Language, Psychosocial, and Theory of Mind Development in Children who are Hard of Hearing

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Outcomes of Children with Hearing Loss
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ARKANSAS SPEECH AND HEARING ASSOCIATION

Hearing loss is the most common birth condition affecting infants

2009: 18% of all newborns in the US were screened for hearing loss; 1.6% did not pass the newborn hearing screen (CDC, 2011)

Prevalence of mild or worse permanent bilateral childhood hearing loss is 0.9%; incidence in US is 1.1 per 1000 infants (Mehra et al., 2009)

Acknowledgements

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Marly McNeely, PhD    Ryan McCreery, PhD    Bruce Tomblin, PhD    Meredith Spratford, AuD

• Intro to OCHL
• Role of language input
• How sources of inconsistent access influence outcomes
  • Phonology and grammar
  • Narratives
  • Psychosocial
  • Theory of mind

• Intro to OCHL
• Role of language input
• How sources of inconsistent access influence outcomes
  • Phonology and grammar
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  • Theory of mind
In 2006, NIH convened a panel to discuss outcomes in children who are HH

Conclusion: need for prospective research to determine what factors influence success.

The OCHL study is a multicenter, longitudinal study focusing on outcomes of children with mild-severe hearing loss.

Subjects

<table>
<thead>
<tr>
<th>SUBJEC TS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH</td>
<td>317</td>
</tr>
<tr>
<td>NH</td>
<td>117</td>
</tr>
</tbody>
</table>

Study participants

Inclusion criteria:

- 6 months to 7 years at entry
- English primary language
- No major secondary disabilities
- No cochlear implants
- Permanent mild to severe bilateral hearing loss

Domains of OCHL study
How do children who are hard of hearing compare to children with normal hearing?

Conclusion: Children who are hard of hearing are at risk for language delays.

Previous outcomes research

Degree of HL (PTA)

Outcomes

Degree of HL (PTA)

Outcomes

Timings of intervention

Outcomes

OCHL outcomes model: auditory-linguistic access

Factors that influence relationship between PTA and outcomes.

Does age at HA fitting influence language?

Significant difference

Tomblin et al., 2015

Previous outcomes research

Significant effect for degree of hearing loss.

Tomblin et al., 2015

Degree of HL (PTA)

Outcomes

Auditory Intervention

Educational Intervention

Audibility

Hearing aid use

Linguistic input

Degree of HL (PTA)

Outcomes

Factors that influence relationship between PTA and outcomes.

Significant difference

Tomblin et al., 2015

Degree of HL (PTA)

Outcomes

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Degree of HL (PTA)

Outcomes

Factors that influence relationship between PTA and outcomes.

Significant difference

Tomblin et al., 2015

Degree of HL (PTA)

Outcomes

Factors that influence relationship between PTA and outcomes.
Sources of inconsistent auditory access

Predictors

Linguistic input

• Intro to OCHL
• Role of language input
• How sources of inconsistent access influence outcomes
  • Phonology and grammar
  • Narratives
  • Psychosocial
  • Theory of mind

Acknowledgements:
Sophie E. Ambrose
BTNRH
Mark van Dam
Washington State University

High rates of linguistic input (parent talk) especially important for children with hearing loss

We used two strategies to analyze quality and quantity of parent talk

Art Gallery was conducted at the 18 month visit

Art Gallery
LENA

Difficult to conduct this research

Quality and Quantity of Caregivers' Linguistic Input to 18-Month and 3-Year-Old Children Who Are Hard of Hearing
Sophie E. Ambrose, Rebecca A. Miller, Pamela P. Kistner, Shelly J. Morel

Linguistic Input, Electronic Media, and Communication Outcomes of Children With Hearing Loss
Sophie E. Ambrose, Pam Kistner, and Kelly D. Mims
And the 3 year old visit....

Goal:
Elicit parent-child interaction

Research questions/predictions for the Art Gallery

1. Does the quantity or quality of caregiver input differ for children who are HH compared to children with NH?

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Quality will differ at 18 month and 3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>No difference in quantity</td>
<td></td>
</tr>
</tbody>
</table>

Quality of caregiver input?

• Coded 5-minute samples for quality features

Does quantity/quality of caregiver input differ for children who are HH vs children with NH?

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of total utterances</td>
<td>Average length of utterance</td>
</tr>
<tr>
<td>Number of total words</td>
<td>Number of different words</td>
</tr>
<tr>
<td>Proportion of High Level utterances</td>
<td>Proportion of “directing” utterances</td>
</tr>
</tbody>
</table>

Does quantity/quality of caregiver input differ for children who are HH vs children with NH?

<table>
<thead>
<tr>
<th>18 month visit</th>
</tr>
</thead>
</table>

Parents of HH children used more “directing” utterances than parents of NH children
Does quantity/quality of caregiver input differ for children who are HH vs children with NH?

<table>
<thead>
<tr>
<th>Quantity</th>
<th>NH &gt; HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of total words</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Quality</th>
<th>NH &gt; HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average length of utterance, NH &gt; HH</td>
<td></td>
</tr>
<tr>
<td>Number of different words, NH &gt; HH</td>
<td></td>
</tr>
<tr>
<td>Proportion of ‘high level’ utterances, NH &gt; HH</td>
<td></td>
</tr>
<tr>
<td>Proportion of ‘directing’ utterances, NH &lt; HH</td>
<td></td>
</tr>
</tbody>
</table>

3 year old visit

Research questions/predictions for the Art Gallery

2. Does quantity and quality of parent talk at 18 months influence language outcomes at 3 years?

Prediction

Higher quantity and quality of parent talk at 18 months → Higher child language skills at 3

Ambrose et al., 2015

Big picture: quality and quantity of language input matter

- Parents of children who are HH tended to be more directive (but this is likely to be a bidirectional relationship)
- More directive communication at 18 months is correlated with lower language scores at age 3
- Caregivers may need support to provide children with optimal language learning environments

Auditory Environments influence access to linguistic input

- Televisions serve as one source of background noise AND parents and children talk less when the TV is on.
Is there a difference in input for children who are HH compared to children who are NH?

Van Dam, et al., 2012; Ambrose, et al., 2014

No significant differences between groups

There is a relationship between PTA/audibility and input

As hearing gets worse and audibility decreases, input and # turns decrease

Van Dam, et al., 2012; Ambrose, et al., 2014

There is a relationship between language scores and # conversational turns

As # turns increase, receptive and expressive language scores increase

Ambrose et al., 2014

Is there a relationship between amount of time TV is on and conversational turns?

On average, 8% of our LENA recordings were classified as electronic media (~ 58 min in 12 hr recording)

Ambrose et al., 2014
Is there a relationship between amount of time TV is on and conversational turns?

For every 1% increase in electronic media, the number of conversational turns decreased by 2.5 turns.

Van Dam, et al., 2012; Ambrose, et al., 2014

For every 1% increase in electronic media

Number of conversational turns decreased by 2.5 turns

Van Dam, et al., 2012; Ambrose, et al., 2014

Is ALL television exposure bad?

Increased exposure to background TV is correlated with poorer executive function skills in low- and high-risk children (Linebarger et al., 2014)... But educational foreground TV can serve as a buffer for executive function skills.

https://www.youtube.com/watch?v=eT7nD0Im5E

Clinical Implications: Auditory Environments

Enhance child's cumulative auditory experience!

- Increase meaningful conversational turns.
- Reduce exposure to TV (background noise).
- Promote more frequent parent-child conversational interactions.

But educational foreground TV can serve as a buffer for executive function skills.

Average US child is exposed to 232.2 minutes (3.87 hours) of background TV per day (Lapierre et al., 2012)

Clinical implications:

- Increase meaningful conversational turns.
- Reduce exposure to TV (background noise).
- Promote more frequent parent-child conversational interactions.

Big picture: Language input

- Children with poorer hearing and lower audibility engaged in fewer conversations and had less exposure to adult input.
- Adult word counts were not significantly correlated with language outcomes.
- Children who were frequently engaged in conversations demonstrated the strongest language outcomes.
- Conversational interactions were less frequent in homes with high rates of audible television → weaker language skills.
• Intro to OCHL
• Role of language input
• How sources of inconsistent access influence outcomes
  • Phonology and grammar
  • Narratives
  • Psychosocial
  • Theory of mind

OCHL outcomes model: auditory-linguistic access

Cumulative auditory experience hypothesis

Differential Vulnerability?

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

Phonology Outcomes by Degree of HL

Open & Closed Set Test (O&C)

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

KEYS

Open and Closed task (2 year olds)

O&C test can be used as an assessment by SLPs or audiologists

Differences in age at HA fit and degree of hearing loss on "Open" scores

Ambrose et al., 2014

"Open" scores at age 2 predict speech production at age 3

Ambrose et al., 2014

Variability on Closed Set Task

McCreery et al., 2015

Higher scores on Open and Closed Task

Greater hearing and use

Higher maternal education level

Model accounted for 35% of the variability.

Grammar: Morphology Elicitation Task

- Auxiliary: He's mixing it.
- Copula: She's a dancer.
- Progressive: He is knocking on the door.
- Third singular: He wants more milk.
- Irregular past: He fell off the chair.
- Regular past: Sara walked fast.
- Possessive: Dad's shirt.
- Plural: Three balls.

This is dad's coat. Whose dress is this? It's _________. (Baby's)
Age 4: vocabulary and grammar development

Bound morphemes, especially in verbs, are less salient and less frequent in the input:
- Typically sentence medial (He needs to find...)
- Often involve fricatives in English
- Complex phonetic contexts (It's, Greg's calling...)

Hearing loss effects processing of subtle acoustic cues important for morphosyntax

Narrative Performance in Children who are Hard of Hearing

Narrative skills?

Research questions
Current study: Participants

- 54 children with normal hearing (24 males, 30 females)
- 88 children who are hard of hearing (47 males, 41 females)
- Average age = 7.1 months (2.5)
- 173 identified at NHS
- 43 later identified

<table>
<thead>
<tr>
<th>Demographic Characteristics</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better-ear PTA (dB HL)</td>
<td>46.4</td>
<td>16.2</td>
</tr>
<tr>
<td>Age at confirmation</td>
<td>9.1</td>
<td>11.8</td>
</tr>
<tr>
<td>Age at HA fit</td>
<td>11.4</td>
<td>11.9</td>
</tr>
</tbody>
</table>

Methods: Narrative task

- Narrative task
  - Spontaneous
    - Examiner presents story pictures one at a time
    - Repeat pictures, with child telling story
  - Retell
    - Examiner tells story
    - Child repeats back story

Narrative scoring scheme (NSS): adapted from Heilman et al. (2010) to judge the quality of narrative performance (macrostructure). The NSS consisted of seven story characteristics, rated on a scale from 0 (poor) to 5 (proficient).

<table>
<thead>
<tr>
<th>Story Characteristics</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Presence, absence, and qualitative depiction and inclusion of story elements</td>
</tr>
<tr>
<td>Character Development</td>
<td>Acknowledgment of characters and their significance in the story</td>
</tr>
<tr>
<td>Mental States</td>
<td>Frequency/variety of mental state words</td>
</tr>
<tr>
<td>Conflict Resolution</td>
<td>Presence/Awareness of conflicts and resolutions required to express the story</td>
</tr>
<tr>
<td>Referencing</td>
<td>Consistent and accurate use of antecedents and clarifiers</td>
</tr>
<tr>
<td>Cohesion</td>
<td>Sequencing and transitions between events</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Description of final event and story wrap up</td>
</tr>
</tbody>
</table>

Results: Is hearing status related to narrative scores?

- Spontaneous: 20% NH > 1 SD below mean
- Spontaneous: 27% HH > 1 SD below mean
- Retell: 18% NH > 1 SD below mean
- Retell: 35% HH > 1 SD below mean
Grammatical Measures

<table>
<thead>
<tr>
<th></th>
<th>Spontaneous</th>
<th>Retell</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NH</td>
<td>HH</td>
</tr>
<tr>
<td>MLUm</td>
<td>9.35</td>
<td>8.36</td>
</tr>
<tr>
<td>Omit Morph</td>
<td>1.37</td>
<td>1.61</td>
</tr>
<tr>
<td>Subord Index</td>
<td>1.36</td>
<td>1.19</td>
</tr>
</tbody>
</table>

Not different: # of utterances, NTW, mazes, error word codes, total mental states. NH children used more words on retell than HH (63.6 vs 56.6, p = .006)

Results: What factors influenced narrative performance?

- Better ear SII, syntax, and vocabulary were significantly correlated with spontaneous narrative scores.
- Better ear SII, syntax, vocabulary, and nonword repetition were significantly correlated with retell narrative scores.

Summary of findings

- On average, children who were hard of hearing demonstrated delays in spontaneous and retell narrative skills, both in terms of macrostructure and microstructure.
- A large percentage of children performed within the average range on the narrative task.
- Amount of aided audibility was associated with individual differences in the hard of hearing group.
- Future directions: examine performance on retelling of fables and Test of Narrative Language in 8-9 year olds

Acknowledgements:

Sophie E. Ambrose
BTNRH
John Knutson
University of Iowa
• Does hearing status affect language abilities?
• Do the auditory access variables contribute to variance in language abilities?

Psychosocial development
• Delayed communication and limited access to conversational exchanges may lead to risk in psychosocial development (Moeller, 2007)
• Encompasses social participation, self-esteem, quality of life
• May be exhibited as
  • Internalizing behaviors (depression, anxiety, withdrawal)
  • Externalizing behaviors (aggression, rule-breaking)

Previous research on psychosocial outcomes
• Children who are deaf or HH combined into one group
• Small sample sizes
• Measurement differences

“Predictors of Psychosocial Outcomes in Hard-of-Hearing Preschool Children” (Laugen et al.; 2016)
• 35 CHH tested at 4 years of age
• Strengths and Difficulties Questionnaire (SDQ) and the Social Skills Rating System (SSRS)

“Predictors of Psychosocial Outcomes in Hard-of-Hearing Preschool Children” (Laugen et al.; 2016)
• CHH displayed significantly more emotional, hyperactivity, and peer problems than CNH
• Age at detection and female gender were associated with better outcomes; degree of hearing loss and vocabulary were not.
OCHL Psychosocial Measures

- Child Behavior Checklist (CBCL)
  - Administered at 2, 4, and 6 years of age

CBCL (Achenbach, 1992)

- Preschool version: parents rate child's behavior on 3 point scale (not true; somewhat true; very true)
- Composite scores: Internalizing and Externalizing
- T-scores
  - Average = 50, lower is better

Psychosocial: Hearing status

**Externalizing**

- 2 year olds
- 4 year olds

**Internalizing**

- 2 year olds
- 4 year olds

- \( p = .038 \)
- n.s. correlated with BEPTA

Psychosocial: Auditory Access

- \( p < .001 \)
- Less audibility = better score
- \( p = .04 \)
- Ear earlier = better score
- \( p = .53 \)

- *Externalizing* • 2 years
• Externalizing
  • 4 years

• Internalizing
  • 2 years

When we look at hearing status in isolation, get significant differences, but is hearing status a proxy for amount of hearing aid use?

Psychosocial: Summary

• On average, children who are hard of hearing display age-appropriate internalizing and externalizing behaviors (not in clinical range)
• Also show variability
  • Age at hearing aid fit contributes at 2 and 4 years (later fit = more anxiety and aggression)
  • Amount of hearing aid use contributes at 4 years (less use = more anxiety)
  • Aided audibility contributes at 2 and 4 years, but in an unexpected direction (better audibility = more anxiety and aggression).
• Influence of early intervention?

• Background on relationships between language and behavior outcomes
• For 4-year-old children who are HH:
  - Are language and psychosocial outcomes related to one another?
  - Are these relationships a result of shared variance in auditory access?
Language and Psychosocial

• Early speech and language delays are associated with later behavior problems (Lindsay et al., 2007, St Clair et al., 2011)
• We use language internally to regulate our behavior (direct)
• Poor language skills may interfere with socialization (indirect)
  • Parents may reason more with children who have better language skills and use more punishment with children with poor language skills.
  • Lower language associated with peer rejection

Petrie et al., 2013

Variance in Psychosocial Outcomes

\( \rho^2 = 0.26^{**} \)
\( \text{Variance in Psychosocial Outcomes} \)
\( \text{R}^2 = 0.04, F = 6.13, p = .015 \)

Age at HA fit

More use = Better language = Better behavior

\( \rho = 0.04, p = .011 \)

Summary

• Language skills are related to psychosocial outcomes
• More HA use, better language, contribute uniquely to better psychosocial outcomes

Summary on psychosocial outcomes

• Additional supports for psychosocial development may be warranted when children have low language skills

Intro to OCHL
• Role of language input
• How sources of inconsistent access influence outcomes
  • Phonology and grammar
  • Narratives
  • Psychosocial
  • Theory of mind

Outcomes of Children with Hearing Loss
Theory of Mind Development in Children who are Hard of Hearing: Understanding False Belief

Outcomes of Children with Hearing Loss

Acknowledgements:

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Merry Spratford
Abby Bogatz
Meaghan Foody
Sarah Al-Salim

Research Audiology and SLPs

Overview

1. Background
   - What is Theory of Mind?
   - Theory of Mind Stages: Typical development
   - Theory of Mind: Children who are Deaf or Hard of Hearing
2. Research Questions & Study Methods
3. Results
   - Five and Six Year Olds (Cross Sectional)
   - Three to Five and Five to Six (Longitudinal)
   - Second Graders (Cross Sectional)
4. Implications and Future Directions
   - Sarcasm Study

What is Theory of Mind?

- Increasing awareness that self and others have feelings, thoughts, beliefs, dreams
- Our internal states guide our behaviors
- Our understanding of self and others supports reasoning about situations
- Allows us to take the perspective of others (communication)

Astington, 1993; Wellman, 2002

What do you know about the situation?
How do you know?

Used with permission of the Norman Rockwell Foundation

Typical Developmental Stages

Social cognition/theory of mind
Factors Supporting ToM Development

- CHILD LANGUAGE ABILITIES
- CONVERSATIONS ABOUT THOUGHTS AND FEELINGS
- CONVERSATIONAL ACCESS (SHARING OF VIEWPOINTS)
- SIBLINGS AND CONFLICT RESOLUTION
- RECALLING PAST EVENTS
- EXECUTIVE FUNCTION
- PRETEND PLAY
- MATERNAL EDUCATION/SES

ToM: Children who are D/HH

Late Signing Deaf Children

- Marked delays (as in autism)
- Due to language delays and limited communication access

Native Signing Deaf Children

- Achieve ToM/False Belief on schedule

Children with CIs

Mixed findings = Delayed, not delayed

Ketelaar et al., 2012; Peterson, 2004; Peters et al., 2009; Remmel & Peters, 2006; Sundqvist et al., 2014
ToM: Children who are D/HH
Children who are HH
Netten et al. (2017) = delayed compared to hearing peers in spite of language match

Focus of Current Study (Walker et al., in press)

Research Questions: 5 and 6 years
1. How do CHH compare to CNH in their understanding of first-order FB concepts at 5 and 6 years of age?
2. What factors influence children’s performance on FB tasks at 5 and 6 years of age?
3. Are mental state input and child language abilities at age 3 years related to children’s FB understanding at age 5 years?
4. Is FB understanding at age 5 years related to social-pragmatic language skills at age 6 years?

Research Questions: Second Grade
5. How do CHH compare to CNH in their understanding of FB concepts at second grade?
6. What factors influence children’s performance on FB tasks at second grade?

Methods
Participants, Assessing False belief and predictive factors

Participants
- Five-year olds:
  - 142 children with mild-to-severe HL from OCHL study
  - 57 children with normal hearing, matched on age and maternal education
- Six-year olds (subgroup of non-passers at 5 who returned at 6 yr)
  - 50 CHH
  - 6 CNH
- Second graders:
  - 80 CHH
  - 43 CNH
Procedures at 5 and 6 years

**Measures at 5 years**
- Audiological Measures
- 4 False Belief Tasks (scores = 0 to 4)
- CELF-4 Word Structure (syntax)
- Peabody Picture Vocabulary Test
- Preschool Language Assessment Instrument (verbal reasoning)

**Measures at 6 years (non-passers)**
- Audiological Measures
- Repeat 4 False Belief Tasks
- Matrix Reasoning – WASI-2 (cognition)
- Heads-to-toes Task (Executive function)
- CASL Syntax

False Belief: Unexpected Contents

Now, let’s bring your friend Joey in the room. What will Joey think is in this box?

Crayons  | Spoon

What do you think is in the box?

Crayons

Oh look what’s really in the box!

A spoon

FB: Change of Location Stories

CASL: Pragmatic Judgment

Mary walks over to her friends who are playing dolls. Mary wants to play with them. What does Mary say?

Results – Research Q1

Comparison of CNH to CHH on first-order FB concepts at 5 and 6 years of age

\[ \chi^2 = 30.34, \ p < .001 \]

CNH outperform CHH at age 5 on FB

Note: CHH differed significantly from matched peers on all language measures (effect sizes = 0.62 – 0.85)
Results – Research Q2

What factors influence children’s performance on FB tasks at 5 and 6 years of age?

Logistic Regression Results: Age 5

<table>
<thead>
<tr>
<th>Variable</th>
<th>Word Chi-Square</th>
<th>Pr&gt;Chi-Square</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>CELF-4 Word Structure SS</td>
<td>5.959</td>
<td>.015</td>
<td>1.050</td>
</tr>
<tr>
<td>PLAN-2 Reasoning SS</td>
<td>5.191</td>
<td>.023</td>
<td>1.191</td>
</tr>
<tr>
<td>PPVT-4 SS</td>
<td>0.173</td>
<td>.678</td>
<td>0.990</td>
</tr>
<tr>
<td>Maternal education</td>
<td>0.000</td>
<td>.996</td>
<td>1.000</td>
</tr>
<tr>
<td>Hearing status (NH, HH)</td>
<td>9.505</td>
<td>.002</td>
<td>5.139</td>
</tr>
</tbody>
</table>

Linear regression verified results: 47% of variance explained

CHH only (auditory factors at age 5)

- Passers > non-passers on BESII (0.81 vs. 0.75; \( p = .008 \))
- Matched on BEPTA, age of confirmation, age of HA fitting
- BESII correlated with language and false belief measures (\( r = 0.35; r = 0.23 \))
- Regression model: Maternal ed, language scores, BESII explain 45% of variance in FB at age 5
- Only Grammar and Verbal Reasoning were unique predictors (effect of audibility mediated by child language)

Results: Predictors at Age 6

<table>
<thead>
<tr>
<th>Variable</th>
<th>Passers of FB at 6</th>
<th>Non-passers of FB at 6</th>
<th>Between Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal education (years)</td>
<td>31 24.71 (2.7)</td>
<td>24 24.83 (2.2)</td>
<td>.854</td>
</tr>
<tr>
<td>Heads to Toes (Raw)</td>
<td>5 20.5 (14.3)</td>
<td>0 0</td>
<td>.001 1.02</td>
</tr>
<tr>
<td>WASI Matrix Reasoning (T)</td>
<td>29 47.61 (7.9)</td>
<td>25 47.61 (7.9)</td>
<td>.002 0.99</td>
</tr>
<tr>
<td>CASL Syntax (SS)</td>
<td>31 98.3 (16.6)</td>
<td>25 74.0 (15.6)</td>
<td>.001 1.48</td>
</tr>
</tbody>
</table>

\( r = 0.88 \); Predictors = matrix reasoning, grammar, executive function
Syntax was the only significant predictor

Research Q3 (Longitudinal)

Are mental state input and child language abilities at age 3 years related to children’s FB understanding at age 5 years?
Participants and Methods
- Subgroup of 46 CHH and 19 CNH
- Interactive language samples at age 3 (Ambrose et al., 2015) + FB at age 5 years
- Transcribed and Coded for parent use of mental terms (think, know, remember, etc.)
- Language Measures: CASL basic concepts, pragmatic judgment

Results - Research Q3
- CHH = CNH (at age 3 years)
  - CASL Basic Concepts ($p = .09$)
  - CASL Pragmatic Judgment ($p = .52$)
- Conclusion: Parents addressing CHH used significantly fewer mental terms than parents addressing CNH; not fully explained by language

Results – Research Q4
- Linear Regression Model (Maternal Education controlled)
- Predictors: Age 5 Child Language (syntax) and FB Scores
- Dependent Variable: Social-Pragmatic Language Ability at Age 6
- Model explains 61.5% of variance [$F (3, 152) = 83.56$, $p = .001$]
- Significant independent predictors:
  - Syntax (CELF word structure)
  - FB Scores (small but unique contribution over language)

Research Q4 (Longitudinal)
Is FB understanding at age 5 years related to social-pragmatic language skills at age 6 years?
- Does FB relate to daily social communication?

Research Q5
How do CHH compare to CNH in their understanding of FB concepts at second grade?

Procedures at Second Grade
- Audiological Measures
- False Belief Stories
  - Knowledge/ignorance = 4 items, 1st FB = 8 items, 2nd FB = 4 items
  - Total of 16 points
- CELF-4 Word Structure (syntax)
- WJTA Picture Vocabulary
- AWMA backward digit recall
Advanced FB: The Bake Sale

Two Story Narratives with Cartoon Illustrations
• First Order – What does the character know or believe?
• Second Order – What does one character know or believe about another?

Results – Research Q5

Between group comparison on subtest scores

No significant differences between groups on total score or subtest scores

Research Q6

What factors influence children’s performance on FB tasks at second grade?

Logistic Regression Results: 2nd Order FB

<table>
<thead>
<tr>
<th>Variable</th>
<th>Wald Chi-Square</th>
<th>Pr(Chi-Square)</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing category</td>
<td>0.437</td>
<td>0.932</td>
<td>0.728-1.014</td>
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<tr>
<td>Maternal education</td>
<td>2.920</td>
<td>0.088</td>
<td>1.167</td>
</tr>
<tr>
<td>AWMA Backward Digits SS</td>
<td>1.733</td>
<td>0.188</td>
<td>1.020</td>
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<tr>
<td>CELF-4 Word Structure SS</td>
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<td>0.002</td>
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<tr>
<td>WJTA Picture Vocabulary SS</td>
<td>1.305</td>
<td>0.252</td>
<td>0.971</td>
</tr>
</tbody>
</table>

For CHH only, effect of BESII on FB is mediated by language abilities.

Summary (5 and 6 years)

• Majority of CNH (84%) passed FB at age 5, consistent with literature
• Majority of CHH (59%) demonstrated delay – CHH 5 times less likely than CNH to pass
• Partially confirms Natten et al (in press)
• Results on 6 year olds suggests delays resolving, but some CHH remain at risk
• Non-passers at age 6 had combined disadvantages of lower language, cognitive, and EF
• Language is a major contributing factor explaining individual differences
• Audibility contributes, but mediated by language
• Strong audibility + strong language may lead to resilience in complex listening situations
• Parental talk at age 3 differed between groups; not unique predictor
• FB at 5 related to social language abilities at age 6 years (deRosnay et al., 2014)
Summary (Second Grade)

- CHH performed like hearing peers at second grade
  - Language was the primary predictor of outcome
- Does this mean that CHH “catch up” in FB understanding by ages 6 to 8 years?
  - Possibly due to resolving language delays?
  - Greater access to conversation than deaf children with hearing parents?
  - Will both groups proceed to mastery on same schedule?
- FB may be “too narrow a lens?”

Widening the lens: IRONY/SARCASM

Method

- 9 Picture-Supported Stories
  - de Villiers & de Villiers
  - Presented in standard A-V format
  - Child answered questions requiring interpretation or reasoning

Sarcasm (Grade 2)

Main effect of hearing category $p = .004$

Positive Predictors: (36% of variance)
- Language
- Social Cognition

Implications

- Need to support families in engaging in talk and conversations that promote social-cognitive abilities
- Do parents make assumptions about child’s readiness to engage in “abstract” talk?
- Do parents limit exposure that is not within “earshot?”
- Studies demonstrate that training helps children develop these concepts
  - Value in targeting ToM skills in intervention
  - Opportunities to innovate methods for measuring social-cognitive skills, especially advanced abilities
Conclusions

- HL does have an effect on speech and language development during the preschool years
- Even the mild group was significantly poorer
- Children with moderate to severe HL were in the low average to poor range
- Audibility provided by HAs resulted in improved language growth
- Early identification and clinical management including well-fit HAs that are worn consistently improved outcomes

Theoretical Implications

- Results have implications for theories about sensitive periods and role of experience in language development
- The language development system appears to remain open to experience
- Possibly at a lower level of learning efficiency

Future Research Directions

1. Cascading effects of early delays (literacy, psychosocial)?
2. Impact of complex listening environments on learning and listening effort?
3. Protection offered by working memory & linguistic knowledge?
4. Can strategic interventions protect against risk and better support families at risk?

Are children who are hard of hearing still forgotten?

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

Thank you to NIDCD and to the families who have been dedicated participants.

www.ochlstudy.org

Free access to OCHL supplement in Ear & Hearing