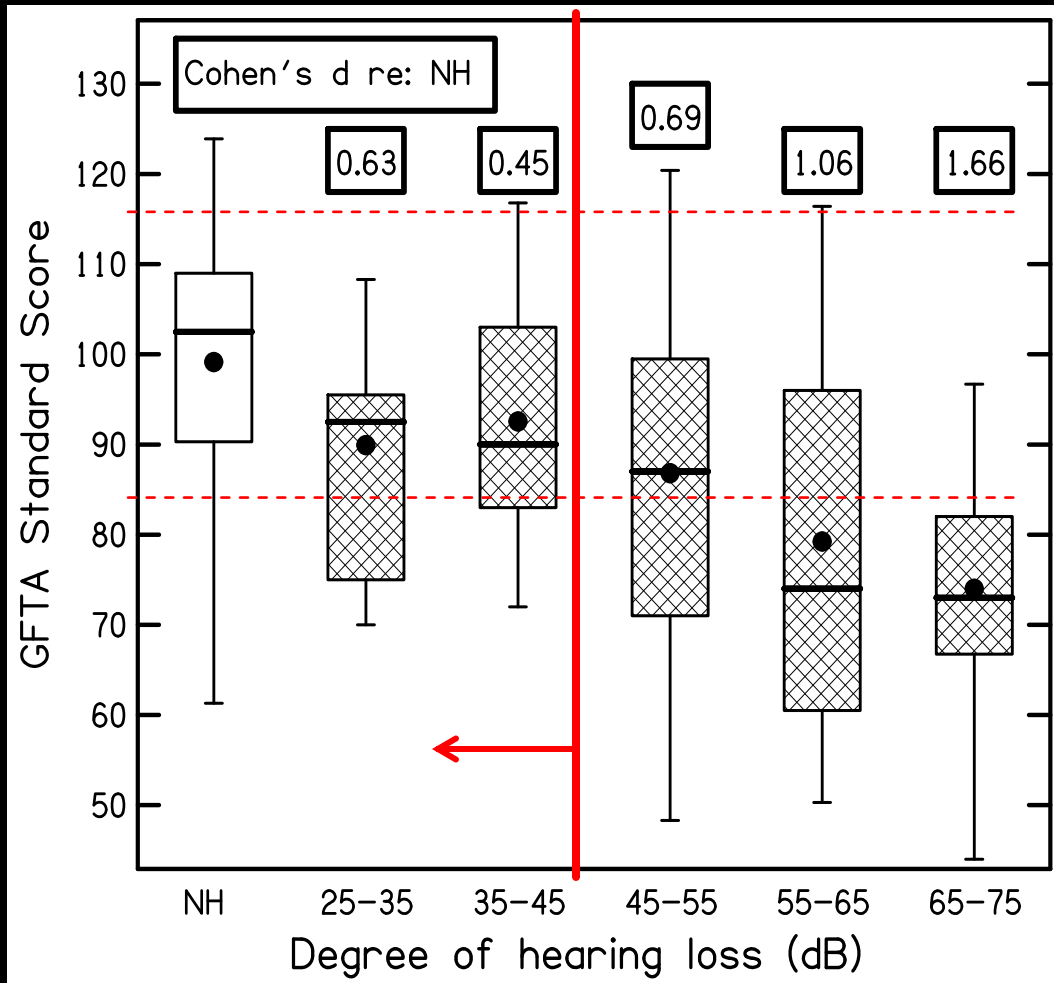


- Each child followed for 3+ years (around birthday)
- Comprehensive battery of child, family, & intervention measures

Sample Description

	HH	NH
Number of subjects	316	115
Hearing (PTA)	25-75 dB HL	< 20 dB HL
Age ranges	0;6 to 6;11 at entry	
No	From 17 states 76.1% HH children identified through NHS	
M		
Language use	Spoken English in the home	
Additional disabilities	No autism; no major vision, cognitive, or motor disabilities	

Big Picture Findings to Date



Many HH children demonstrate resilience

- ✓ Some children (25-30%) & some aspects of development are particularly susceptible to effects of HL.
- ✓ Strong and systematic effects of degree of loss on speech and language development.
- ✓ HL interferes with consistency/quality of access to input.
- ✓ Aspects of language *most dependent on the fidelity of the speech signal* may be most vulnerable to delays.

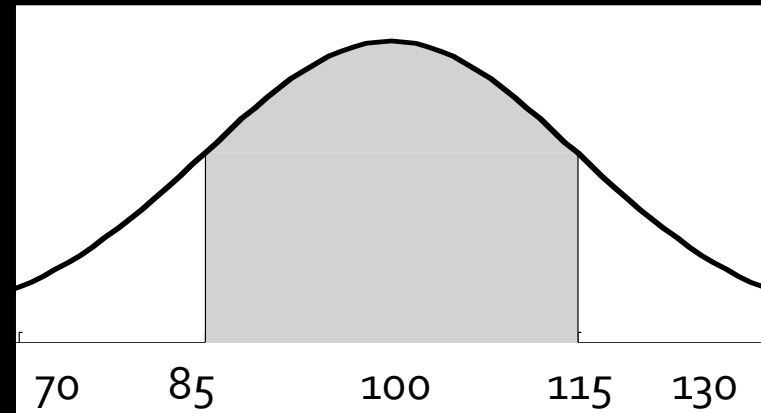
Inconsistent Access?

Children with HL experience inconsistent access to linguistic input, due to:

- **Periods without amplification**
 - Delays in hearing aid fitting
 - Inconsistent hearing aid use
- **Limitations of hearing aids**
 - Bandwidth
 - Audibility
- **Effects of negative environmental acoustics**
 - Distance, noise, and reverberation

Profile of Relative Strengths and Vulnerabilities at 3 yrs

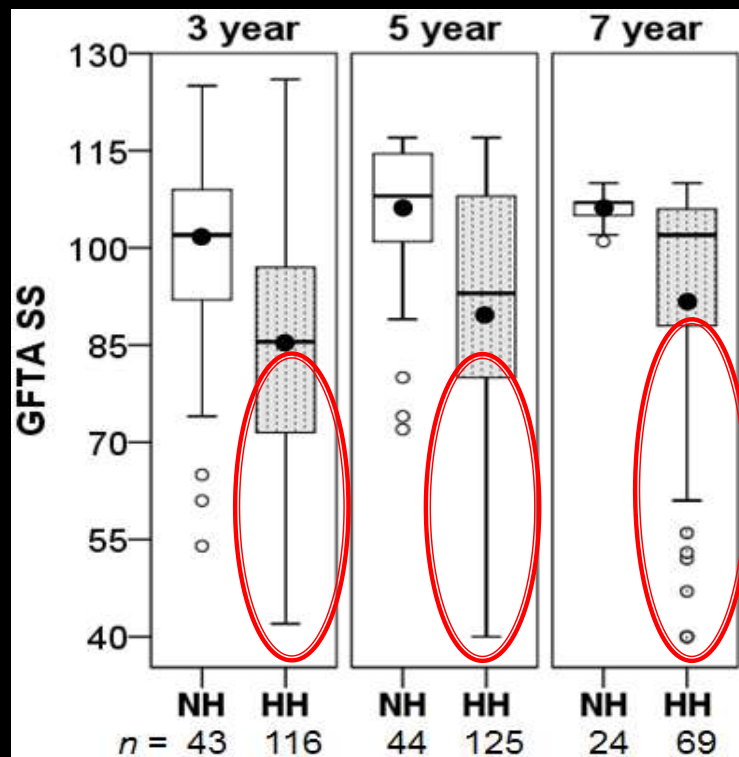
- ★ Mild hearing loss (25-45 dB HL)
- ★ Moderate & Mod-Severe (> 45 dB HL)



	70	85	100	115	130
BASIC CONCEPTS			★	★	
SYNTAX		★	★		
PRAGMATICS			★	★	
SPEECH PRODUCTION		★	★		

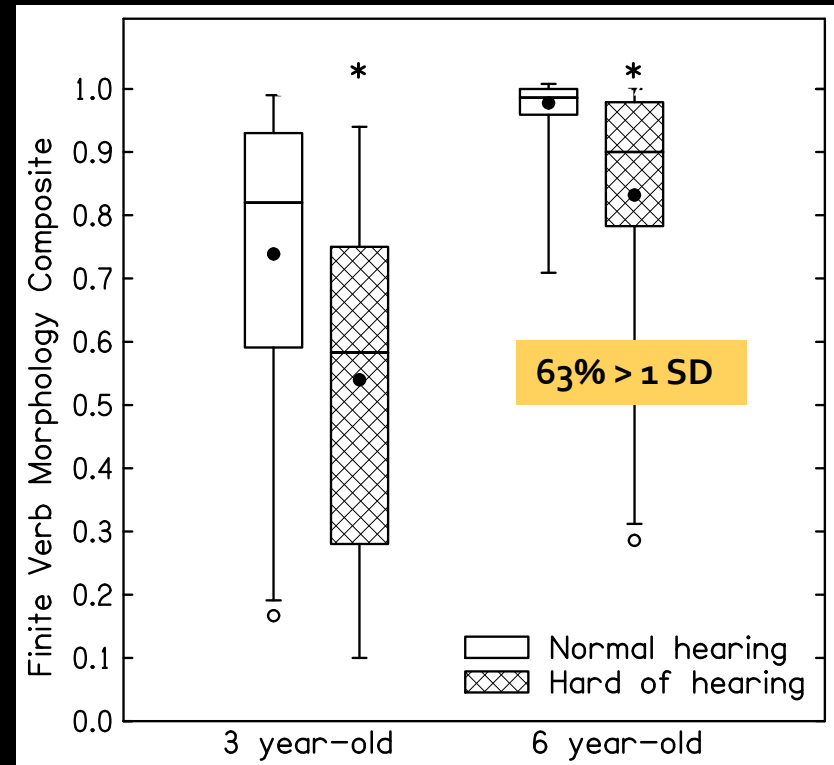
Evidence of Vulnerable Domains

Articulation



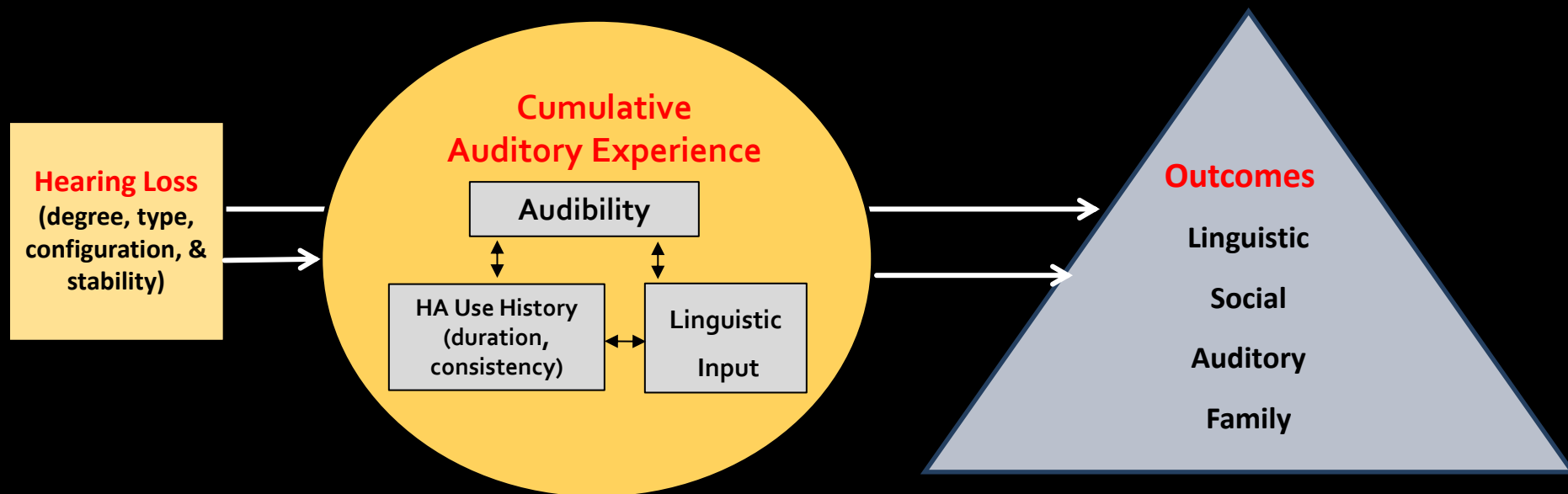
$p < .001$

Use of verb endings (sits, goes, walked)



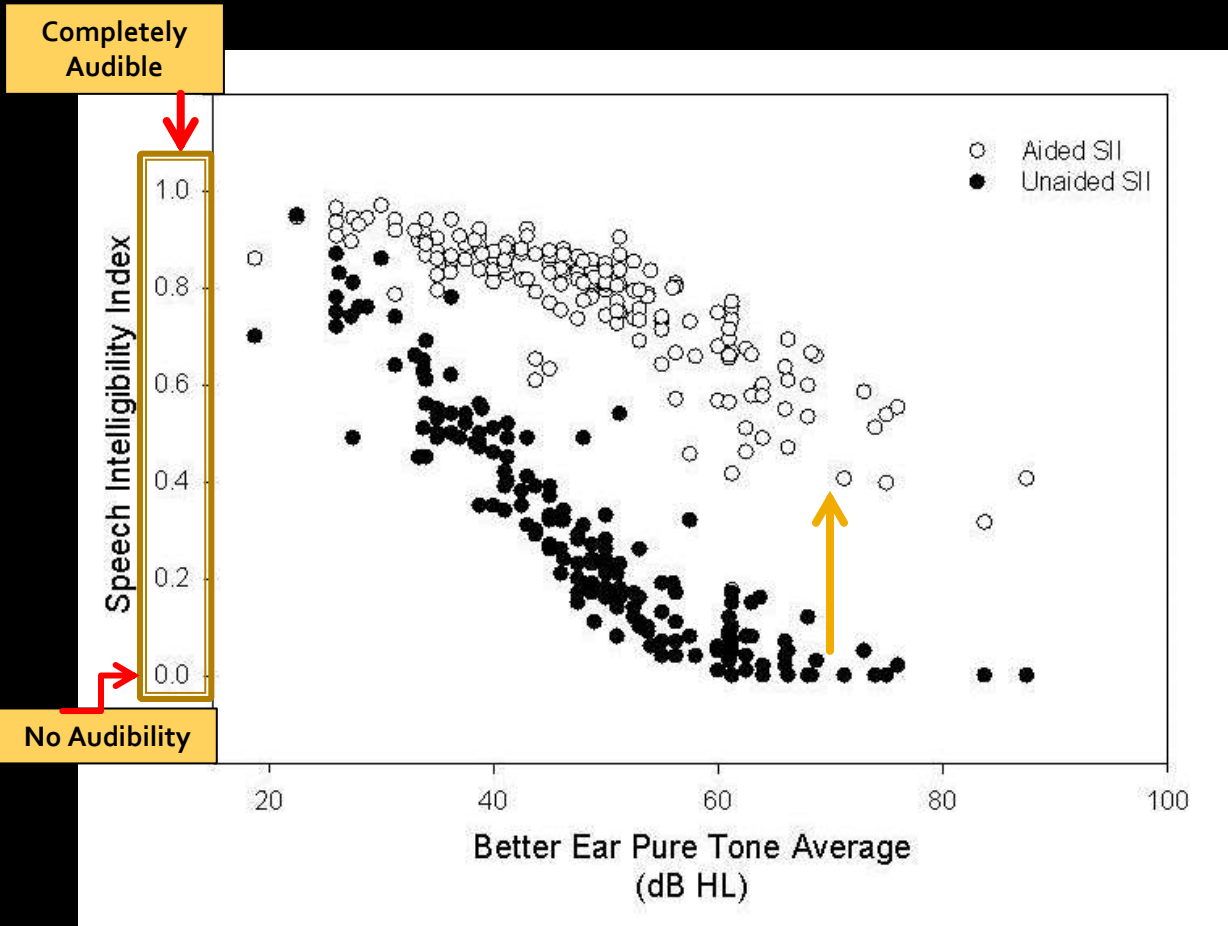
Koehlinger, Owen Van Horne & Moeller,
JSLHR, 2013

Emerging Model: Inconsistent Access



audibility
↕
use ↔ input

Speech Intelligibility Index (SII)



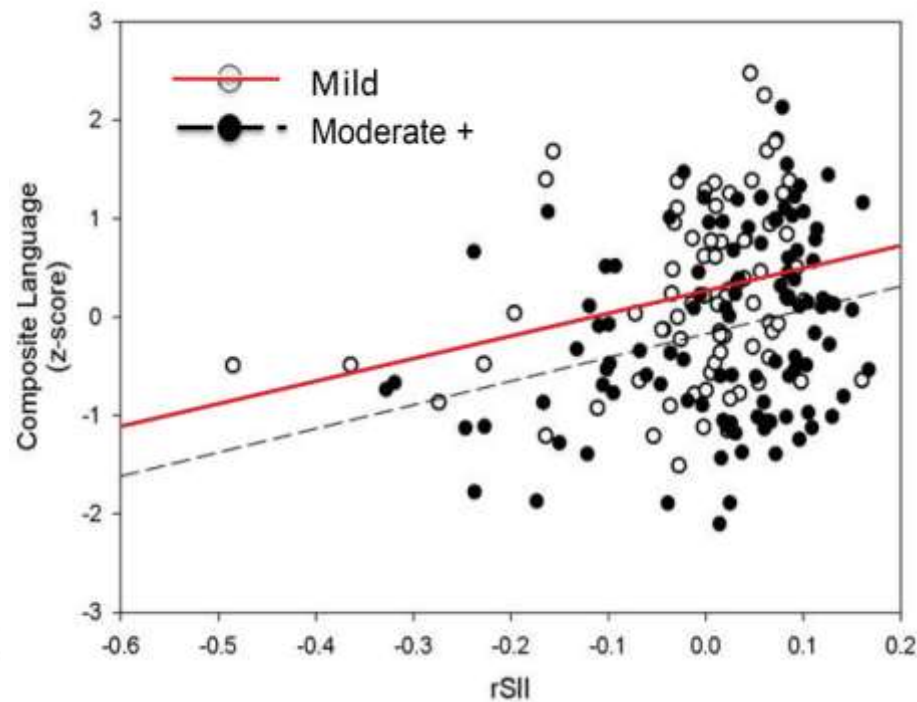
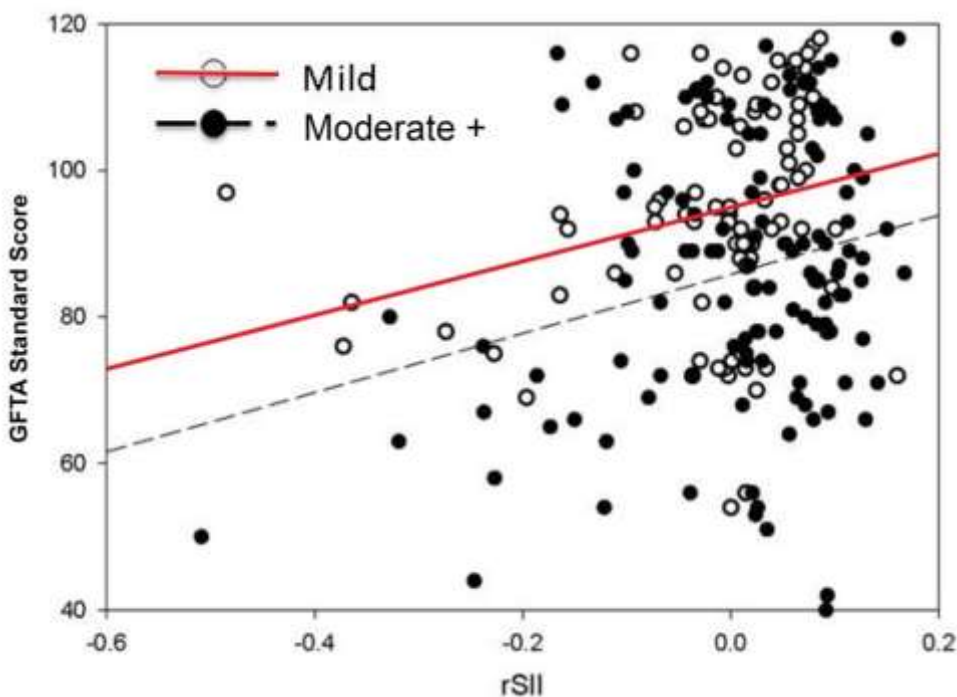
- Degree to which HA improves audibility is constrained by severity of HL
- Created residual SII (rSII)
 - To test unique contribution of HAs (Aided SII)
 - After controlling for the unaided SII

audibility
↕
use ↔ input

Is Aided Audibility Associated With Outcomes?

Speech Production

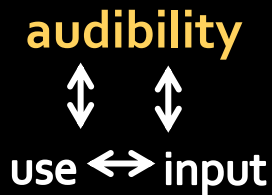
Language Composite



$n = 179, r = .27, p = .0003$

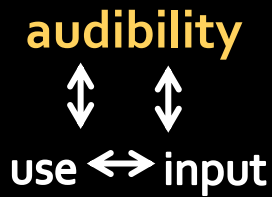
$n = 155, r = .23, p = .004$

1. Audibility provided by HA is significantly associated with speech & language.
2. Audibility has similar relationship with outcomes for children with mild and moderate-to-severe HL.



Is Audibility Associated with Grammar Use?

- Spontaneous language samples - 51 HH 3 yr olds
- Do hearing-related factors predict use of word endings?
 - BEPTA, SII, 4kHz SL
- Does perceptibility influence accuracy in HH?
 - In NH children, /s/ and /z/ emerge before /lz/
 - Hits, cars > houses, fixes → More audible?



Summary of Results

■ Audibility matters

- 4kHz SL predicts word endings

Audibility in the high frequencies + articulation skills are essential for development of English morphology

■ Perceptibility influences in HH

- HH different from NH /lz/ > /s/ and /z/

audibility
↕
use ↔ input

Challenges to Consistent HA Use



More challenges:

- At young ages (toddlers)
 - With mild degrees of hearing loss
 - Less educated families
- Strategic counseling?

Walker, Spratford, Moeller, et al. 2012

audibility



use ↔ input

Greatest Benefit of Aided Hearing Seen With Longer Use

rSII significantly associated
with speech & language

Duration Category

Outcome

Linear Slope
(Beta)

p value

1

Language

3.89

longest

Spe

0.02

80.26

0.005

Language

2.43

0.14

Speech

52.93

0.06

4

Language

-0.70

0.71

Speech

30.42

0.17

shortest

**Greatest benefit of aided hearing for s/l seen
with longer HA use**

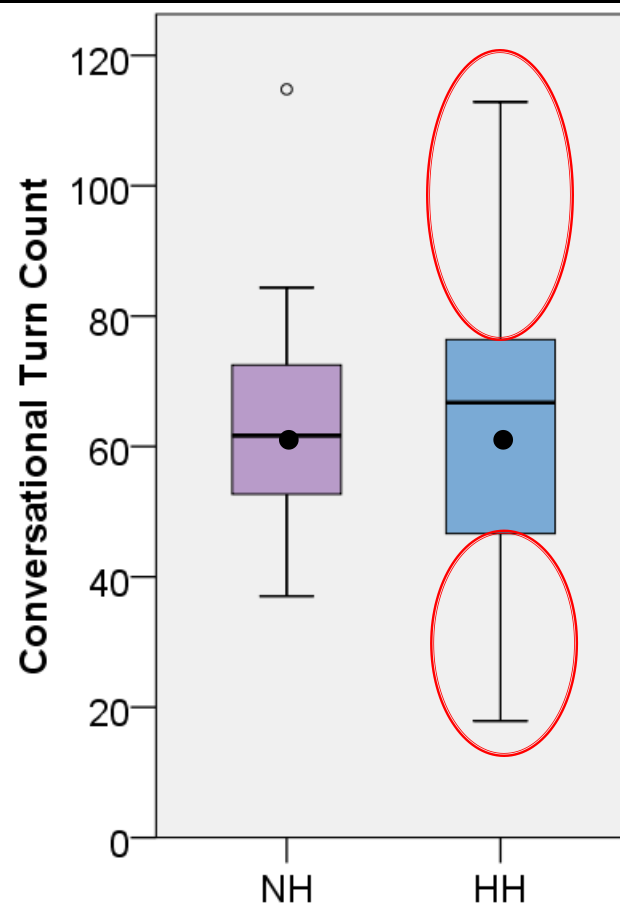
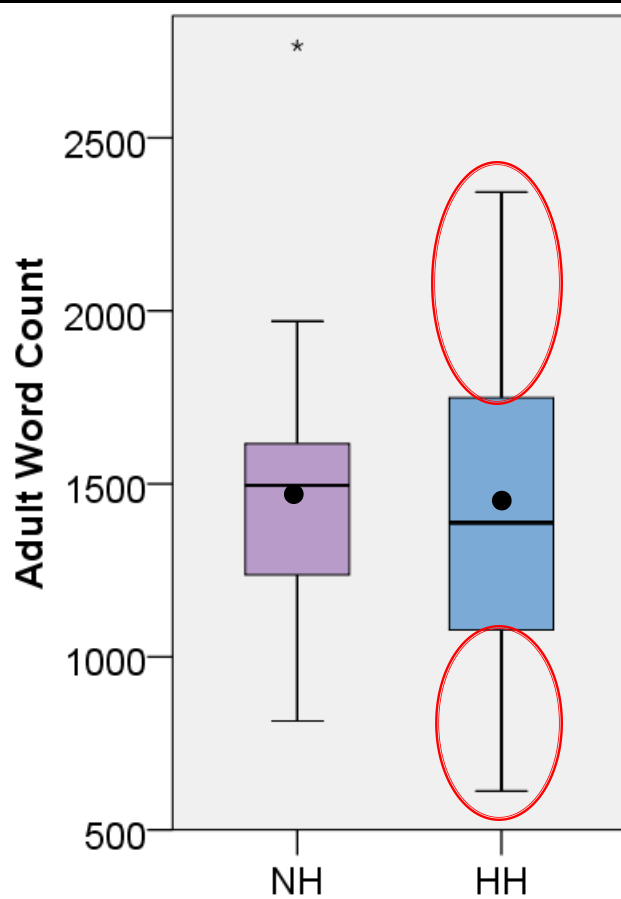
n.s.

n = 161 (Speech); n = 148 (Language)
HH children at 3 and 5 years of age

Tomblin, et al., in review

audibility
↕
↕
use ↔ input

How Much Input?



M age = 30 months

HH *n* = 38

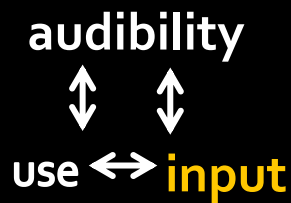
NH *n* = 17

No significant differences between groups

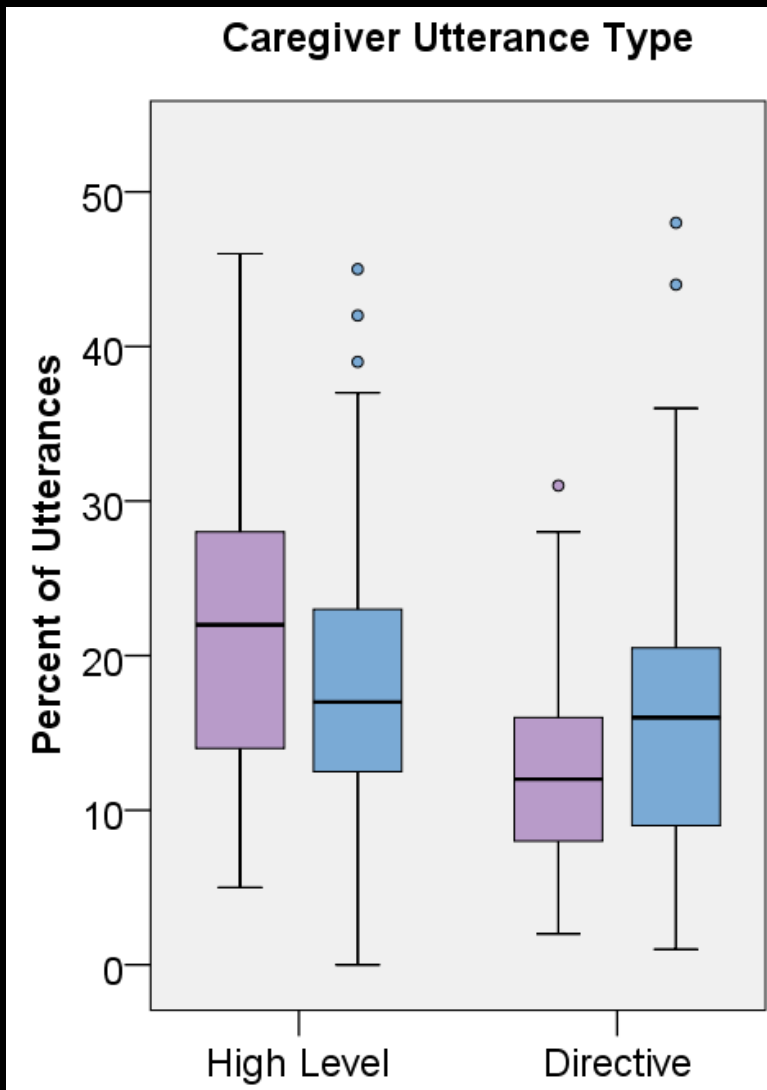
For HH group, more input = better language

- Mullen Receptive correlated with AWC ($r = 0.44^{**}$) and CTC ($r = 0.46^{**}$)

Ambrose, Van Dam & Moeller, JDSDE, 2012



How Rich is the Input?



Parent-child interaction samples analyzed in 3-year olds

HH group exposed to significantly:

- fewer high-level utterances
- more directive utterances

HH CASL scores significantly correlated with:

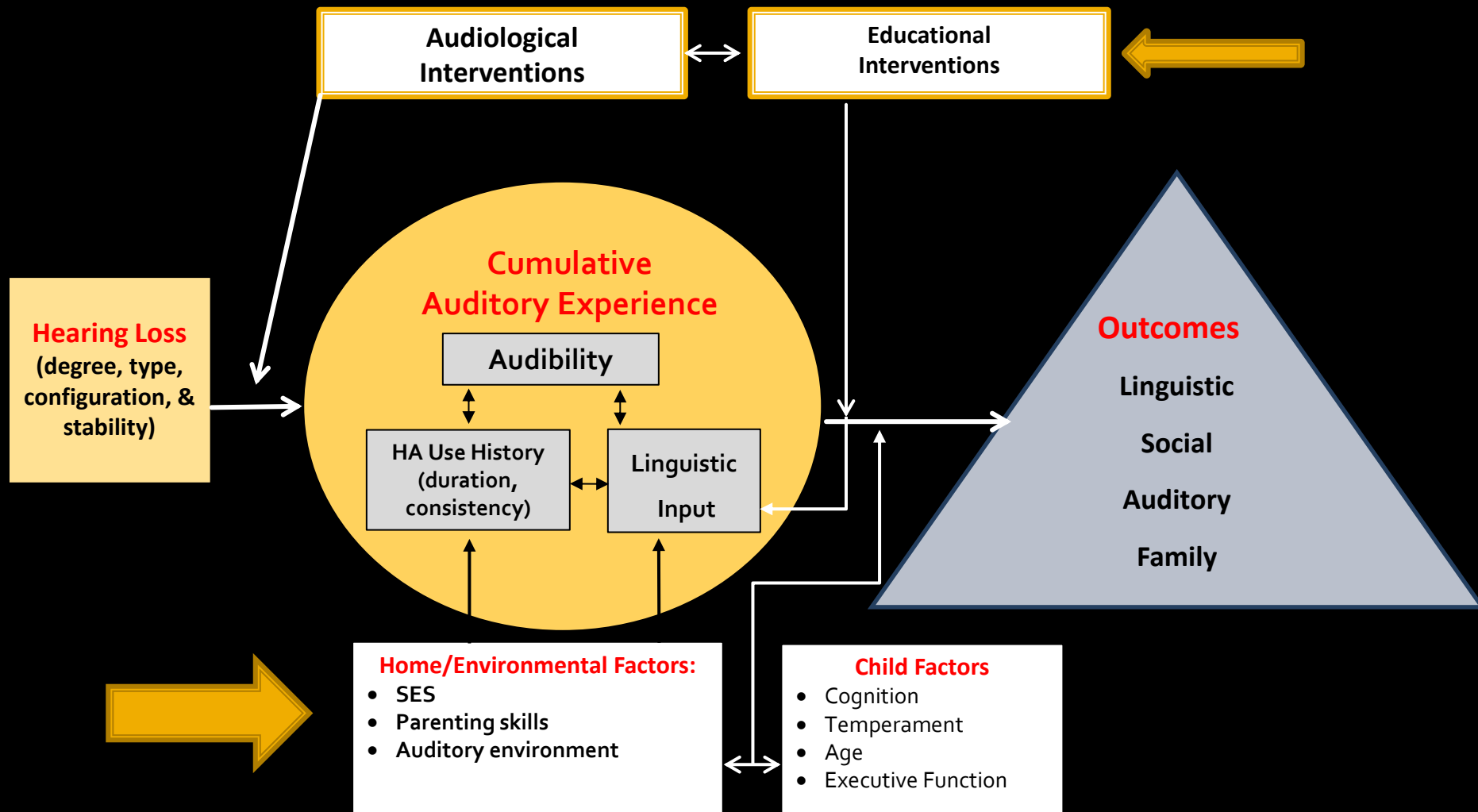
- proportion of high-level utterances ($r = 0.57$)
- proportion of directives ($r = -0.38$)

HH group also exposed to:

- less complex utterances
- fewer different words

Ambrose, et al., in preparation

Emerging Model: Inconsistent Access



Protective Factors

What protective factors result in resilience?

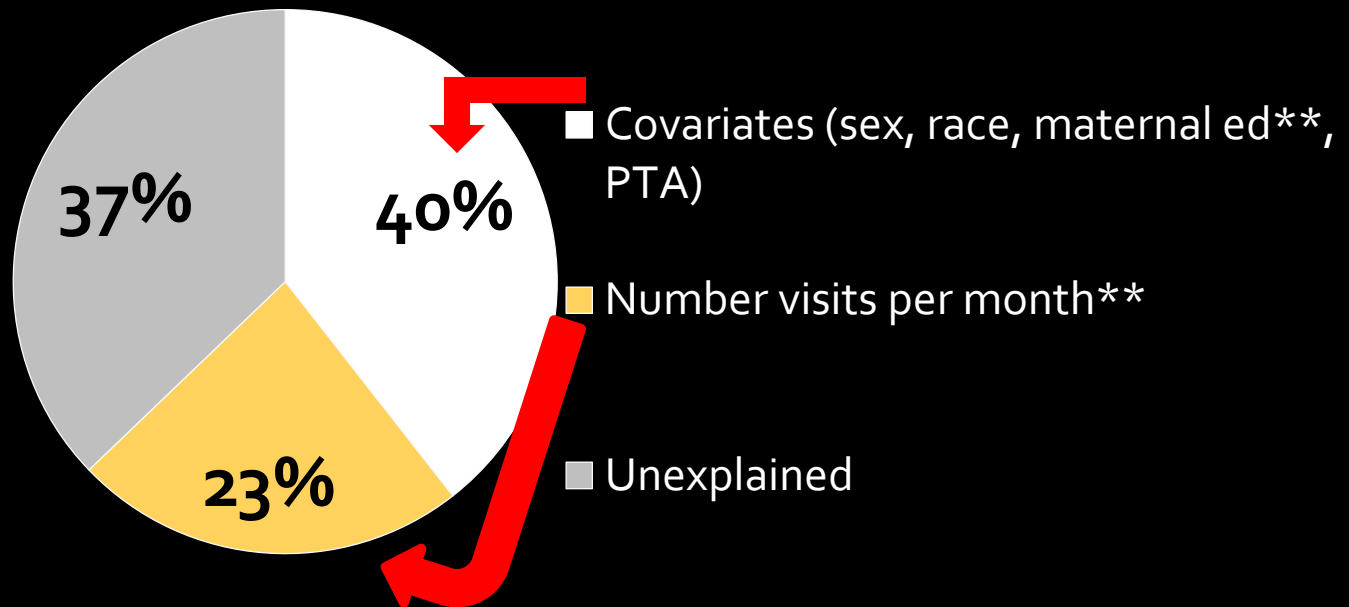


Protective Factors: Big Picture

- Milder degree of hearing loss
- Better audibility ★
- Well-fit amplification ★
- Longer duration of hearing aid fitting (early fit) ★
- Amplification worn consistently ★
- High quantity and quality of linguistic input ★
- Provision of timely & consistent early interventions ★
- More resourced homes
- Stronger cognitive abilities

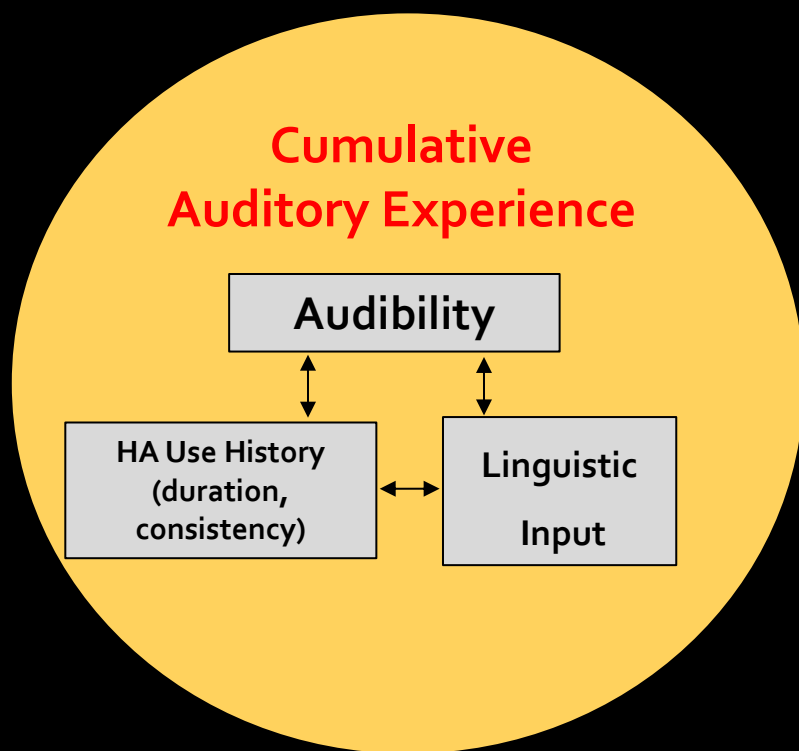
Early Intervention Services

Contribution of number of early intervention visits per month to CASL Scores at 3 years (regression results)



145/155 infants received early intervention

Implications: No Longer Forgotten



- Optimize audibility
 - Audibility matters
 - Benefits observed with longer durations of use
- Promote use consistency
 - Toddlers; mild HL
 - Novel approaches?
- Support families to provide language-rich environments
 - Promotes cumulative auditory-linguistic experience

Acknowledgement: OCHL Project Team



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