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)**

**Children (n=227)**
All Audiograms

**Adults (n=248)**

**Children (n=227)**
Audiometric Classification

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

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

- Adults
- Children
Results - Configuration

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

Focusing on the different hearing levels across various frequency bands for adults and children.
All Audiograms

Adults (n=248)

Frequency (Hz)
250 500 1000 2000 4000 8000

Hearing Level (dB HL)

Children (n=227)

Frequency (Hz)
250 500 1000 2000 4000 8000

Hearing Level (dB HL)
Sloping Losses

- **Adults**: 73%
- **Children**: 33%

Bar chart showing the percentage of audiograms for adults and children across different types of hearing losses.
Summary

- 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

Performance
Short-Term Audibility Performance
Results

Normal-Hearing Adults

- Performance vs. Short-Term Audibility
- Black circles: w/ transition
- White circles: w/o transition
Normal-Hearing Adults

Normal-Hearing Children

Hearing-Impaired Adults

Hearing-Impaired Children
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
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**
- Better
- Worse

**Secondary Task**
- Worse
- Better

# of Learning Trials

Quiet | Noise
0 | 0
1 | 1
2 | 2
3 | 3
4 | 4
5 | 5
6 | 6
7 | 7
8 | 8
9 | 9
10 | 10
11 | 11
12 | 12

Reaction Time (ms)

Quiet | Noise
0 | 0
50 | 50
100 | 100
150 | 150
200 | 200
250 | 250
300 | 300
350 | 350
400 | 400
Downs (1982)

Hearing-Impaired Adults

Word Recognition Task & Probe Reaction Time

- 58 dB SPL
- 0 dB SNR

**PRIMARY TASK**

- Word Recognition (% correct)
- Aided vs. Unaided

**SECONDARY TASK**

- Reaction Time (ms)
- Aided vs. Unaided
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**

<table>
<thead>
<tr>
<th>NHC (%)</th>
<th>HIC (%)</th>
</tr>
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<tbody>
<tr>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>250</td>
<td>300</td>
</tr>
</tbody>
</table>

**SECONDARY TASK**

<table>
<thead>
<tr>
<th>Word Categorization (% correct)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet</td>
</tr>
<tr>
<td>+10 dB SNR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reaction Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet</td>
</tr>
<tr>
<td>+10 dB SNR</td>
</tr>
</tbody>
</table>
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

![Graphs showing results for primary and secondary tasks under different conditions.](image)

**PRIMARY TASK**
- Word Categorization: Comparison between Quiet and 0dB SNR conditions.
- NHC vs. HIC performance.

**SECONDARY TASK**
- Dot Rate: Comparison between Quiet and 0dB SNR conditions.
- NHC vs. HIC performance.
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