HOW DO WE KNOW IF TECHNOLOGY DOING WHAT IT NEEDS TO DO?

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LEARNING OBJECTIVES

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

- Determine what type of technology is appropriate
- Determine if children are receiving appropriate benefit from technology
- Determine when new technology is needed
- Determine how to use technology information to optimize management

TECHNOLOGY IS A MEANS TO AN END

- The goal of technology
  - To provide access to sound sufficient to
    - Develop the auditory brain
    - Hear and learn language
    - Build literacy skills
    - Develop social skills

COMPONENTS OF SUCCESS

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

WHAT DOES IT TAKE TO GET THERE?

- The better you hear the better you learn
- Early identification
- Early, **appropriately fit** technology
- Full time use of technology
- 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

GOAL OF ASSISTIVE TECHNOLOGY

- Reduce sensory deprivation
- Provide auditory access sufficient for auditory learning
- Improve auditory access to language
- Maximize use of residual hearing
- Lay foundation for academic learning using audition
- Facilitate information access/extended learning/ incidental learning
- Facilitate socialization
- Safety
- Comfort

AMPLIFICATION ASSUMPTIONS

- Appropriate amplification is the most important habilitative tool available for children with hearing loss
- While appropriate technology is critical, it is not sufficient by itself. Technology should be part of a program including auditory therapy and parent counseling to permit parents to be their babies primary teachers.

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AMPLIFICATION ASSUMPTIONS

- The amplification system of choice is dependent on the child, communication environment, as well as the hearing loss
- Standard hearing aids work well for children with mild to moderately-severe hearing loss when talker and listener are close and it is quiet.
- Cochlear implants work well for children with severe and profound hearing loss.
- If a child is not receiving sufficient auditory access with hearing aids, consider cochlear implants

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AMPLIFICATION ASSUMPTIONS

- An FM system will improve auditory access for every person with impaired auditory function by reducing the negative effects of distance and noise.

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FIRST YOU HAVE TO HEAR WELL

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THE BETTER YOU HEAR, THE BETTER YOU LEARN

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

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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.***

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HOW MUCH PRACTICE IS NEEDED TO INFLUENCE NEURAL STRUCTURE?

- Malcolm Gladwell: 10,000 hours of practice
- Hart and Risley: 46 million words heard by age 4
- Dehaene: 20,000 hours of listening as a basis for reading
- Pittman: Children with hearing loss require three times the exposure to learn new words and concepts due to the reduced acoustic bandwidth caused by the hearing loss

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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

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Appropriate Technology + Enriched Auditory Exposure = AUDITORY BRAIN DEVELOPMENT

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ACOUSTIC ACCESS TO THE BRAIN

- Access is the biggest problem for all degrees of hearing loss.
- Hearing aids, FM systems and cochlear implants are *"brain access"* tools.
- Technology must be programmed to today's possibilities.
- ***Evidence must be obtained***, daily that the technology is functioning appropriately.
- If the child is not progressing as expected – and everyone has very high expectations – suspect the technology first.

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AUDITORY ACCESS

- It is critical that children have good auditory access to facilitate auditory brain development and to enable them to use audition to learn language.
- Good auditory access requires
  - That a child hear all phonemes throughout the frequency range.
  - That the child hear sound at the top of the speech banana
  - That the child hear normal and soft speech
  - That the child hear in noise
  - That the child hear for many hours during the day

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WHY IS AUDIOLOGIC INFORMATION CRITICAL?

- ***Because of advances in technology and new research about brain neuroplasticity***,
  - the landscape of deafness has changed.
  - the audiologist's role has expanded in pediatrics
  - families, audiologists, listening and spoken language specialists, speech-language pathologists and teachers of the deaf need to be sure they are stimulating auditory brain development

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HOW DOES THE AUDITORY BRAIN WORK?

- The auditory cortex is directly involved in speech perception and language processing in humans (Kretzmer ie al, 2004).
- Normal maturation of central auditory pathways is a precondition for the normal development of speech and language skills in children (Sharma et. Al, 2009).
- Important changes have been shown in the higher auditory centers due to hearing loss/deafness.

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KEY POINTS

- 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.

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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.
- Aided thresholds at 0 dB is not the goal
- Aided thresholds at 20 dB is the goal

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TECHNOLOGY NEEDS TO BE DISTORTION FREE

- Kids with HL have more difficulty managing distortion
- Sources of distortion in the technology
  - Does activation from the special features of technology cause distortion?
  - Timing and activation of special features could cause issues
  - Activation of some of these features may reduce audibility of some of the frequency range
- If the child is not making progress, consider
  - Distortion from each piece of technology or between pieces of technology
    - HA and FM
    - CI and FM
    - HA and CI
    - FM input
      - Personal FM and SF

EXTERNAL DISTORTION

- Noise and reverberation
  - What effects do noise and reverberation have on the hearing aid?
  - What does noise do to the technology?

WHAT DO INFANTS AND CHILDREN NEED TO HEAR?

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	

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p			1500-2000	
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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	

If The Child Is Not Progressing As Expected

- Suspect technology first
  - Is the child hearing well enough with the technology?
  - Is the child hearing high frequencies
- Is the child wearing technology consistently?
  - If a child is using technology 4 hrs/day it will take 6 years for the child to hear what a typically hearing child hears in one year.
- Does the family have appropriate expectations?
  - Are they requiring full time use of technology'
  - Are they providing auditory stimulation
  - Do they expect the child to listen and talk
- Do the clinicians working with the child have appropriate auditory expectations?

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TEST PROTOCOLS

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TEST PROTOCOL

To determine OPTIMAL speech perception
- test at a loud level

To ASSESS DAILY FUNCTIONING test at
- Normal conversational level (50 dBHL)
- Soft conversational level (30-35 dBHL)
- Normal conversation in competing noise (+5 SNR)
  - Noise needs to be realistic – eg four talker babble
  - Classroom noise level is +5 SNR
- When testing auditory processing add
  - 50 dB at 0 SNR
  - 35 dB at 0 SNR

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TEST CONDITIONS

- 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.
  - Can he hear sufficiently well in quiet?
  - Can she hear sufficiently well in noise?

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		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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SPEECH IN NOISE NORMS

			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

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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 habilitation needs
- Make better educational placement recommendations
- Raise expectations for patients with HL
- Better determination about who needs to move to a CI
- Provide better research

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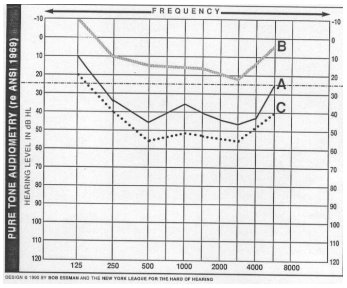
THE AUDIOLOGY FRUIT



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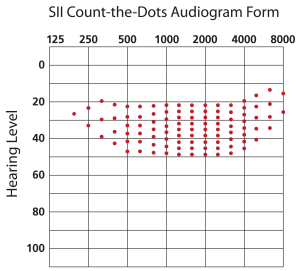
Mueller And Killion - 2010



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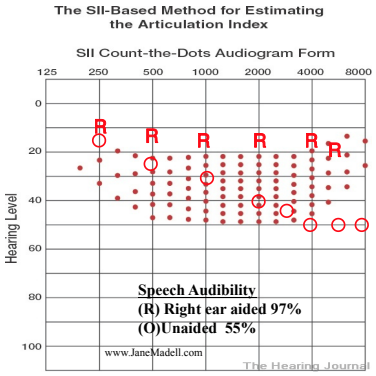

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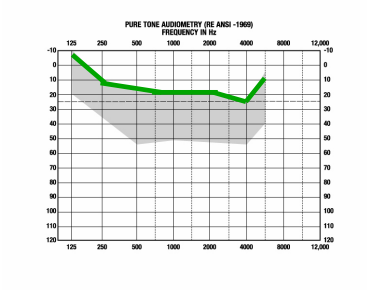
CAN WE CALL IT THE SPEECH BEAN?



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HOW DO WE KNOW THAT THE CHILD'S TECHNOLOGY IS PROVIDING SUFFICIENT ACOUSTIC ACCESSIBILITY?

- Evidence obtained in the sound room
  - Thresholds
  - Speech perception tests
- Evidence of a child's progress in attaining desired outcomes
  - One year progress in one year
- Parental observation of listening and learning at home
- Therapist/teacher observations
- Lena

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DEMONSTRATING AMPLIFICATION BENEFIT

- Electroacoustic measurements
- Real ear measurements
  - Establish targets
  - Test HA in standard way.
  - Test FM microphone
  - Test HA and FM separately and together
- Are we done yet?
- What does real ear tell you about what the child hears?

WHY TEST FUNCTIONAL GAIN?

- Electroacoustic testing does not provide information about how a child hears.
- Is the child aware of sound?
- Does the child attend to sound?
  - At what levels?
- Does the child use the information?
- Is it clear? Distorted?

HOW DO WE KNOW AUDITORY ACCESS IS SUFFICIENT?

- Aided thresholds at 20-25 dB throughout the frequency range
- Speech perception at good to excellent levels
  - At normal conversational levels
  - At soft conversational levels
  - In quiet and in noise.

TEST CONDITIONS WITH TECHNOLOGY

- Aided thresholds – 250-8000 Hz
  - Right, Left
- Speech perception
  - Normal conversation (50 dBHL)
    - Right, left, binaural
  - Soft conversation (35 dBHL)
    - Binaural
    - Right, left if time permits
  - Normal conversation in noise (50 dBHL +5 SNR)
    - Binaural
    - Right, left if time permits

AIDED TEST RESULTS

	RIGHT TECHNOLOGY	LEFT TECHNOLOGY	BINAURAL TECHNOLOGY
AIDED THRESHOLDS 250-8000 HZ	✔	✔	
SPEECH PERCEPTION 50 dBHL	✔	✔	✔
35 dBHL	✔	✔	✔
50 dBHL + 5 SNR	✔	✔	✔

Essential ✔
If time permits ✔

IS AUDITORY ACCESS SUFFICIENT?

- Technology thresholds – 20-25 dBHL
  - If not sufficient,
    - Reprogram or change technology
    - Acoustically-tuned earmolds
    - Remote microphone is not a substitute for well programmed primary technology
  - YES, YOU CAN PERFORM AIDED THRESHOLD TESTING
    - Present from below expected threshold
    - Short presentation will not turn on compression

WHAT CAN PARENTS DO?

- Teach parents how to identify how well the baby is hearing.
- Stimulate child at ear level with each of the Ling sounds
  - Put hearing aids on in morning
  - Turn them on,
  - Stimulate with one Ling sound
    - *Ah, ah, ah*
  - Observe child to see response
  - Each day choose a different sound
  - Report back to the audiologist which sounds the child can hear
- If child hears */a/, /u/ /i/* but not */sh/ or /s/* what do we do?
- Listen to therapists if they say there is a problem
- Audiologist should adjust hearing aid settings based on what the child is and is not hearing.

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IS SPEECH PERCETION SUFFICIENT?

- What is good enough?
- The goal is 90-100% in all conditions
  - At least at normal conversation
  - Good (80-89%) for soft speech and speech in noise

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SUGGESTED SCORING - SPEECH PERCEPTION
Madell et al 2010

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

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IF SPEECH PERCEPTION IS NOT GOOD

- Are aided thresholds sufficiently soft in each ear?
- Is child using the technology full time?
- Is the child receiving auditory based language stimulation
- Review therapy
- Help parents improve language stimulation skills

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MAKING TECHNOLOGY DECISIONS

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WHO NEEDS TECHNOLOGY?

- Any child who has poorer than 15 dB thresholds in either ear
- Any child with insufficient auditory access
  - Less than excellent speech perception (90-100%)
    - At normal conversation
    - At soft conversation
    - In competing noise

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WHO NEEDS TECHNOLOGY?

- Mild to profound hearing loss
  - Mild hearing loss?
    - Immediately?
    - After 6 months?
    - When mobile?
    - Does it depend on the auditory environment?
- Unilateral hearing loss
- Auditory neuropathy spectrum disorder
- Poor speech perception

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WHEN IS TECHNOLOGY NEEDED?

- Difficult listening situations
  - School
  - Car
  - Dinner table
- When sick or tired
- When hearing is fluctuating
- Any situation in which listening is critical

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WHEN IS TECHNOLOGY NEEDED?

- *If a child wears hearing aids 4 hours/day it will take 6 years for the child to hear what a child with normal hearing hears in one year.*
- Always?
- Awake hours?
- When being held?
- Is there a difference in need to listen between younger and older infants?
- Between infants and toddlers?
- Toddlers and older kids?
- Tweens, and teens?

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FACTORS TO CONSIDER IN SELECTING TECHNOLOGY

- Age
- Degree of hearing loss
- Auditory environment
- Educational environment
- Special needs
- Family needs

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MONAURAL VS BINAURAL

- Fit MONAURALLY
  - When significant differences between ears
    - **And** poorer ear cannot be made to hear
  - **NO** usable hearing in one ear
    - What is usable?
- BINAURAL advantage
  - Localization
  - Auditory perception
  - Hearing in noise
  - Sensory deprivation

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TECHNIQUES FOR IMPROVING AUDITORY ACCESS

- Frequency modification based on perception errors
- Digital programming
- Increased gain
- Earmold modifications
  - Horned earmolds
- Close microphone
- Multiple memories

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REPAIRING SPEECH PERCEPTION DEFICITS

- Auditory brain access with equipment
- Auditory exposure –
  - Listening age
  - Hrs/day equipment is worn
- Auditory environments
  - Do we need FM at home? Playground?
- Daily auditory enrichment and embellishment
  - Parent focused, guided by the Listening and Spoken Language Specialist (LSLS)

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HEARING AIDS FOR KIDS

- Flexible electroacoustic characteristics
  - Ability to increase output should hearing change
- Childproof battery compartment
- Childproof volume control – inactive
- Retention devices
- FM
- Compression?
- Directional mic?
- Extended warrantee
- Availabilities of loaners

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MEASURING OUTCOME

- Auditory awareness
- Audibility of speech
- Speech intelligibility
- Accuracy of speech production
- Rate of language acquisition
- Loudness discomfort
- Social development

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WHEN SHOULD OUTCOME BE MEASURED?

- Repeat measures
  - How often?
- Longitudinal monitoring
- Separating hearing changes from other factors
- When are adult outcome measures adaptable?

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THE MYTH OF "OVER"-AMPLIFICATION

- Where's the data?
- How much is too much?
- The importance of auditory access
- "Saving hearing" vs learning language
- The protection that hearing loss provides

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**HOW DO YOU KNOW
WHEN IT IS TIME TO MOVE TO A CI?**

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TRANSITIONING FROM HEARING AIDS TO COCHLEAR IMPLANTS

- Evidence to support transitioning from HA's to CI's
  - Is the child receiving acoustic access to all frequencies at a sufficiently soft level to hear normal and soft conversation?
- Evidence that is irrelevant in determining the need for better acoustic accessibility
  - Child likes his hearing aids
  - Concern about cosmetics
  - Child's progress in language and academics
    - Why is this irrelevant?
      - What does it take to sustain progress, not just attain it.
      - Without good acoustic access the child will miss incidental information both inside and outside the classroom and will start to fall behind
      - Sustaining requires ongoing access to incidental knowledge and information in ever increasing complex and nuanced learning situations.
- Can we wait?

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HOW DO YOU KNOW IT'S TIME TO MOVE FROM HA TO CI?

- Insufficient auditory access
  - Not hearing in the "string bean"
  - Not receiving high frequencies
  - FM dependent
  - Slow auditory progress
  - Slow language progress
    - Less than one year's gain in one year
- Critical periods
  - Sharma and Dorman's work

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BABIES

- Time is critical
- Severe is the new profound
- Good auditory access is critical for language learning
  - Limits of hearing only close speech
  - Overhearing
  - Hearing at a distance
  - Hearing in noise
- How young?
  - As soon as you are sure HA's are not sufficient

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DEGREE OF HEARING LOSS

- Severe
- Profound
- Auditory neuropathy spectrum disorder

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AGE

- FDA approval for 12 months
- Younger under special circumstances
  - Many centers in US implanting at 20 lbs (sufficient for reduced anesthesia risk) (6 months)
  - Australia implanting at 3 months
- No upper age limit

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DURATION OF HEARING LOSS

- Not a significant factor if other considerations make the person a candidate
- Ideal
  - Relatively short duration
  - Recent decline to severe-profound

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COMMUNICATION MODE

- Oral communicator
- Goal of developing auditory-oral skills
- Older children who rely on sign language and have not had auditory experience may not demonstrate open set skills.
  - *No part of the brain functions on it's own*

BABIES AND YOUNG KIDS

- Enrolled in an auditory-oral / auditory verbal program
- TC program only if it is really "T"
  - with a significant auditory-verbal/auditory-oral component
- Parents willing to work on auditory development
- Reasonable expectations

EARLY SCHOOL AGE

- Families often consider CI as kids start to struggle
- Sometimes after drop in hearing
- If kids have had good auditory development the transition is simple
- Recommendation – sooner rather than later

TEENS

- Factors affecting results
  - Age of implantation
  - Duration of deafness
  - Mode of communication significant
- Kids with hearing aid experience on the unimplanted ear did better when they got a CI than the kids who did not have a HA on the unimplanted ear

NYU group, 2008

TEENS

- Motivated to improve auditory status
- Willing to attend mapping and therapy
- Enrolled in an educational program which emphasizes auditory development
- Reasonable expectations
- Family support

Importance of Auditory Access for Children

- Most children with hearing loss are educated in the mainstream
- These children are using audition to learn language
- It is essential for them to hear at sufficiently soft levels
  - To receive high frequency phonemes
  - To hear soft speech (35 dB HL)
- Typically children who are "borderline" candidates for a CI are dependent on audition for communication and language learning

Results Summary

	Pre Op Aided	Post Op CI	p value
PTA Aided Better ear	39.5 dB *(27-58 dB)*	25.6dB *(15-40 dB)*	*< 0.001*
HFA aided Better ear	47.5 dB *(27-72 dB)*	23.3 dB *(17-30 dB)*	*< 0.001*
Wd recognition Poorer ear	23% *(0-54%)*	86.5% *(44-100%)*	*<0.001*
Wd recognition Better ear	55% *(16-85%)*		
Best Performance	57% *(24-95%)*	88% *(48-100%)*	*<0.001*

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Study Conclusions

- As a group there was a significant improvement in speech understanding as the result of CI
- Most Ss demonstrated substantially better performance following CI
- The CI provides access to more auditory information which can be expected to result in improved language learning as well as academic performance
- Further research should examine language learning and academic performance
- Centers may want to consider aided high frequency thresholds, and word recognition at softer levels in determining implant candidacy

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Expectations Post Implant Young Children

- Auditory development commensurate with hearing age
- Improved auditory thresholds and speech perception compared to what is possible with amplification
- Will continue to need therapy
- Other disabilities will be a factor in development

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RED FLAGS

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RED FLAGS: Basic Behavioral Observations

- Child not tolerating technology
  - Child resistant to wearing technology
  - Behavior management issues related to technology
- Behavioral observations
  - No response/poor response to sound
  - Hypersensitive to sound
  - Involuntary eye blinks/facial stim when wearing devices
- **IF CHILDREN HEAR WELL WITH THEIR TECHNOLOGY, THEY SHOULD WANT IT ALL DAY, EVERY DAY!!**
- Parents (or other family members, esp. grandparents) are concerned about progress
  - Parents are often hesitant to express concerns
  - If parents are concerned we need to take their concerns seriously
  - Are they realistic?

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RED FLAGS: Ineffective Intervention

- Child and family are enrolled in ineffective intervention if the intervention:
  - Involves the child without involvement of the parents and family
  - Does not monitor technology ***every*** day
  - Does not follow a normal developmental model
  - Does not stress the development of audition as the basis of all speech and language

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Support effective intervention by :

- Monitoring parent education and training:
  - PARENTAL INVOLVEMENT AND EDUCATION ARE CRITICAL!!
  - Auditory based therapy model
  - Parents need to be involved in the therapy sessions and trained in sessions
  - Therapy for 1, 2 or even 3 hours does not replace parental involvement and reinforcement 24/7

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Support effective intervention by:

- Teaching technology monitoring / checking
  - Who is checking it daily?
    - Do parents, clinicians, and teachers have appropriate listening technology (hearing aid stethoscope, CI earbuds, CI listening check)?
    - Do parents know how to use the technology?
    - Do clinicians and teachers know how to use the technology?

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Support effective intervention by:

- Evaluating signs of difficulty noted by clinicians/parents
  - Not responding to high frequency stimuli
  - Poor high frequency responses
  - Distorted vowel production
  - Dropping certain consonants consistently
  - Speech sound deterioration
  - Mishearing
  - Increased "what?"
  - Reporting static
  - Any sudden and/or dramatic change in performance
- All members of the team listen to and respect input of other team members

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Support effective intervention by:

- ***Hearing loss*** limits access to speech and language; thus, the ***hearing loss*** creates the delayed speech and language.
  - Defined auditory component to therapy
  - Auditory skill development in appropriate sequence must be the focus of therapy
  - Auditory abilities are developed through the auditory modality
  - Parental guidance and coaching provided at every session for transfer to all settings

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RED FLAGS: Auditory observations

- Child does not tolerate technology
- Child cannot tolerate specific sounds/ noises
  - Water running (faucet, toilet flushing) dog barking, vacuum
- Skills from hearing aids do not readily transition and become skills with CIs
- Relies on visual input for skills
  - "watches like a hawk"
- Child does not respond to sound or to name
- Responding to less sounds with HAs on than with HAs off
- Responding to less sounds with CIs on than previously with HAs

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RED FLAGS: Speech Production

- Poor voice quality
  - Gravelly
  - Intensity - whispers or too loud or unable to produce whisper
  - Poor control of nasality
  - Poor pitch control
  - Vocalizations on inhale

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RED FLAGS: Speech Production

- Poor syllabification
- Poor vowel recognition
- Vowel development, but no consonant development
- Issues of concern regarding consonant development
  - Inappropriate/unusual consonant development
  - Limited variety of consonants

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RED FLAGS: Language Development

- Lack of development of "conversational" babbling / jargoning
- Babbling / jargoning, but no intelligible vocabulary or language development
- Receptive language development, but no parallel development of expressive abilities
- Expectation: one year's growth in one year

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RED FLAGS: Deterioration of Skills

- Speech discrimination deteriorates
  - No longer demonstrates perception, discrimination or comprehension previously observed
- Speech production deteriorates
  - Unable to produce a phoneme previously mastered or emerging
- Vocabulary and language development plateau or regress

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NEVER ASSUME!!!!

- ALWAYS COLLECT DATA!!!
- Parent, teacher, and clinician data and documented observations are essential to appropriate remediation of the problems.
- We must ***test*** to begin to determine what is affecting progress.

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IF A CHILD HAS APPROPRIATE PARENTAL AND INTERVENTIONAL SUPPORT, THEN RED FLAGS POINT TO TECHNOLOGY ISSUES.

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TECHNOLOGY ISSUES FOR HEARING

- The most important use of our hearing is for speech and language perception.
- Very simply, speech and language perception issues result from one or more of four situations:
  - I did not understand because it was too quiet.
  - I did not understand because it was too loud.
  - I did not understand because it was not clear.
  - I did not understand because I do not have the language development.

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WHAT DOES TECHNOLOGY TELL US ABOUT HEARING?

- Real ear measures and CI mapping do ***NOT*** tell you what the child is hearing!
  - Real ear only tells you what is reaching the eardrum.
  - CI MAPs/NRT only tell how much electrical stimulation is being provided.
  - Real ear and CI MAPs tell you ***nothing*** about what the auditory brain hears!!

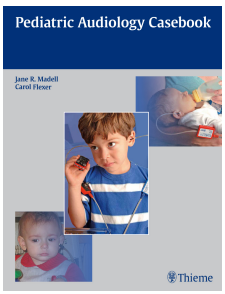
IF HA AND CI PROGRAMS DO NOT TELL US WHAT A CHILD HEARS, THEN WHAT DOES?

- Children provide us with accurate and reliable information about what they hear:
  - When we observe and understand their behaviors
  - When we listen to what they say and how they say it
  - When they complete detailed audiological testing with an experienced pediatric audiologist
  - Parents, interventionists, teachers, family members, and friends are essential to this process

POOR CLARITY

- English has approximately 44 phonemes (not just the Ling 6).
- Assess the majority of consonants.
- Assess vowels as needed.
- Assessing phoneme perception at 3 ft. and 10 ft. can identify specific areas of programming to change.
- Use the frequency allocation charts to identify the specific frequency bands needing change.
- Programming changes can and do lead to ***IMMEDIATE*** speech perception changes.

QUESTIONS?



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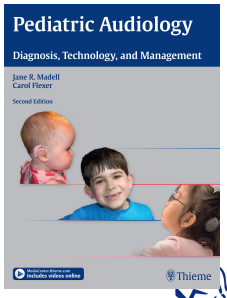

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