

The Impact of Minimal and Mild Hearing Loss on Children

**Anne Marie Tharpe, Ph.D.
Vanderbilt Bill Wilkerson Center
for Otolaryngology &
Communication Sciences
Nashville, Tennessee**

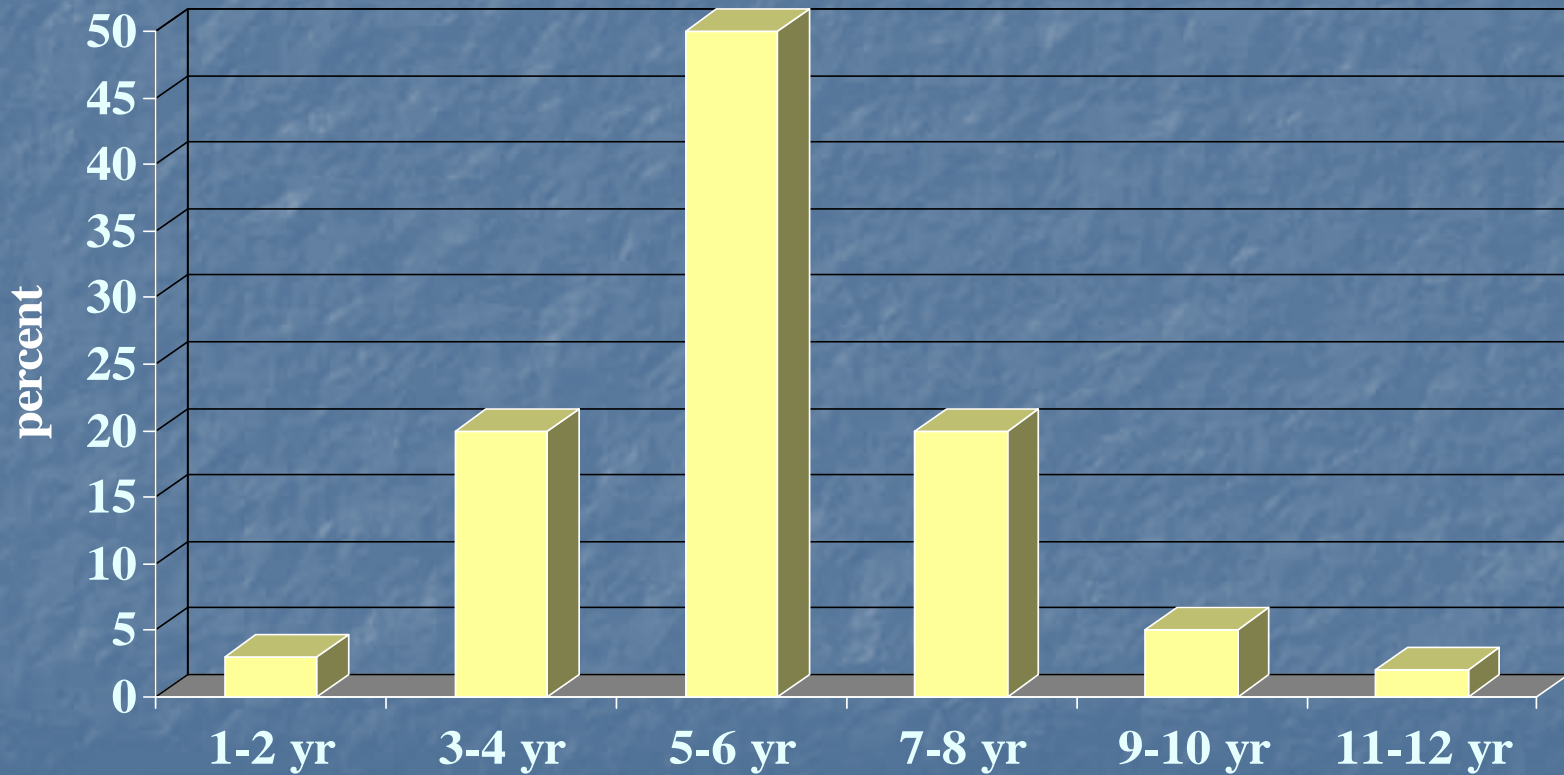
Current Definitions of Minimal Hearing Loss

- Permanent mild bilateral HL = PTA at 0.5, 1.0, 2.0 kHz between 20 & 40 dB HL
- Permanent high frequency HL = PT thresholds > 25 dB HL at two or more frequencies above 2.0 kHz
- Permanent unilateral HL = PTA at 0.5, 1.0, 2.0 kHz \geq 20 dB or PT thresholds > 25 dB HL at two or more frequencies above 2 kHz in the affected ear

- I. Academic, Social, & Behavioral Outcomes
- II. Screening for Unilateral & Mild HL
- III. Audiological & Medical Management

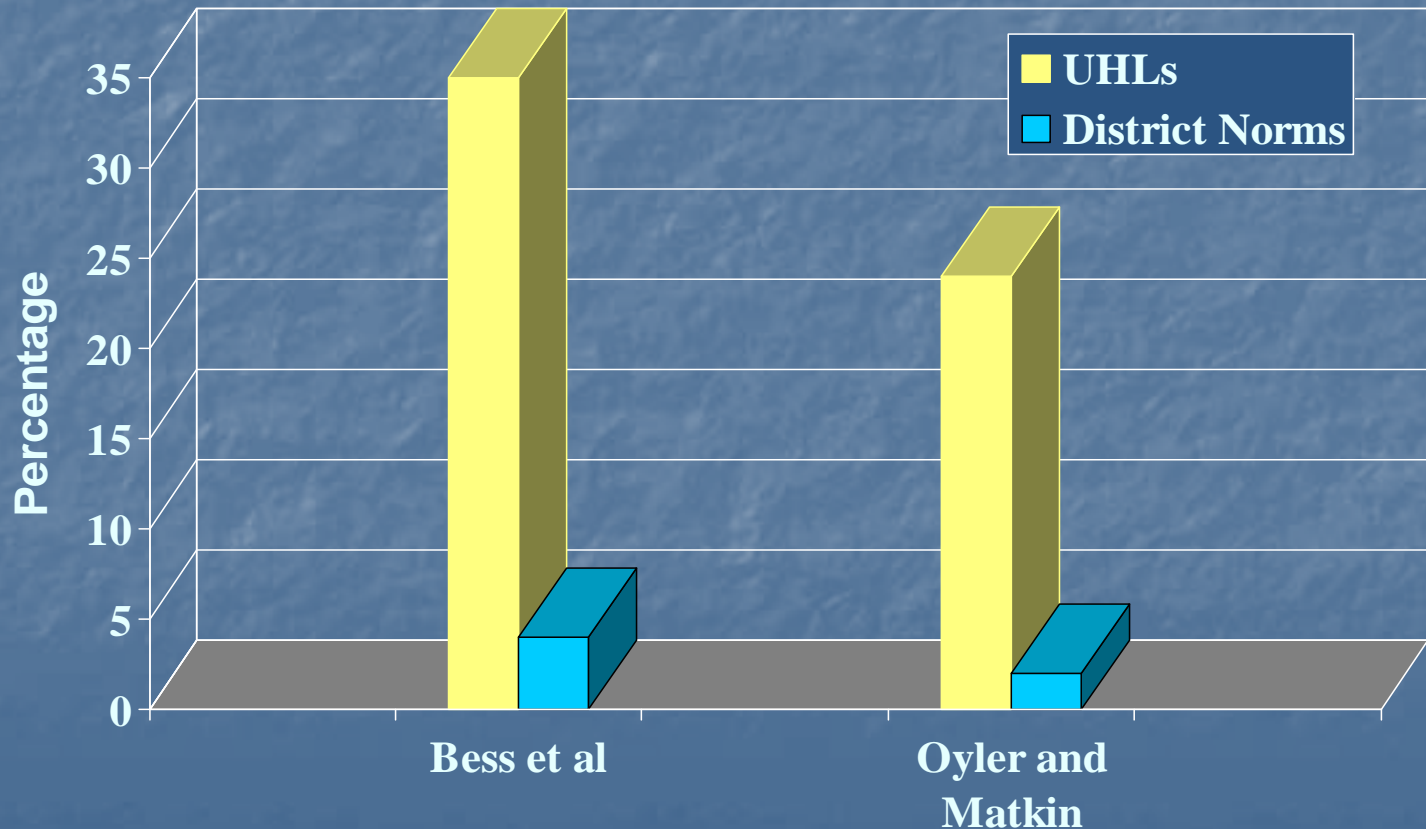
Academic, Social, & Behavioral Outcomes

Age of Identification: UHL



Bess & Tharpe, 1986

Percent Failing at Least One Grade: UHL



STUDIES OF UNILATERAL HEARING LOSS

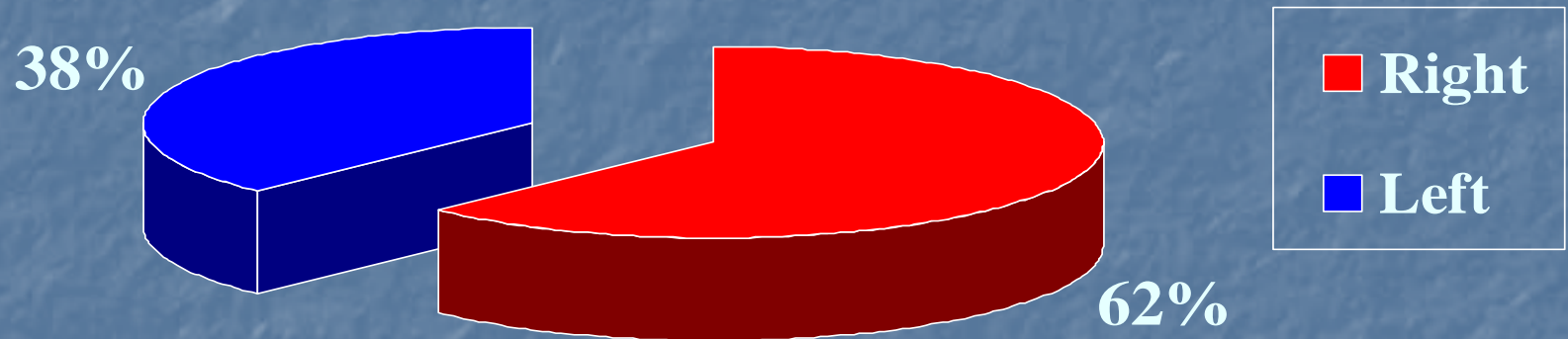
Investigation	Failed (1 or more grades)	Resource Help (1 or more years)	Combined (failed and/or resource help)
Bess (1986)	35%	13.3	48.3%
Oyler (1987)	27.3%	40.7	68.0%
Jensen (1988)	18.0%	36.0%	54.0%
Martini (1988)	25.0%	?	?

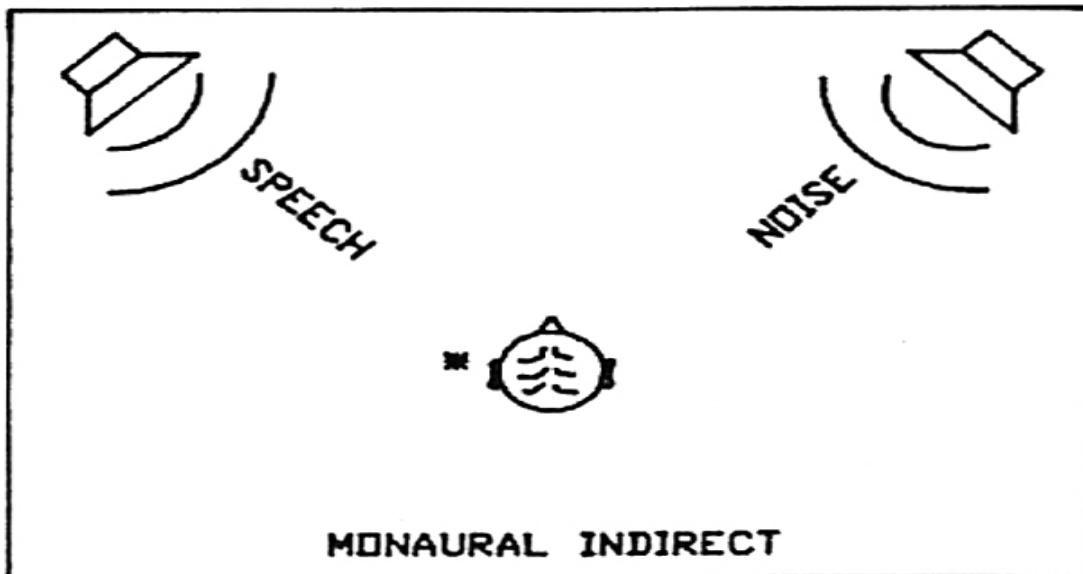
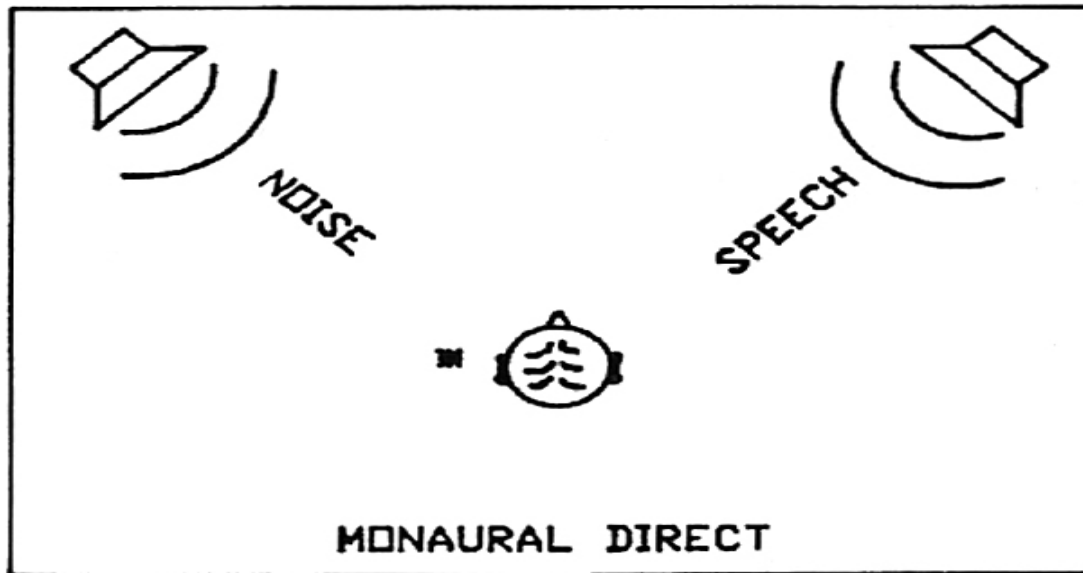
Speech-Language & Educational Consequences of Unilateral Hearing Loss in Children

- Literature search 1966-June 1, 2003
- 22-35% rate of failing one grade in school
- 12-41% receiving educational assistance

(Lieu, J.E. *Arch Otolaryngol Head Neck Surg.* 2004;130:524-530)

Failure as a Function of Ear





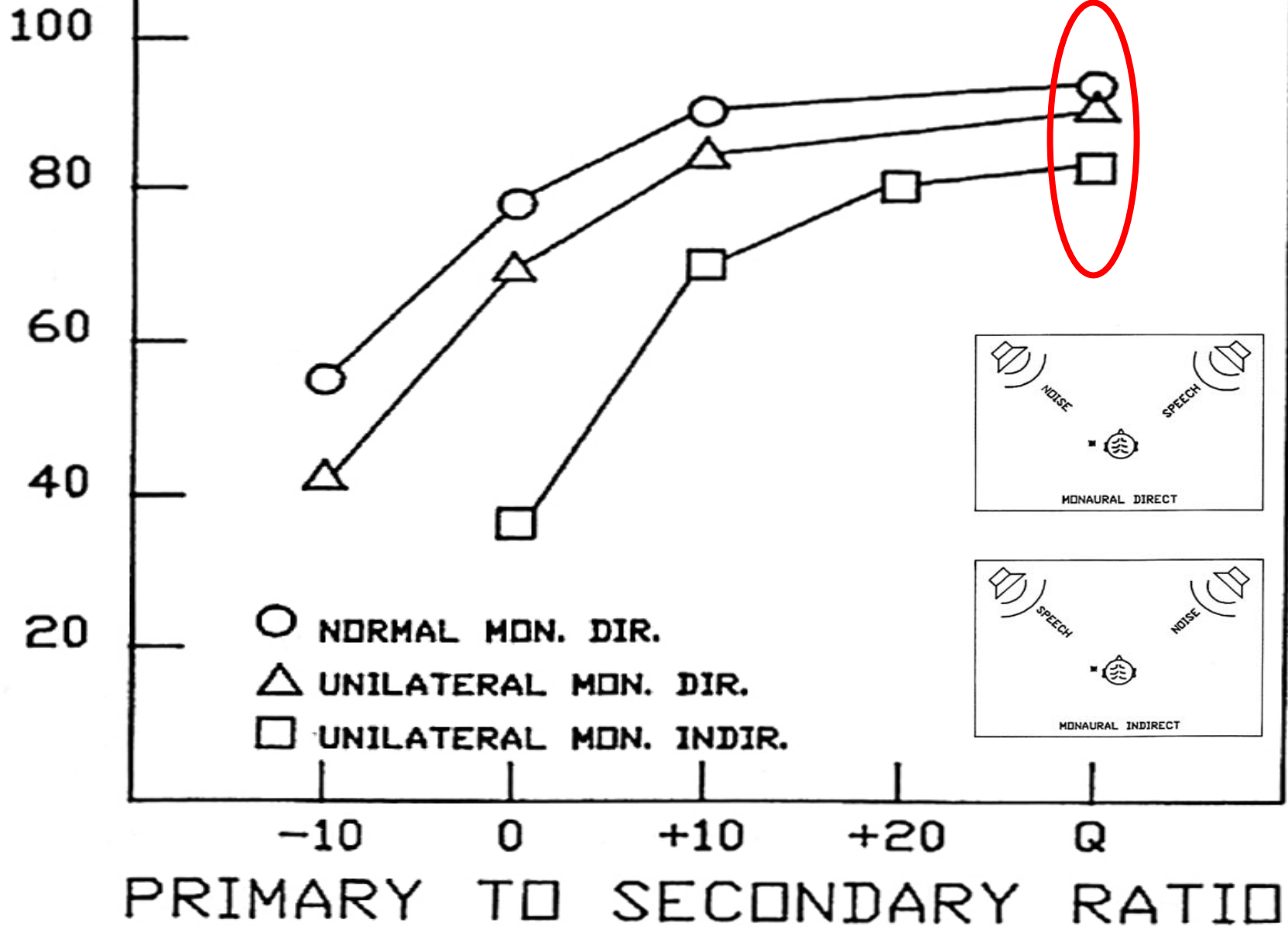
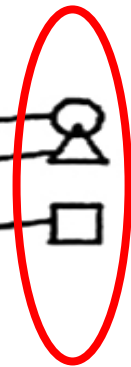
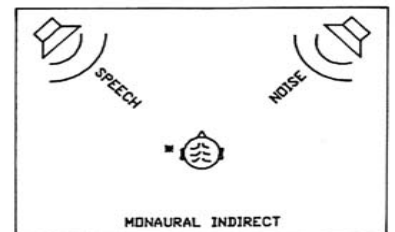
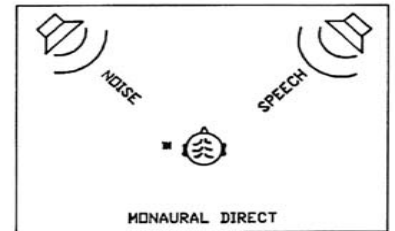
PERCENT CORRECT

100
80
60
40
20

- NORMAL MDN. DIR.
- △ UNILATERAL MDN. DIR.
- UNILATERAL MDN. INDIR.

PRIMARY TO SECONDARY RATIO

-10 0 +10 +20 Q



Bilateral Minimal Hearing Loss

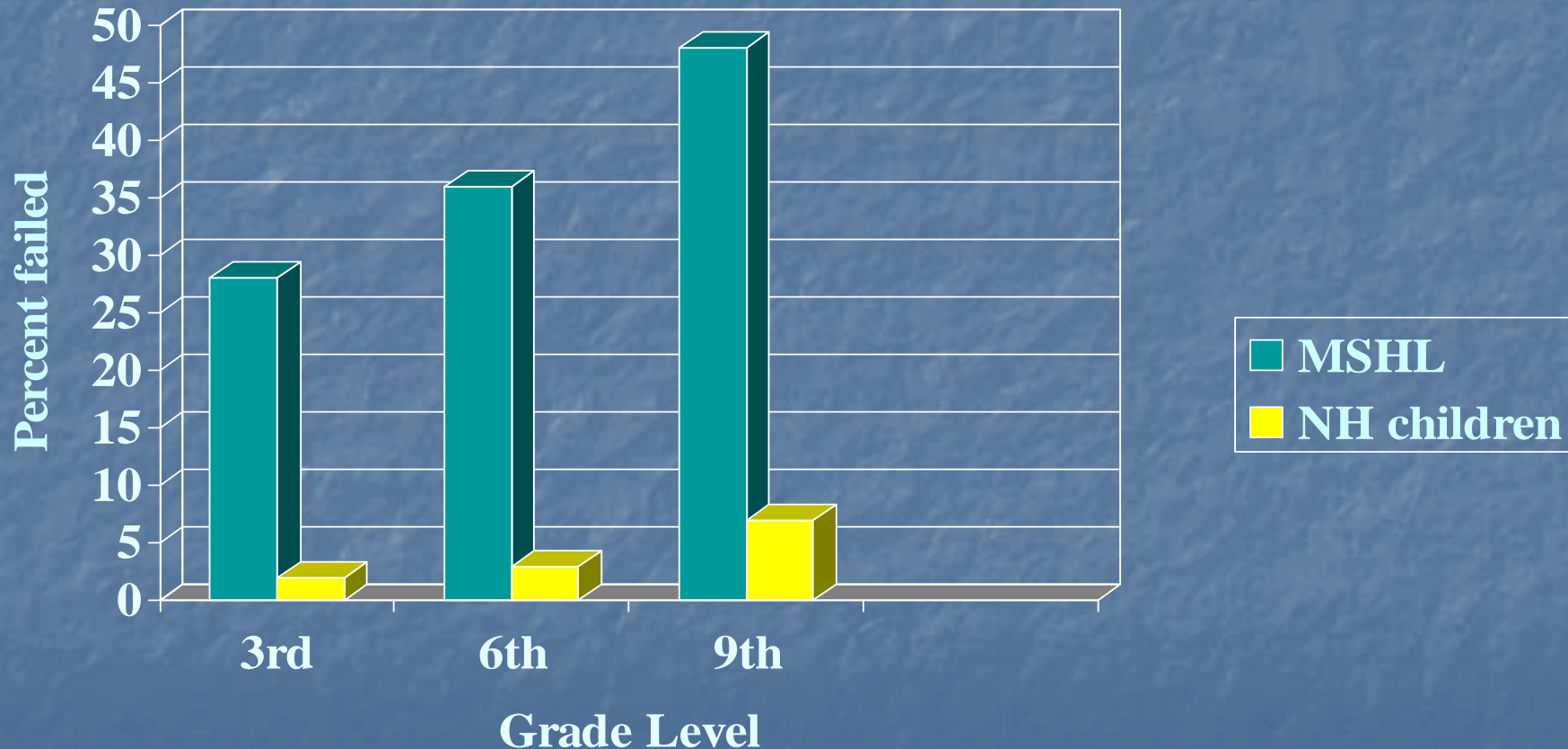
Hearing Loss in School-Age Children (3rd, 6th, & 9th grades; N=1218)

(Bess et al., 1998)

HL Category	N	Percent
BSNHL	12	1.0
HFSNHL	17	1.4
Minimal losses		3.0
CONDHL	41	3.4
OTHER	30	2.5
TOTAL	139	11.3

Minimal losses = 8.8 % !!!

Failure Rates of Children with MSHL & with NH (Bess et al., 1998)



EDUCATIONAL STATUS OF CHILDREN WITH MINIMAL HEARING LOSS (N=66)

- 37% failed at least one grade.
- 8% not judged to perform at grade level.

Educational Performance:

- Comprehensive Test of Basic Skills:
 - In 3rd grade, children with MSHL exhibited significantly lower scores than the control group for reading, language mechanics, word analysis spelling, & science
- SIFTER:
 - Consistently performed more poorly than their normal-hearing peers

Ross et al. (2005)

- NHANES data 1996
- Children 6-16 years of age with minimal or mild or UHL were twice as likely to score 2 SDs below the norm on standardized arithmetic and reading tests

COOP CHARTS

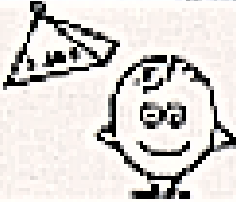

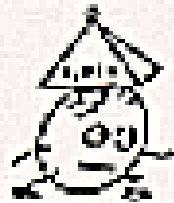

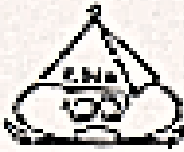
- Screening tool for functional health
- Developed at Dartmouth
- Ten different charts

DOMAINS USED IN COOP CHARTS

- Emotional feelings
- School work
- Social support
- Stress
- Family
- Self esteem
- Behavior
- Energy
- Getting along with others
- Overall Health




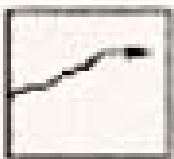






STRESS

During the past month, how much stress or pressure did you feel from other people? (family, friends, teachers, other grown-ups or other kids)

1	None	
2	A little	
3	Some	
4	Quite a bit	
5	A lot	

SCHOOL WORK

During the last month you were in school, how did you do?

I did very well		
I did as well as I could		
I could have done <u>a little</u> better		
I could have done <u>much</u> better		
I did poorly		

COOP Results:

- For 6th graders -
 - scores were higher (more dysfunction) for MSHL group in 9 of 10 domains
 - Significant difference found on energy domain
- For 9th graders –
 - Scores were higher for MSHL group in 9 of 10 domains
 - Significant differences found on stress and behavior domains

Listening Effort

Effort = the exertion of physical or
mental power

Dual-Task Paradigm (Effort)

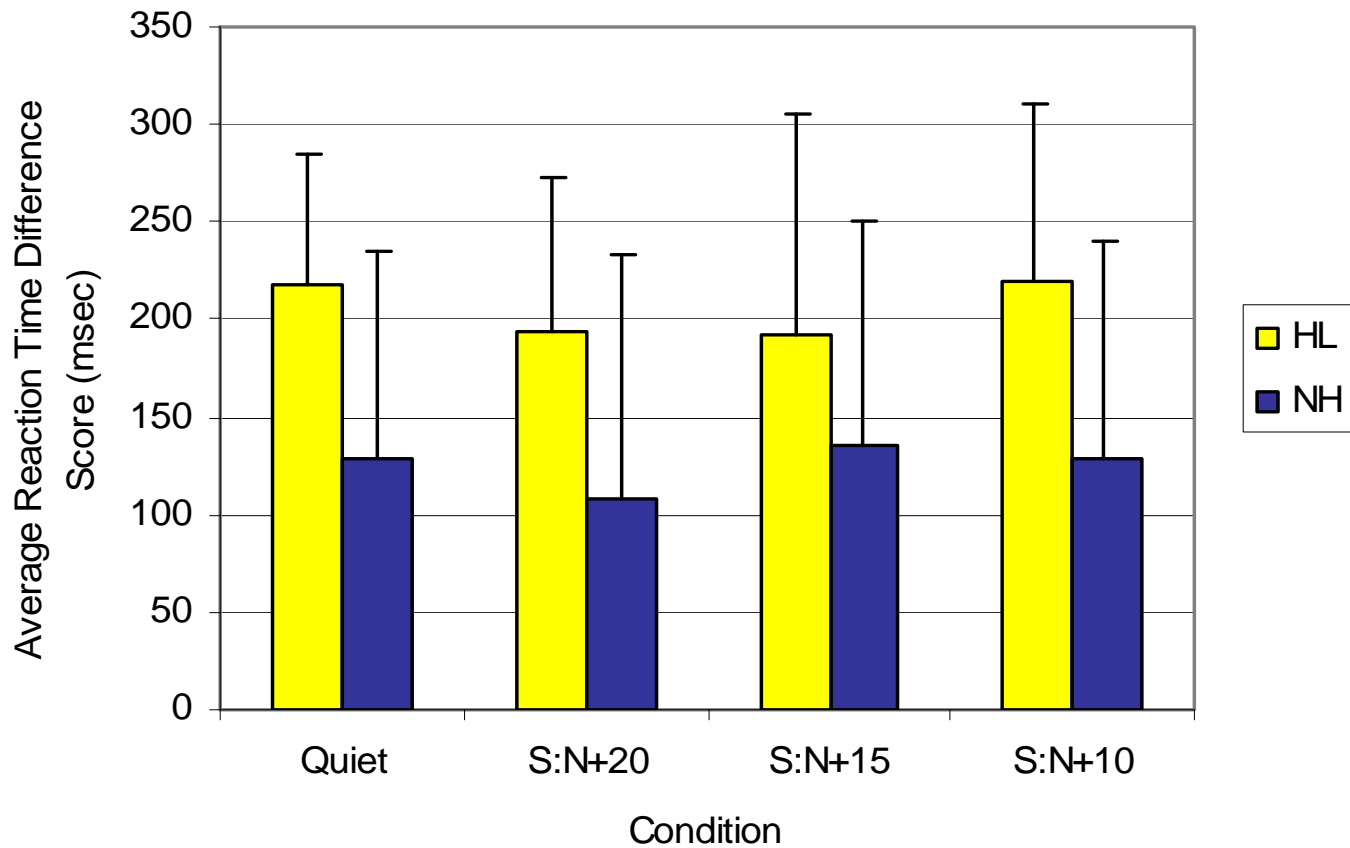
- Subjects
 - 14 children with mild or HF HL matched with NH children for grade level
 - Ages between 6 – 11 years

(Bourland-Hicks & Tharpe, 2002)

Dual-Task Paradigm

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

Dual Task Paradigm



No difference in baseline RTs between groups

Still Unknown...

Will knowledge about underlying etiology shed some light on why some children with minimal and mild losses perform well while others appear to have significant deficits?

Can we change these outcomes?

We Don't Know, But We Can...

- Improve identification practices
- Enhance listening in adverse listening situations

Screening for Unilateral & Mild HL

Judy Gravel, Ph.D.
Center for Childhood
Communication
The Children's Hospital of
Philadelphia

Challenges:

Screening for Mild & Unilateral HL

- Under identification/confirmation of mild and UHL:
 - CDC 2003 (Version E) DSHPSHWA Data
 - Prevalence calculation based on 1,580,536 screenings:
 - Unilateral SNHL ($n=294$) = 0.19/1000
 - Bilateral mild SNHL ($n = 136$) = 0.09/1000

Identifying Minimal/Mild HL in Newborn Period

- Not in target population: U.S. \geq 30-40 dB* HL; U.K./Europe \geq 40 dB HL (JCIH 2000; NHSP 2004)
- Current screening technology does not identify some cases of mild hearing loss (Widen et al. 2000; Cone-Wesson et al. 2000)

Identifying Minimal/Mild HL in through Newborn Period

Cone-Wesson et al. (2000); n = 2995 infants

- VRA confirmed mild PHL (n=22; 30.2% of PHL)
- Outcomes (neonatal ABR and OAE [DPOAE and TEOAE])
 - 10 ears failed both OAE and A-ABR tests,
 - 4 ears passed both OAE and A-ABR tests,
 - 4 passed ABR and failed both OAE measures
 - 2 failed ABR and passed OAE tests.
 - 2 ears that failed ABR passed DPOAE but failed TEOAE.

Incidence of Mild PHL in Infants

Johnson et al. (2005, *Pediatrics*)

- Designed to address question of how many infants who pass 2-step screening protocol (OAE/A-ABR) have hearing loss
 - Multi-center birth cohort (n = 86,634)
 - Enrolled study cohort: failed OAE/passed A-ABR
 - Study Group: 64% (973 infants) returned for VRA (8-9 months)

Degree of PHL (poorer ear) in Study Group & Comparison Group (Johnson et al. 2005)

	Mild (25-40 dB)	Mod (41-70 dB)	Sev/Prof (\geq 71 dB)	Total with PHL
Study Grp	15 (71.4%)	5 (23.8%)	1 (4.8%)	21 (100%)
Comp Grp	31 (19.6%)	64 (40.5%)	63 (39.9%)	158 (100%)
Total	46 (25.7%)	69 (38.5%)	64 (35.8%)	179 (100%)

Examples of PHL in Infants who failed OAE/passed A-ABR

(Johnson et al. 2005)

<u>ID #</u>	.5 kHz	1 kHz	2 kHz	4 kHz
091	20	25	35	35
055	25	25	20	30
053	25	25	30	35
130	25	30	35	45
002	25	25	30	25

Examples of PHL in Infants who fail OAE/pass A-ABR

(Johnson et al. 2005)

ID #	.5 kHz	1 kHz	2 kHz	4 kHz
131	30	35	40	45
005	45	40	40	60
122	40	40	45	40
072	50	40	30	40
003	45	45	60	55

Johnson et al. (*Pediatrics* 2005)

Conclusions:

- Infants with PHL (bilateral or unilateral) who pass 2-step NHS in this birth cohort;
 - 11.7% of PHL missed
 - Adjusted estimate: 22.8% of PHL missed
- Based on Johnson et al. birth cohort:
 - Conservative estimate of mild bilateral/unilateral PHL in infancy = 0.55/1000 (Gravel et al. 2005)

Prevalence of UHL

Lieu 2004

- Majority of cases of moderate to profound congenital/early onset permanent UHL detected by NHS (e.g., Dalzell et al. 2000)
- 0.4% to 3.4% in infants identified by UNHS (Widen et al. 2000; Barsky-Firkser & Sun 1997; Mehl & Thompson 1998);
- 0.1% to 5% in school-aged children
- Prevalence variation: differences in inclusion criteria; include late onset/acquired; HR pop

Niskar et al. (1998)

- NHANES data
- P-T thresholds at 0.5 to 8 kHz in 6166 children
- Ages 6-19 years
- High frequency and low frequency HL
- Prevalence-- ~15%

Challenges:

Screening for Mild & Unilateral HL

- Need for agreed-upon definition of “mild hearing loss/minimal hearing loss/unilateral hearing loss”:
- Impacts:
 - Estimates of prevalence
 - Screening protocol development
 - Consideration of additional screening methods (i.e., genetic) in the newborn period

Challenges:

Screening for Mild & Unilateral HL

- Lack of uniform standards for the calibration of OAE or ABR instrumentation.
- Insufficient manufacturer supporting evidence allowing determination of the validity of the specific pass-fail criteria and/or automated algorithms incorporated in screening instruments

Challenges:

Screening for Mild & Unilateral HL

- Potential variability of screening results within and between technologies, across manufacturers' devices and by earphone type (ABR technologies)
- Current test protocols and pass-refer criterion will likely not identify the majority of infants with mild forms of hearing loss

Challenges:

Screening for Mild & Unilateral HL

- Lower sensitivity and specificity of audiologic diagnostic methods (particularly < 6 months) for delineating normal hearing from mild hearing loss may preclude early confirmation of some infants
- Lack of organized programs beyond the newborn hearing screen to identify children with mild and unilateral forms of hearing loss in early life

Why MHL Missed at School-Age

- Lack of organized screening efforts beyond neonatal period
- Behavioral audiometry screening of infants, toddlers & pre-school children requires trained & experienced personnel
- Little data on efficiency and effectiveness of OAE screening + tympanometry for detection of MHL
- OME prevalence high; refer rate high; follow-up problematic (School age: Bess et al. 1998: 3.5% conductive loss)

Why MHL Missed at Pre-School & School-Age

- Background noise levels during screening not optimal:
 - Change pass-fail criterion
 - Bess et al. 1998: identification of MHL in acoustically-treated test space
- Lack of use of functional measures in screening protocols (caregiver/teacher report; SIFTER; Pre-School SIFTER; ELM; etc.)

Audiological & Medical Management

**Anne Marie Tharpe, Ph.D.
Vanderbilt Bill Wilkerson Center for
Otolaryngology & Communication Sciences
Nashville, Tennessee**

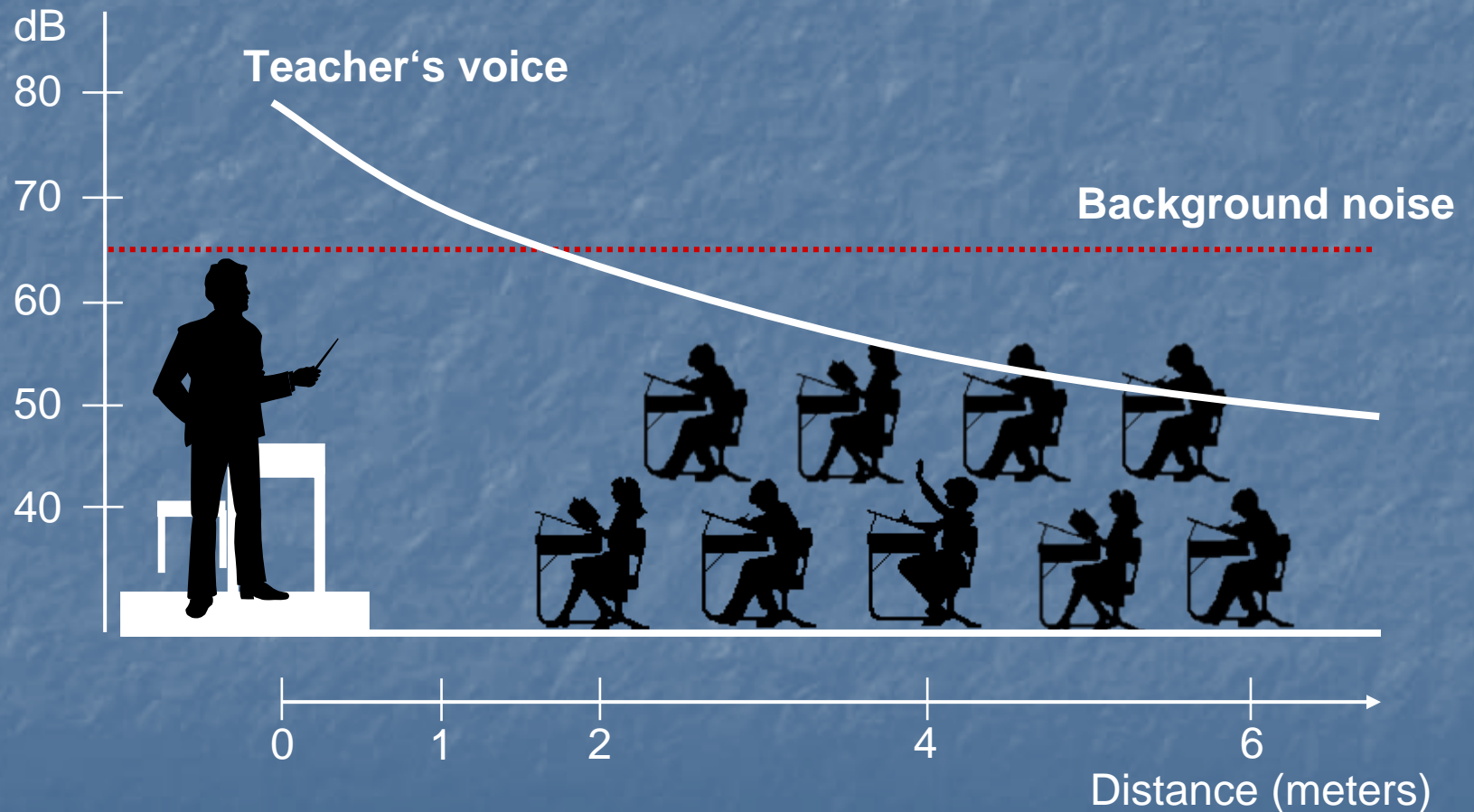
Literature on aid use – Unilateral Loss

- CROS HAs are not recommended for consideration until child is able to control his/her communication environment (AAA, 2003; Kenworthy et al., 1990)
- BAHA can be considered at age 5 years and above; however, data with the pediatric population are lacking (AAA, 2003)
- There is a lack of data to support a strong recommendation for HA use in children with UHL but should be presented as option to families for children with “aidable” ear at time of diagnosis (McKay, 2002)
- Retrospective survey showed benefit from amplification provision (McKay, 2002)
- But ... low compliance in aid use among children with unilateral hearing loss (Kiese-Himmel & Kruse, 2000; Reeve, 2002; McKay, 2002)

Literature on Aid Use – Mild Loss - Contributors to poor compliance?

- Dalzell et al. (2000) found a 5 month delay in fitting aids
- Harrison & Roush (1996) found a 7 month delay
- The older the child, the less likely to wear HAs (Reeve et al., 2005)
- Uncertainty among professionals on whether to aid mild loss
 - Level below which you would not consider providing aids:
 - 25 dBHL (range from 15 - 35dBHL)
 - Level above which you would definitely provide aids:
 - 40 dBHL (range from 25 to 50dbHL)

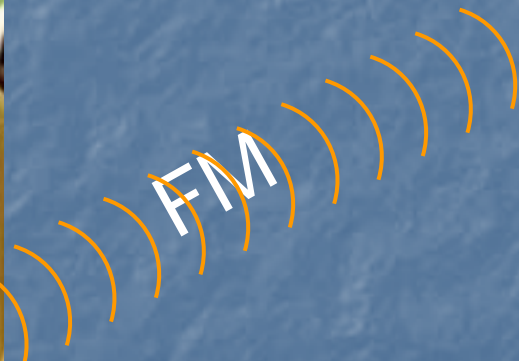
Distance and background noise



A wireless FM system consists of two basic components



receiver



transmitter

Follow up Concerns: Unilateral to Bilateral HL

- Of 159 unilateral refers who were found to have HL, 64% had UHL and 36% had bilateral HL
- Two groups who move from UHL to BHL:
 - Those who had BHL at time of screening
 - Those who had UHL at time of screening but develop BHL later

(Neault, 2005)

Follow up Concerns: Unilateral to Bilateral HL

- Some unilateral losses prove to be progressive
 - Cytomegalovirus (CMV)
 - Enlarged vestibular aqueduct (EVA)
 - Hereditary progressive loss
 - Unknown causes

(Neault, 2005)

CT Scan Findings in UHL:

- Of 18 children with unilateral sensorineural hearing loss (mild to profound) who underwent CT scans of the temporal bone, 8 (45%) had abnormal findings, including:
 - Enlarged vestibular aqueduct
 - Mondini deformity
 - Cochlear hypoplasia
 - Dysplastic vestibule and semicircular canals

The CT scan findings were abnormal
BILATERALLY in 5 of the 8 children

(Licameli, Robson & Kenna, Children's Hospital Boston)

Centers for Disease Control & Prevention Workshop Proceedings (2005)

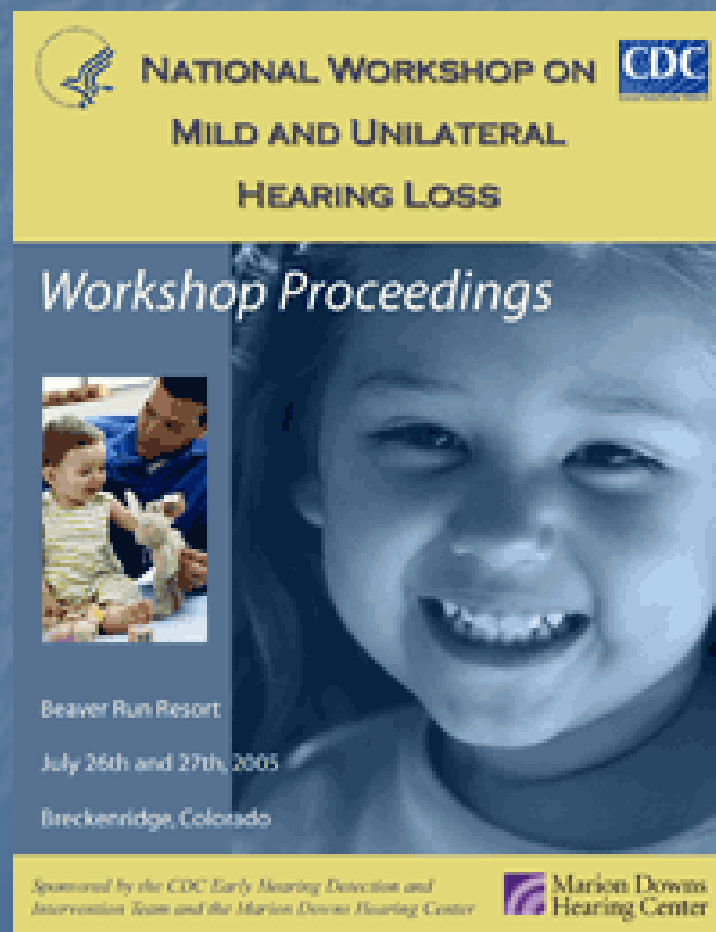
Summarizes



- presentations & breakout group discussions
- future research needs

Online Literature Review

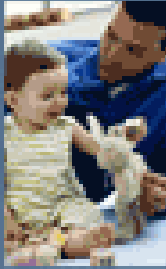
- Includes summary tables (by topic)
- Over 100 articles
- All available on the CDC EHDI website:


www.cdc.gov/ncbddd/ehdi/



 NATIONAL WORKSHOP ON 
MILD AND UNILATERAL
HEARING LOSS

Workshop Proceedings


Beaver Run Resort
July 26th and 27th, 2005
Breckenridge, Colorado

Sponsored by the CDC Early Hearing Detection and Intervention Team and the Marion Downs Hearing Center  Marion Downs Hearing Center