USING SPEECH PERCEPTION TO ACHIEVE BEST OUTCOMES

HEAR INDIANA
10/3/14

Jane R. Madell, PhD,
CCC A/SLP, LSLS Cert AVT
www.JaneMadell.com

LEARNING OBJECTIVES

As a result of this continuing education activity, participants will be able to:

- Determine if children are receiving appropriate benefit from technology
- Determine if technology is working in the classroom
- Assist school staff in understanding how to use technology appropriately in the classroom

COMPONENTS OF SUCCESS

- Language at age level
- Literacy at age level
- Socialization skills at age level

WHAT DOES IT TAKE TO GET THERE?

- Early identification
- Early, **appropriately fit** technology
- Full time use of technology
- The better you hear the better you learn
- Therapy, preferably auditory based, involving family
- Family support
- Language rich environment
- Opportunities to learn
- Educational program willing and able to make the necessary adaptations for maximizing learning

FIRST YOU HAVE TO HEAR WELL

THE BETTER YOU HEAR, THE BETTER YOU LEARN

- Yes, the kids have a hearing loss
- Yes, they are fit with technology
- Are they wearing it? How much?
- BUT IS THE TECHNOLOGY DOING WHAT IT NEEDS TO DO?
  - Never assume
  - If you don't test, you don't know

Hearing

- Hearing is a first-order event for the development of spoken communication and literacy skills.
- Anytime the word "hearing" is used, think "**auditory brain development**"!!
- Acoustic accessibility of *intelligible* speech is essential for brain growth.
- Signal-to-Noise Ratio is the key to hearing intelligible speech.
- ***Our early intervention programs and classrooms must take into consideration the listening capabilities and acoustic access of our children.***

Hart and Risley (1995)

	PARENTS			CHILDREN	
	Professional	Working class	Welfare	Professional	Working class	Welfare
IQ age 3				117	107	79
Vocab size	2,179	1,498	974	1,116,	749	525
Average. Utterances per hour	487	301	176	310	223	168
Average Diff Words per Hour	382	251	167	297	216	149
Average Words per Hour	2,153	1,251	616			
Average Words per 14 hour day	30.142	17,514	8,624			

Hart, B and Risley, T.T (1995) Meaningful Differences in the Everyday Experience of Young American Children, Baltimore: Paul H. Brooks Publishing Co, Inc

Appropriate Technology + Enriched Auditory Exposure = AUDITORY BRAIN DEVELOPMENT

WHAT DOES THE TECHNOLOGY NEED TO BE DOING TO MEET THE NEEDS OF ACOUSTIC ACCESSIBILITY?

- The child needs to hear throughout the frequency range
  - 6000 and 8000 Hz really do matter
  - Missing high frequencies results in missing grammatical markers for pluralization, possessives, and missing non-salient morphemes (eg morphemes that are not stressed during conversation –eg prepositions)
- The child needs to hear at a soft enough level
  - Soft speech is about 30-35 dBHL.
  - If a child cannot hear soft speech, she will not hear
    - Peers in the classroom or on playground
    - Will not "overhear" conversation and will have limited incidental learning
    - Will have reduced language and literacy skills
  - Moeller (2011) reported that in her research 40% if children fit with hearing aids were underfit.

Vowel Frequency Bands

POSITION	VOWEL		1ST FORMANT	2ND FORMANT
Front	Who	u	430	1170
	Would	ʊ	540	1410
	Know	o	760	1250
	More	ɔ	840	1060
Middle	Of	ɑ	1030	1370
	Art	a	1020	1750
	Must	ʌ	850	1590
	Learn	ɝ	580	1740
Back	And	æ	1010	2320
	Then	ɛ	690	2610
	Take	e	610	2680
	His	ɪ	530	2730
	Ease	i	370	3200

Consonant Frequency Bands

p			1500-2000	
b	300-400		2000-2500	
t			2500-3500	
d	300-400		2500-3000	
k			2000-2500	
g	200-300		1500-2500	
m	250-350	1000-1500	2500-3500	
n	250-400	1000-1500	2000-3000	
ŋ	250-350			4500-6000
f				4000-5000
v	300-400			3500-4500
s				5000-6000
z	200-300			4000-5000
ʃ			1500-2000	4500-5500
ʒ	200-300			4000-4500
θ				6000
ð				5000
tʃ			1500-2000	4500-5000
dʒ	200-300		1500-2000	
h			2000-2500	
r	600-800	1000-1500	1800-2400	
l	250-400		2000-3000	

Consonant Frequency Bands

p			1500-2000	
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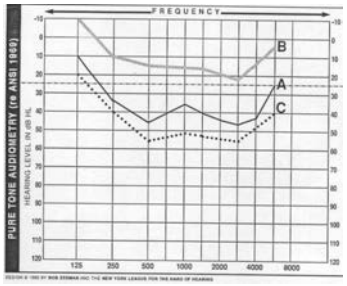
k			2000-2500	
g	200-300		1500-2500	
m	250-350	1000-1500	2500-3500	
n	250-400	1000-1500	2000-3000	
ŋ	250-350			4500-6000
f				4000-5000
v	300-400			3500-4500
s				5000-6000
z	200-300			4000-5000
ʃ			1500-2000	4500-5500
ʒ	200-300			4000-4500
θ				6000
ð				5000
tʃ			1500-2000	4500-5000
dʒ	200-300		1500-2000	
h			2000-2500	
r	600-800	1000-1500	1800-2400	
l	250-400		2000-3000	

SPEECH INTELLIGIBILITY

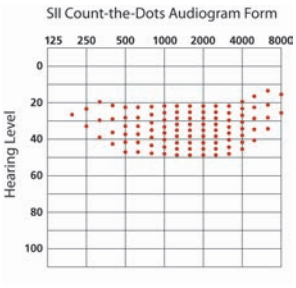
WHAT DOES INTELLIGIBLE SPEECH LOOK LIKE?

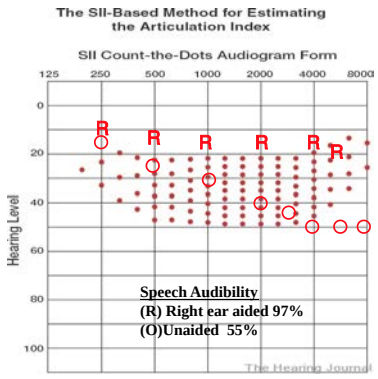
- Every speech sound needs to be audible
- At typical and soft conversational levels
- At distances and up close
  - "Overhearing" is critical

THE AUDIOLOGY FRUIT

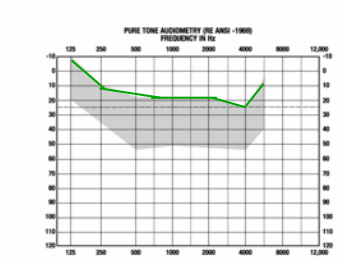


Mueller And Killion - 2010





CAN WE CALL IT THE SPEECH BEAN?



SPEECH PERCEPTION TESTING

SELECTION TEST MATERIALS

What is the goal of the evaluation?

- To obtain the highest possible score?
- To compare child to peers?
- To monitor technology benefit?
- To monitor treatment?
- To identify specific speech perception errors?

FACTORS AFFECTING SPEECH PERCEPTION IN INFANTS

- Degree of hearing loss
- Test stimuli
- Ability to process auditory stimuli

REASONS FOR SPEECH PERCEPTION TESTING

- Determine candidacy for technology
  - Obtaining hearing aids
  - Moving from hearing aids to CI's
  - Changing hearing aid or cochlear implant settings
- Assess performance with technology
- Monitor changes in performance over time
- Identify problems that develop over time
  - Reduction in functioning
  - Equipment problems/failure
  - Specific phoneme perception errors
- Demonstrate habilitation/rehabilitation needs
- Assist in selecting appropriate educational environment and technology

SELECTING TEST MATERIALS

- Linguistically appropriate
  - Not too easy or too hard
- Appropriate level of complexity
  - Sentences
    - Makes use of person's ability to "fill in the blanks"
    - Not necessarily providing accurate measure of what the person hears
    - For current potential patients with more hearing, sentences may not be the appropriate test of choice for determining candidacy for CI
  - Monosyllabic words
    - More accurate measure of auditory perception
  - Phoneme testing or phoneme scoring
    - Most accurate measure of auditory perception
  - Nonsense syllables

TEST LEVELS

- In daily living people need to hear at
  - Normal conversational levels (50 dBHL)
  - Soft conversational levels (30-35 dBHL)
- And in competing noise
  - Normal conversation (50 dBHL+5 SNR)
  - Using realistic noise (4 taker babble)

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SELECTING TESTS

- How do we determine what test to use?
  - Auditory vocabulary level
  - Appropriate cognitive level
    - Lets not use a test with a vocabulary of a 4 year old for a 9 year old who is in the mainstream

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PURPOSE OF SPEECH PERCEPTION TESTING

- Confirm tonal threshold testing
- Assess ability to perceive speech information
- Assess auditory processing
- Assess benefits of amplification
- Plan and monitor (re)habilitation

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Determine child's auditory language age

- If auditory language age is less than 2 years administer ESP
- If auditory language age ≥2 to <5 years administer NU CHIPS
- If auditory language age is ≥4 and <6 years administer WIPI
- If auditory language age is ≥5 and <8 years administer PBK
- If auditory language age ≥8 years, administer CNC, NU 6, Baby Bio's.

From Madell and Flexer
Pediatric Audiology: Diagnosis Management and Technology, 2nd edition,2014

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Speech Perception Test Protocol General Concept

- Administer test at 50 dBHL
- If score < 50% go to easier test
- If score is ≥50 % and < 75 % test at 35 dB and 50 dB+5 SNR
- If score is ≥75 % administer more difficult test at 50 dBHL
- If score on difficult test is < 50 % STOP
- If score on difficult test is ≥50-75 % test at 35 dB and 50 dB +5 SNR

From Madell and Flexer
Pediatric Audiology: Diagnosis Management and Technology, 2nd edition, 2014

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Administer NU CHIPS Standard Format Closed Set at 50 dBHL.

- If test score <50%, go to ESP.
- If test score ≥ 50% and < 75%, administer NU CHIPS at 35 dBHL and at 50 dBHL +5 SNR.
- If test score ≥75%, administer NU CHIPS in *OPEN SET* form at 50 dBHL
- If test score < 50%, STOP.
- If test score 50-75%, administer NU CHIPS at 35 dBHL and at 50 dBHL +5 SNR

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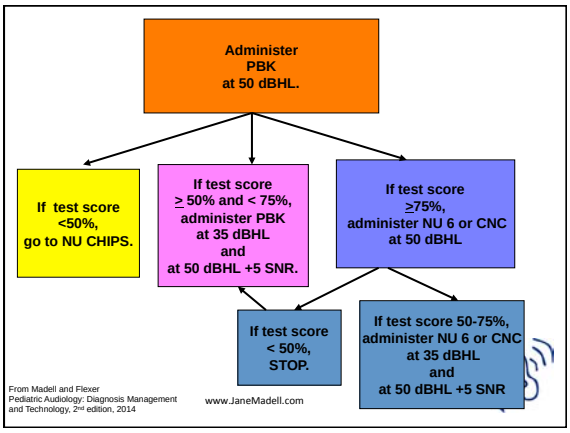

TEST PROTOCOL

To determine OPTIMAL speech perception
- test at a sufficiently loud level

To ASSESS DAILY FUNCTIONING test at
- Normal conversational level (50 dBHL)
- Soft conversational level (35 dBHL)
- Normal conversation in competing noise (50 dBHL +5 SNR)
  - Noise needs to be realistic – eg four talker babble
  - Classroom noise is at +5 SNR
- Testing auditory processing
  Normal and soft conversation at 0 SNR (optional)

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SUGGESTED PROTOCOL

			Male				Female			
Condition	CA	List	N	WR%	SD	95% CI	N	WR%	SD	95% CI
Quiet 50 dB	3-5	NU-C	14	98	3.7	96-100	12	98	3.2	96-100
Quiet 50 dB	6-8	PBK	13	98	3.1	97-100	12	98	3.2	96-100
Quiet 50 dB	9+	W-22	13	99	1.9	98-100	6	96	5.1	92-100
Quiet 35 dB	3-5	NU-C	19	95	5.2	92-97	13	96	4.8	93-98
Quiet 35 dB	6-8	PBK	23	97	3.7	95-98	24	98	3.1	97-99
Quiet 35 dB	9+	W-22	17	98	2.8	97-100	9	96	4.2	93-98
50 @ +5 SNR	3-5	NU-C	28	93	4.6	91-95	16	94	4.1	92-96
50 @ +5 SNR	6-8	PBK	13	94	4.5	92-96	25	95	5.1	93-97
50 @ +5 SNR	9+	W-22	17	97	4.1	95-99	7	93	3.8	90-96
50 @ 0 SNR	3-5	NU-C	23	91	6.9	88-94	17	92	6.5	89-95
50 @ 0 SNR	6-8	PBK	18	91	5.4	89-93	28	93	6.0	90-95
50 @ 0 SNR	9+	W-22	19	95	4.7	93-97	11	93	4.8	91-96
35 @ 0 SNR	3-5	NU-C	23	90	6.1	87-93	16	92	6.0	89-94
35 @ 0 SNR	6-8	PBK	28	91	6.2	88-93	28	90	6.1	87-92
35 @ 0 SNR	9+	W-22	18	91	6.2	88-94	11	90	7.0	86-94

	Mean score
50 dB in quiet	84%
35 dB in quiet	56%
50 dB +5 S/N	58%
50 dB 0 S/N	46%
35 dB 0 S/N	34%

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BY TESTING IN MORE DIFFICULT CONDITIONS

- We can get a more realistic picture of every day performance
- Make better decisions about performance
- Better indication of rehabilitation needs
- Make better educational placement recommendations
- Provide better research
- Raise expectations for patients with HL
- Better determination about who needs to move to a CI

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QUIET VS NOISE CONDITIONS

- Quiet speech at comfortably loud levels provides optimal results
- Quiet speech at normal and soft conversational levels provide more realistic comparison to daily listening situations
- Testing at normal conversational levels with competing noise is most realistic test
  - +10 S/N – relatively easy
  - +5 S/N – most realistic
    - Typical classroom setting

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STIMULUS PRESENTATION

- Monitored live voice
  - Affected by rate and quality of presentation
  - May not provide sufficient test re-test reliability
  - Useful with young children and others who require flexibility when testing
- Recorded speech
  - Better test-retest reliability
  - Difficult to get reliable results with patients who require flexibility when testing
  - Results are usually poorer than with MLV

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OPEN SET VS CLOSED SET

- Closed set measures
  - Limited set of response possibilities
  - Useful for young children with limited vocabulary because they reduce the confounding variable of linguistic knowledge
  - Useful for patients with articulation which is difficult to access
  - May inflate performance or overestimate speech perception skills compared to real life
  - Inappropriate use

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OPEN SET VS CLOSED SET

- Open set measures
  - More challenging test condition
  - Stimulus possibilities are unlimited
  - More representative of what the listener might encounter in everyday situation
  - Very little kids can do this!

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- Why do we need to test more than one condition?
  - Knowing a person hears loud speech well is only part of the information we need.
  - Is it sufficient to hear well in quiet?

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FACTORS TO CONSIDER WHEN ASSESSING OUTCOMES

- Stimulus presentation
  - Monitored voice vs recorded
  - Level of difficulty
  - Phoneme – whole word scoring
- Testing format
  - Open vs closed set
  - Recorded vs monitored live voice
- Presentation level
  - Normal, soft and/or loud conversation
  - In competing noise
- Listening condition
  - Right
  - Left
  - Binaural
  - FM

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OTHER FACTORS WHICH MAY AFFECT SPEECH PERCEPTION

- Degree of hearing loss
- Audiometric contour
- Length of hearing loss
  - Length of profound hearing loss
- Number of hours/day child uses technology
- Ability to process auditory stimuli
- Experience with technology
- Demands on using audition
  - Educational setting
  - Family demands
- Language level
- Primary language
- Etiology of hearing loss
- Appropriateness of
  - Hearing aid settings
  - MAPping strategy, rate, etc.
- Experience of audiology team

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SPEECH PERCEPTION TEST RESULTS

	Right	Left	Binaural	Binaural + FM
WORDS				
50 dB HL Words				
Phonemes				
35 dB HL Words				
Phonemes				
50 dB HL +5 S/N words				
Phonemes				
SENTENCES Quiet 50 dB				
Quiet 35 dB				
Noise 50 dB+5S/N				

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- The more boxes you fill in, the more you will know about functioning
- The more you know about functioning, the better chance you have to improve functioning
  - Improving settings of technology
  - Providing information to the rehab team about what to work on
  - Assisting school in knowing what to expect and planning to maximize functioning

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SPEECH THRESHOLD TESTS
Speech awareness/detection

- Conversational voice
- Music
- 6 sound – a, i, u, sh, s, m (Ling)
- 3 sound – ba, sh, s
  - /ba/ approximately 500 Hz
  - /sh/ approximately 2000 Hz
  - /s/ approximately 4000 -5000 Hz
- VRASPAC (infants)
- VRISD (infants)

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SPEECH THRESHOLD TESTS
Speech Reception threshold

- Standard spondee pictures
- Standard spondee words
- Familiar objects or toys (infants)
- Body parts (infants)
- Numbers

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THRESHOLD TEST STIMULI
BY AGE

- 0-9 months
  - SAT (ba /sh /s)
- 9-12 months
  - SAT (ba /sh /s)
  - SRT for familiar words
    - Body parts, toys etc.
- 12 months and older
  - SAT (ba /sh /s)
  - SRT for familiar words, standard spondees

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SPEECH PERCEPTION TESTS
Closed Set

- Numbers
- Auditory numbers test (ANT) (Erber)
- Body parts/familiar objects
- PINT
- NU-CHIPS (Katz and Elliot)
- WIPI (Ross and Lerman)
- PSI (Jerger and Jerger)
- Speech Pattern Contrasts (Boothroyd)
- Alphabet test (Ross and Randolph)
- CRISP (Litovsky)
- Western Ontario Plurals test

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SPEECH PERCEPTION TESTS
Open set

- NU-CHIPS words without pictures
- WIPI words without pictures
- PBK (Haskins)
- Isophonemic word lists (Boothroyd)
- Lexical Neighborhood Test
- Modified Lexical Neighborhood test
- CNC
- NU 6
- Connected discourse tracking
- Western Ontario Plurals test
- Baby Bio's

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SPEECH PERCEPTION TESTS
CLOSED SET
Younger Toddlers

- Body parts/familiar objects
- ESP (Moog and Geers)
- Potato Head (Robbins)
- Auditory numbers test (ANT) (Erber)
- NU-CHIPS (Katz and Elliot)
- CRISP – Litovsky

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SPEECH PERCEPTION TESTS
Open set
Older Toddlers

- NU-CHIPS words without pictures
- WIPI words without pictures
- Alphabet test (Ross and Randolph)
- Isophonemic word lists (Boothroyd)
- Lexical Neighborhood Test
- Modified Lexical Neighborhood test

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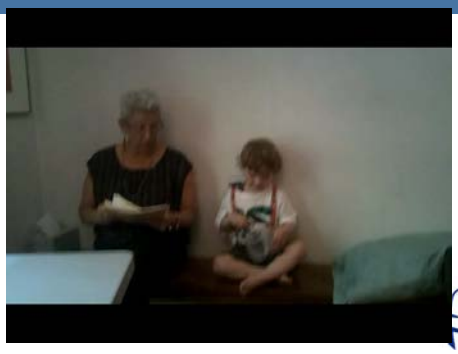

TESTS FOR PROFOUND HEARING LOSS

- Auditory numbers test (ANT)
- Monosyllabic Spondee Trochee
- Early Speech Perception Testing
- Potato Head Task
- Alphabet test
- Minimal Auditory Capabilities Test
- Test of Auditory Competencies
- Speech Patterns Contrast Test (SPAC)
- Hint and Hint-C (Hearing in Noise Test)
- Western Ontario Plurals Test
- Baby bio's

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Speech Test Protocols by Age

	0-6 months	6-12 months	12-18 months	18-24 months	24-36 months	3-5 yrs	6-8 yrs	8+ yrs
SAT	X	X	X	X				
SRT			X	X	X	X	X	X
ESP	X	X	X	X				
PINT						X	X	
NU Chips				X	X	X		
WIPI						X	X	
PBK						X	X	
NU 6/ CNC							X	X
HINT							X	X
Baby Bio's							X	X
AZ Bio's			www.JaneMadell.com					X

DESCRIBING AUDITORY PERFORMANCE

- Unaided
- With technology
  - R, L, B, FM
- Speech perception in quiet
  - normal conversational level (50 dB)
  - soft conversational level (35 dB)
- Speech in noise 50 dB HL +5 SNR
- Clued vs unclued materials
- Phoneme vs word vs sentence vs paragraph
- First presentation vs multiple presentations

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SUGGESTED SCORING
Madell et al 2010

- Excellent 90-100%
- Good 80-89%
- Fair 70-79%
- Poor < 70%

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Lets look at some cases

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Mark

- Normal hearing (PTA R 7 dB, L 6 dB)
- Word recognition
  - 50 dB (quiet) 100%
  - 35 dB(quiet) 84%
  - 50 dB +5 S/N 84%
  - 50 dB 0 S/N 64%
  - 35 dB 0 S/N 44%

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Josh

- Mild conductive hearing loss
  - AC right 20 dB left 15 dB
  - BC right 4 dB left 6 dB
- Word recognition
  - 50 dB (quiet) 100%
  - 35 dB(quiet) 84%
  - 50 dB +5 S/N 88%
  - 50 dB 0 S/N 64%
  - 35 dB 0 S/N 56%

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Lizzy 12 years

- PTA Right 65 dB sloping
  Left 65 dB sloping

	Binaural	FM
50 dB	88%	100%
35 dB	56%	92%
50 dB +5SNR	48%	92%

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Avi 4 yrs

- PTA Right 84 dB Left 92 dB

	R	L	B	FM
PBK				
50 dB	96%	84%	100%	100%
35 dB			72%	92%
50 dB+5			80%	92%

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John 9 yrs

- PTA Right 107 dB Left 109 dB

NU-CHIPS standard		60%
NU-CHIPS open set		16%
AB lists	whole words	20%
	vowels	70%
	consonants	40%

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Danny 7 yrs

- PTA Right 84 dB Left 87 dB

	Right HA	Left HA	Bin
PBK	84%	64%	80%

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Miryam 7 yrs

- PTA Right 107 Left 109

PBK

R	L	B	B+FM
64%	76%	60%	76%

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Matthew, 9 yrs
Mainstreamed 3rd grade

- Severe hearing loss
- Bilateral cochlear implants

	Right CI	Left CI	Binaural	FM
PBK 50 dBHL	98%	98%	98%	DNT

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Matthew, 9 yrs
Mainstreamed 3rd grade

- Severe hearing loss
- Bilateral cochlear implants

	Right CI	Left CI	Binaural	FM
PBK 50 dBHL	98%	98%	98%	DNT
CNC 50 dBHL	68%	72%	76%	86%
CNC 35 dBHL			54%	
CNC 50 dB +5SNR			46%	

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SCORING SPEECH PERCEPTION TESTS

- What is good enough?
- Do kids with HA's need to hear as well as typical hearing kids?
- Do kids with CI's need to hear as well as typical hearing kids?
- If they don't, what do we expect educationally?
- WE ARE NOT EXPECTING ENOUGH FROM THE KIDS

Evaluating the Test Scores

- Speech perception scores
  - Normal vs soft vs loud speech
    - If speech perception is good at loud levels the patient has the ability to understand speech using audition.
    - If scores are poorer at normal conversational levels, maybe the signal needs to be louder
    - Soft speech?
- Right vs Left ear
  - Are results comparable?
    - Check that aided thresholds are similar
    - If not, can be improved?
    - Consider working on auditory tasks with the poorer ear alone.
      - Improving the poorer ear will improve binaural functioning

Evaluating Test Scores

- Word scoring vs phoneme scoring
  - Word scoring is a small part of the picture
  - What exactly is the person misperceiving?
    - High frequencies? – which frequencies?
    - Vowels – is technology providing enough lows
    - What is the confusion?
      - Bed/bet
      - Shoe/sue
    - What can be done to change the response of the technology?
- Therapy should work on improving perception of the difficult to hear sounds

SUGGESTED SCORING (again)

• Excellent	90-100%
• Good	80-89%
• Fair	70-79%
• Poor	< 70%

USING TEST INFORMATION

Normal conversation (50 dB)

- If good – can hear at 6 ft in quiet
- If poor – It will be difficult to hear in a classroom
  - Try testing at louder levels
    - If good, it shows you have auditory potential
  - Try changing HA settings or the MAP
  - Try increasing sensitivity
  - Re-test to be sure it is better
  - Auditory therapy to improve skills

USING TEST INFORMATION

- Soft conversation – 35 dB
  - If good – can hear at 10 feet in quiet
  - If poor – it will be difficult to hear other kids in a classroom or social situation
    - Try increasing sensitivity or loudness
    - Try modifying the MAP
    - Must use FM system in many situations
    - Auditory therapy - practice listening to soft speech

UNILATERAL HEARING LOSS

- Speech perception testing in soundfield
  - Speech on side of poor ear
  - Noise on side of better ear
- If scores are poor for soft speech and/or speech in noise
  - Consider FM
  - Consider HA for poorer ear

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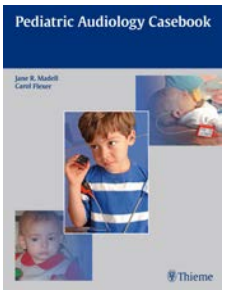
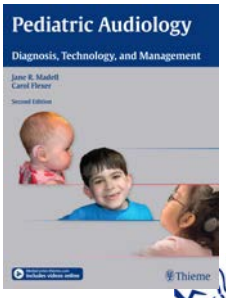
QUESTIONS?



Thieme



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