

# 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 Tassel (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

- $HI < SIM$ ,  $HI = SIM$ ,  $HI > SIM$



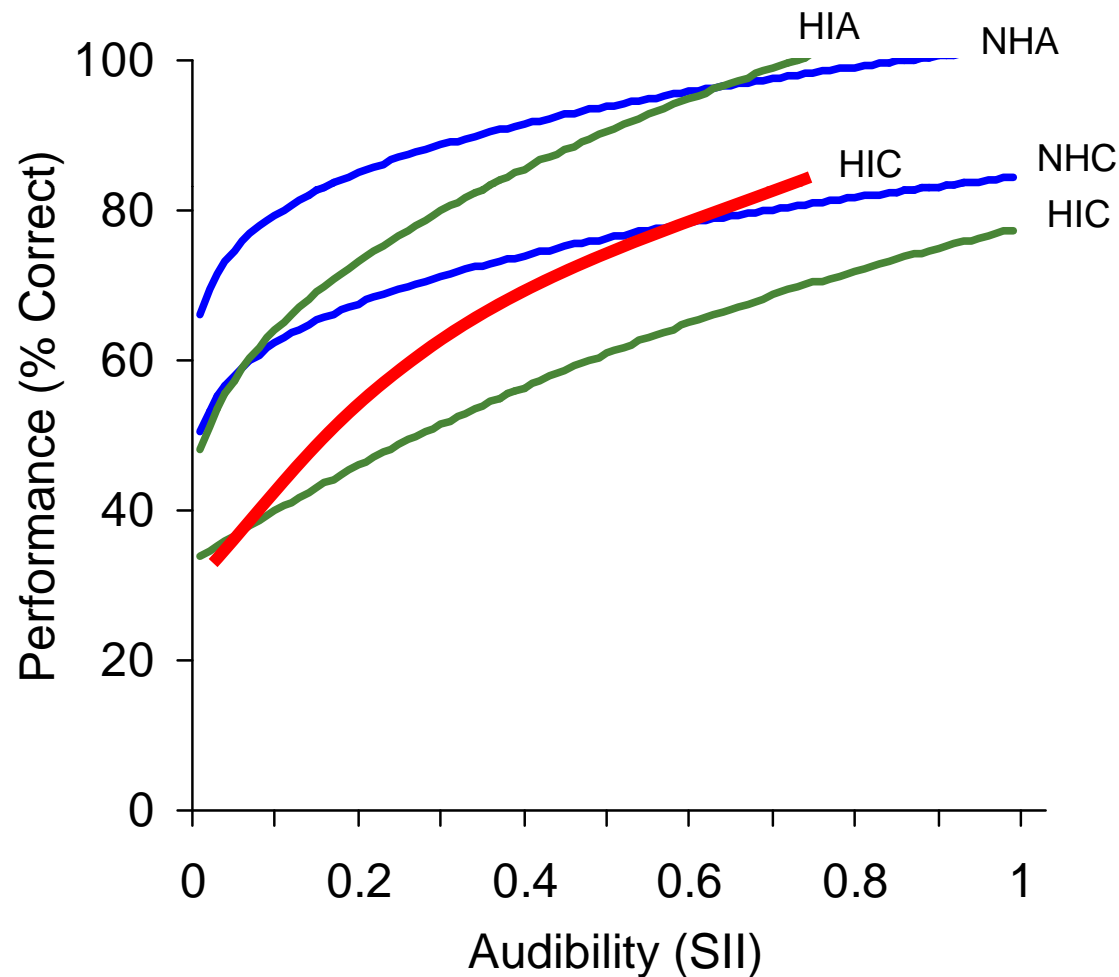
# Rationale

## #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) *Jr of Sp Lang & Hear Res*





# Rationale

#1 Interaction of hearing loss  
and developmental age

#2 Configuration of hearing loss

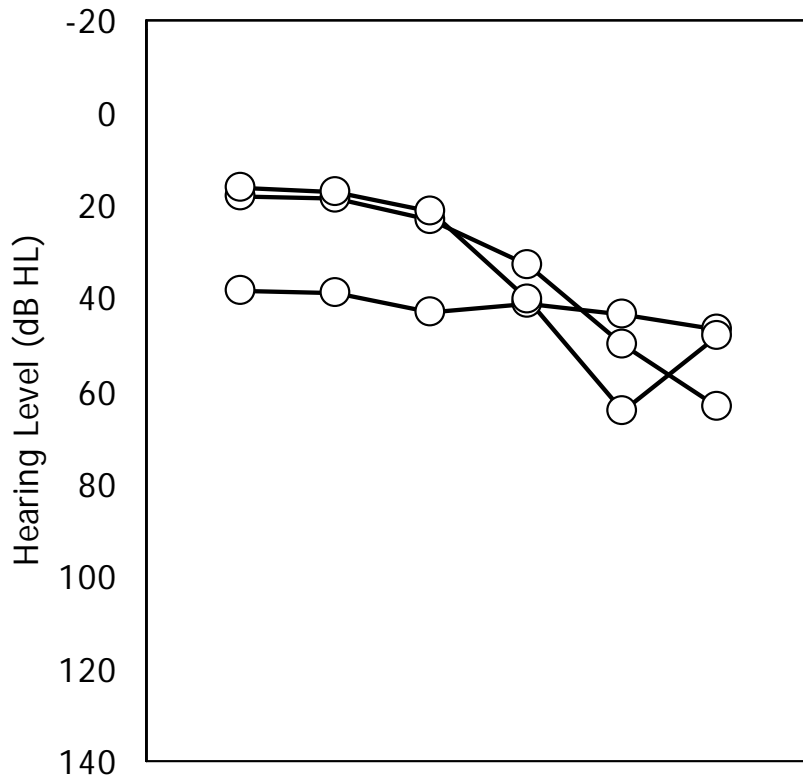
# Configuration of Hearing loss

Pittman & Stelmachowicz (2003) *Ear & Hearing*

60-year-old  
Adults (n=248)

Frequency (Hz)

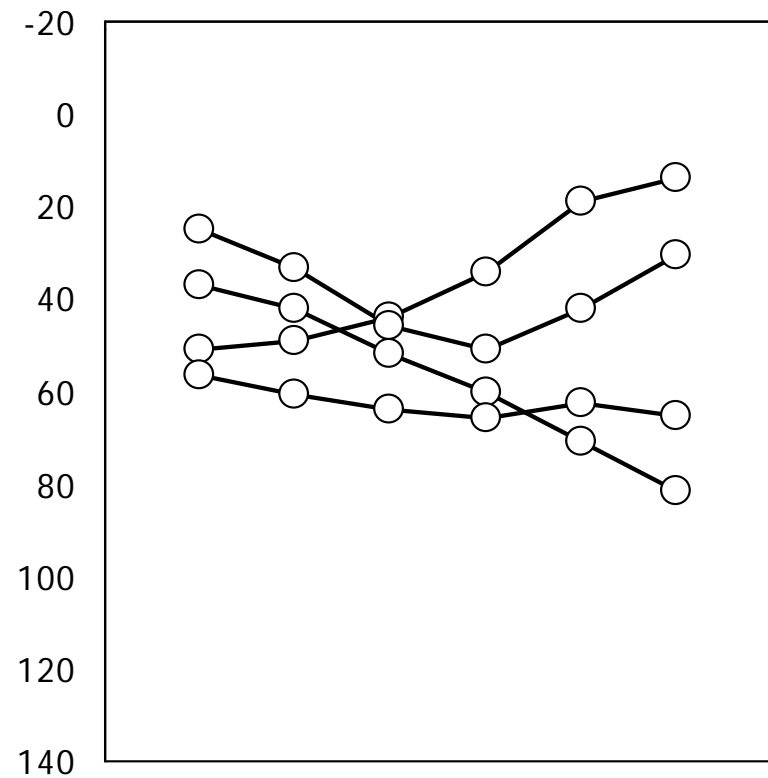
250 500 1000 2000 4000 8000



6-year-old  
Children (n=227)

Frequency (Hz)

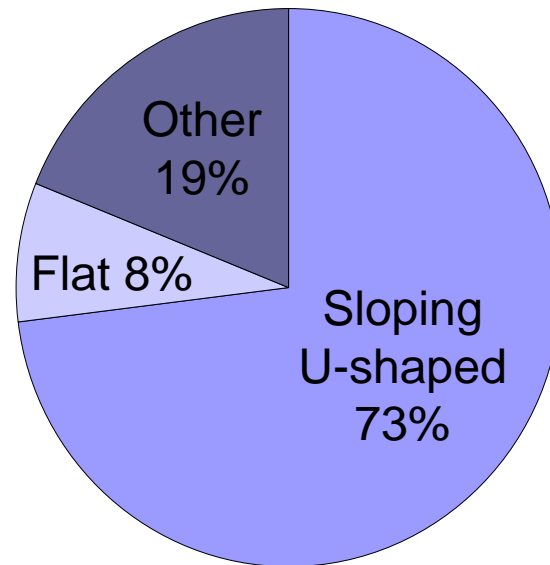
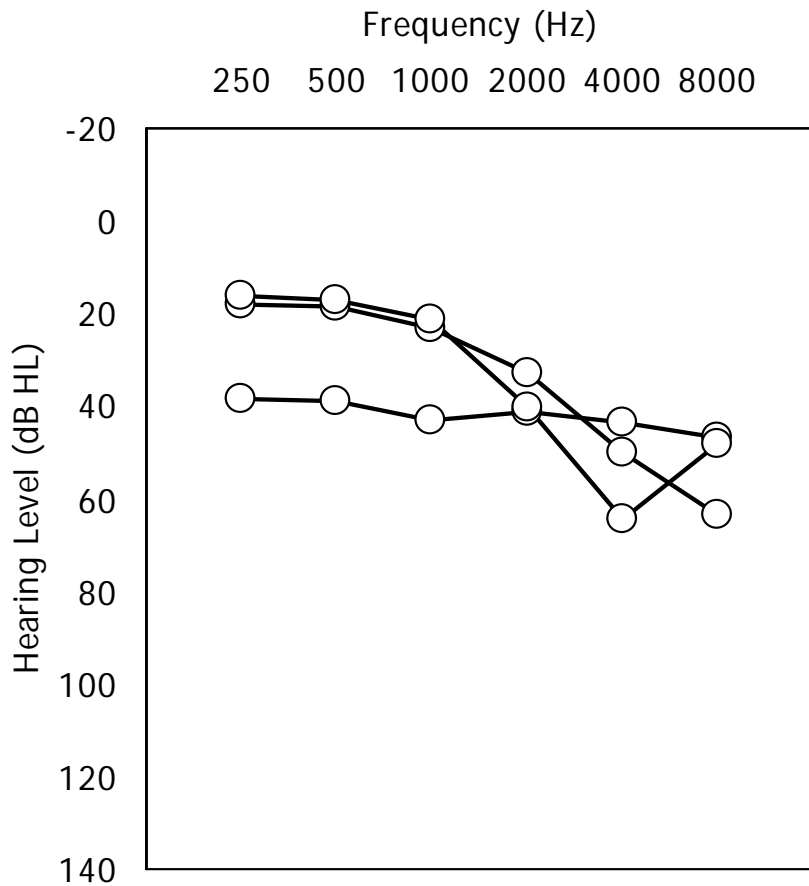
250 500 1000 2000 4000 8000



# Configuration of Hearing loss

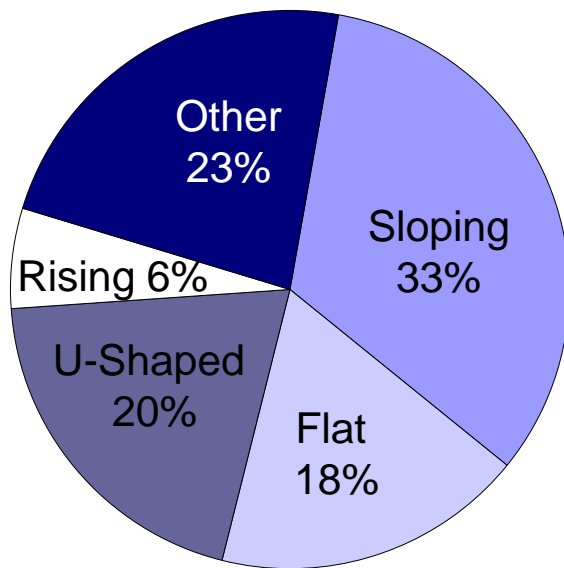
Pittman & Stelmachowicz (2003) *Ear & Hearing*

Adults (n=248)

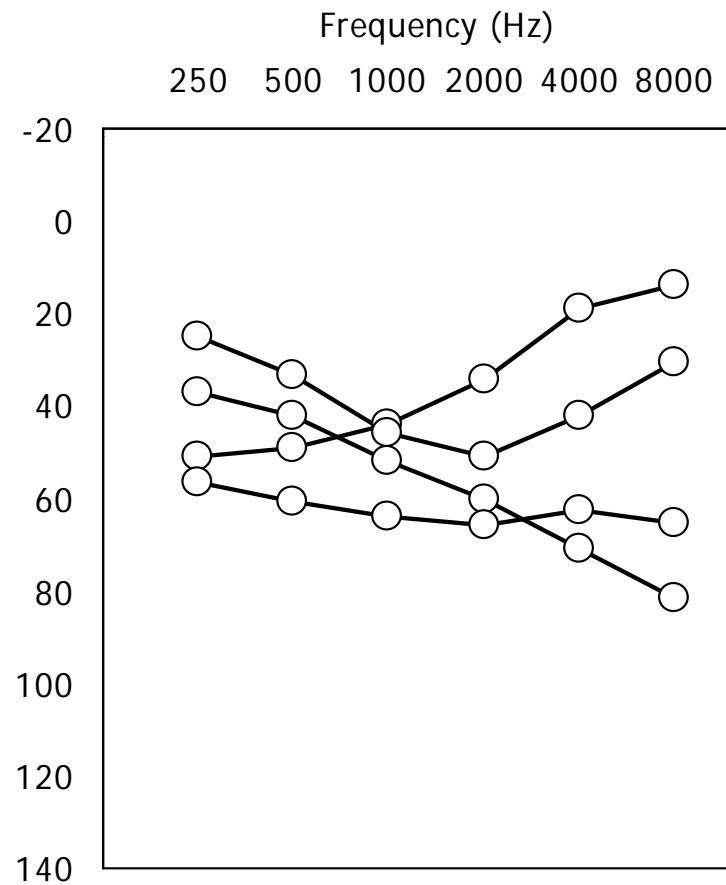


# Configuration of Hearing loss

Pittman & Stelmachowicz (2003) *Ear & Hearing*



Children (n=227)





# 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

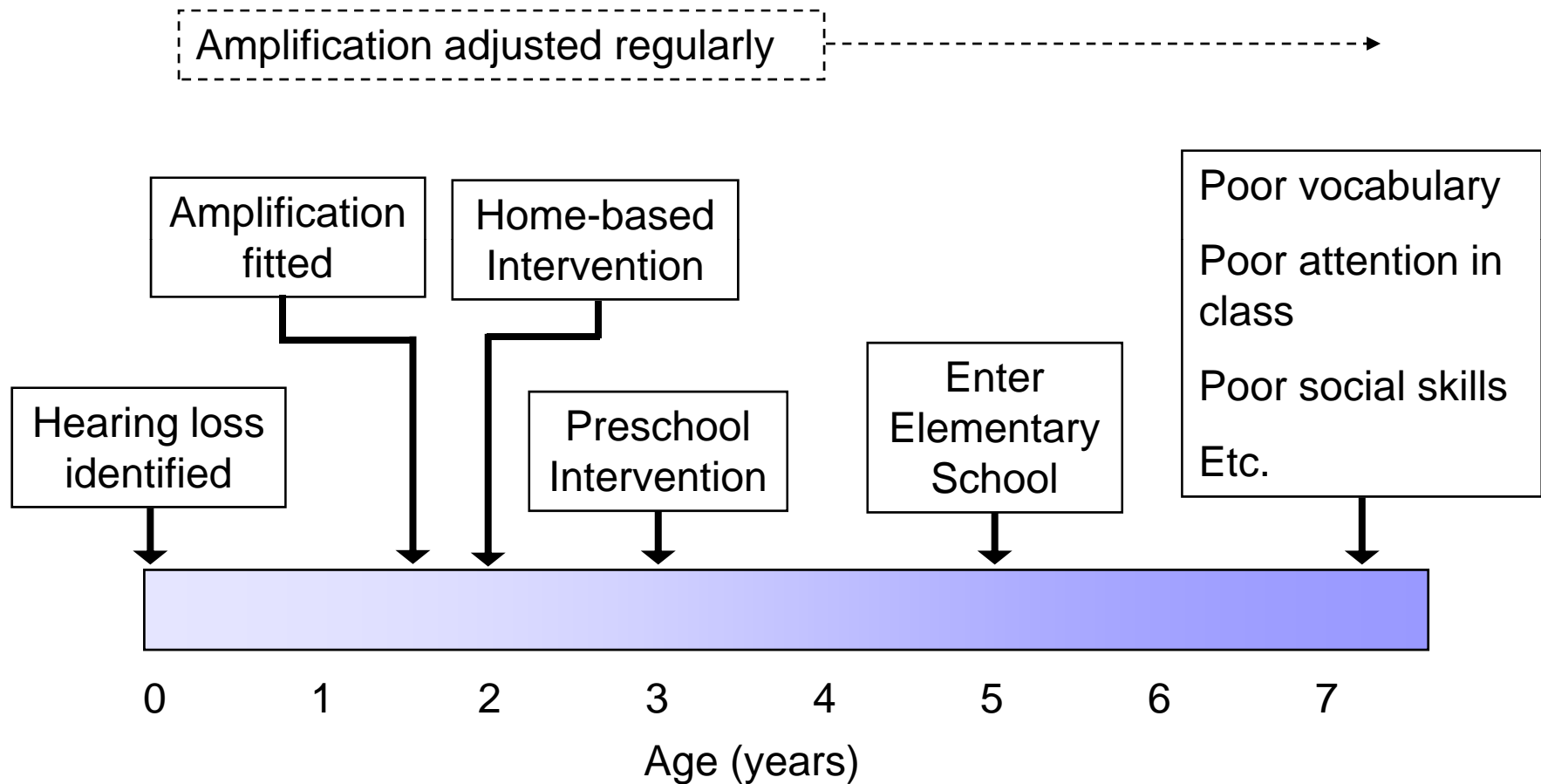
## Intrinsic Heterogeneity

- 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

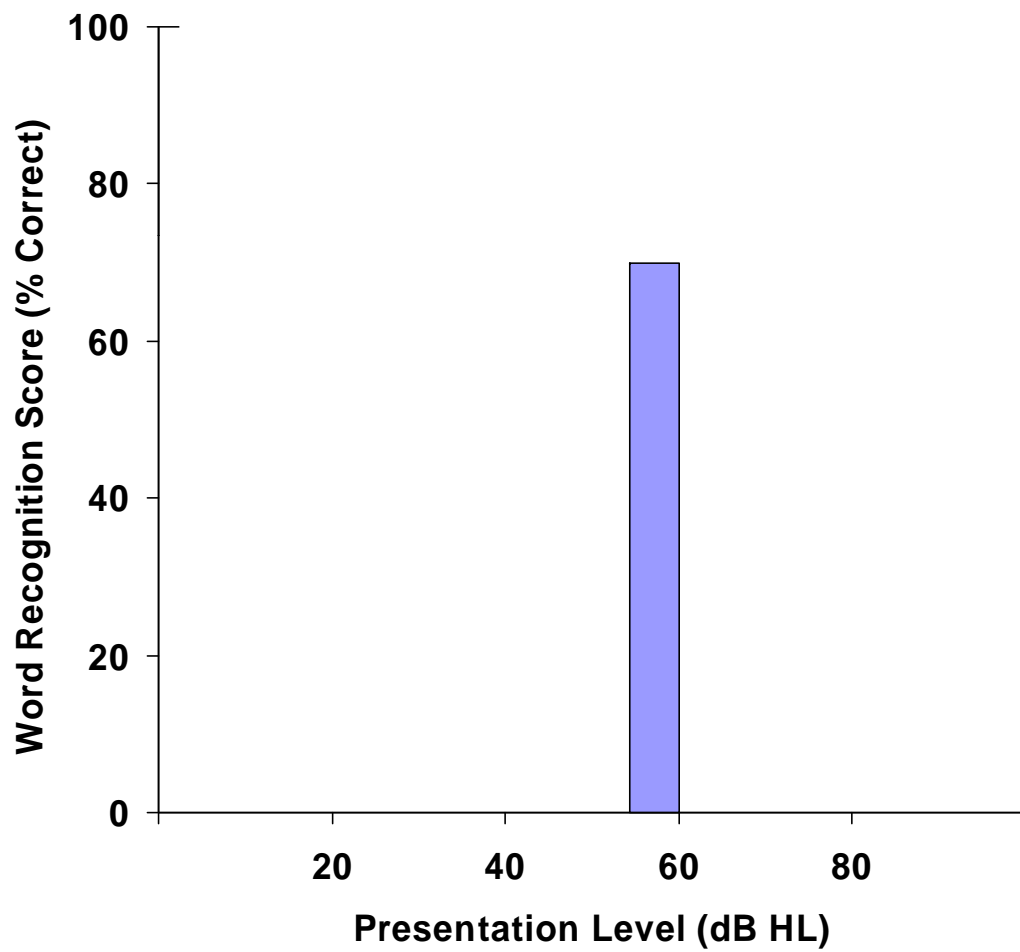
## Extrinsic Heterogeneity

- 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

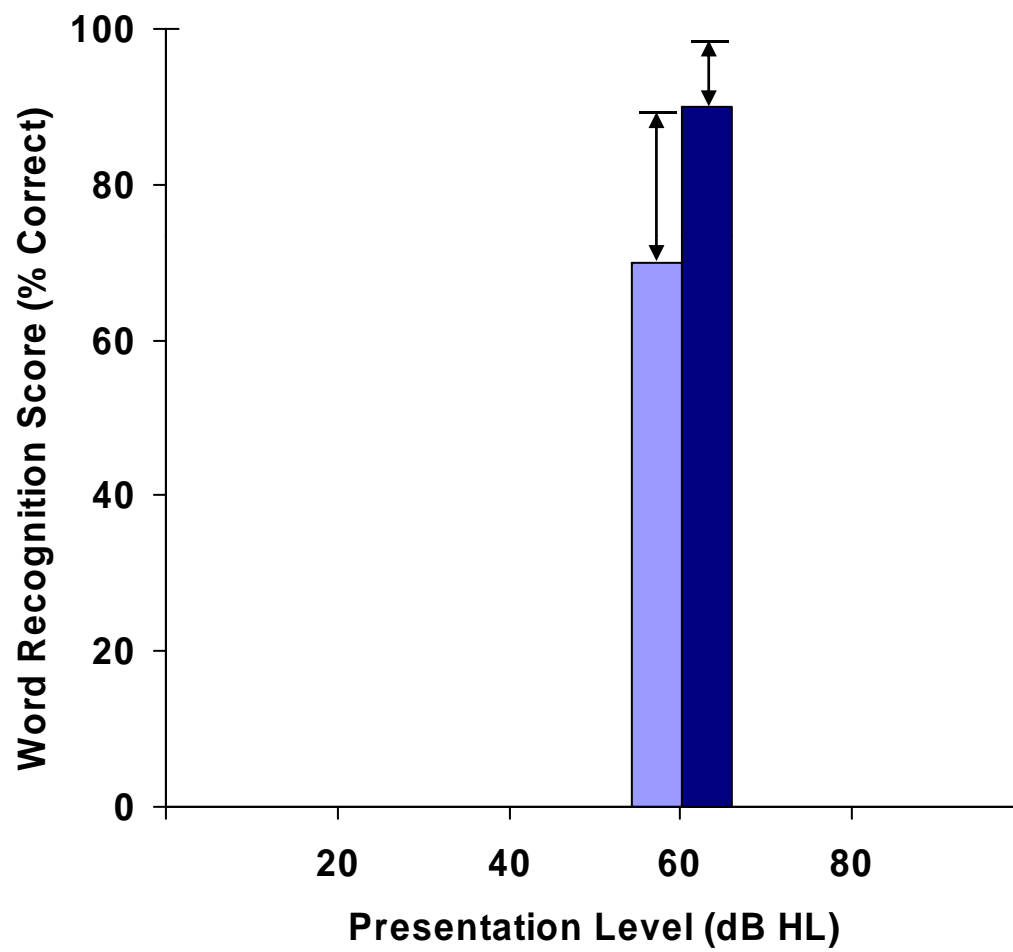
# For example...



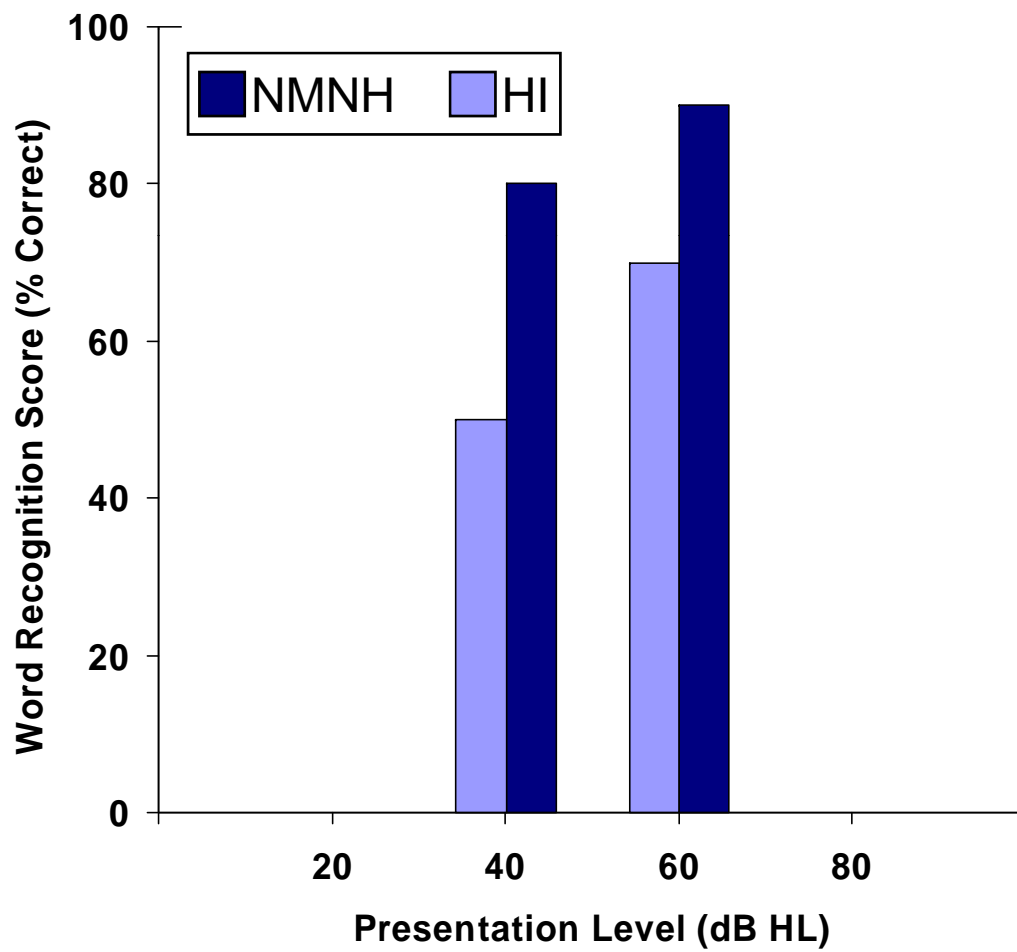
# For Example...



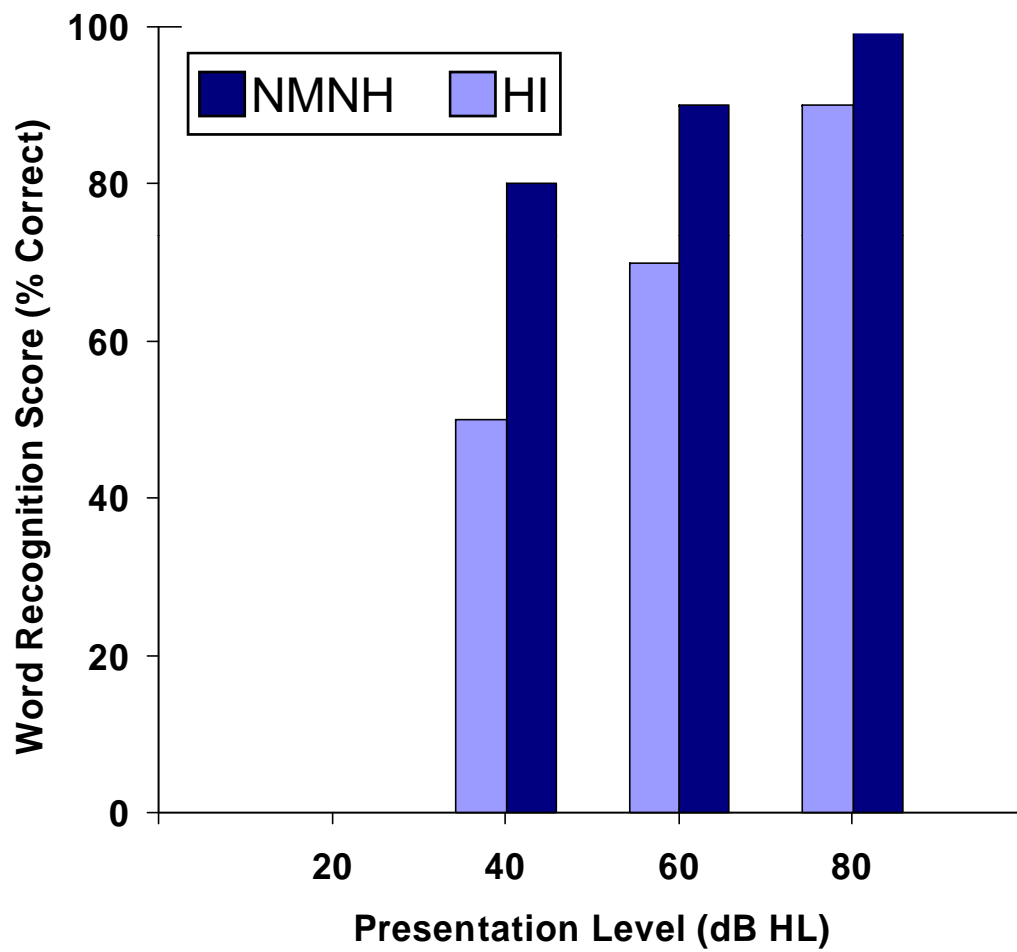
# For Example...



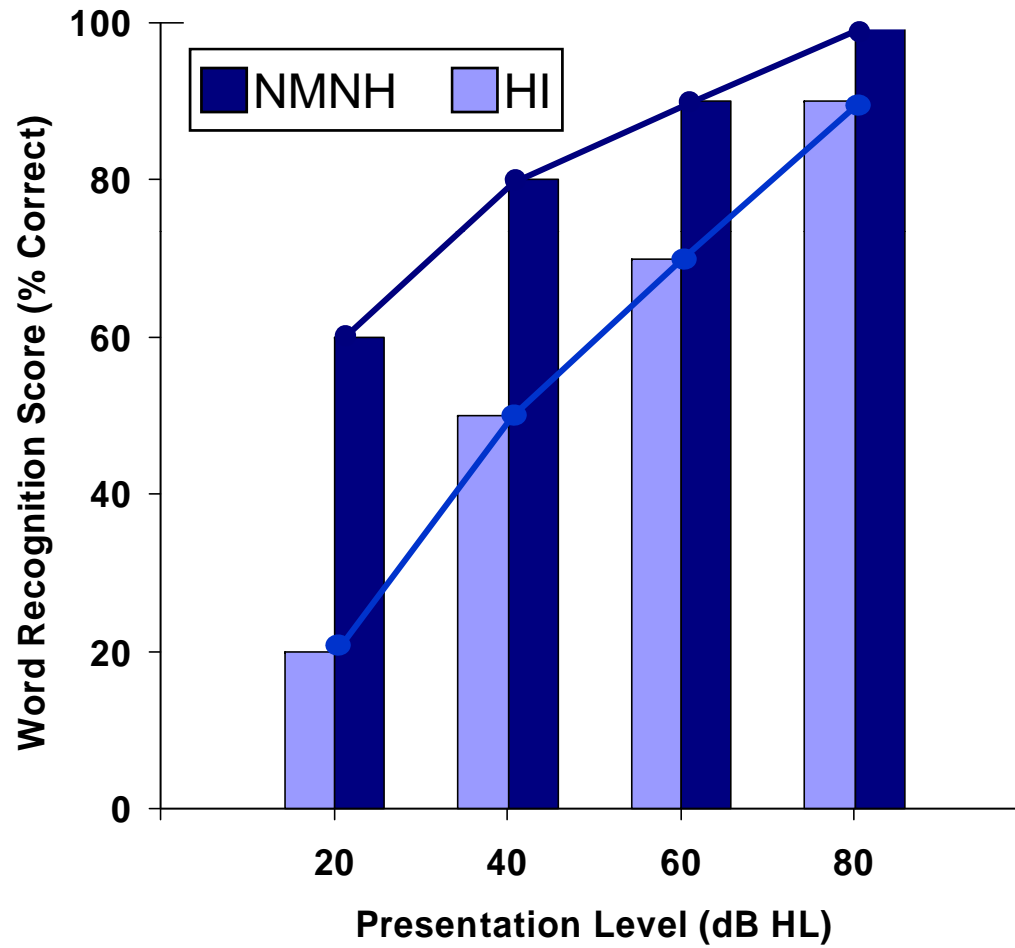
# For Example...

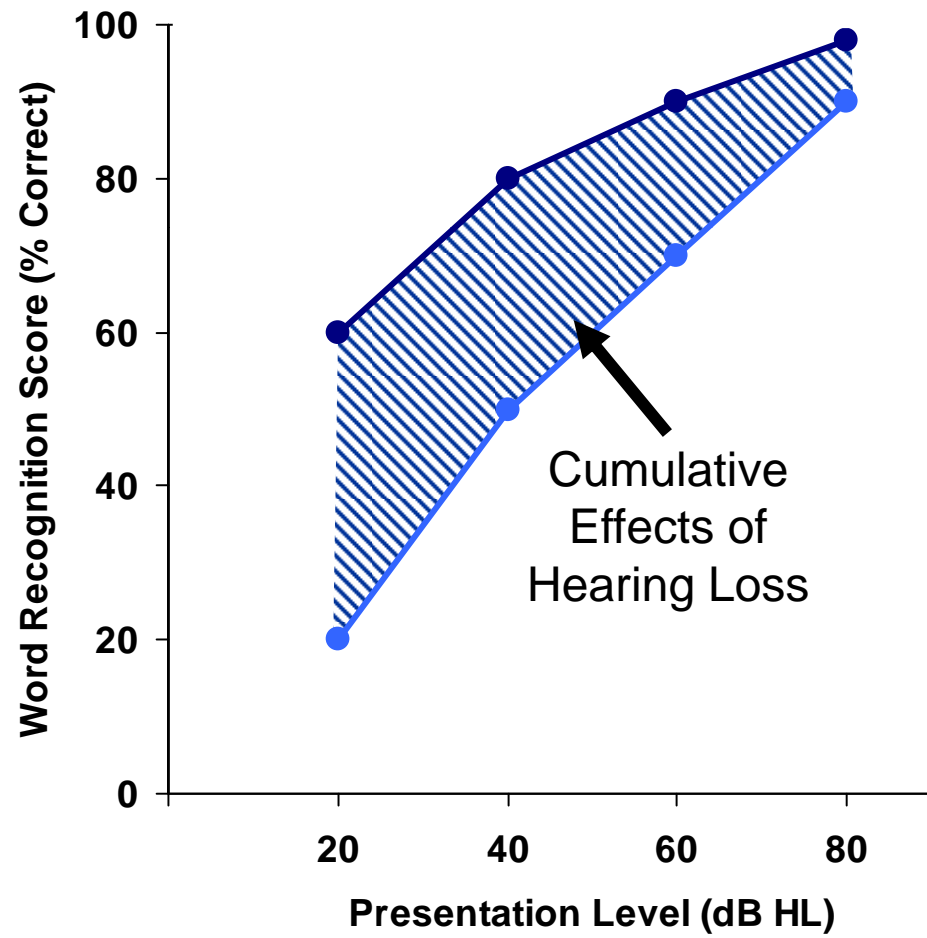


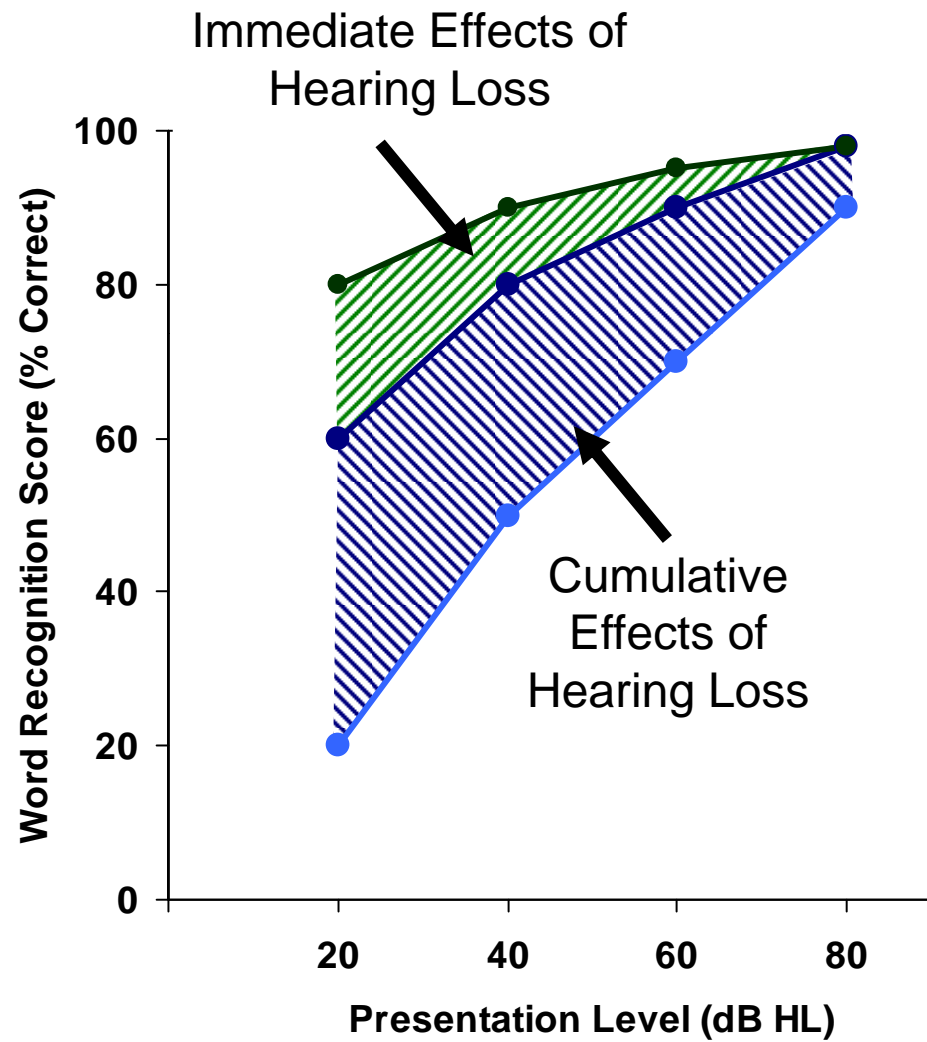
# For Example...




# For Example...





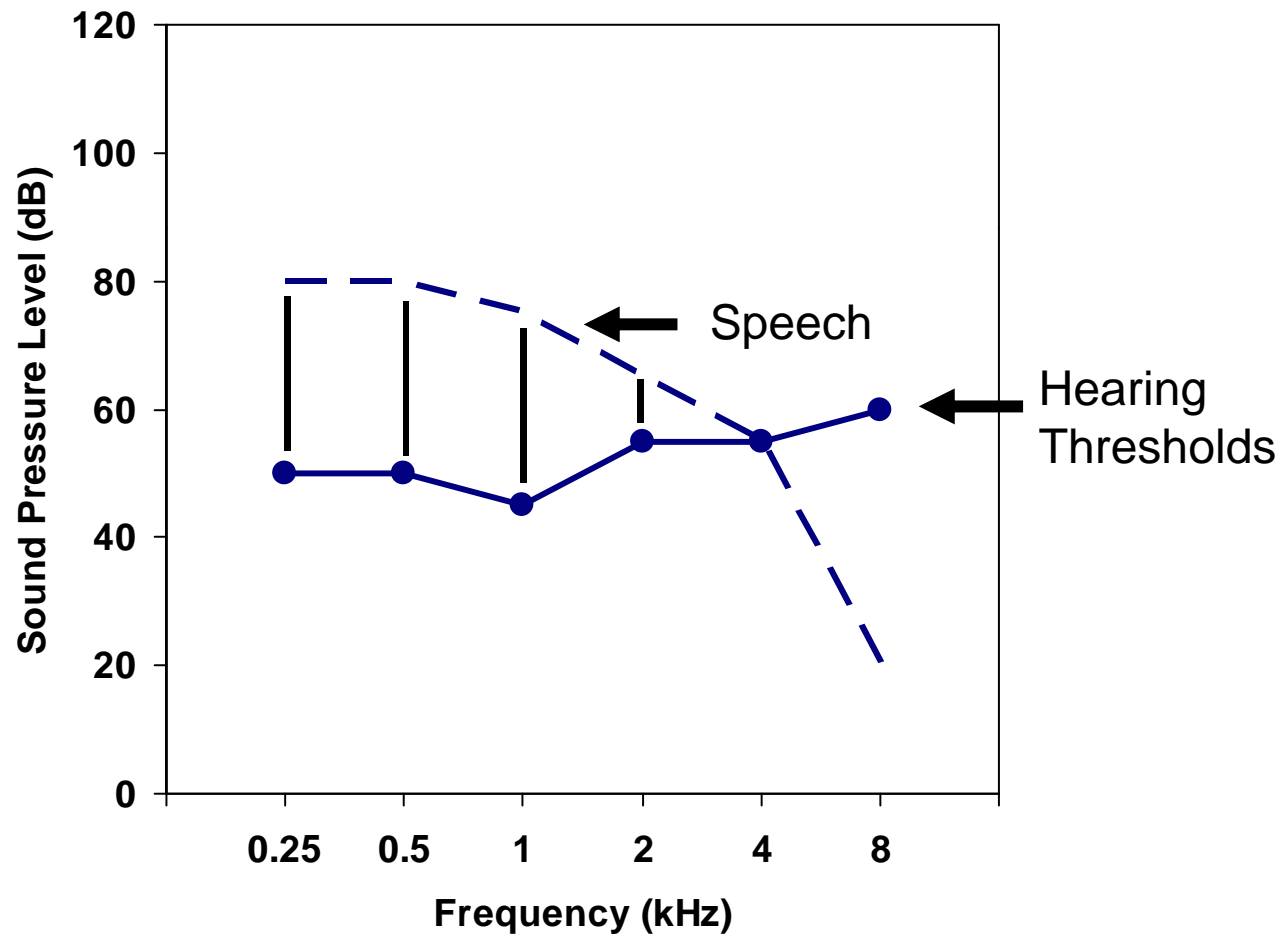




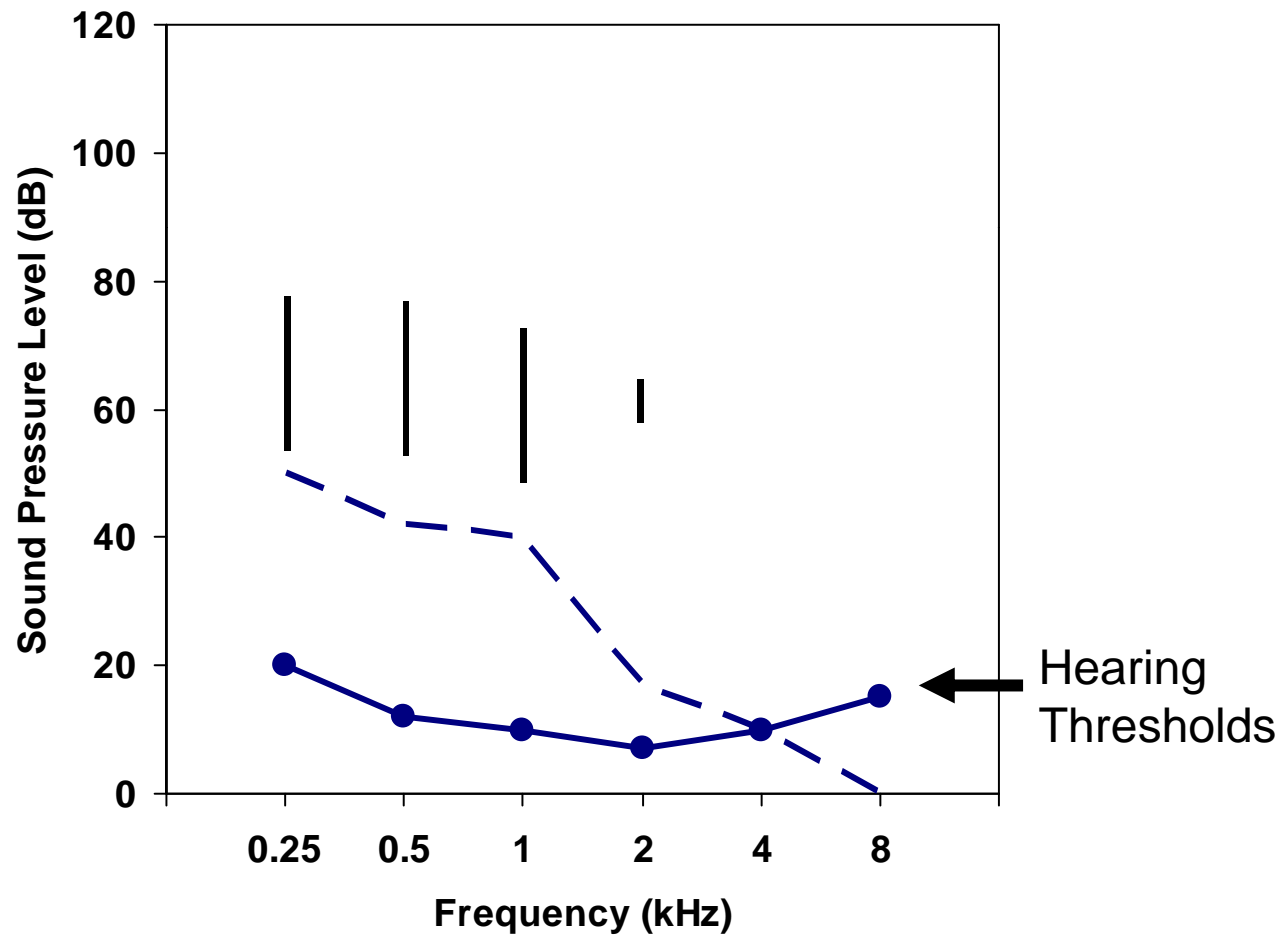
# Methods for Simulating Hearing Loss (in adults)

- 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

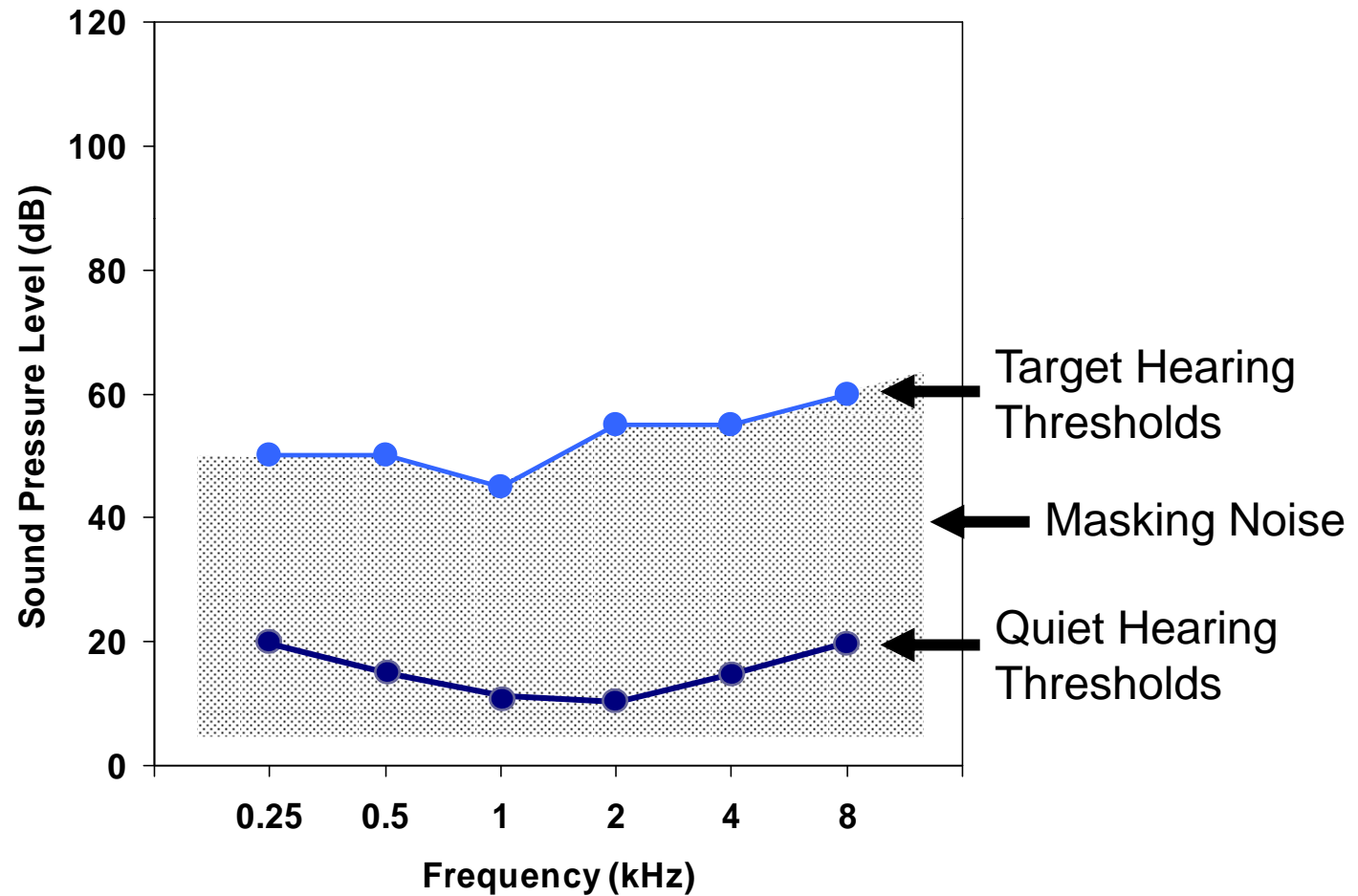
# Simulation - Filtering



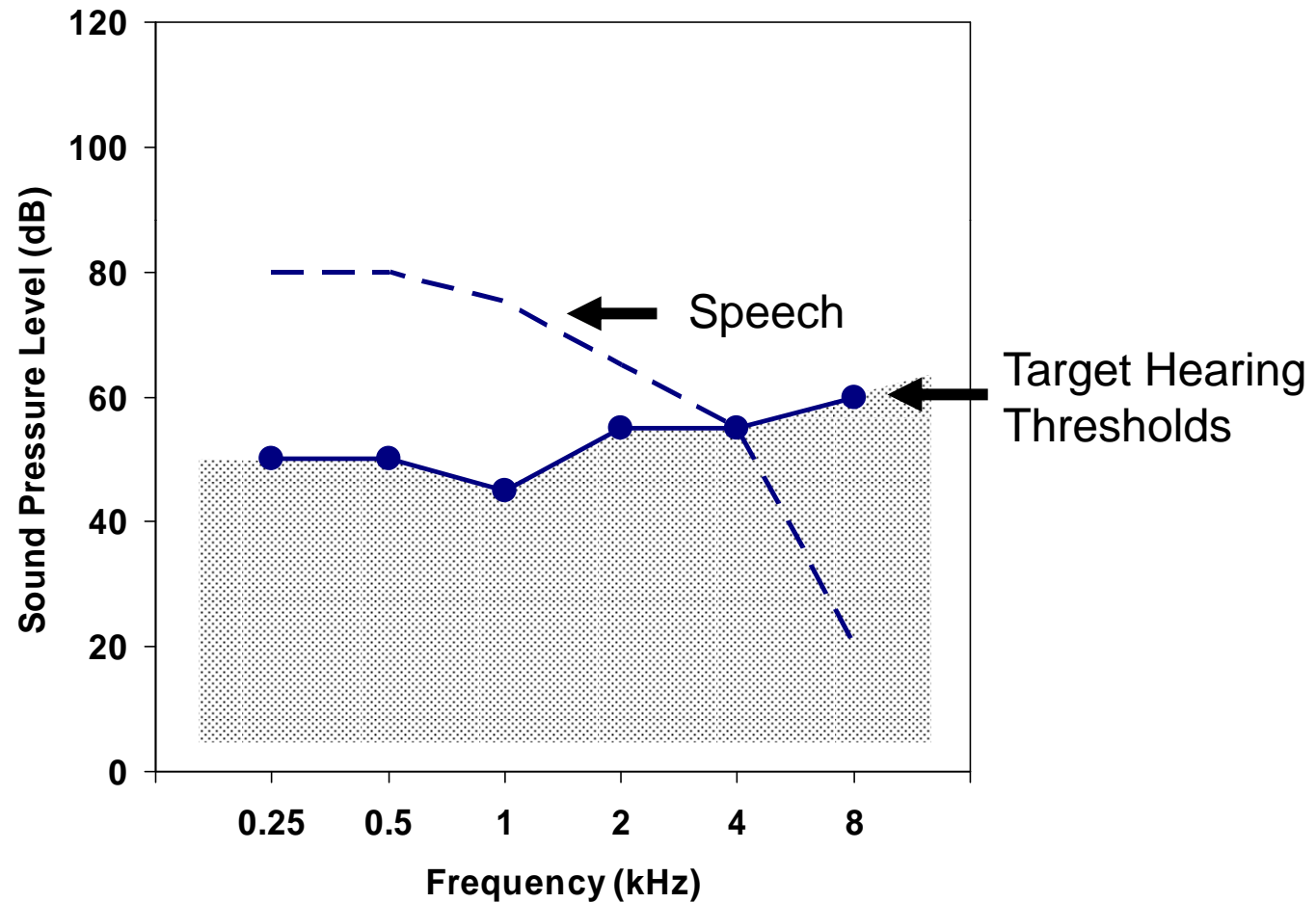
# Simulation - Filtering



# 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

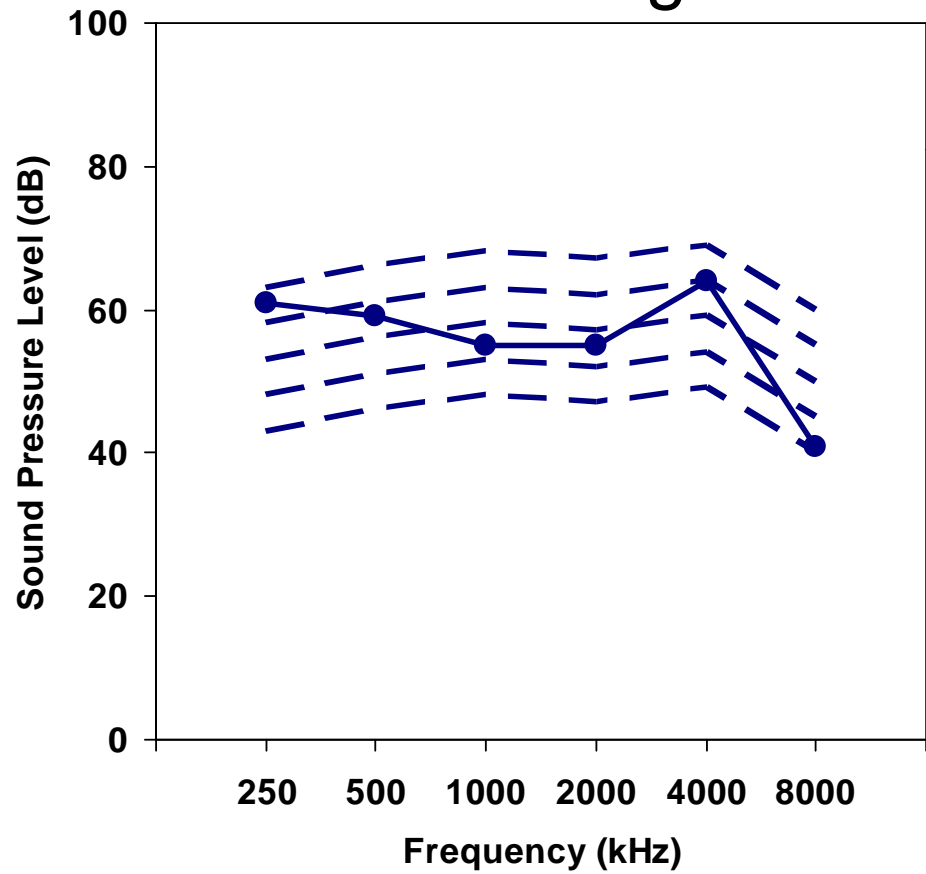
- Stimuli were frequency shaped according to DSL for average conversational speech
- Five presentation levels
- 5 dB steps

### □ NH Children

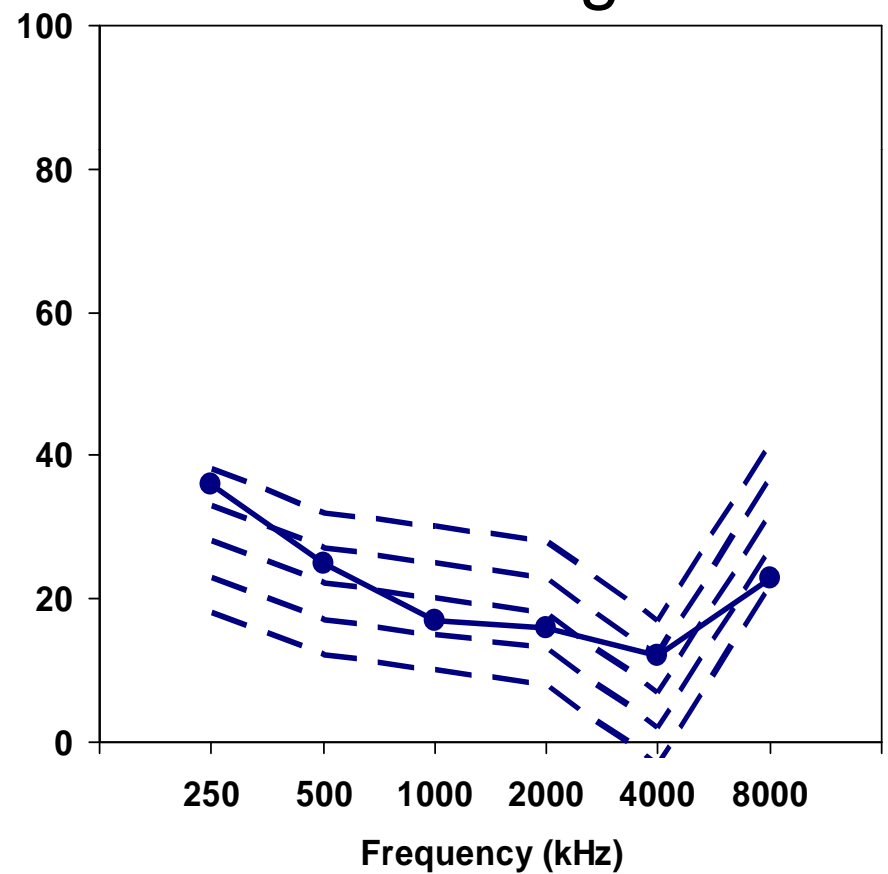
- Same listening conditions
- Masked & Filtered

# Method

## Masking



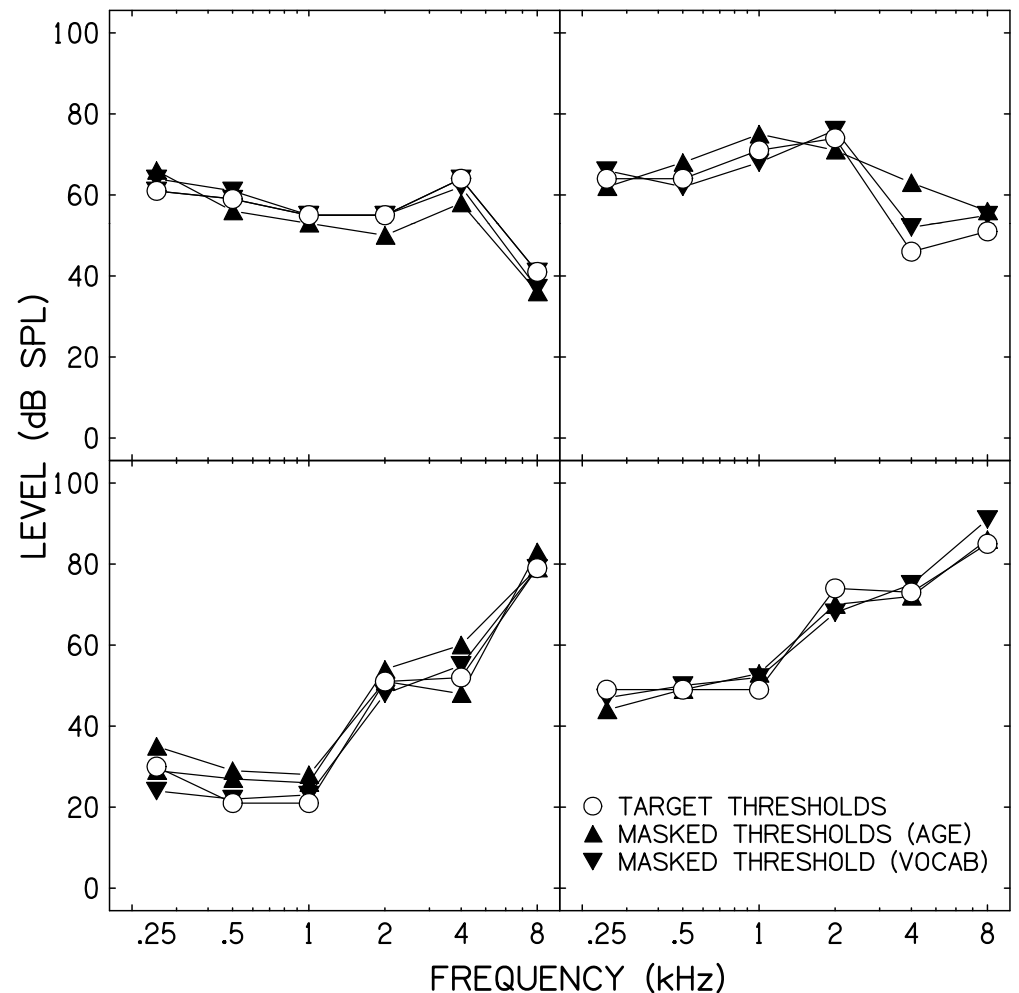
## Filtering



# Results

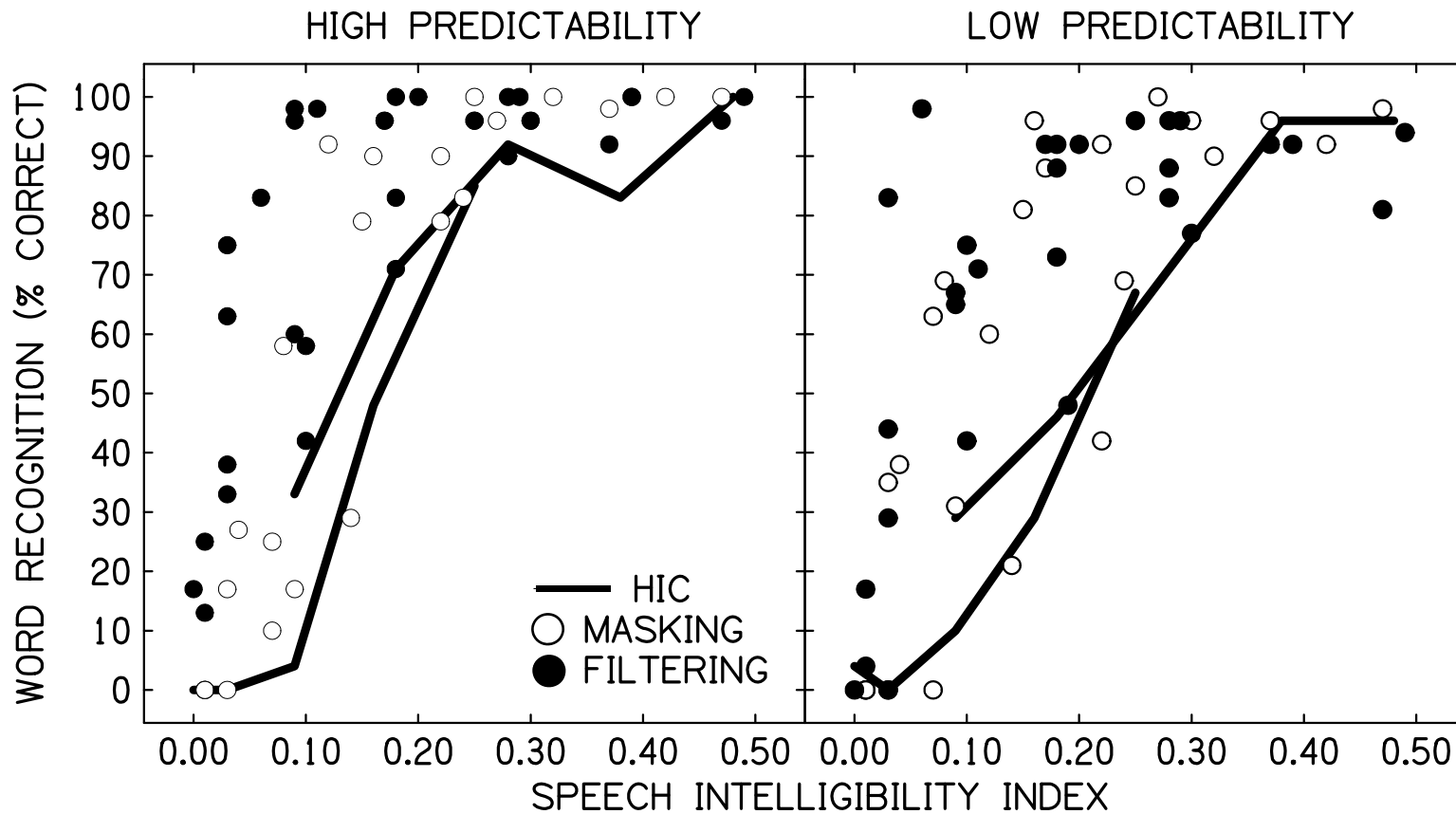
## Masked Thresholds

- 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

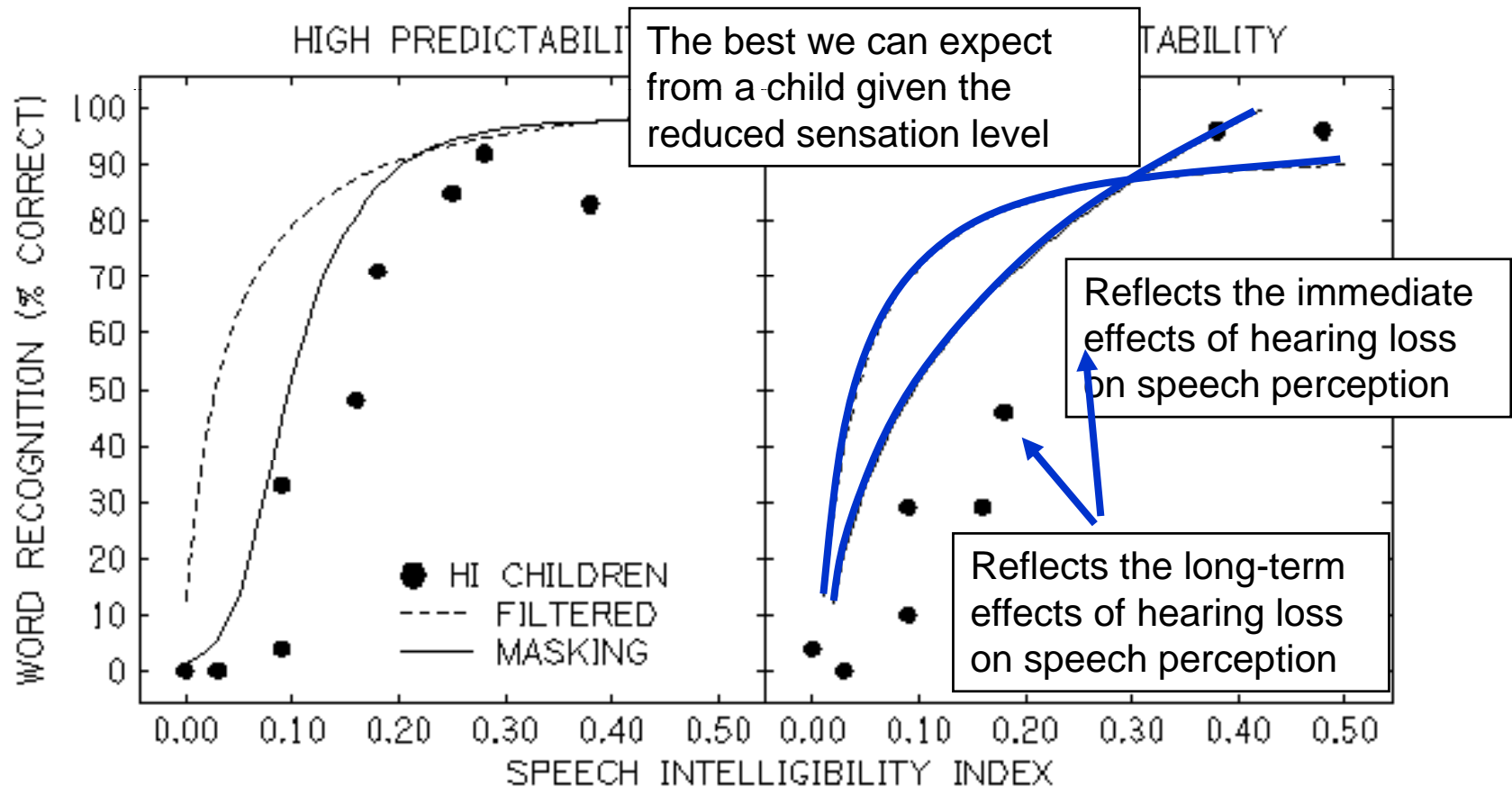
## ■ Flat Hearing Losses



# Simulating Hearing Loss in Children

Pittman, Vincent, Carter (in process)

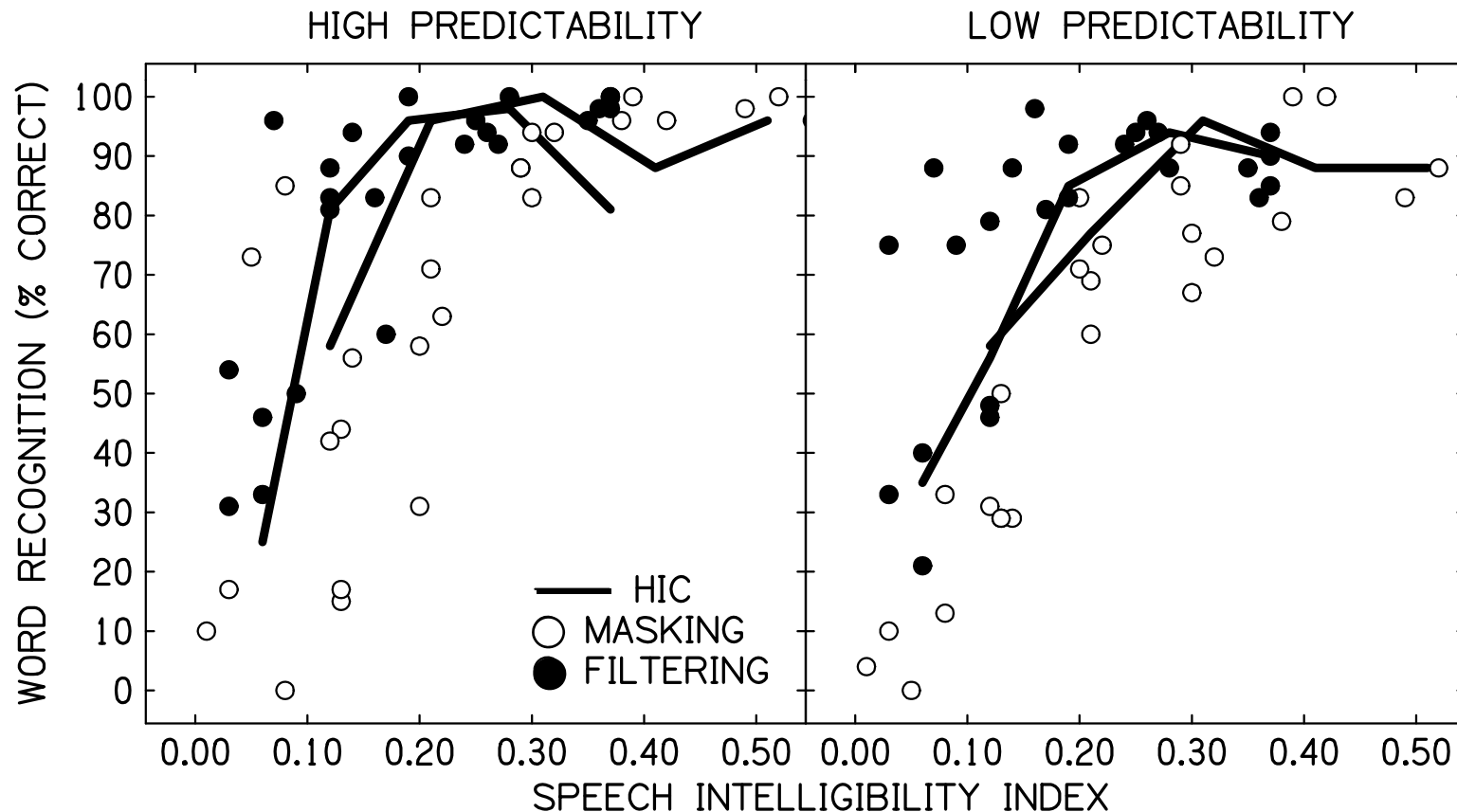
## ■ Flat Hearing Losses



# Simulating Hearing Loss in Children

Pittman, Vincent, Carter (in process)

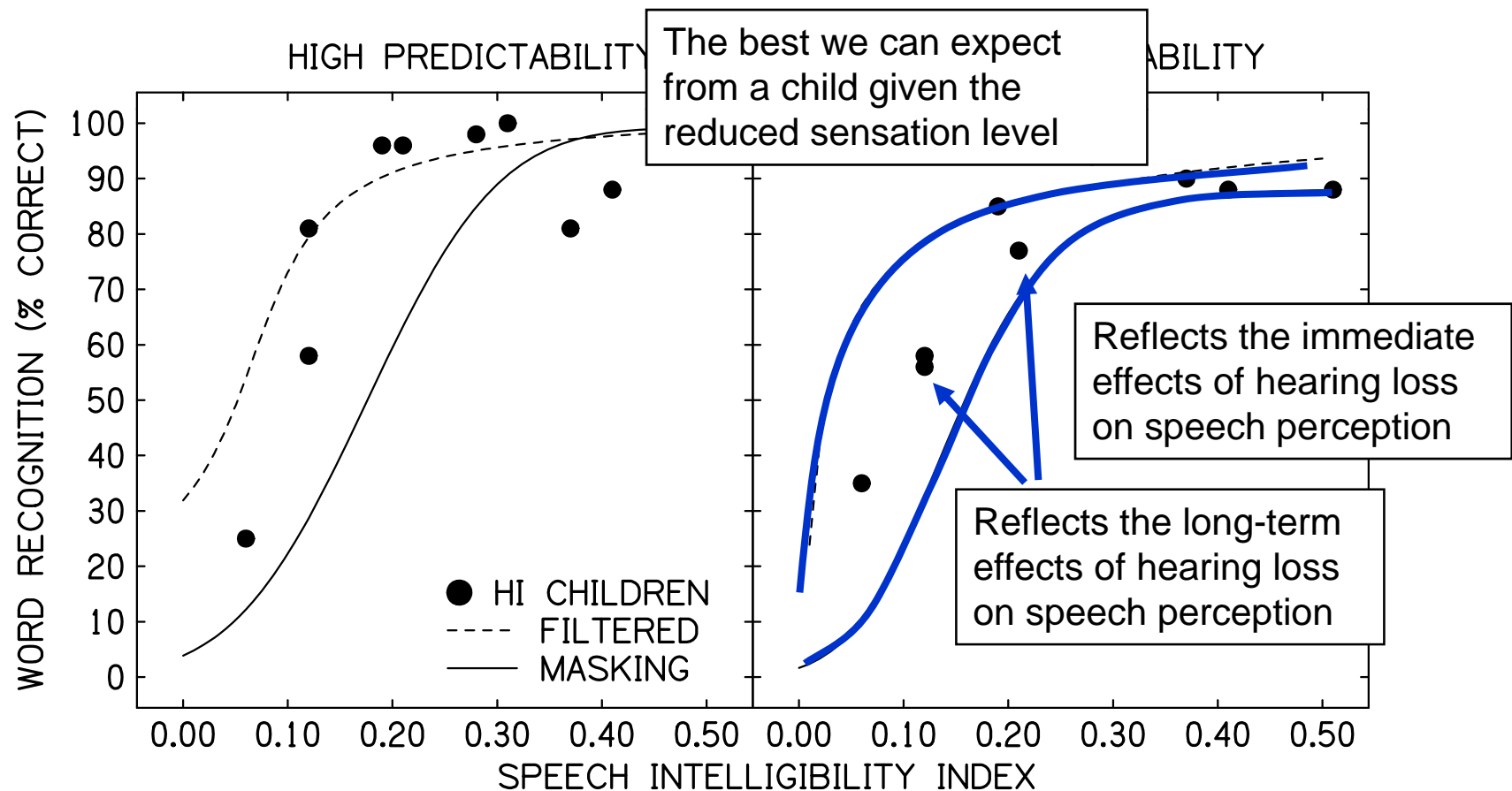
## ■ High-Frequency Hearing Losses



# 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.

[www.pedamp.asu.edu](http://www.pedamp.asu.edu)



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COLLEGE OF LIBERAL ARTS AND SCIENCES

Department of Speech & Hearing Sciences



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