Early vs. Late Onset Hearing Loss: How Children Differ from Adults

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Heterogeneity of Children with Hearing Loss

- Chronological age
- Age at onset
- Age at identification
- Age at amplification
- Age at intervention
- Duration of intervention
- Quality of intervention
- Degree of hearing loss
- Configuration of hearing loss
- Etiology of hearing loss

- Type of amplification
- Consistency of hearing aid use
- Use of supplemental devices (FM system)
- Other handicapping conditions
- Parental involvement
- Socioeconomic status
- Mono vs. Bilingual language learner
- IQ
The big difference between adults and children…

Adults use their residual hearing to *continue* to communicate…
children use their residual hearing to *learn* to communicate.
HI Children vs. HI Adults

- Audiologic differences
  - Configuration of hearing loss
- Perceptual differences
  - Perceptual weighting functions
  - Perceptual coherence
- Perceptual management differences
  - Multitasking
Hearing Loss in Children and Adults: Audiometric Configuration, Asymmetry, and Progression

Pittman & Stelmachowicz (2003)

Ear & Hearing
Methods

**Groups**
- 6-year-old children
- 60-year-old adults

**Audiogram Selection Criteria**
- Right ear thresholds
- Pure-tone thresholds at octave frequencies (250-8000 Hz)
- At least one threshold $\geq 30$ dB HL
- Confirmed sensorineural hearing losses (air-bone gaps $\leq 10$ dB)
Methods

Core Set of Audiograms
- 227 children
- 248 adults

Analyses
- Configuration
- Asymmetry
- Progression
All Audiograms

**Adults (n=248)**

- Frequency (Hz)
  - 250
  - 500
  - 1000
  - 2000
  - 4000
  - 8000

**Children (n=227)**

- Frequency (Hz)
  - 250
  - 500
  - 1000
  - 2000
  - 4000
  - 8000
All Audiograms

Adults (n=248)

Children (n=227)
Audiometric Classification

- **Sloping**
- **Rising**
- **Flat**
- **U-Shaped**
- **Tent-Shaped**
- **Other**
Results - Distribution

- Adults: 50
- Children: 30

Audio Grams:
- Sloping: 40
- U-Shaped: 30
- Tent-Shaped: 20
- Flat: 10
- Other: 10
- Rising: 0

Category:
- Sloping
- U-Shaped
- Tent-Shaped
- Flat
- Other
- Rising
Results - Configuration

- **Sloping**
- **Rising**
- **Flat**
- **U-Shaped**
- **Tent-Shaped**
- **Other**

Graphs showing hearing level (dB) against frequency (Hz) for different configurations and age groups (Adults: black dots, Children: white circles).
All Audiograms

Adults (n=248)

Children (n=227)
Sloping Losses

Adults

73%

Children

33%
The children had a wider variety of audiometric configurations.

The hearing losses in adults were typically sloping in configuration accounting for 3-in-4 audiograms.

The same sloping configurations occurred in only 1-in-3 of the children.
Influence of Hearing loss on the Perceptual Strategies of Children and Adults

Pittman, Stelmachowicz, Lewis & Hoover (2002)
*Jr of Sp Lang & Hear Res*

Pittman & Stelmachowicz (2000)
*Jr of Sp Lang & Hear Res*
Subjects

Normal Hearing
- 10 Adults
  (mean = 28 yrs, 20-44)
- 20 Children
  (mean = 6:8 yrs, 5-7)

Hearing Impaired
- 10 Adults
  (mean = 59 yrs, 49-66)
- 10 Children
  (mean = 7:8 yrs, 5-10)
Stimuli

- 4 words
  - CVC
  - 2 vowels
  - 2 fricatives
- 2 conditions
  - w/ transition
  - w/o transition
Stimuli

- 4 words
  - CVC
  - 2 vowels
  - 2 fricatives
- 2 conditions
  - w/ transition
  - w/o transition
Stimuli

- 4 words
  - CVC
  - 2 vowels
  - 2 fricatives

- 2 conditions
  - w/ transition
  - w/o transition
Presentation

5 levels
Short-Term Audibility
Results

Normal-Hearing Adults

Performance vs. Short-Term Audibility

- w/ transition
- w/o transition
Normal-Hearing Children

Normal-Hearing Adults

Hearing-Impaired Children

Hearing-Impaired Adults

Performance vs. Short-Term Audibility
Conclusions

Relative to the normal-hearing adults…

- The normal-hearing children demonstrated typical development of speech perception.
- The hearing-impaired adults demonstrated the typical effects of hearing loss for the perception of soft speech.
- The hearing-impaired children demonstrated a combination of speech perception development and hearing loss effects.

The whole was greater than the sum of the parts.
Perceptual coherence in listeners with childhood hearing losses, adult-onset hearing losses, and normal hearing

Pittman (January, 2008)
Jr Acoust Society Amer
Perceptual Coherence
Subjects

- 10 Normal hearing (mean age 25 years)
- 10 Acquired hearing losses (mean age 64 years)
- 10 Congenital hearing losses (mean age 35 years)
Stimuli

Speech

- 9 naturally produced words (sonorants)
- Produced by a male, female and child.
Paradigm

- **Yes/No**
  - Yes trial
    - F2 in the word
  - No trial
    - F2 not in the word
Results

![Bar graph showing percent correct and D-prime values for NH, A-HL, and C-HL groups with error bars.](image)
Conclusions

Perceptual coherence was not affected by hearing loss.

Perceptual coherence was affected by the presence of hearing loss early in life.

Practical consequences of poor perceptual coherence are largely unknown.

Results suggest long-term effects of hearing loss.
Effect of minimal hearing loss on children’s ability to multitask in quiet and in noise

McFadden & Pittman (submitted)

*J Lang Sp Hear Ser Schls*
How do children allocate their cognitive resources?
How do children allocate their cognitive resources?
Downs & Crum (1978)

- Normal-Hearing Adults
- Paired Association Task & Probe Reaction Time
  - 35 dB SL
  - Quite and +6dB SNR

### PRIMARY TASK

- # of Learning Trials
- Better: 6, Worse: 7, 8, 9, 10

### SECONDARY TASK

- Reaction Time (ms)
- Better: 0, 50, 100, 150, 200, 250, 300, 350, 400
- Worse: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Types of Noise:
- Quiet
- Noise
Downs (1982)

- Hearing-Impaired Adults
- Word Recognition Task & Probe Reaction Time
  - 58 dB SPL
  - 0 dB SNR

**PRIMARY TASK**

- Word Recognition (% correct)
-更好 (Worse - 不佳) 更好 (Better - 佳)

**SECONDARY TASK**

- Reaction Time (ms)
- 更好 (Worse - 佳) 更好 (Better - 佳)
Hicks & Tharpe (2002)

- Normal-Hearing & Hearing-Impaired Children
- Word Recognition Task & Probe Reaction Time
  - 70 dB SPL
  - Quiet, +20, +15 & +10 dB SNR

** PRIMARY TASK **

- Word Categorization (% correct)
- Better & Worse

** SECONDARY TASK **

- Reaction Time (ms)
- Better & Worse
Method

- **NH children**
  - N=11
  - Age = 8-12 years

- **HI children**
  - N=10
  - Age = 8-12 years
  - Minimal Hearing Losses
    - Unilateral
    - Mild
    - High-frequency
Method

Primary Task: Word categorization
- Animal, Person, Food
  - Example: Dog, Mother, Pizza
- Presented binaurally via earphones at 65 dB SPL
- Listening conditions: Quiet, +6 dB SNR, and 0 dB SNR

Secondary Task: Dot to dot puzzles
- 18 puzzles
- Dot rate (dots/minute)
Method

Word Categorization

Dot-to-dot Games

PERSON

FOOD

ANIMAL
Results

**PRIMARY TASK**

NHC         HIC

<table>
<thead>
<tr>
<th>Word Categorization</th>
<th>Quiet</th>
<th>0dB SNR</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td>90</td>
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**SECONDARY TASK**

Quiet 0dB SNR

<table>
<thead>
<tr>
<th>Dot Rate (dots/min)</th>
<th>Quiet</th>
<th>0dB SNR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
<td>30</td>
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</table>
Conclusions

- Hearing loss did not alter the way these children approached multiple tasks.
- Children did not appear to redirect their cognitive resources from one task to accommodate the listening task.
  - May be unwilling to redirect
  - May be unable to redirect
  - May be unaware of the need to redirect
- How does the difficulty of the competing task affect their ability to attend to speech?
Summary

- Children’s hearing loss configurations differ from those of adults.
- The presence of hearing loss early in life has immediate and long-term effects on auditory perception.
- Children do not (or are not able to) approach listening tasks in the same way as adults.
In the future…

- Configuration specific amplification strategies
- Life-long effects of hearing loss
- Management of perceptual resources