# Isolating the Short- and Long-Term Effects of Hearing Loss: Simulating Hearing Loss in Children with Normal Hearing

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# Simulating Hearing Loss in Children

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# Previous Studies in Adults

Humes, Dirks, Bell, Kincaid (1987), Fabry & Van Tassell (1986), Needleman & Crandell (1995), Dubno & Schaefer (1992, 1995)

- Purpose
  - Examine the deficits associated with hearing loss in addition to elevated thresholds
    - Spectral and temporal resolution
  - Explore the possibility of using normal-hearing adults as models for hearing loss
- Equivocal results
  - HI < SIM, HI = SIM, HI > SIM

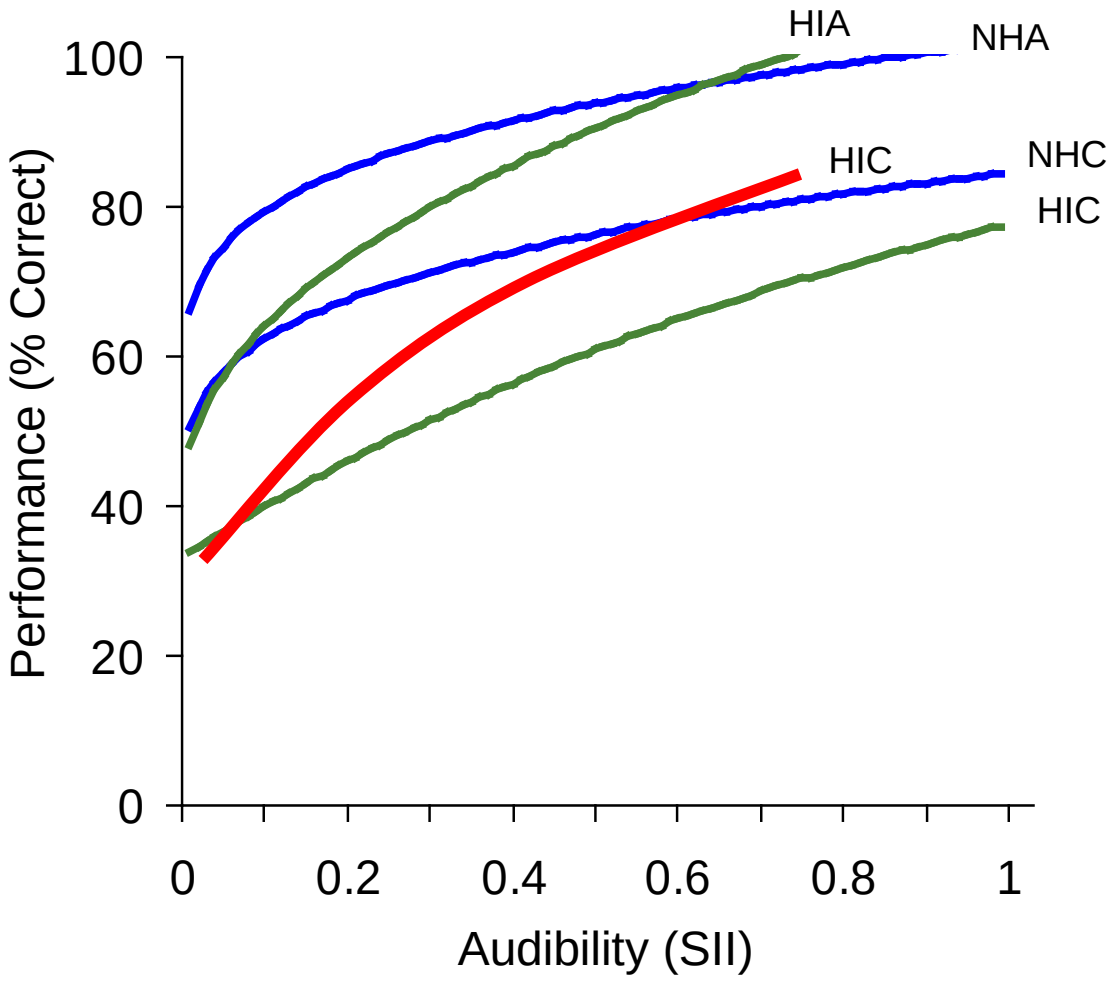
# Rationale

#1 Interaction of hearing loss and developmental age

The whole is greater than the sum of the parts

# Influence of Hearing loss on the Perceptual Weighting Strategies of Children and Adults

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



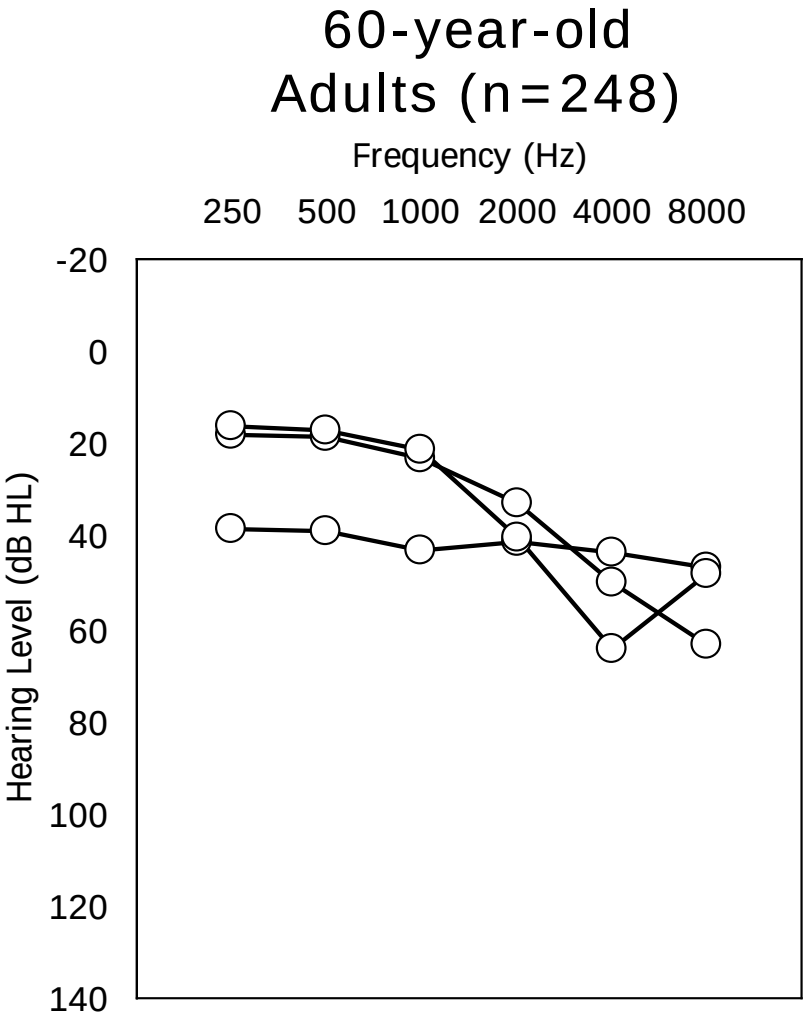
# Rationale

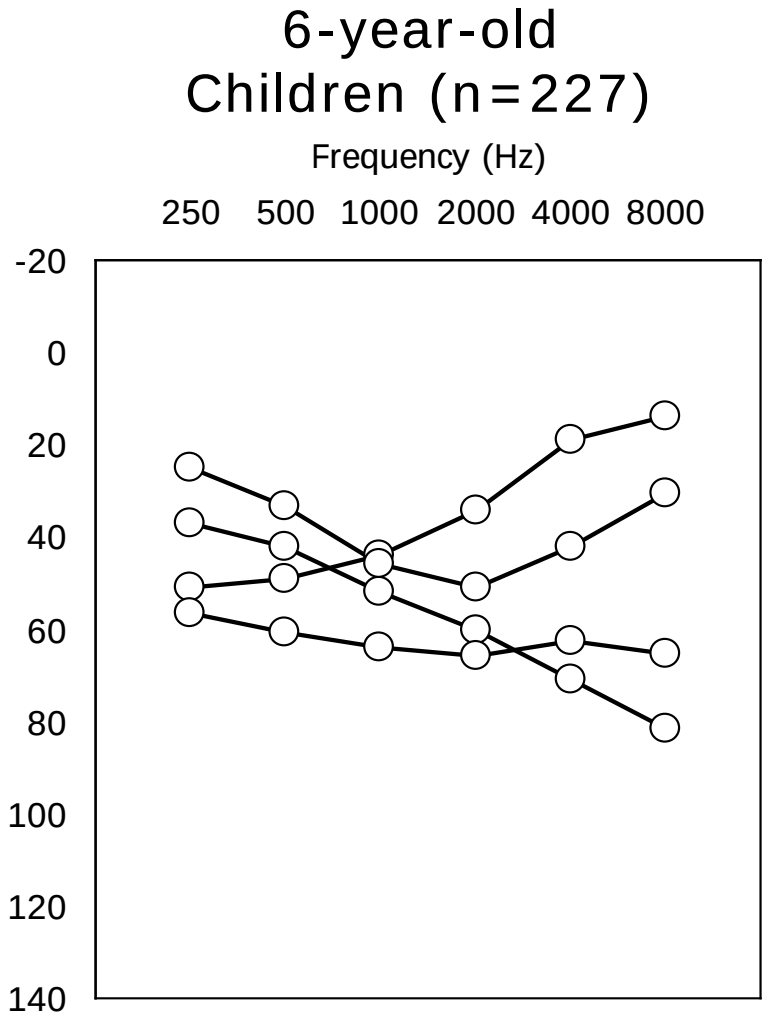
#1 Interaction of hearing loss and developmental age

#2 Configuration of hearing loss

# Configuration of Hearing loss

Pittman & Stelmachowicz (2003) *Ear & Hearing*



# Configuration of Hearing loss

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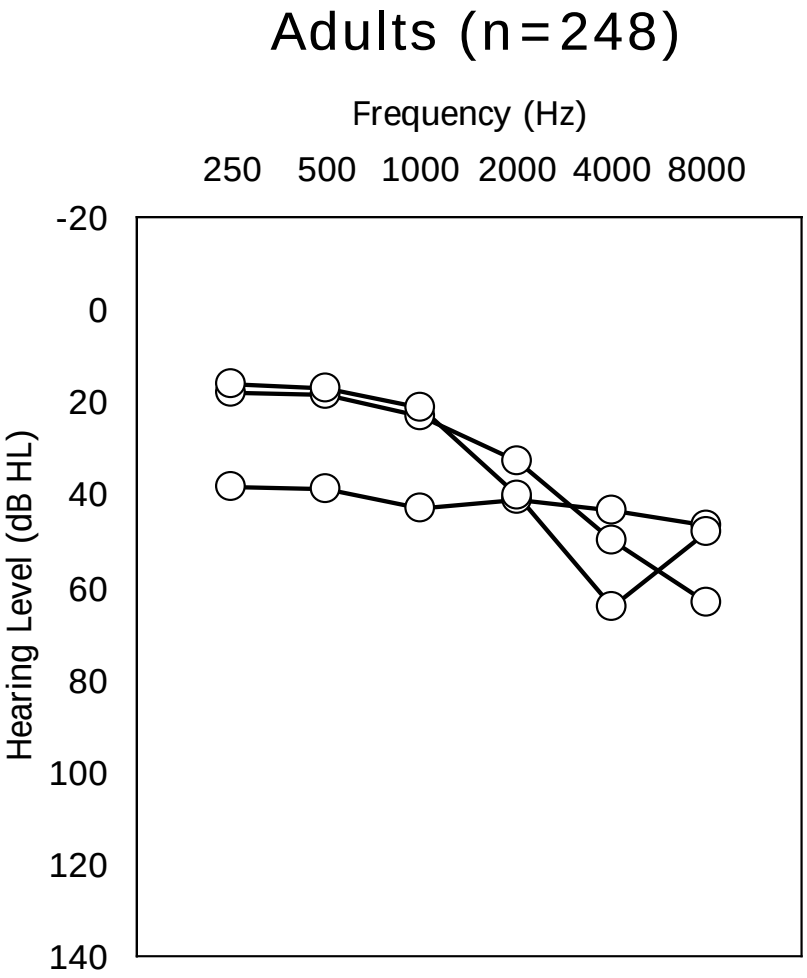


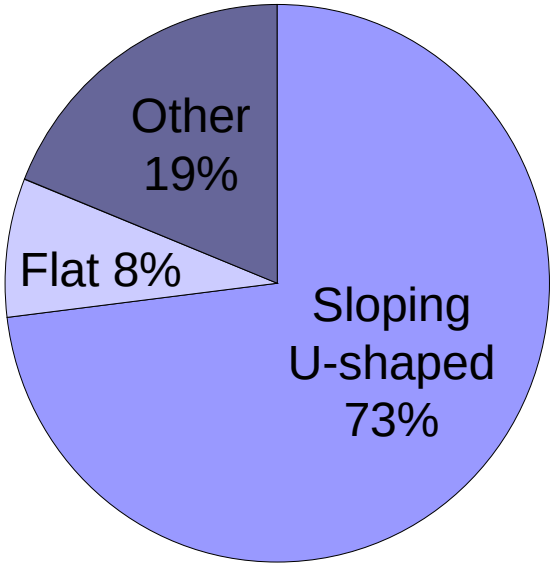

# Configuration of Hearing loss

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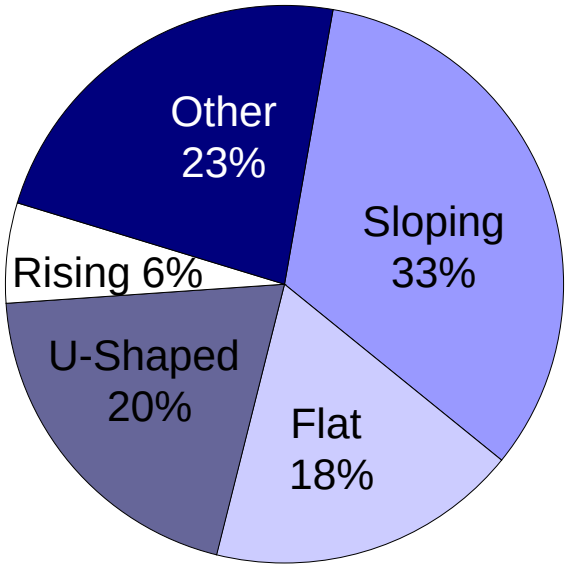
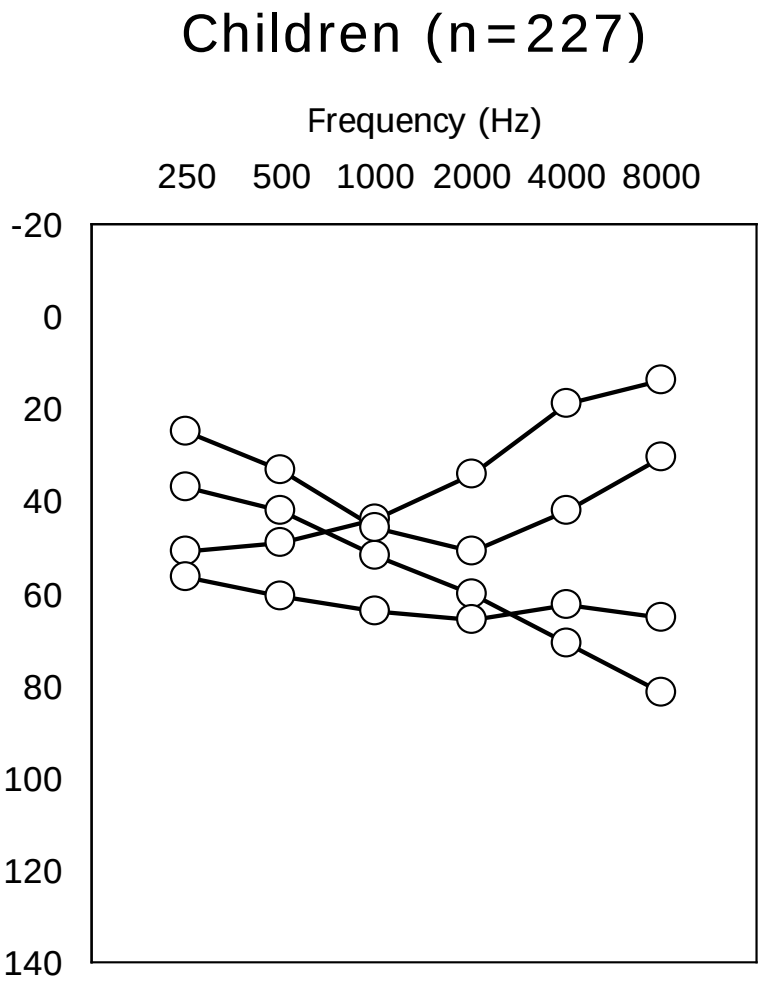


# Rationale

#1 Interaction of hearing loss and developmental age

#2 Configuration of hearing loss

#3 Heterogeneity of children with hearing loss

# Rationale #3…

- Intrinsic heterogeneity
  - Factors inherent to the child
- Extrinsic heterogeneity
  - Factors imposed on the child

# Heterogeneity of HI Children

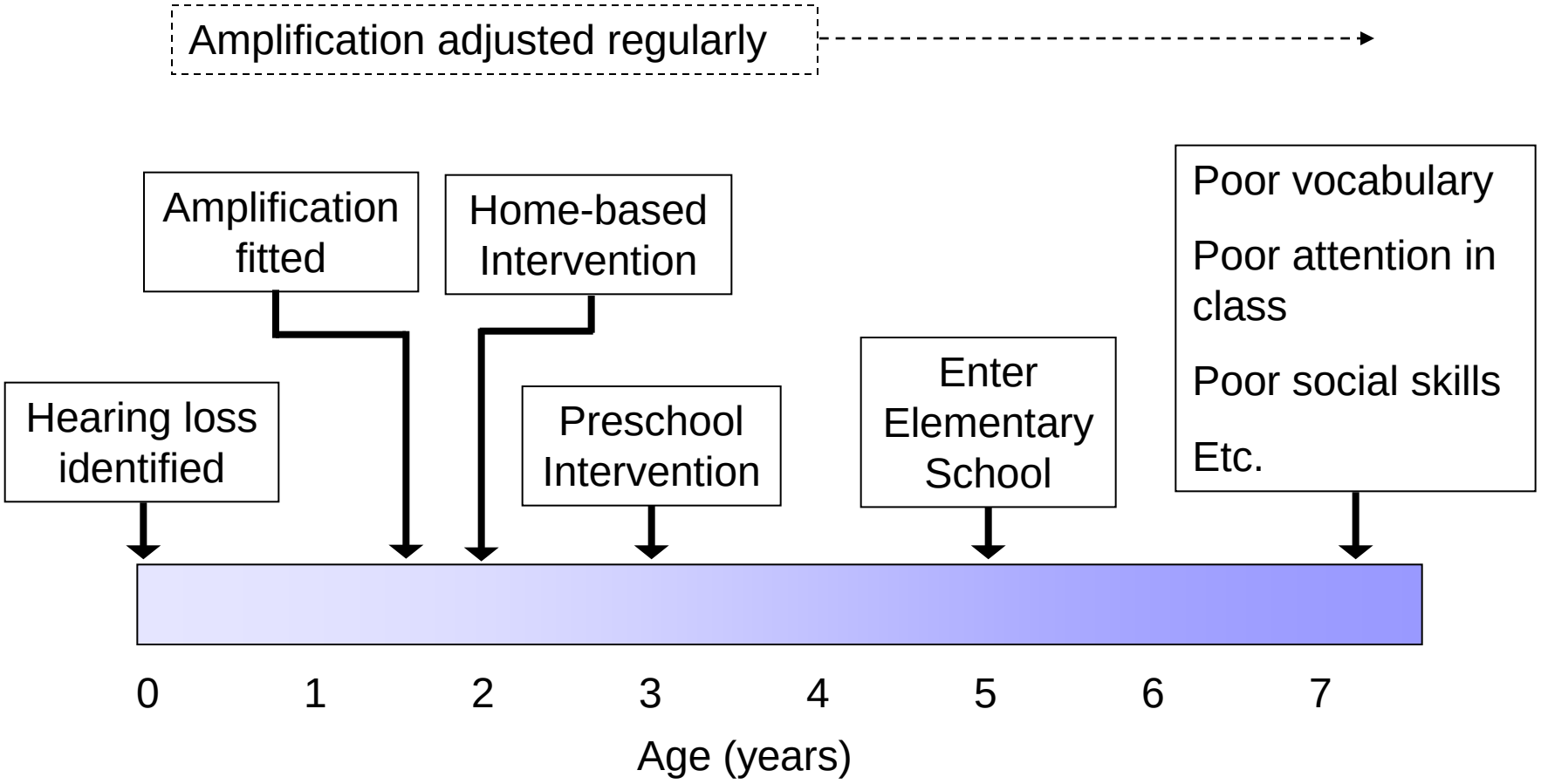
## Intrinsic Heterogeneity

- Chronological age
- IQ/Cognitive capacity
- Age at onset of hearing loss
- Degree of hearing loss
- Configuration of hearing loss
- Etiology of hearing loss
- Other handicapping conditions

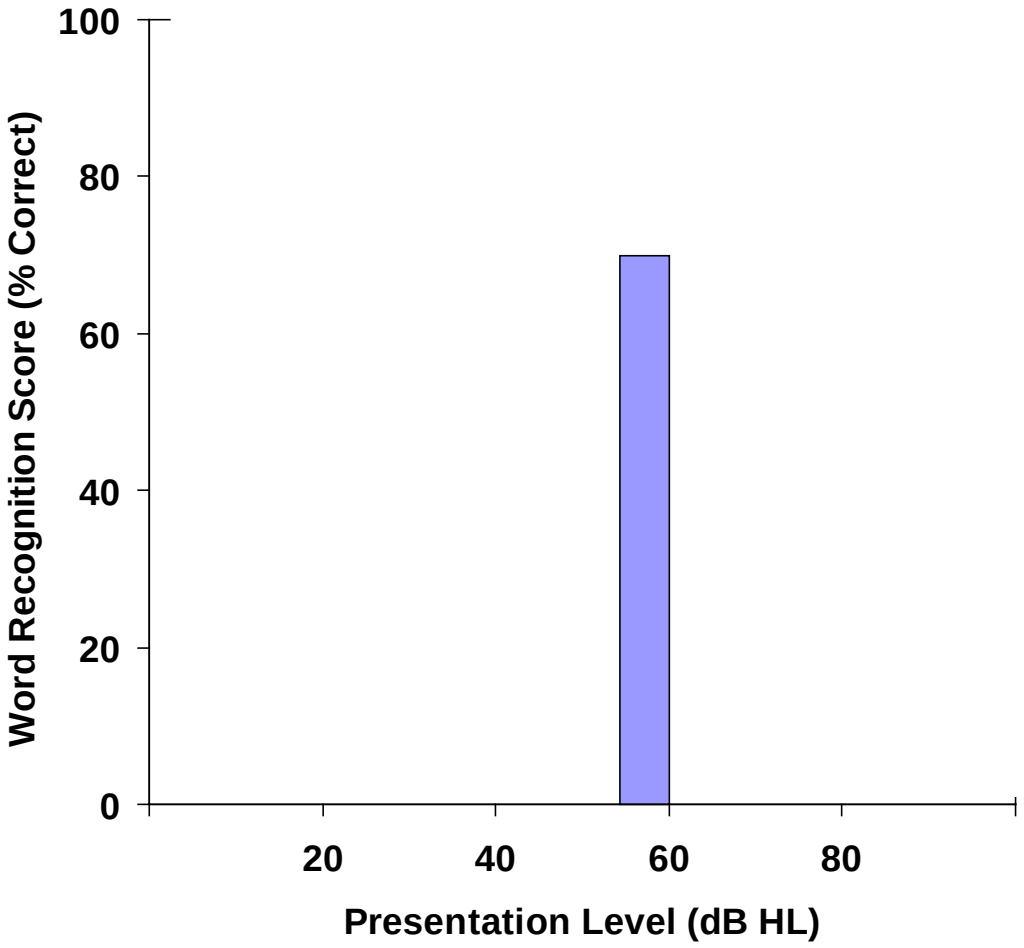
## Extrinsic Heterogeneity

- Age at identification
- Age at amplification
- Type of amplification
- Consistency of hearing aid use
- Use of supplemental devices (FM system)
- Age at intervention
- Duration of intervention
- Quality of intervention
- Parental involvement
- Socioeconomic status
- Mono vs. bilingual language learner

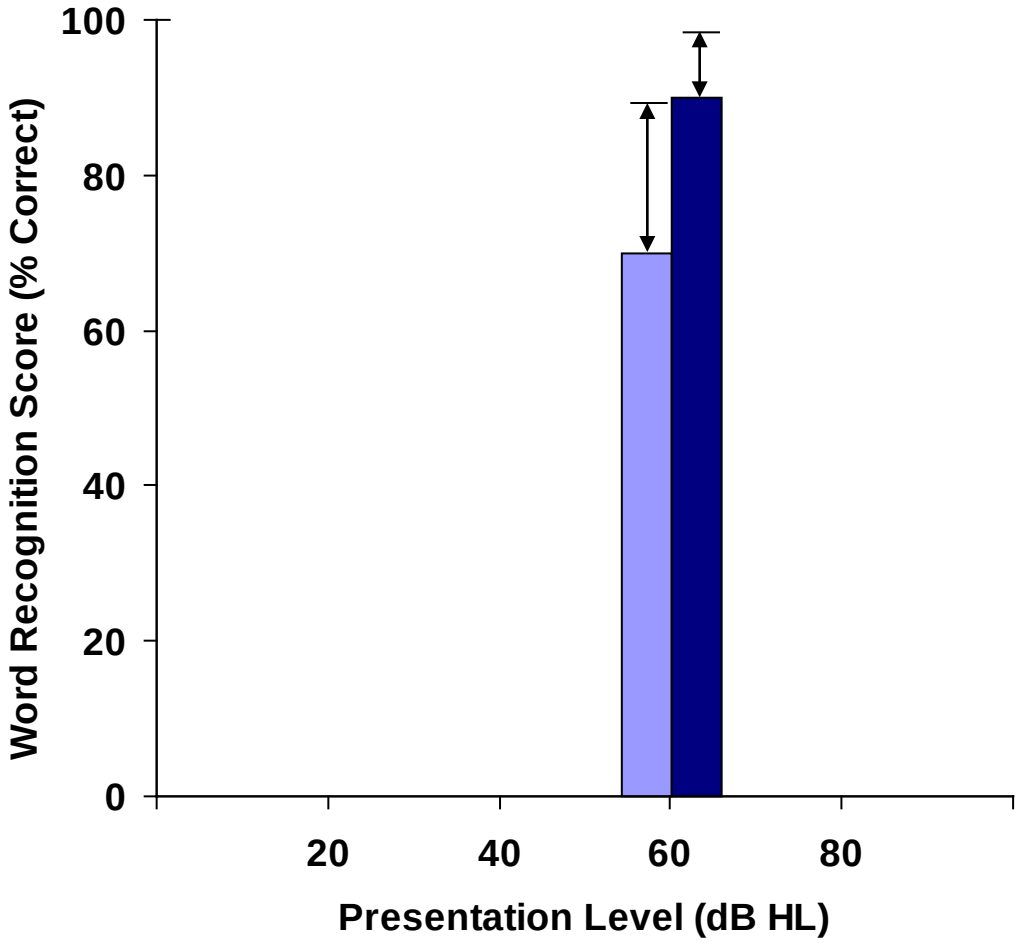
# For example…


Amplification adjusted regularly
Amplification fitted
Home-based Intervention
Poor vocabulary
Poor attention in class
Poor social skills
Etc.
Hearing loss identified
Preschool Intervention
Enter Elementary School
0
1
2
3
4
5
6
7
Age (years)

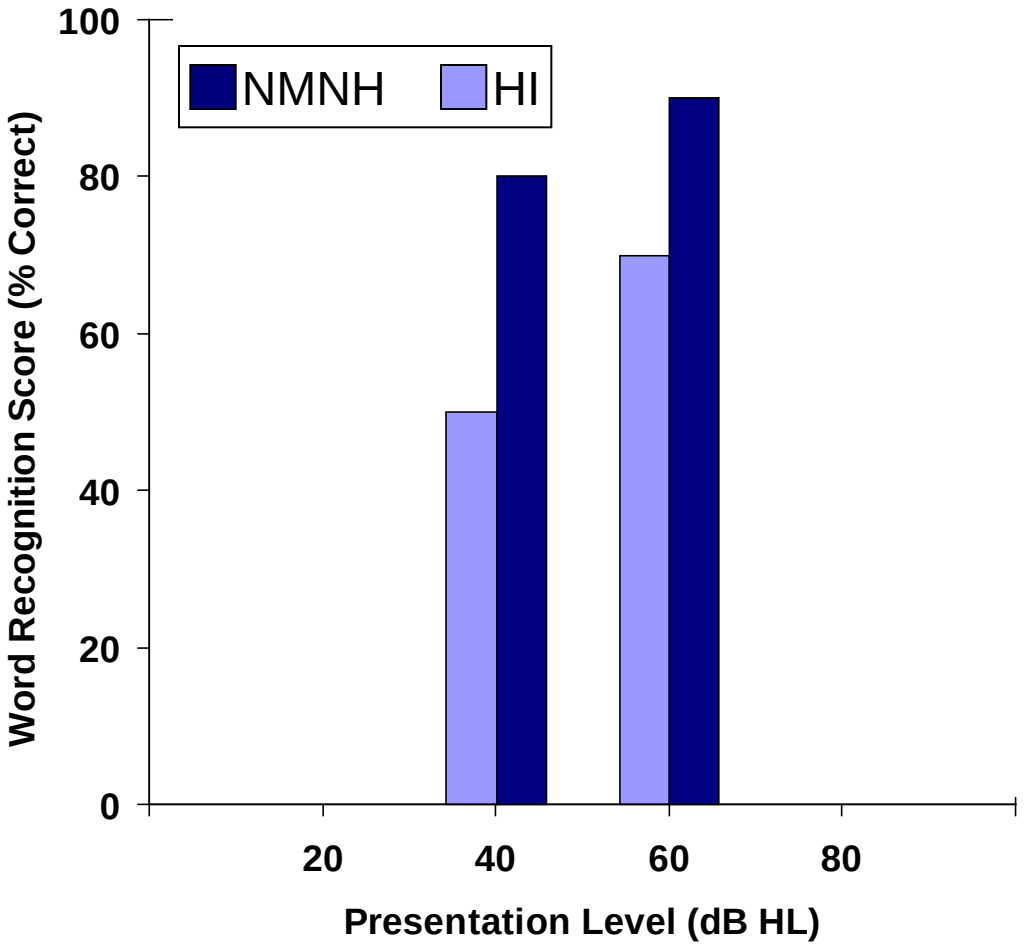
# For Example…


100
80
60
40
20
0
Word Recognition Score (% Correct)
20
40
60
80
Presentation Level (dB HL)

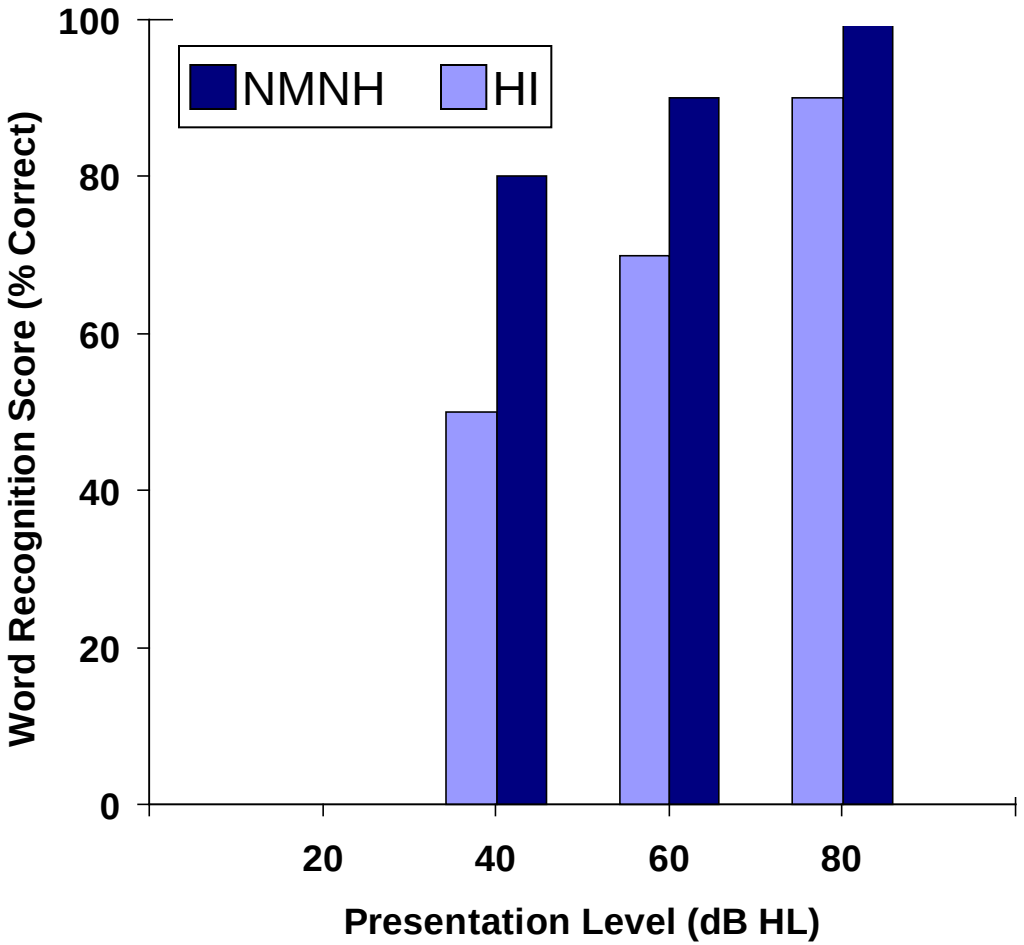
# For Example…


100
80
60
40
20
0
Word Recognition Score (% Correct)
20
40
60
80
Presentation Level (dB HL)

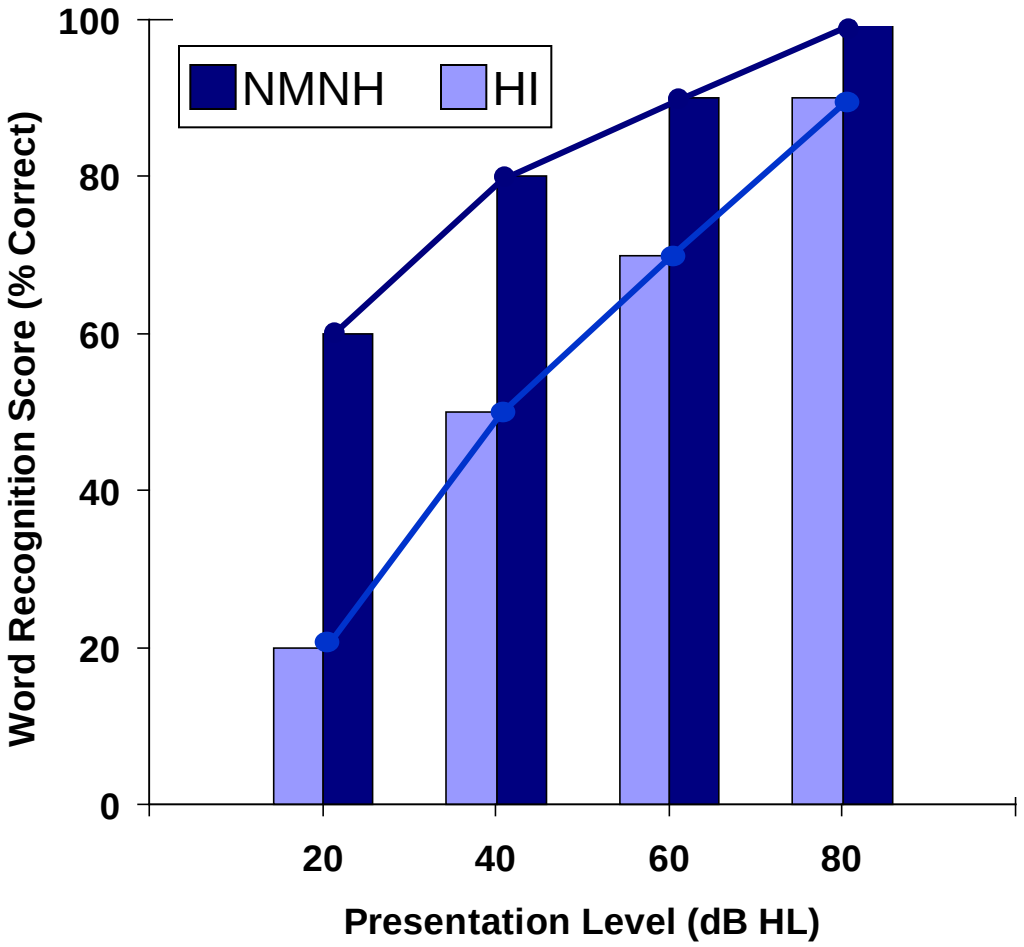
# For Example…

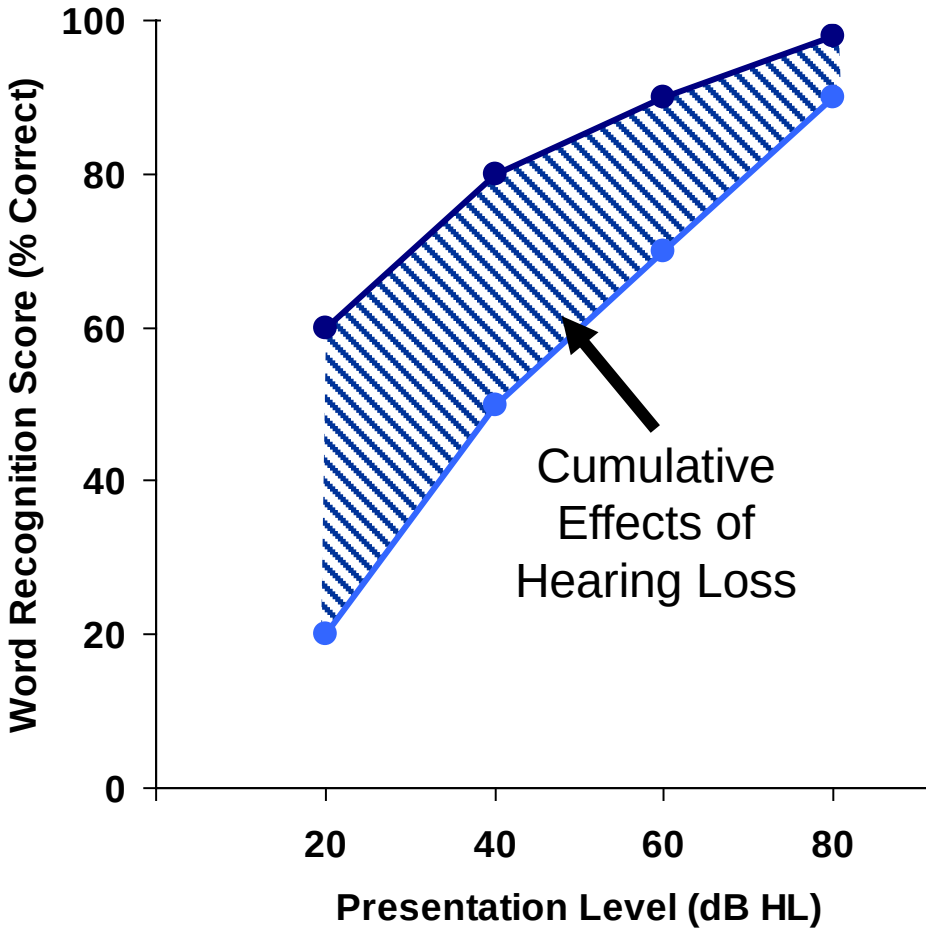

100
80
60
40
20
0
NMNH
HI
Word Recognition Score (% Correct)
20
40
60
80
Presentation Level (dB HL)

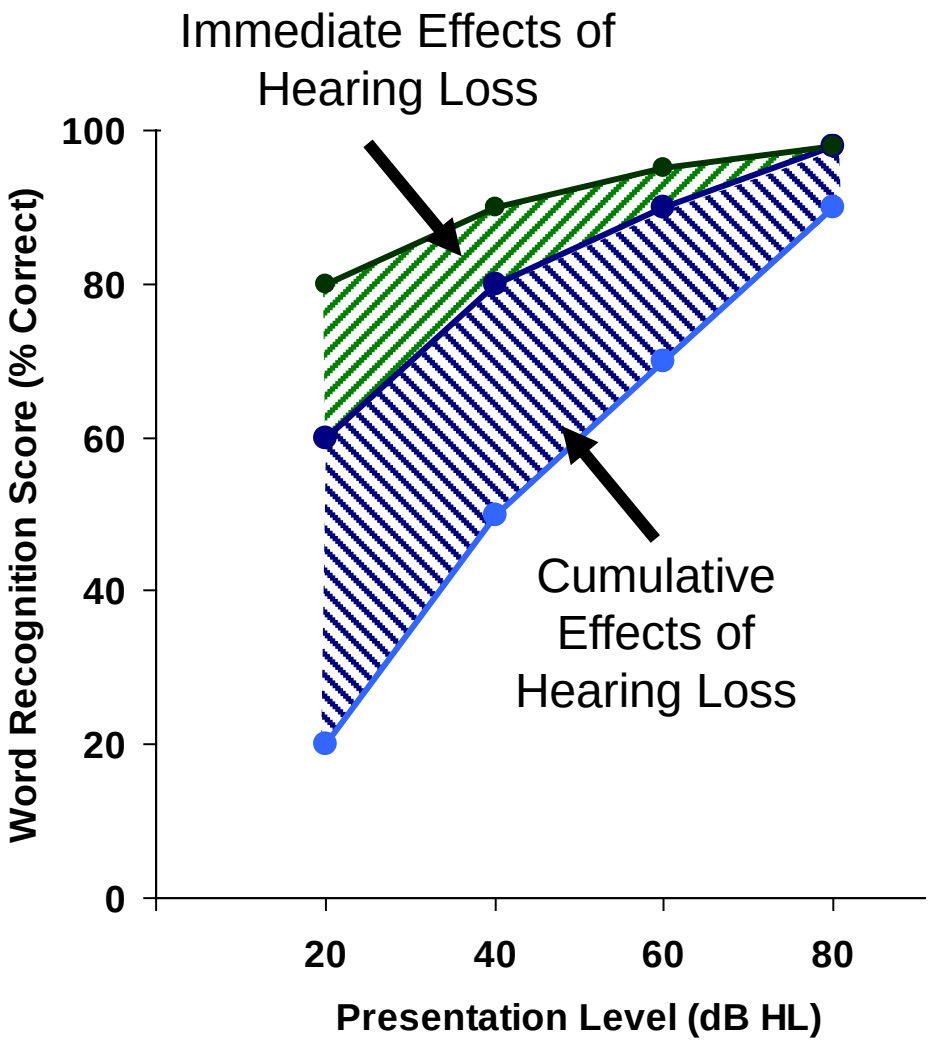
# For Example…


100
80
60
40
20
0
NMNH
HI
Word Recognition Score (% Correct)
20
40
60
80
Presentation Level (dB HL)

# For Example…


100
80
60
40
20
0
NMNH
HI
Word Recognition Score (% Correct)
20
40
60
80
Presentation Level (dB HL)

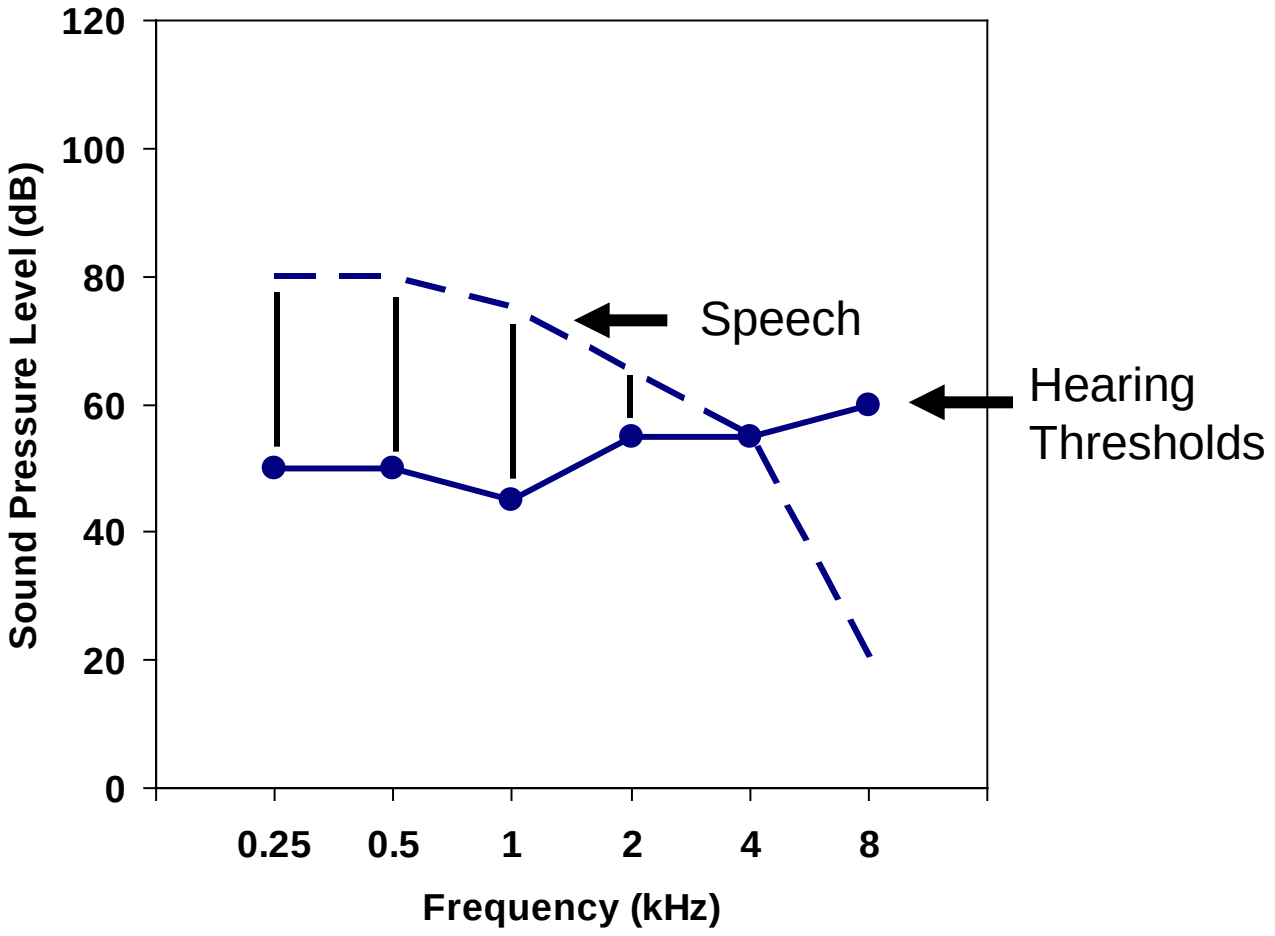

100
80
60
40
20
0
Word Recognition Score (% Correct)
20
40
60
80
Presentation Level (dB HL)
Cumulative
Effects of
Hearing Loss


Immediate Effects of
Hearing Loss
Cumulative
Effects of
Hearing Loss
Word Recognition Score (% Correct)
100
80
60
40
20
0
20
40
60
80
Presentation Level (dB HL)

# Methods for Simulating Hearing Loss (in adults)

- Chemical (not appropriate for children)
  - Acetaminophen
  - Quinine
- Filtering
  - Manipulating the sensation level of the speech signal relative to threshold
- Masking
  - Elevating threshold through the use of frequency-shaped broadband noise

# Simulation - Filtering



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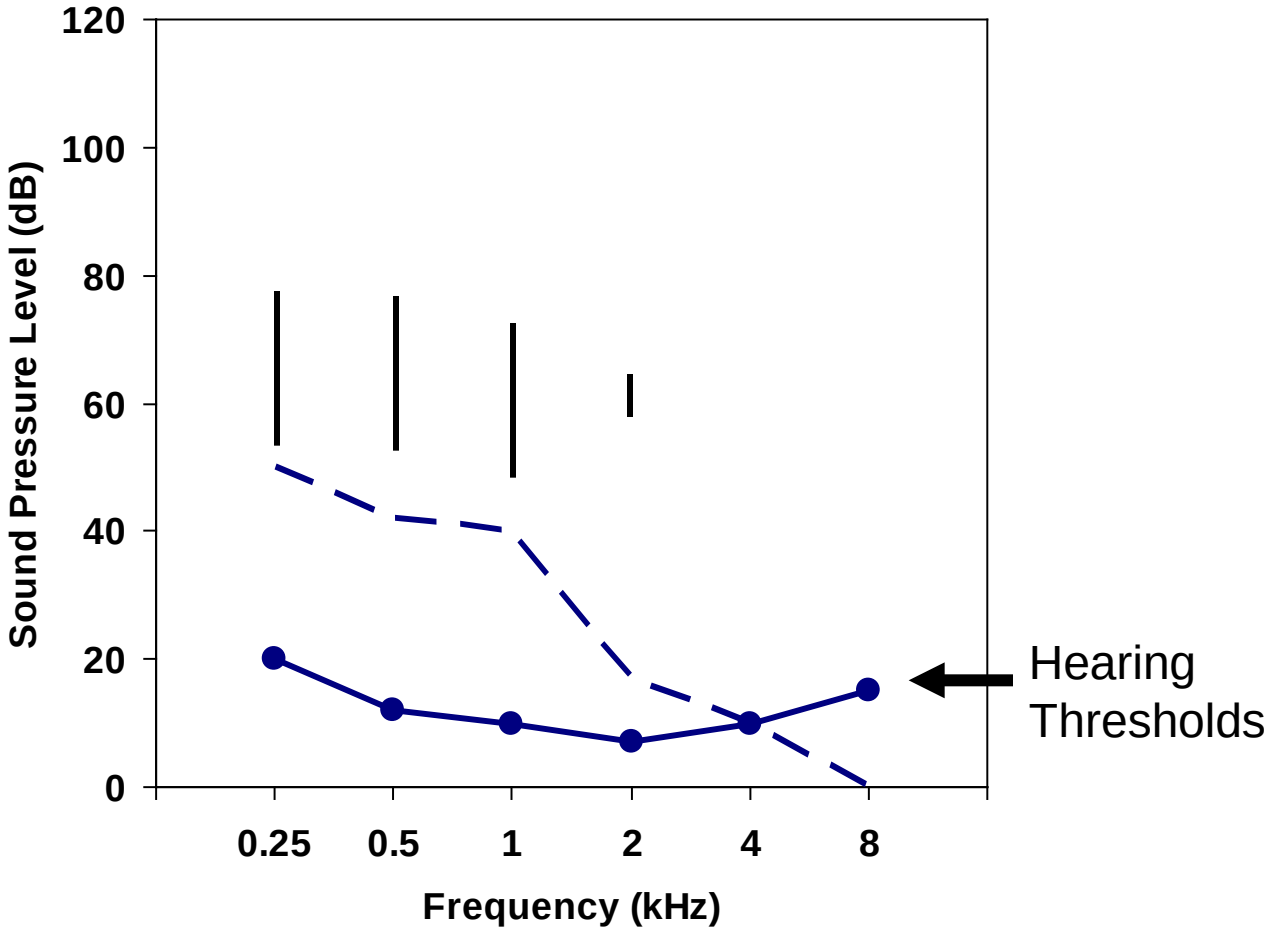
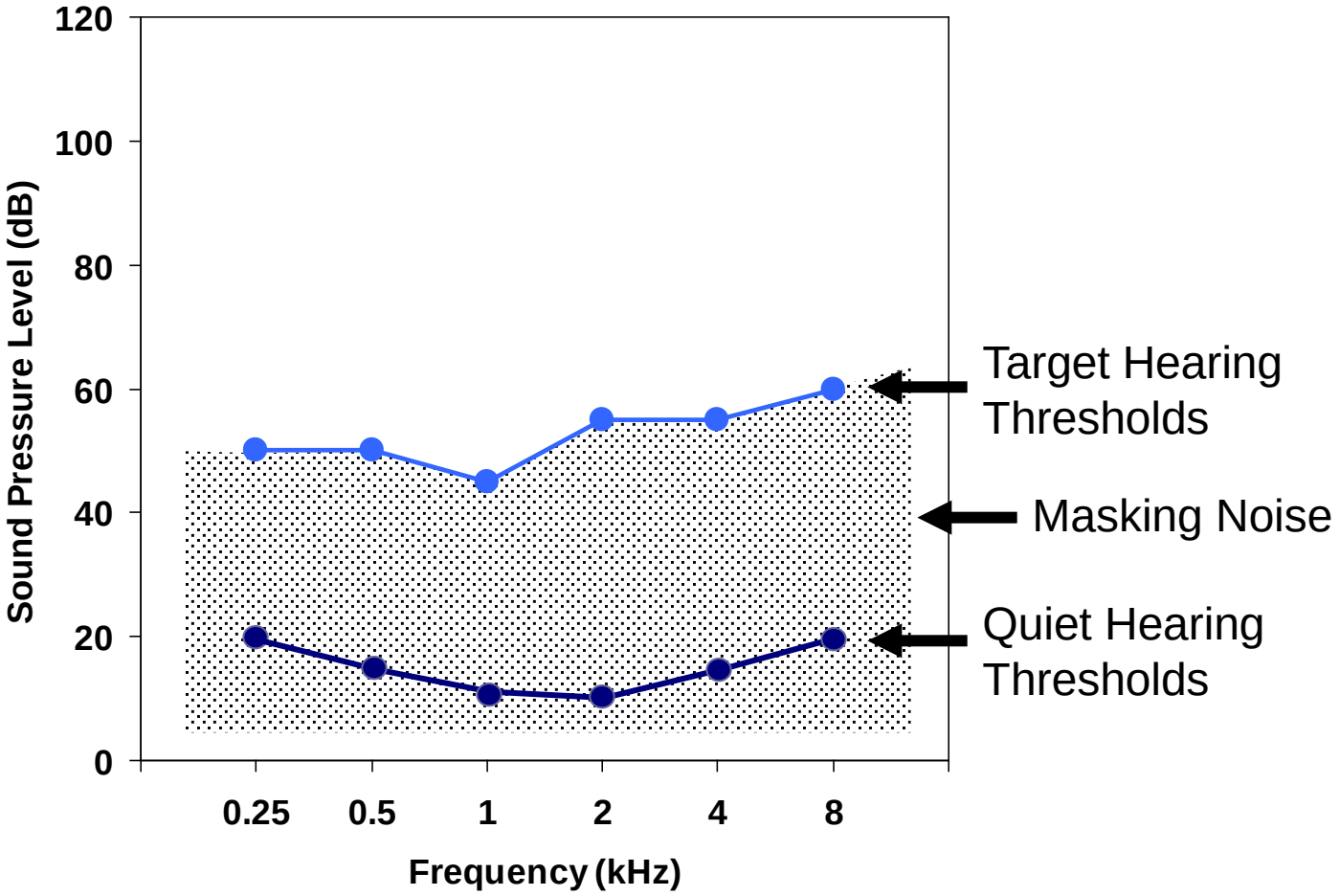
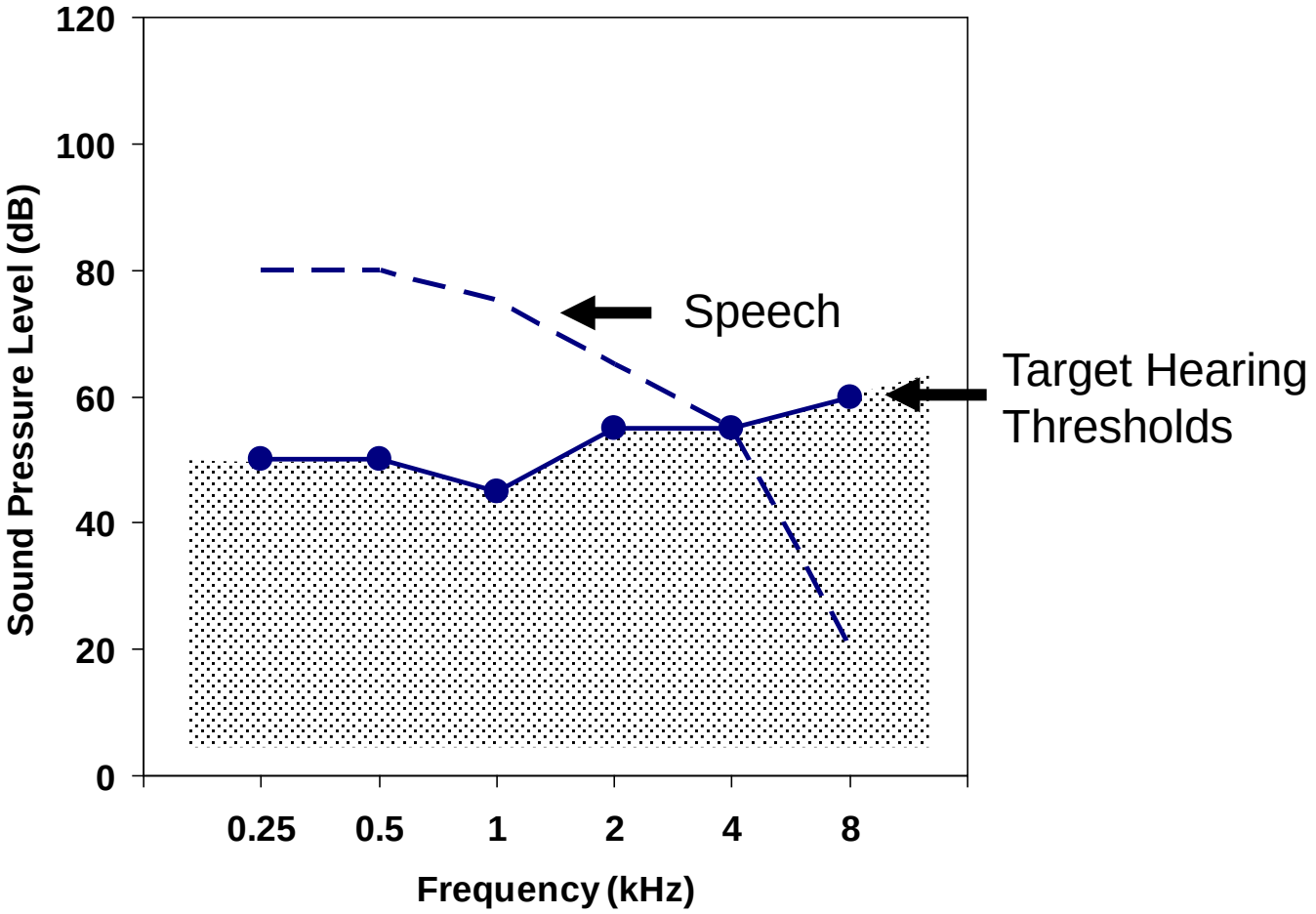


# Simulation - Masking



# Simulation - Masking



# Simulating Hearing Loss in Children

Pittman, Vincent, Carter (in process)

- Purpose
  - Determine whether or not children with normal hearing can response reliably in a broadband noise.
  - Examine the short- and long-term effects of hearing loss on speech perception.

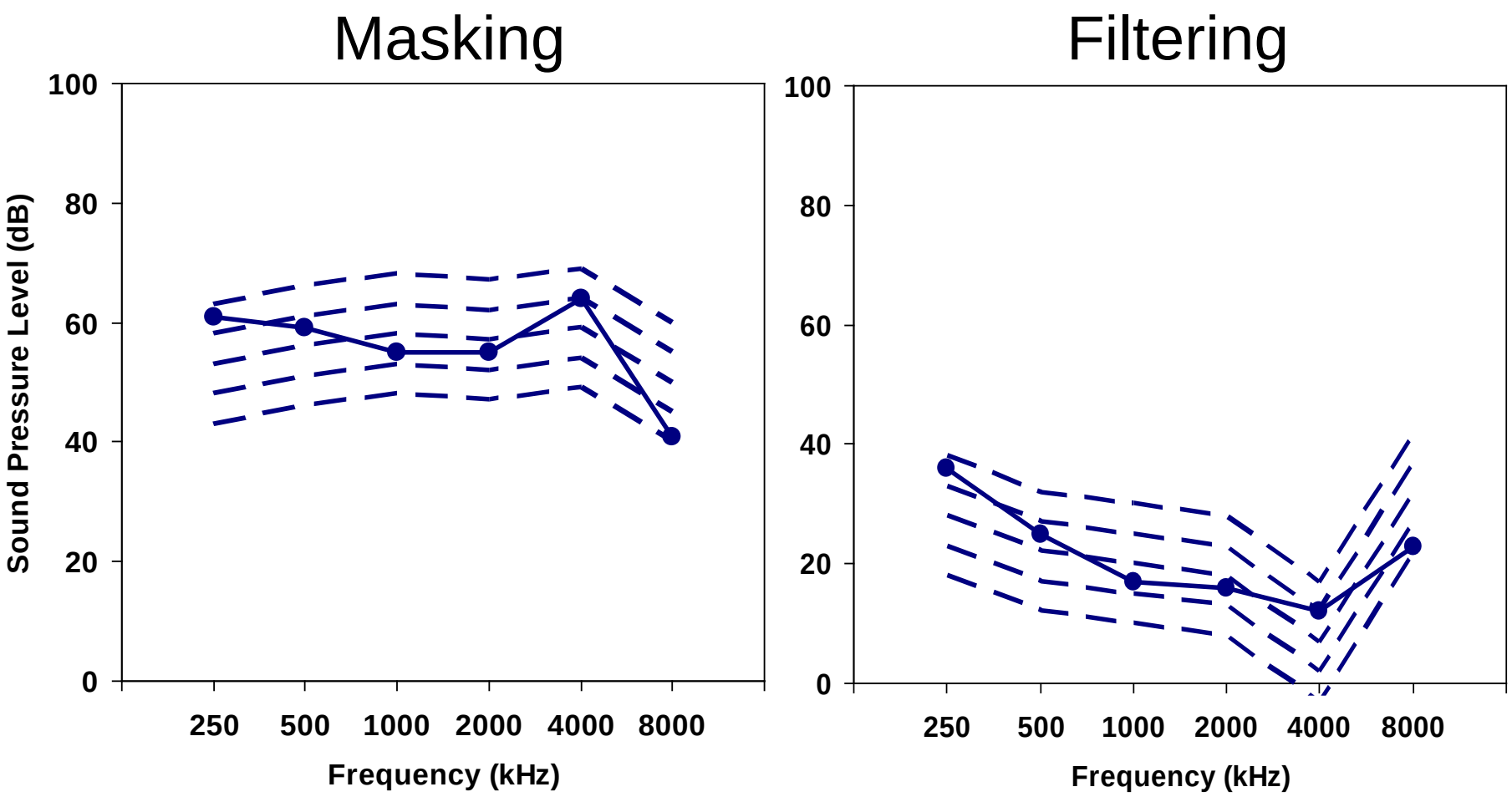
# Method

- Subjects
  - 4 HI children (8 to 12 yrs of age)
  - 10 NH children (8 to 12 yrs of age)
    - 2 to 3 NH children were matched to each HI child (vocabulary or chronological age)
- Stimuli
  - Four-word sentences of varying predictability
    - High – grammatically & semantically correct
    - Low – grammatically correct & semantically anomalous

# Method

- Listening Conditions
  - HI Children
    - Stimuli were frequency shaped according to DSL for average conversational speech
    - Five presentation levels
    - 5 dB steps
  - NH Children
    - Same listening conditions
    - Masked & Filtered

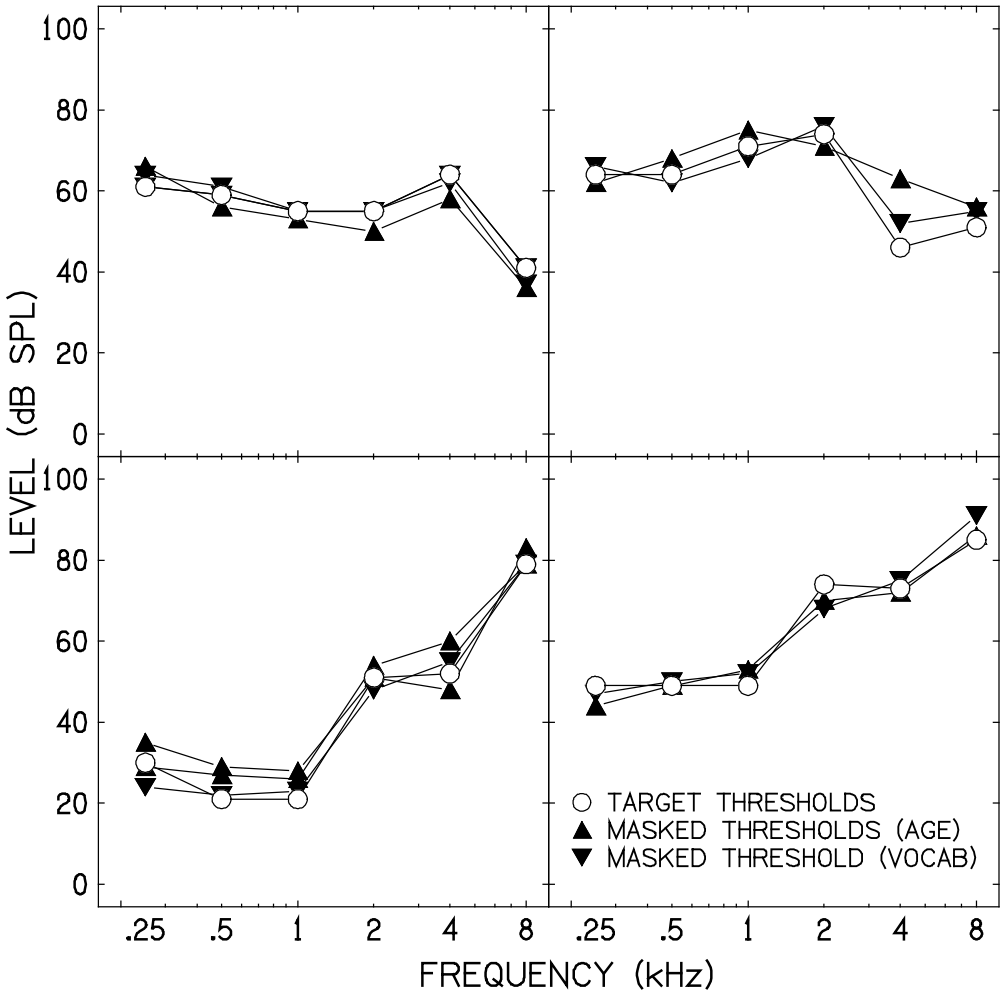
# Method


Masking
Filtering
Sound Pressure Level (dB)
100
80
60
40
20
0
250
500
1000
2000
4000
8000
Frequency (kHz)

# Results

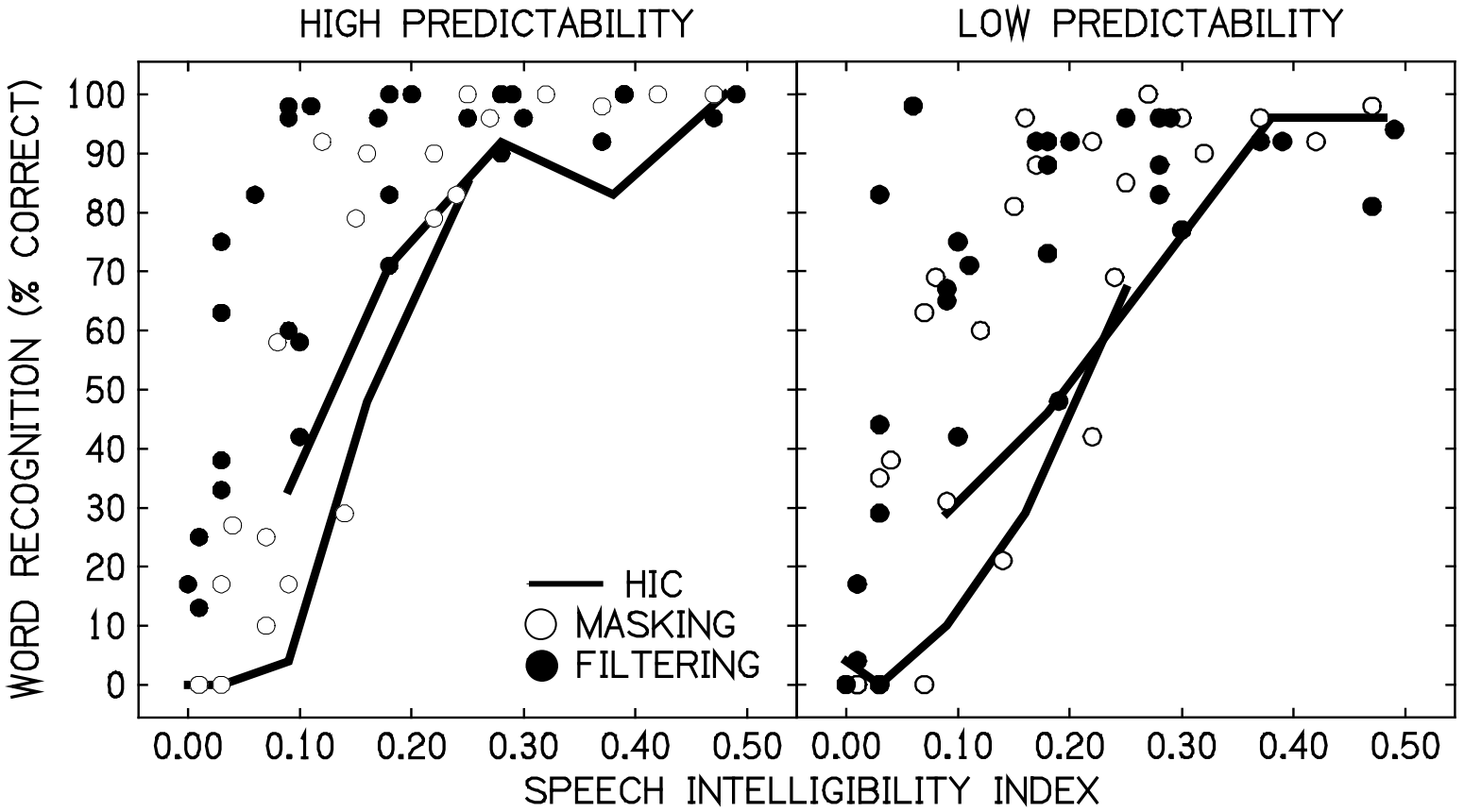
## Masked Thresholds

- Present study
  - RMS error 2.3-6.9 dB
  - 20 minutes
- Humes et al. (1987)
  - RMS error 2.2-6.1 dB
  - 2 hours (equivalent)



# Results

- Flat Hearing Losses



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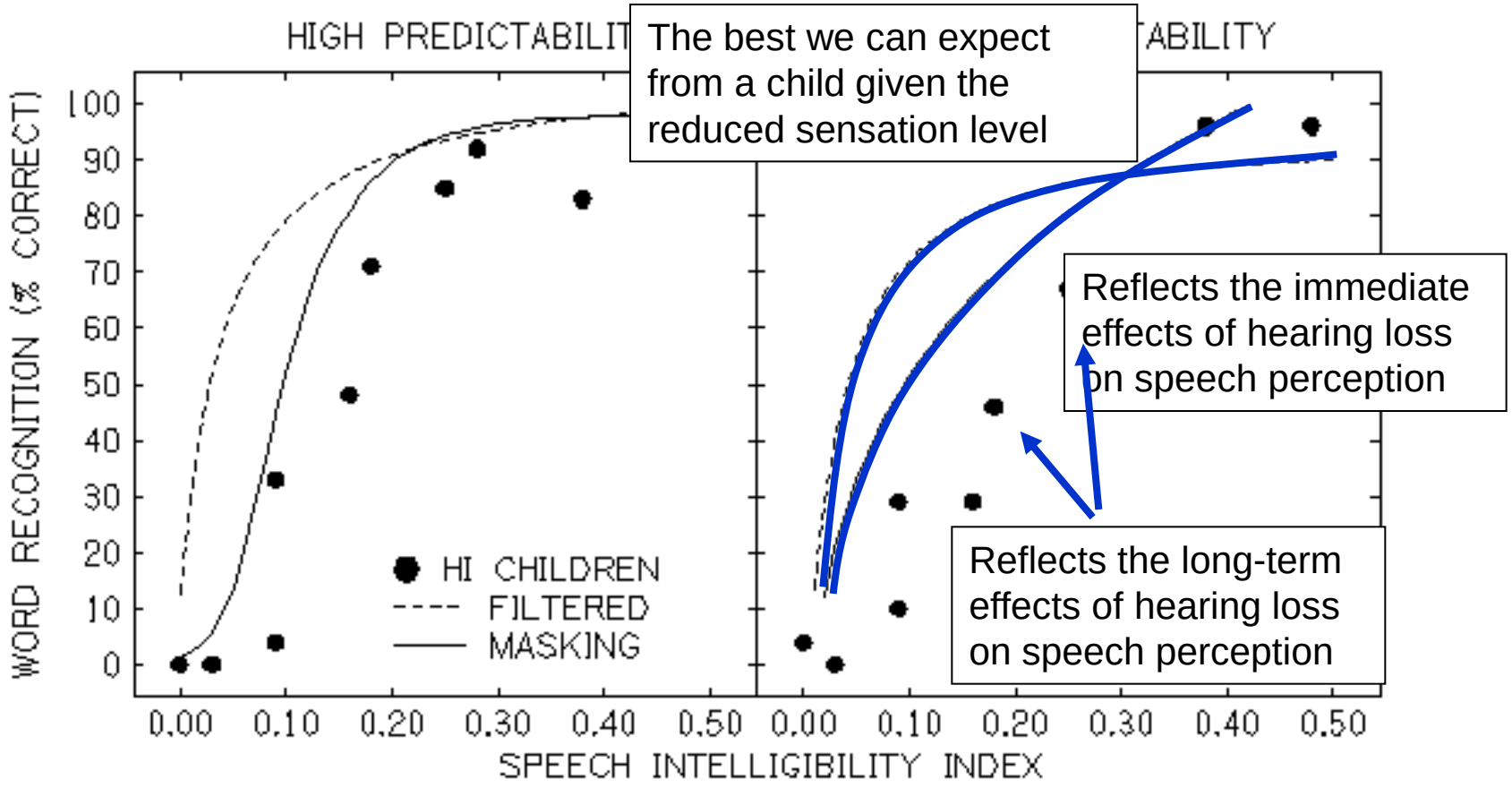
Pittman, Vincent, Carter (in process)

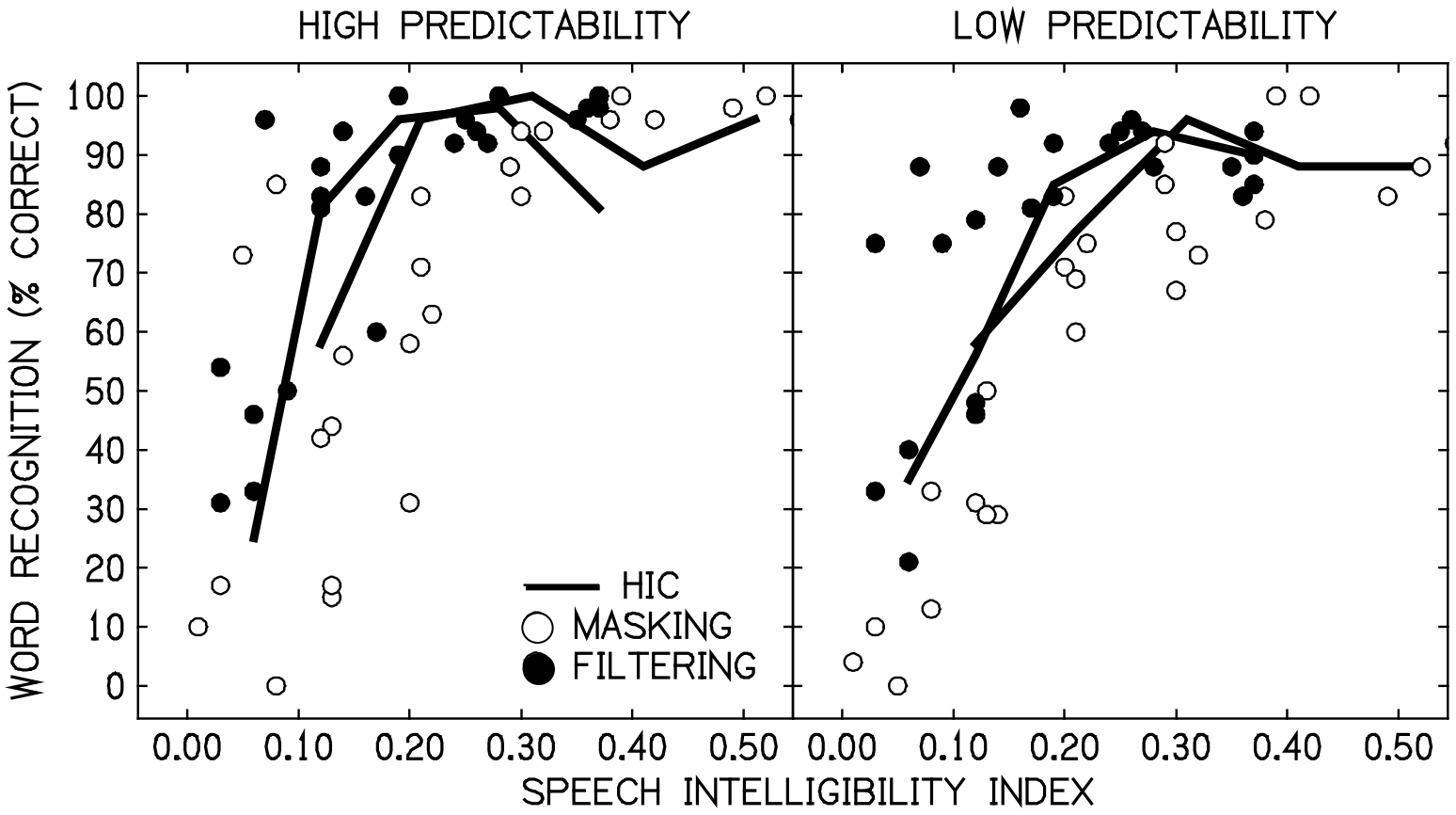
- Flat Hearing Losses



# Simulating Hearing Loss in Children

Pittman, Vincent, Carter (in process)

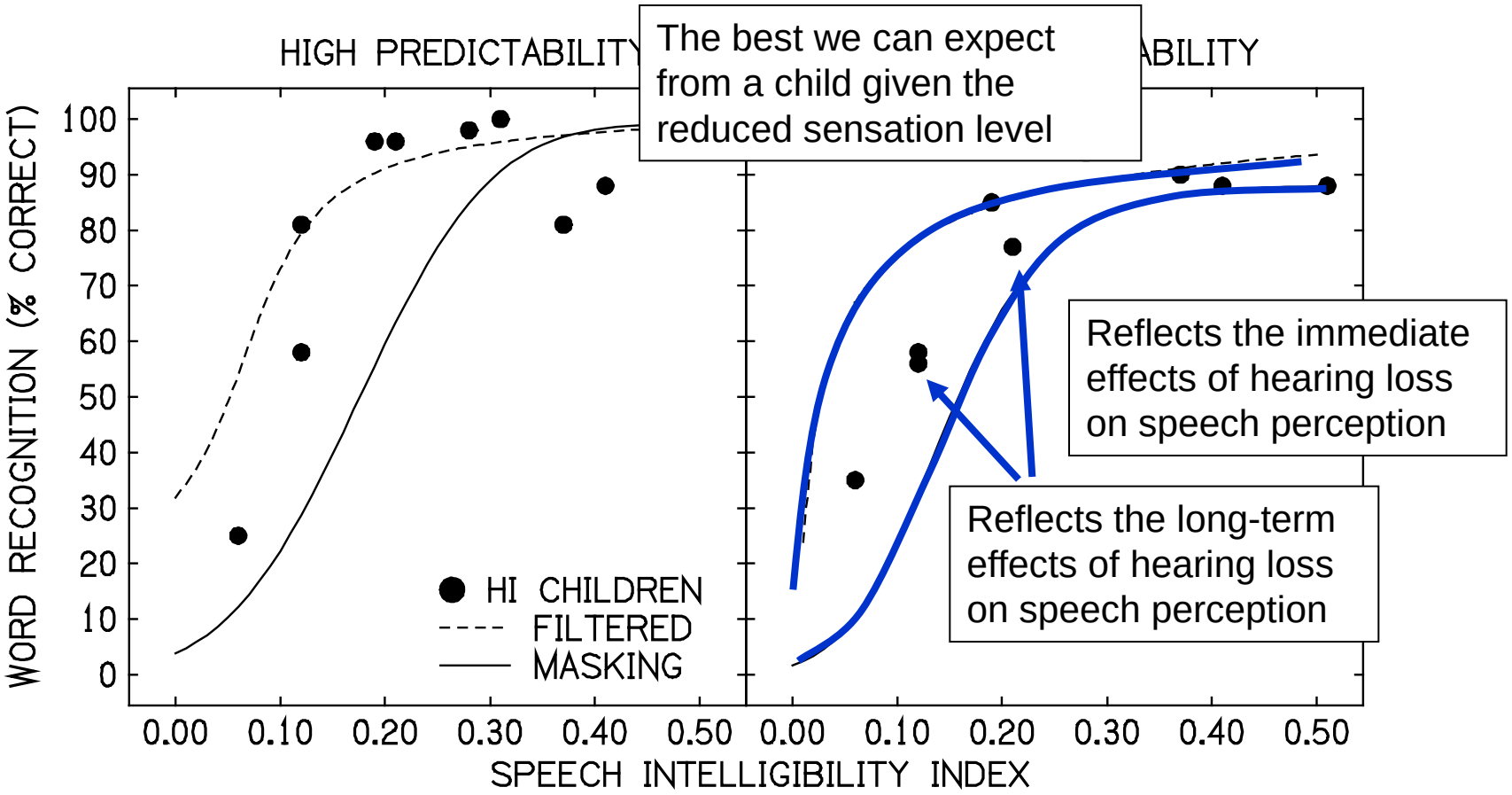
- High-Frequency Hearing Losses



# Simulating Hearing Loss in Children

Pittman, Vincent, Carter (in process)

- High-Frequency Hearing Losses



# Conclusions

- Hearing loss can be simulated as reliably in children as it is in adults
- Like adults, the speech perception of HI children can be better, the same, or worse than that of NH children
  - The relative performance of the HI children compared to the NH children may indicate the degree to which they were able to adjust to their hearing loss.
  - The ability to adjust to the hearing loss may be related to the configuration of loss

# Some last thoughts…

- In the future, simulating hearing loss may
  - Provide insight into the short-term and long-term effects of hearing loss
    - Both good and bad
  - Provide a method with which to optimize intervention for children
    - Amplification

# …and a commercial.

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