VANDERBILT UNIVERSITY
MEDICAL CENTER

Minimal and Unilateral Hearing Loss in Children: Implications for Management

Anne Marie Tharpe

Sao Paulo August 21, 2015

Background

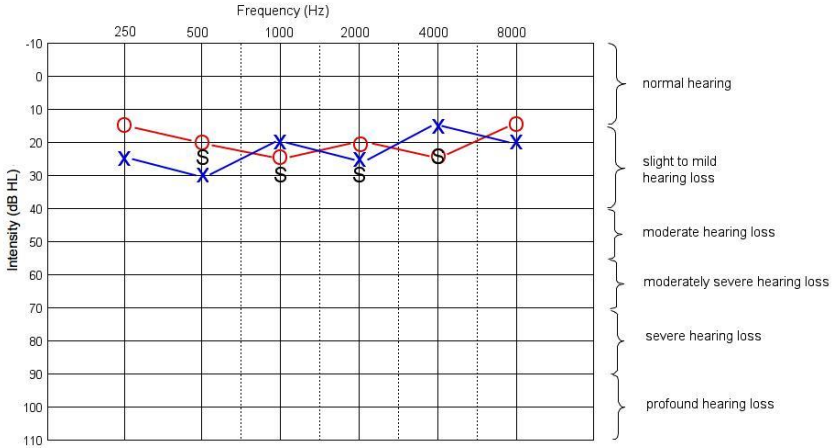
VANDERBILT UNIVERSITY
MEDICAL CENTER

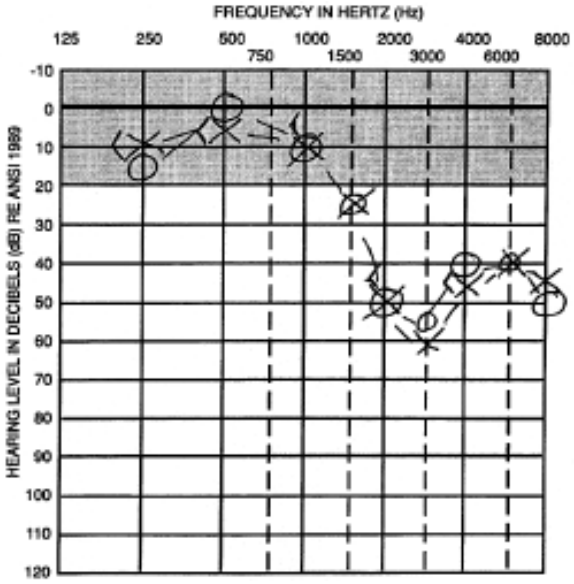
Normal Hearing

- Between -10 and 15 dB for children
  (Clarke 1981; Diefendorf & Gravel, 1996)
- Between 0 and 20-25 dB for adults

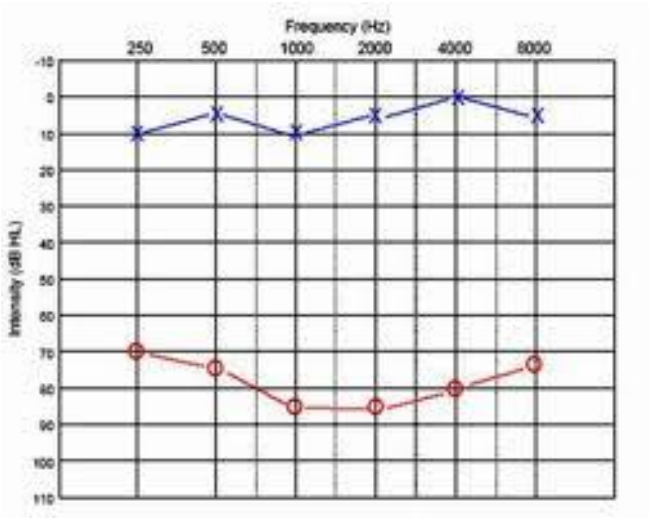
Minimal Hearing Loss

- PTA between 15 and 25 dB bilaterally
- High-frequency sensorineural loss = $\geq$ 2 frequencies above 2 kHz in one or both ears
- Loss of any degree in one ear


Frequency (Hz)
250
500
1000
2000
4000
8000
-10
0
10
20
30
40
50
60
70
80
90
100
110
Intensity (dB HL)
normal hearing
slight to mild hearing loss
moderate hearing loss
moderately severe hearing loss
severe hearing loss
profound hearing loss

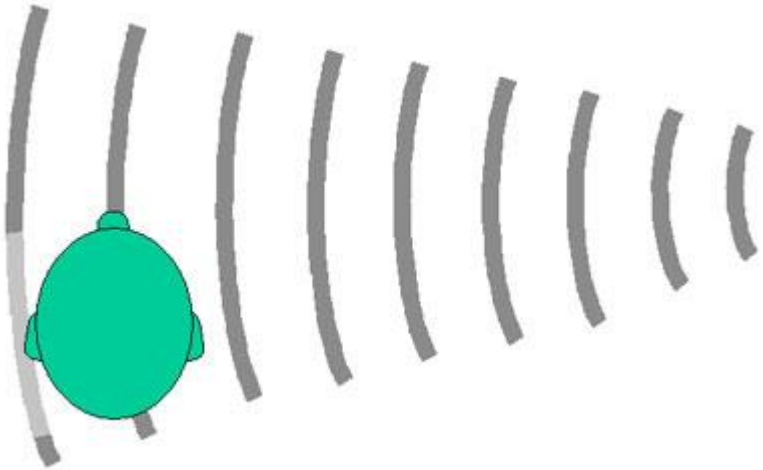

FREQUENCY IN HERTZ (Hz)
125
250
500
750
1000
1500
2000
3000
4000
6000
8000
HEARING LEVEL IN DECIBELS (dB) RE ANSI 1969
-10
0
10
20
30
40
50
60
70
80
90
100
110
120


125
250
500
1K
2K
4K
8K
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130


Frequency (Hz)
250
500
1000
2000
4000
8000
Intensity (dB HL)

Binaural Advantages

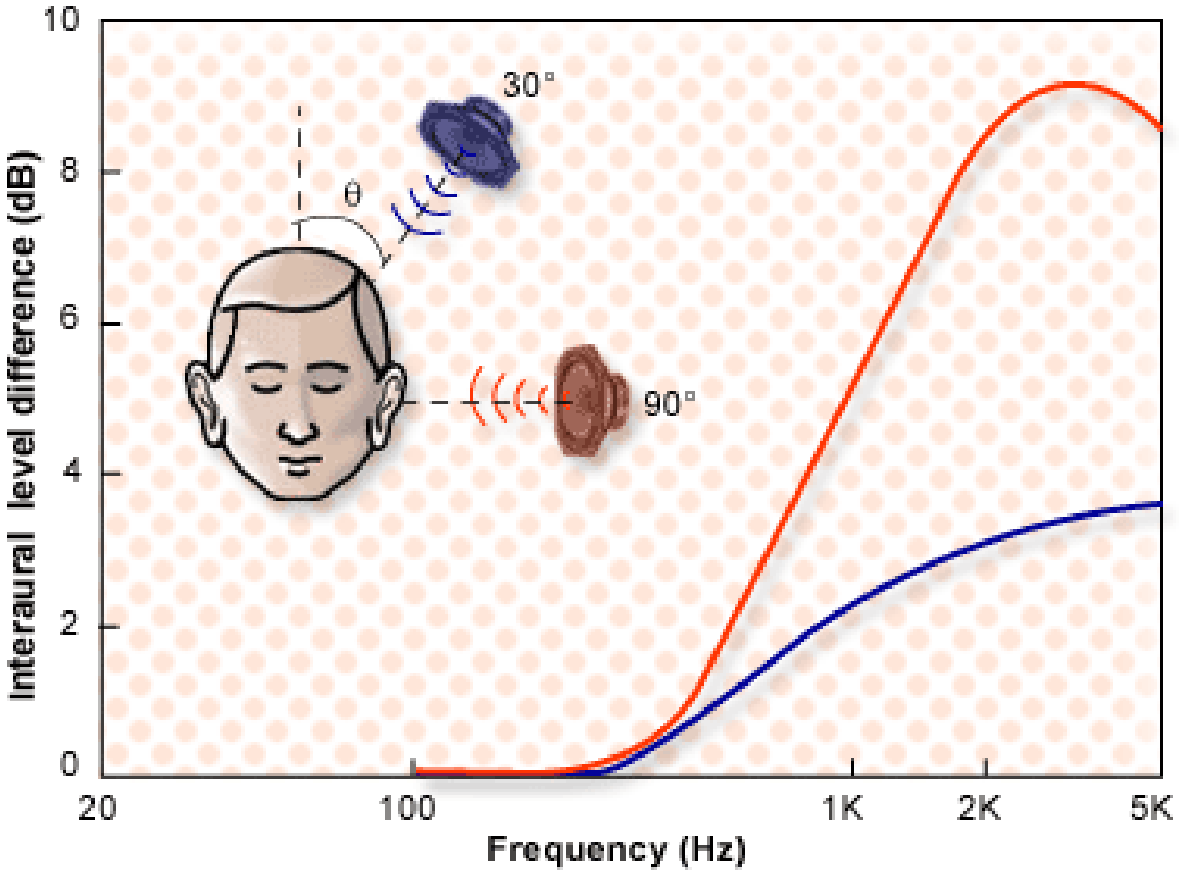
Head Shadow = 6 – 12 dB



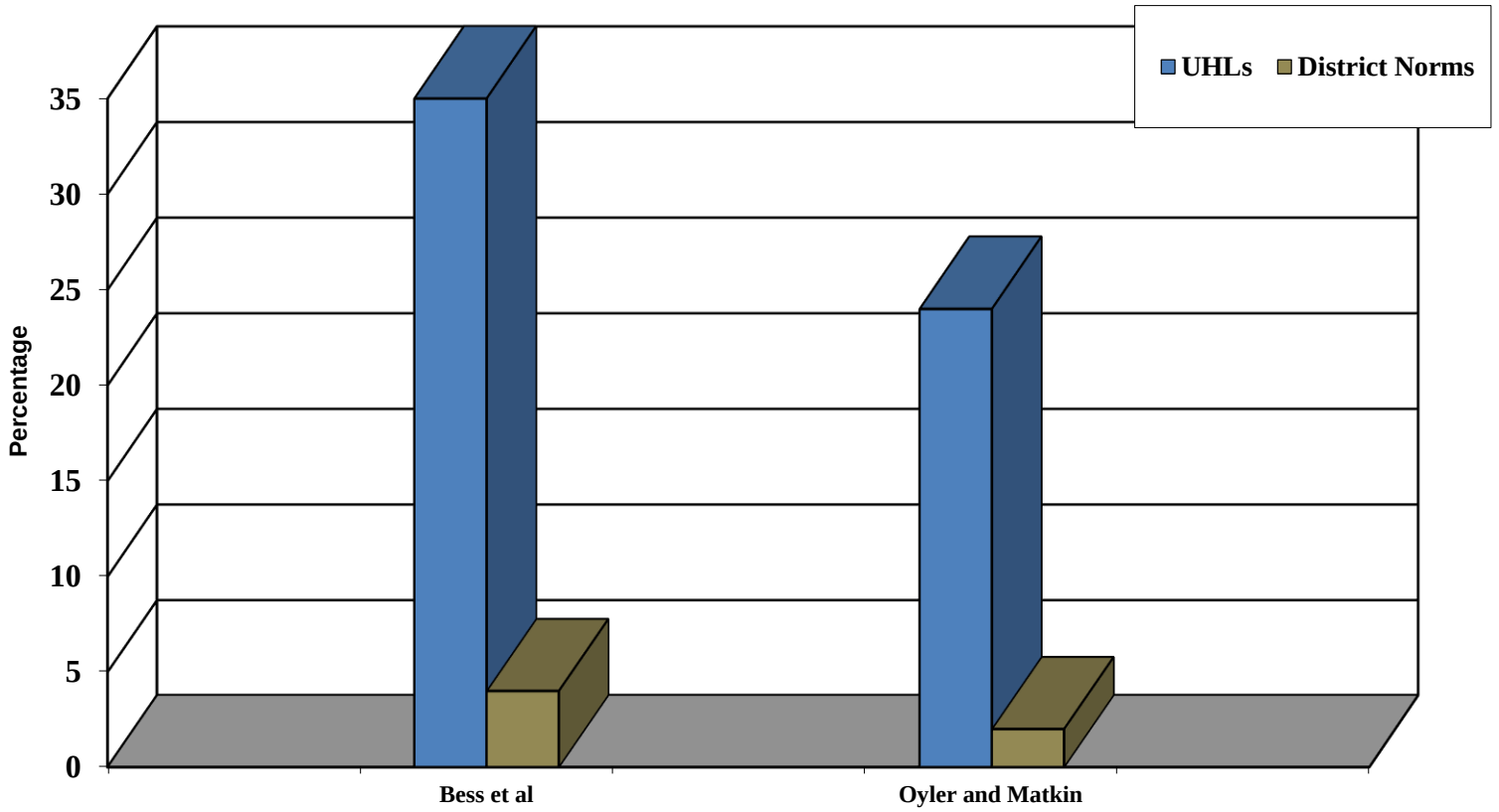
Binaural Summation = 3-10 dB

Binaural Advantages

Localization

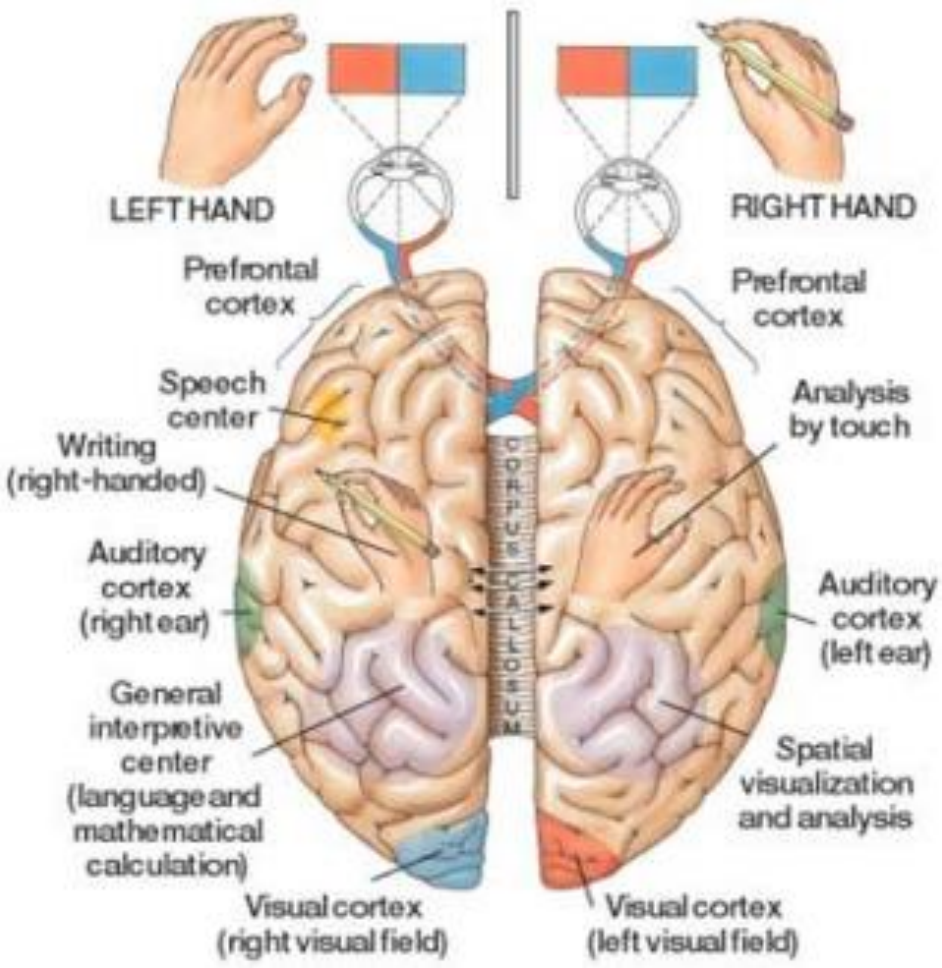


Grade Failure Rate

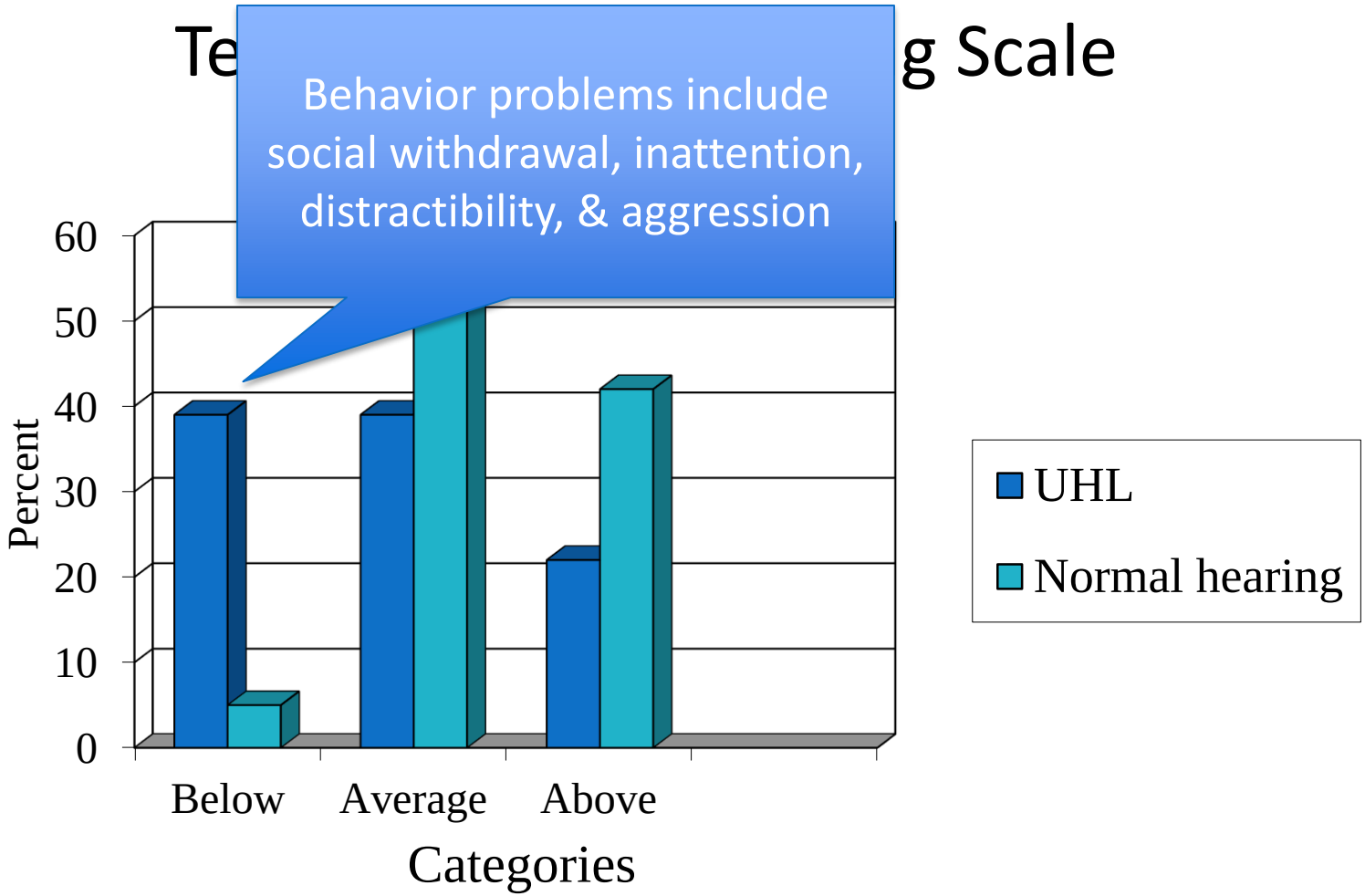


Bess & Tharpe, 1986

62% of those with academic difficulty had hearing loss of the right ear.



Te g Scale


Behavior problems include social withdrawal, inattention, distractibility, & aggression
60
50
40
30
20
10
0
Percent
Below
Average
Above
Categories
UHL
Normal hearing

UHL and Speech-Language Scores

(Lieu, Tye-Murray, & Piccirillo, 2010)

- Sibling-controlled study of 6-12 y.o. with UHL
- n = 148
- Oral & Written Language Scales (OWLS)

Results:

- Children with UHL had poorer language comprehension, oral expression, and oral composite scores
- No right- or left-ear differences

Impact of Unilateral Conductive HL on Academic Performance

(Kesser, Krook, Gray, 2013)

- Case control survey
- School children with aural atresia
- None repeated a grade but 65% required resource help
- 45% received speech therapy

Psychoeducational Outcomes: Minimal/Mild Bilateral Hearing Loss

VANDERBILT UNIVERSITY
MEDICAL CENTER

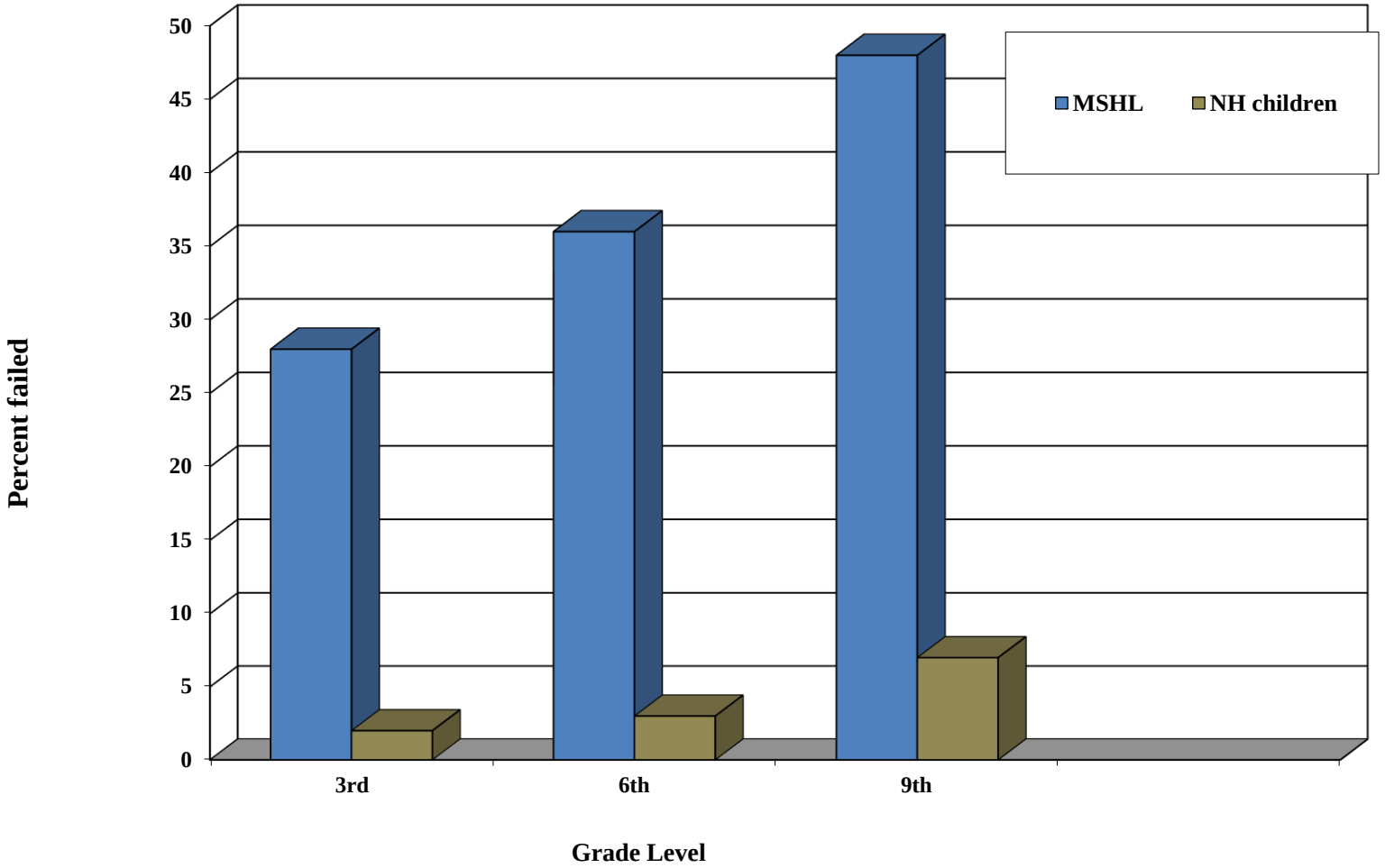
SAMPLE SELECTION: Minimal Hearing Loss

(Bess, Dodd-Murphy, & Parker, 1998)

- Grades: 3, 6, 9
- Examined:
  - demographics
  - educational performance
  - functional health status
  - behavior

Failure Rates of Children with MSHL & with NH

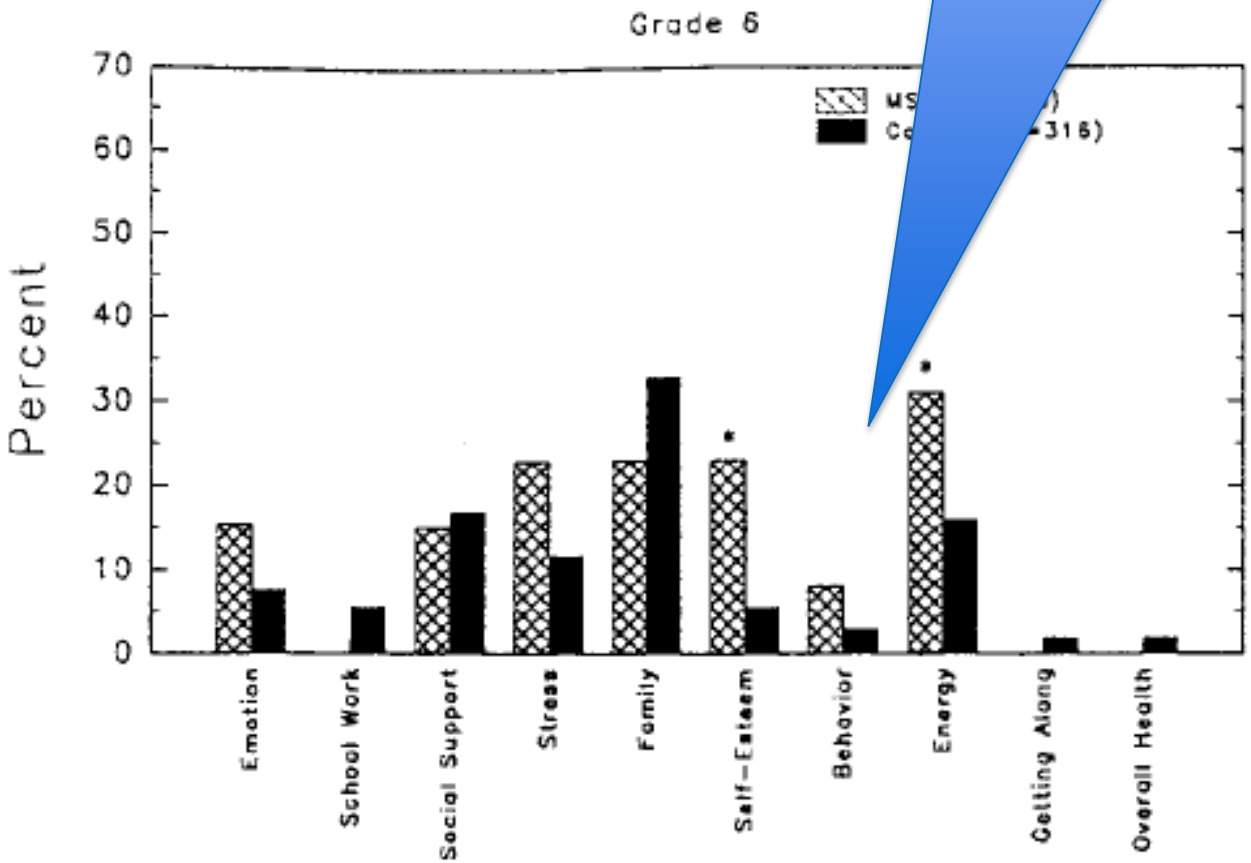
(Bess et al., 1998)



Children with Minimal Sensorine
Prevalence, Educational Per
Functional Stat

Fred H. Bess, Jeanne Dodd-Murphy, and

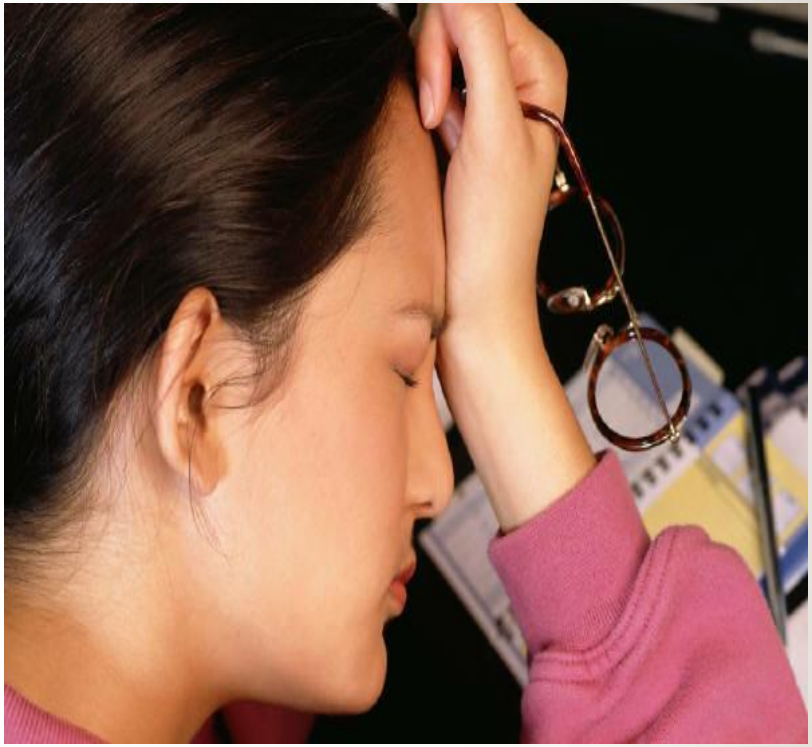
Children with MHL reported less energy than children with NH



VANDERBILT UNIVERSITY
MEDICAL CENTER

Listening Effort

Attentional requirements necessary to understand speech



VANDERBILT UNIVERSITY
MEDICAL CENTER

Hypothesis:

Assuming a limited effort capacity, performance on a secondary task will decrease when the primary listening task is made more difficult, regardless of whether primary-task performance is affected.

VANDERBILT UNIVERSITY
MEDICAL CENTER

Dual-Task Paradigm

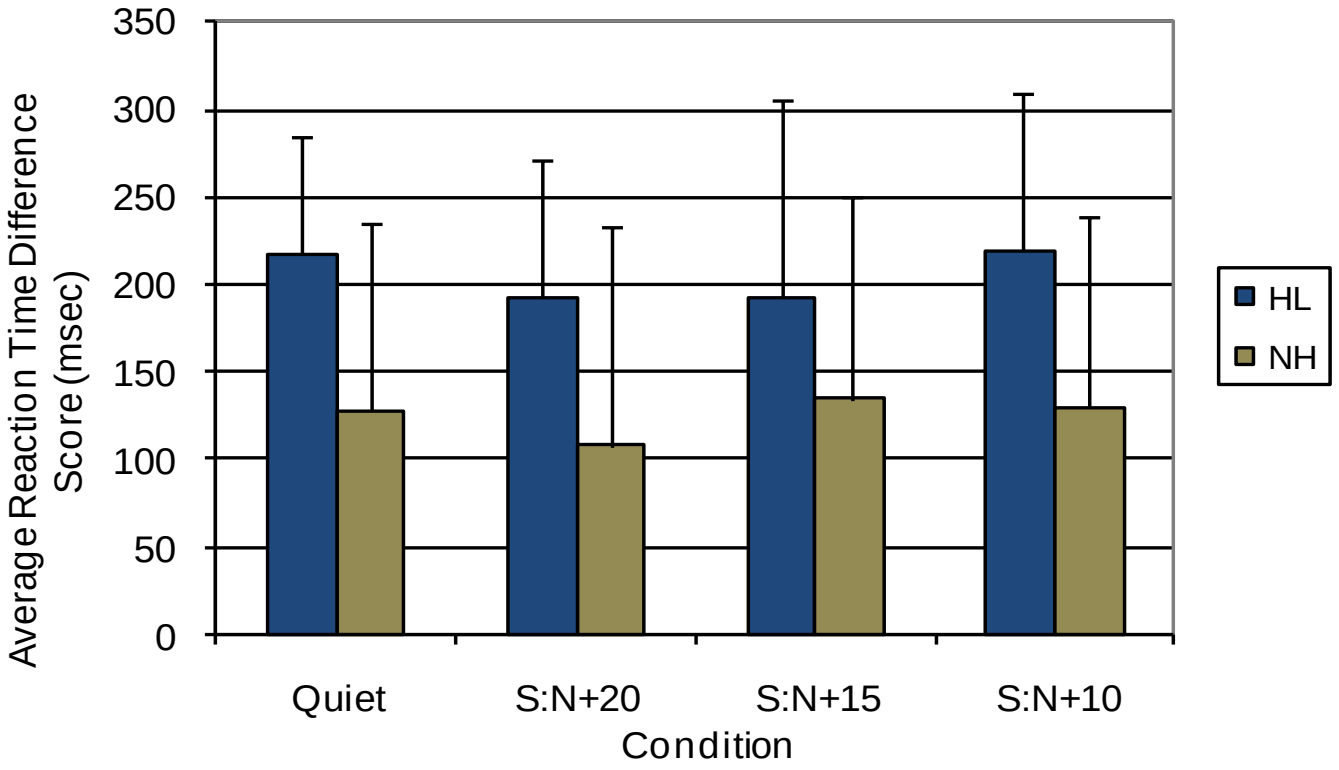
- Subjects
  - 14 children with mild HL matched with NH children for grade level
  - Ages between 6 – 11 years

(Bourland-Hicks & Tharpe, 2002)

Dual-Task Paradigm

- Primary task: speech recognition in noise (PBK)
- Secondary task: button push to random presentations of probe light

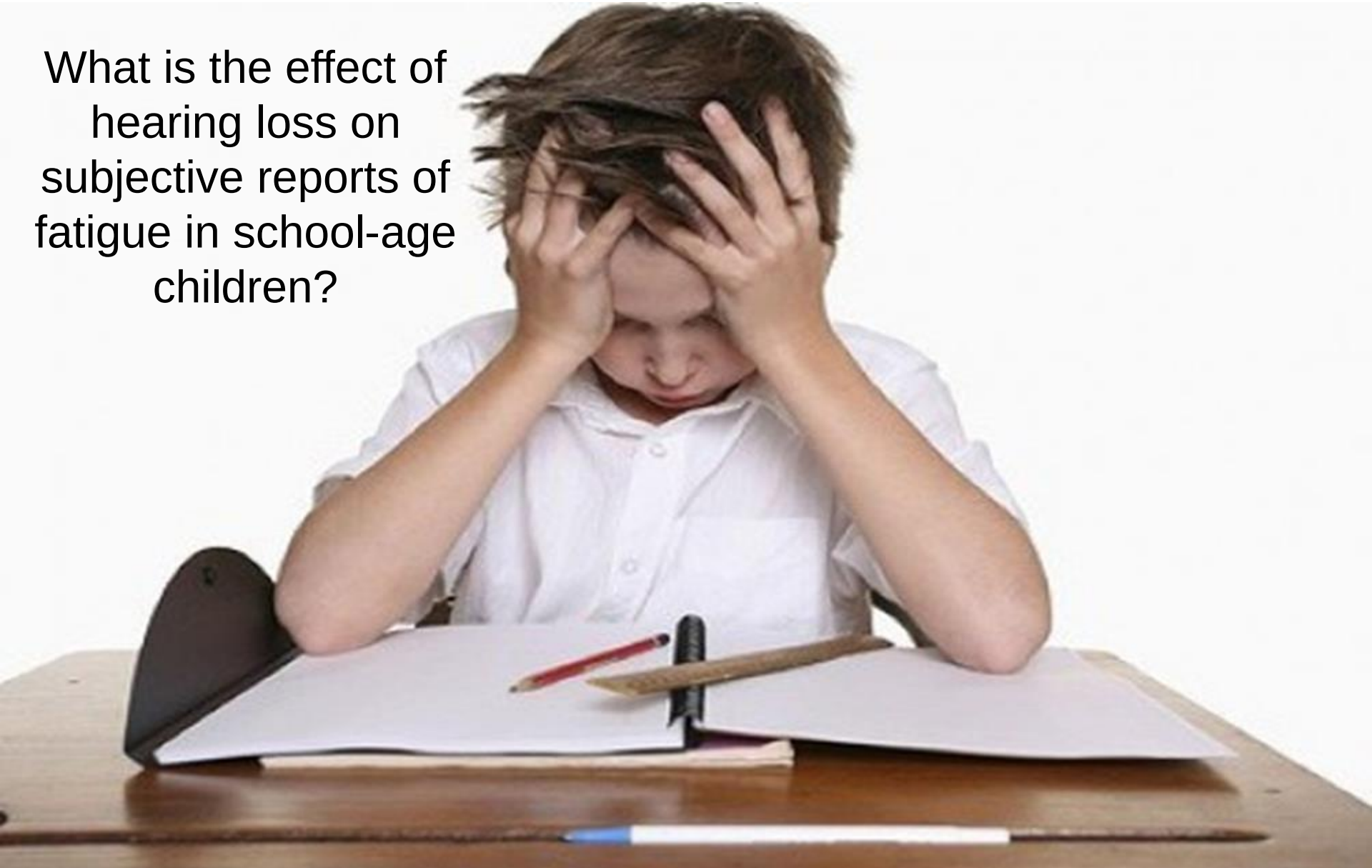
Dual Task Paradigm



No difference in baseline RTs between groups

Hornsby et al., 2013

What is the effect of hearing loss on subjective reports of fatigue in school-age children?



VANDERBILT UNIVERSITY
MEDICAL CENTER

What they did…

- 10 children (10-13 yrs) with hearing loss (CHL) and 10 age-matched peers with normal hearing (CNH)
- Subjective ratings of fatigue using the PedsQL Multidimensional Fatigue Scale
- All had normal non-verbal intelligence

VANDERBILT UNIVERSITY MEDICAL CENTER

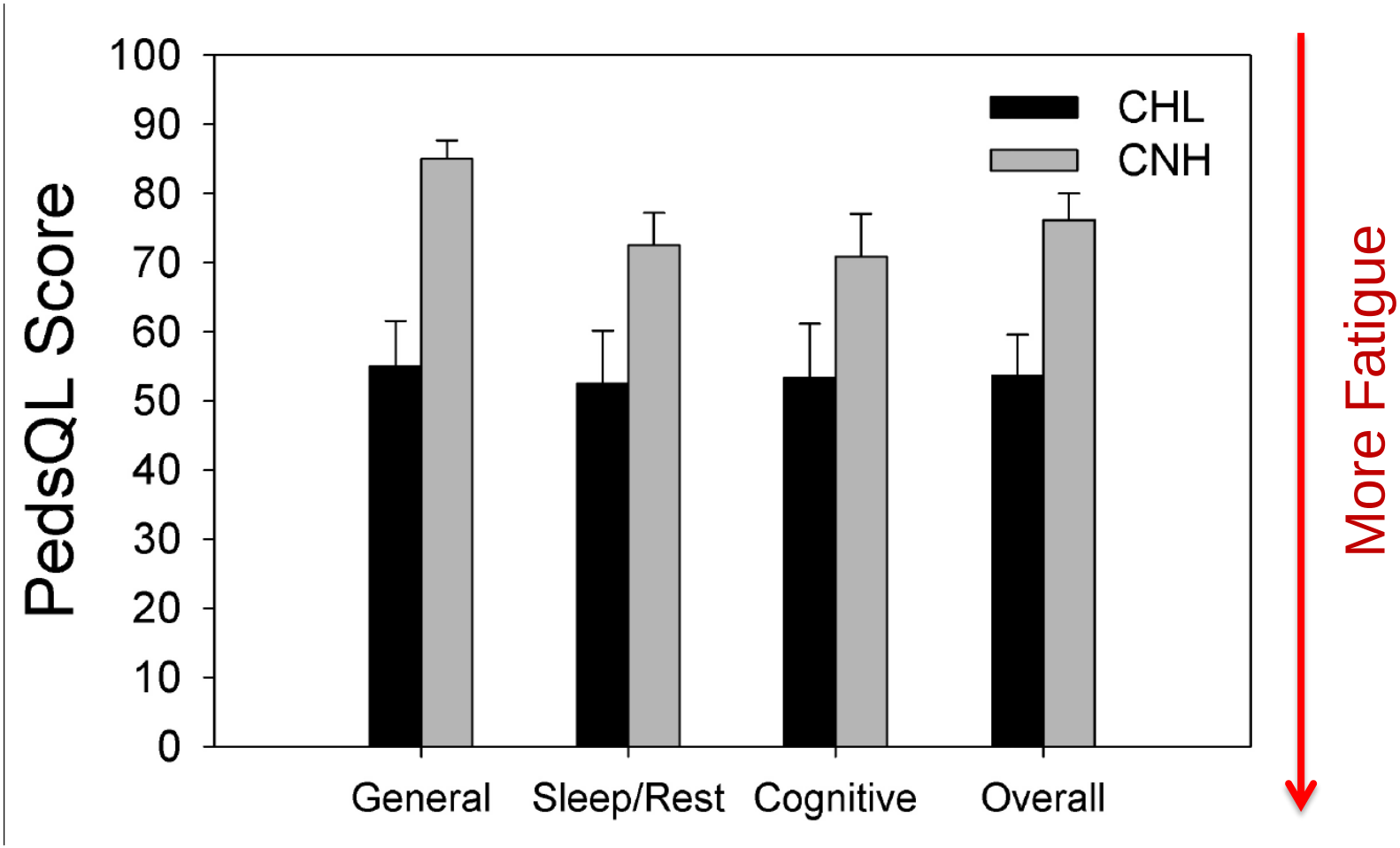
What they did…

Method:

PedsQL Multidimensional Fatigue Scale:

- General Fatigue (e.g., “I feel tired”)
- Sleep/Rest Fatigue (e.g., “I rest a lot”)
- Cognitive Fatigue (e.g., “It is hard for me to think quickly”)
- Composite Score

What they found…



VANDERBILT UNIVERSITY
MEDICAL CENTER

Why is this important?

The fatigue scores indicated more fatigue experienced by CHL than children with cancer, rheumatoid arthritis, diabetes, and obesity (Varni et. Al, 2002; 2004; 2009; 2010)

Current Status of Hearing Technology Use

Hearing Technology Options for UHL

- Traditional hearing aids
- Contralateral Routing Of Signal (CROS) hearing aids
- Frequency modulated (FM) systems
- Cochlear implants

Traditional Hearing Aids for UHL

- Unaidable hearing
  - Profound SNHL
  - Very poor word recognition
  - Marked intolerance for amplified sounds

(Valente et al., 2002)

Traditional Hearing Aids for UHL

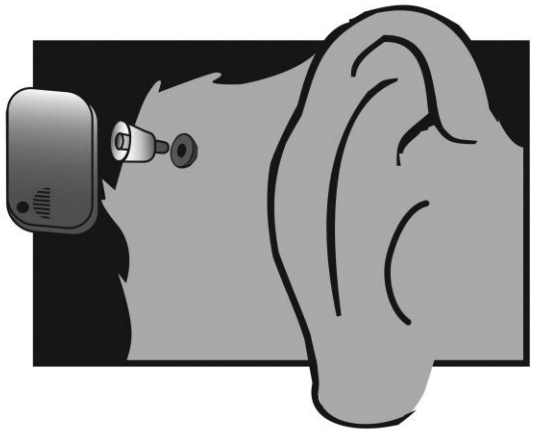
- Binaural interference - decrease in bilateral performance when an individual is receiving asymmetric auditory input (Jerger et al, 1993)
- Evidence of BI for adults, but not children, when listening to asymetrically-degraded speech (Rothpletz et al, 2004)
- No binaural advantage when listening to asymetrically-degraded speech (Rothpletz et al, 2004)

CROS HAs for UHL

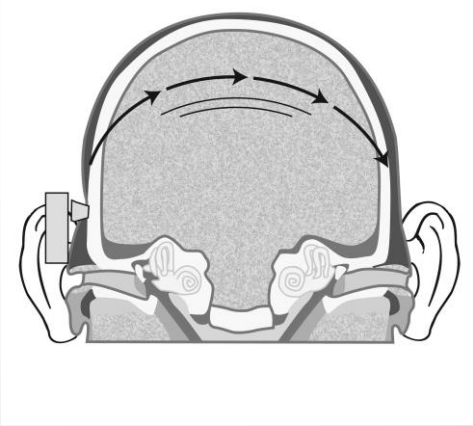
- CROS HAs are considered for those ineligible for other technology
- CROS HAs are not recommended for consideration until child is able to control his/her communication environment (AAA, 2003; Kenworthy et al., 1990)
- Useful for children who do not have access to FM or need assistance outside of school

Transcranial CROS Aids

- Quasi-transcranial – high level AC signal creates vibration of skull to stimulate opposite ear



- True transcranial – BC signal is transmitted from poor ear to opposite normal cochlea (eg, BAHA)



- BAHA can be considered at age 5 years and above; however, data from the pediatric population are lacking (AAA, 2003)

Cochlear Implantation for SSD

- Most work has been done on adults as tinnitus-reduction treatment
- Recent systematic review of literature (17 studies, Vlastarakos et al., 2013)
  - Post-lingually deafened adults and children only
  - Tinnitus improvement
  - Wider use of implantation in SSD
- Better outcomes with shorter length of deafness

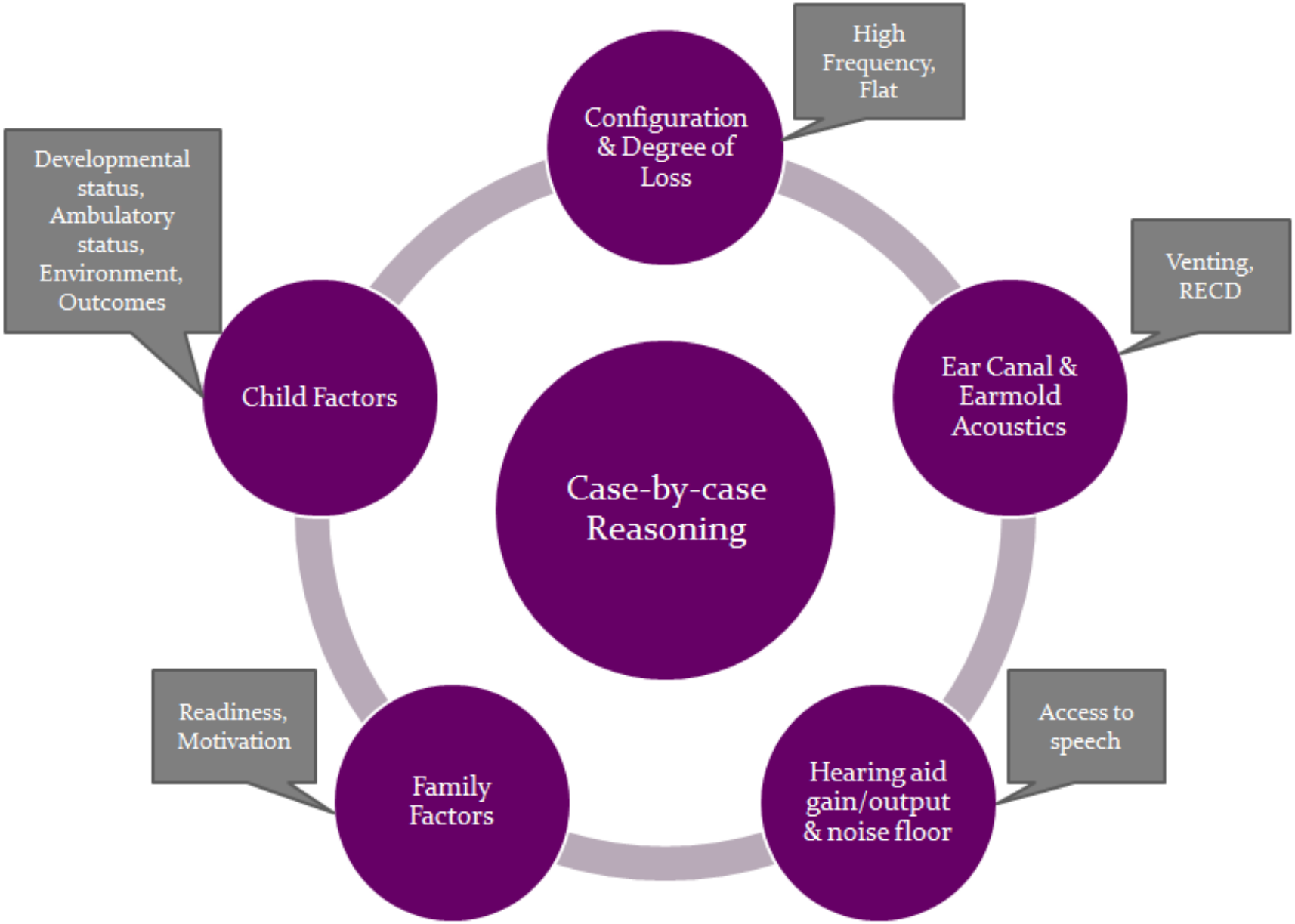
When to fit a UHL or MBHL?

Babies are usually at a close distance to the caregiver allowing for an optimal signal-to-noise ratio

After 12 months, they venture off…

Hearing Technology Guide for MBHL

Bagatto & Tharpe

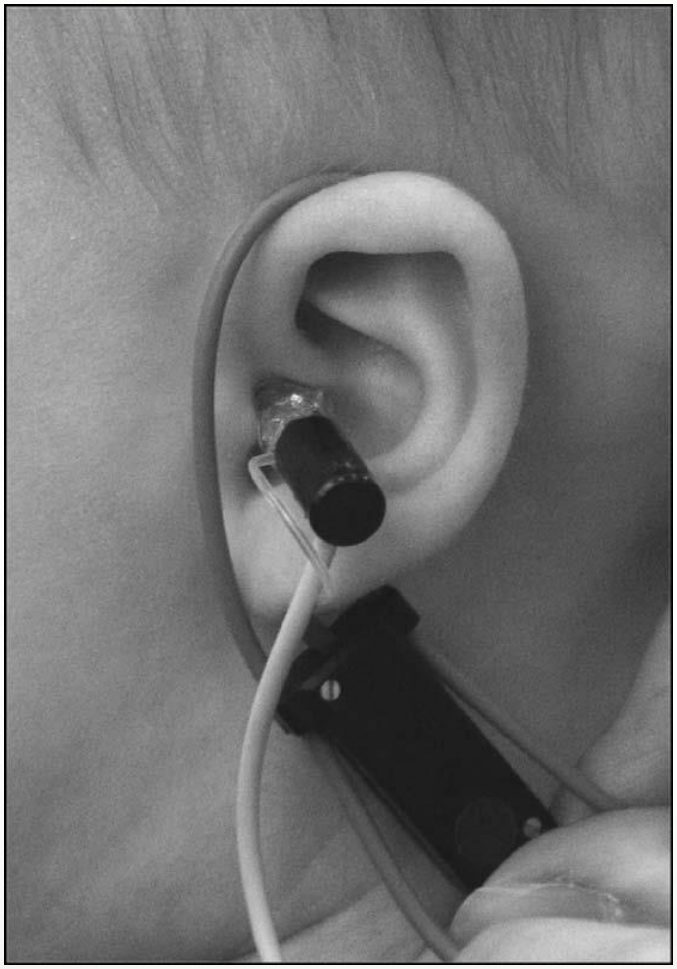

Case-by-case Reasoning
Configuration & Degree of Loss
High Frequency, Flat
Ear Canal & Earmold Acoustics
Venting, RECD
Hearing aid gain/output & noise floor
Access to speech
Family Factors
Readiness, Motivation
Child Factors
Developmental status, Ambulatory status, Environment, Outcomes

Traditional HAs for Infants & Young Children with MBHL

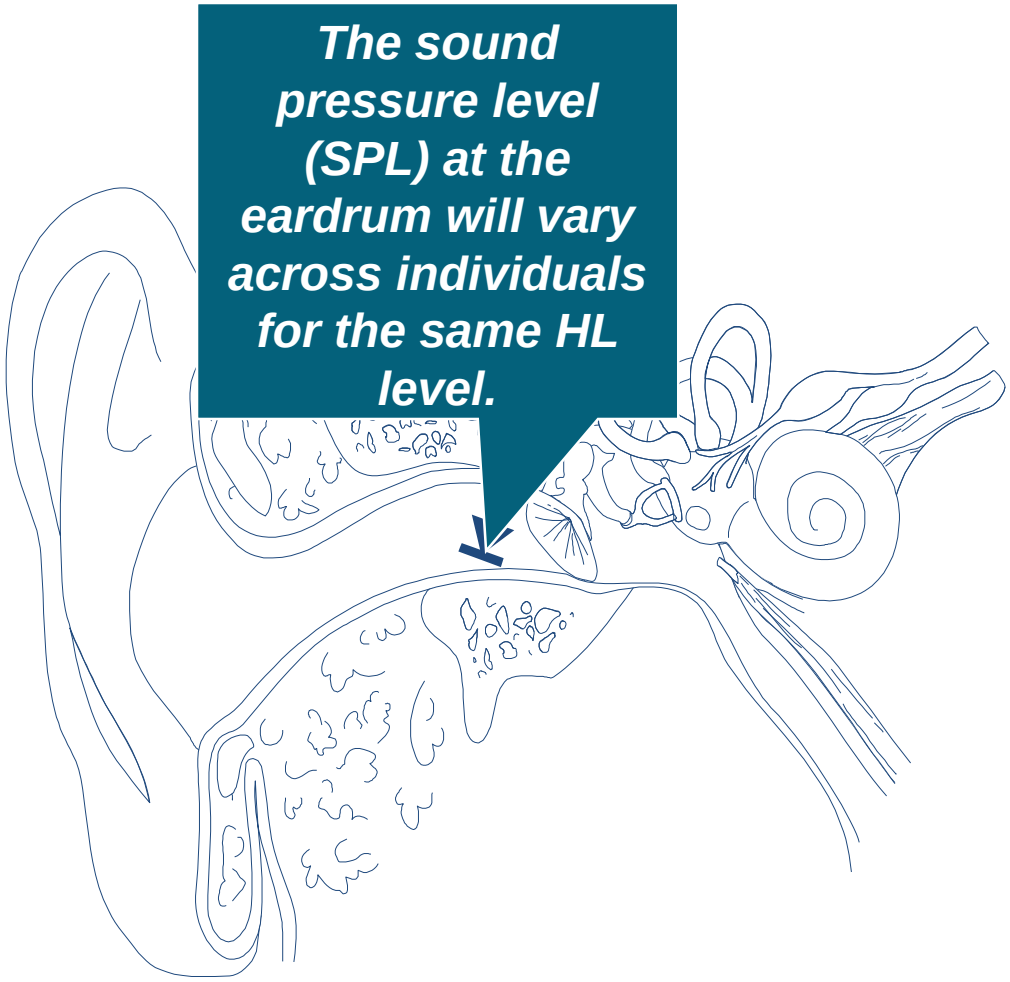
- Consider acoustic modifications, shorter speaker-listener distance, and increased voice volume
- Will have large RECDs leaving only a few dB recommended gain across frequencies
- Counsel regarding need for amplification as RECD decreases
- Consider noise floor of HAs – typically not heard by those with greater degrees of HL

VANDERBILT UNIVERSITY
MEDICAL CENTER

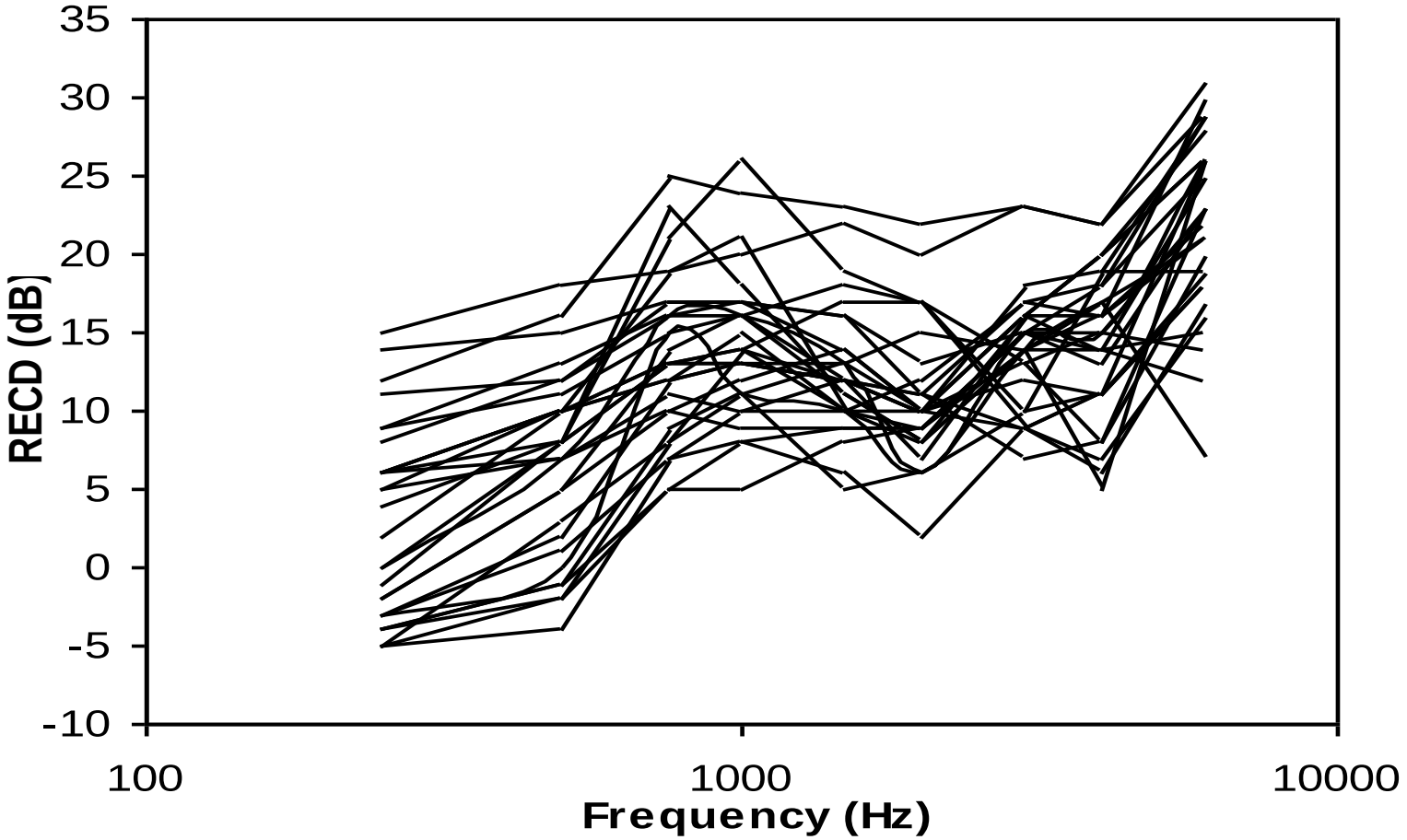
Importance of RECD



Influence of External Ear Canal

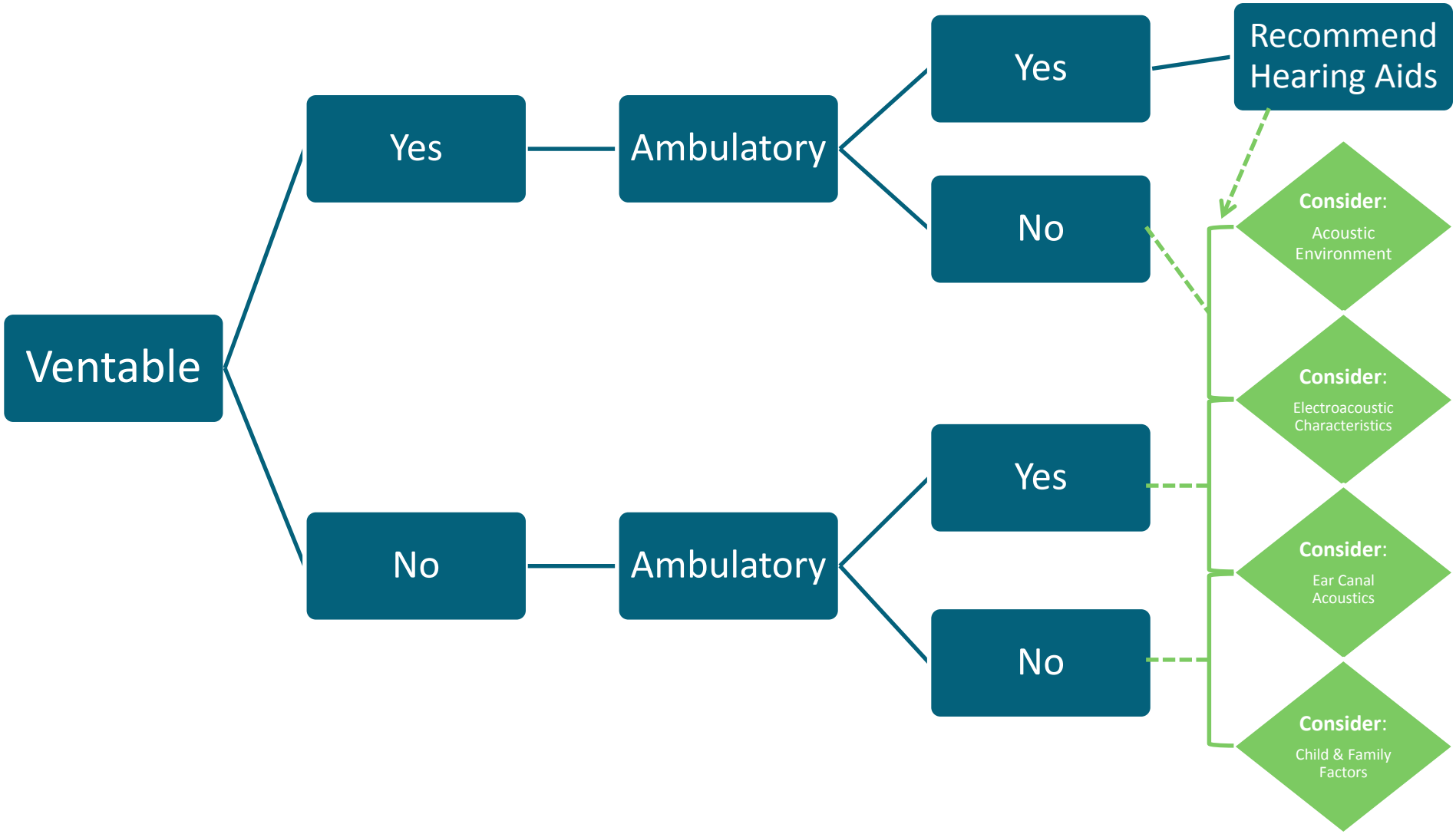


Variability in RECDs in Infants (2-6 mos)



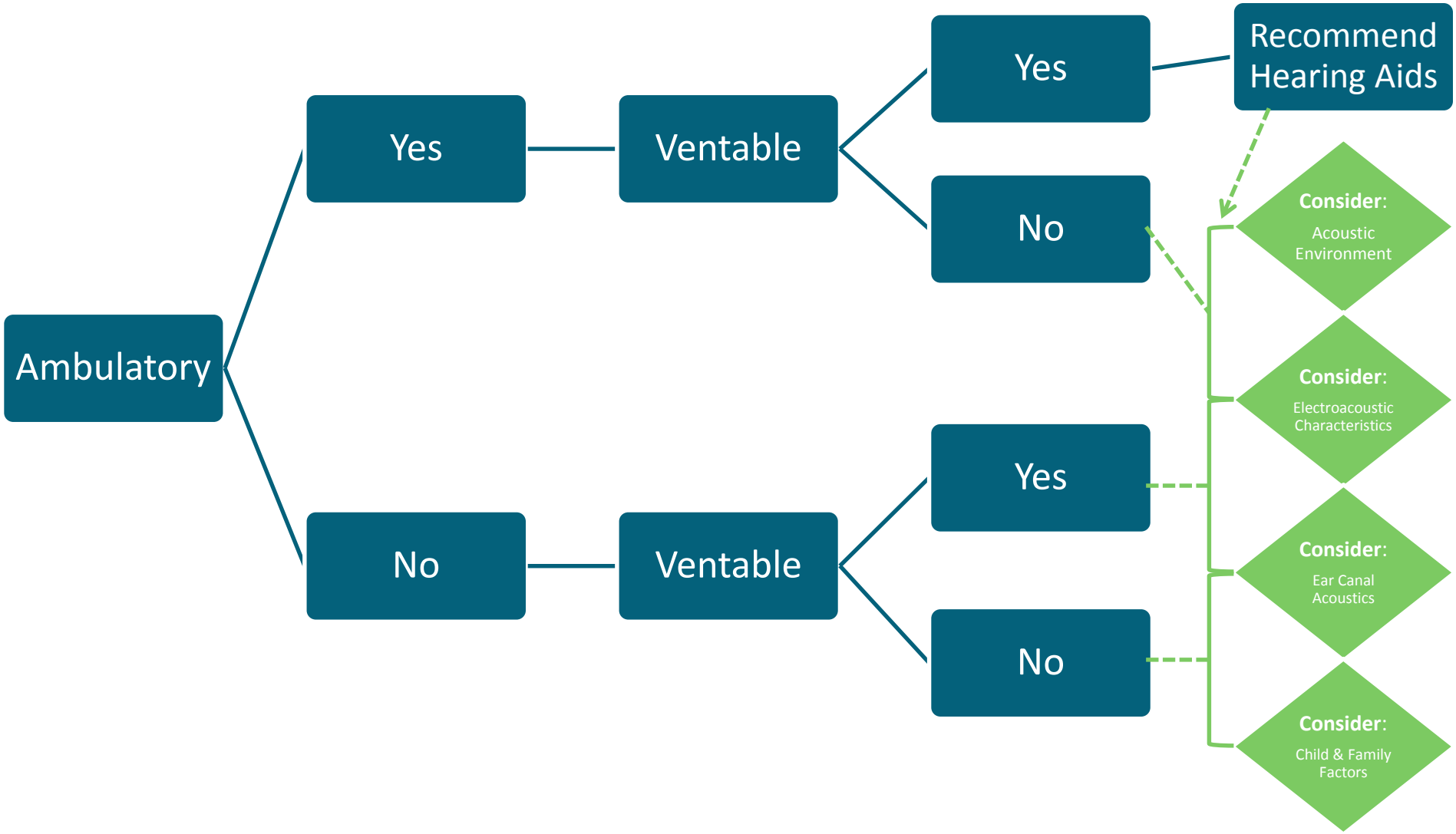
(Bagatto, Seewald, Scollie, & Tharpe 2006)

High Frequency Hearing Loss:
Hearing Aid Guide

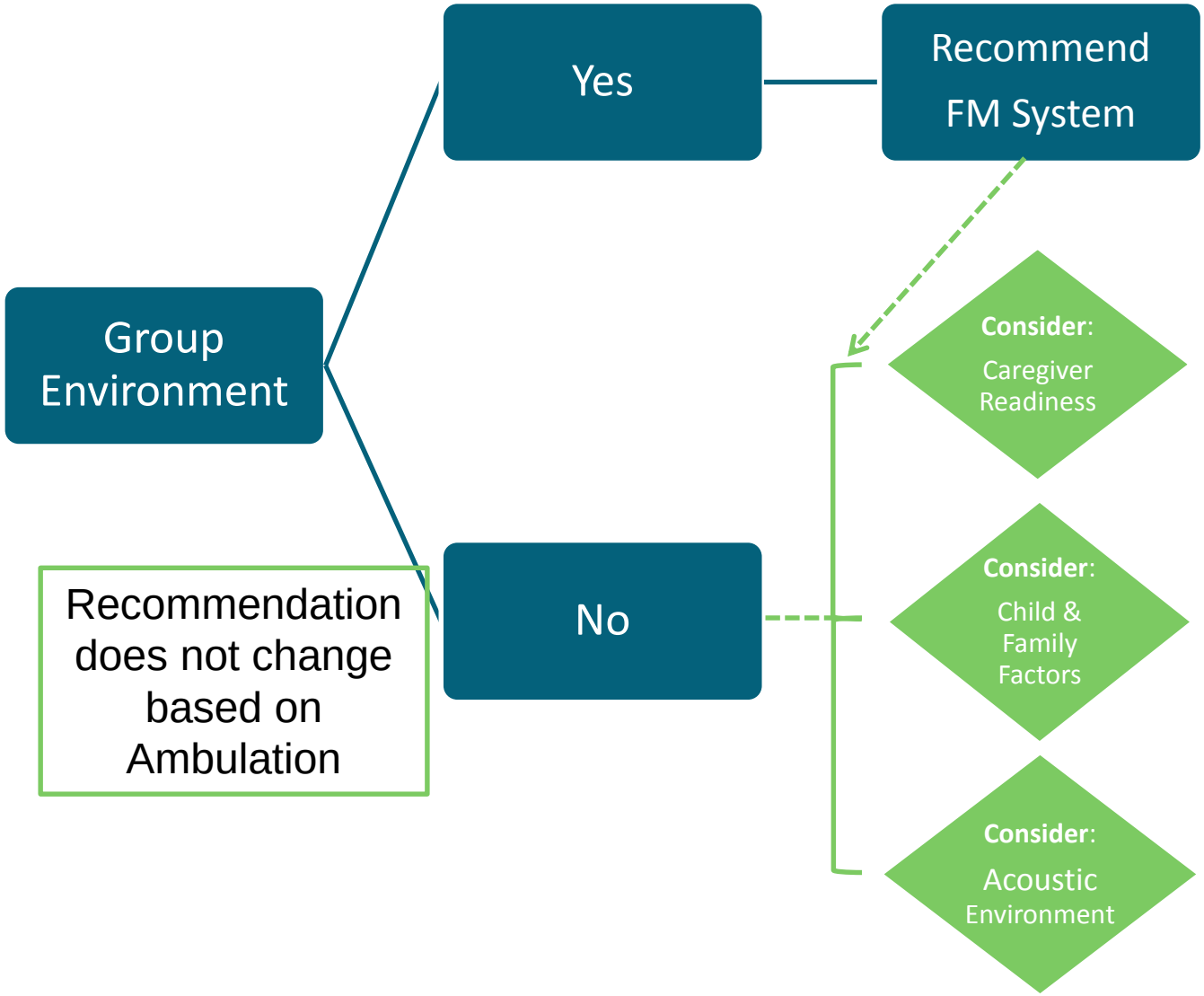


Bagatto & Tharpe, 2014)

Flat Hearing Loss:
Hearing Aid Guide



Minimal/Mild Bilateral Hearing Loss:
FM System Guide



Tool	Target	Age
Early Language Milestone Scale-II	Receptive & expressive language	B-36 mos
Early Listening Function	Auditory detection	Infants & toddlers
Pre-School SIFTER	Classroom listening behavior	3 yrs to K
SIFTER	Classroom listening behavior	Grade school
Communication & Symbolic Behavior Scales	Language & symbolic development	Infants & toddlers

Importance of Monitoring

- As the child's ear canal grows and changes, the acoustic properties change which impact hearing thresholds (dB HL)
  - Important to consider when monitoring hearing levels and considering intervention strategies
- Children in the first 3 years of life experience otitis media with effusion (OME) which can increase hearing thresholds
  - Include immittance measures in audiological monitoring protocol
- Audiologists should closely monitor the child's functional auditory abilities as part of routine evaluation
  - Recommend every 6 months
  - Intervention strategies should be adjusted as needed

" . . . hard-of-hearing children are not easily recognizable and often are mistaken for children with vague, sometimes exotic, always bewildering 'problems.' Thus, …they are invisible children."

(Julia Davis, 1977)