

Maximizing Outcomes for Children with Auditory Disorders

PEDIATRIC AUDIOLOGY PROJECT

Jackson Hole Wyoming

and

AudiologyOnline

September 2015

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Auditory Brain Development: Listening for Learning

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Learning Objectives

As a result of this Continuing Education Activity, participants will be able to:

- 1) Describe auditory brain development as the foundation of listening, language and literacy **for all children**
- 2) Explain bottom up and top down processing as influenced by acoustic accessibility
- 3) Define signal-to-noise ratio (SNR) and discuss technologies that are designed to enhance the SNR

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To Begin With: What is 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**” using 1 billion neurons with a quadrillion connections!
- Acoustic accessibility of *intelligible* speech is essential for brain growth – children speak what and how they hear.
- **There are no “earlids” – the brain is available for auditory information 24/7.**
- Signal-to-Noise Ratio (SNR) is the key to hearing intelligible speech (spoken information) – speech must be 10 times louder than background sounds. SLM APP
- ***Our early intervention programs and classrooms must take into consideration the listening capabilities and acoustic access of ALL of our children.***

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So, What is Hearing Loss? Think about Hearing Loss as a “Doorway” Problem

- The ear is the “doorway to the brain” for sound.
- Hearing loss obstructs that doorway, preventing sound/information from reaching the brain.
- Hearing aids, cochlear implants, FM systems break through the doorway to allow access, stimulation and development of auditory neural pathways with auditory/linguistic information.



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The purpose of technologies (e.g. hearing aids, cochlear implants, FM systems) is to get sound/information through the doorway to the brain. There is no other purpose!

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What is Sound? (Boothroyd, 2014)

- Sound is an “event”.
- For example, you don’t “hear” Mommy. You hear Mommy in action, such as walking, talking, singing, dancing.
- An event creates vibrations.
- Vibrations are picked up by the “ear doorway” and are sent to the brain as energy for coding, and for perception as information.

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What About Hearing vs Listening?

- **Hearing** is acoustic access of information to the brain; it includes improving the signal-to-noise ratio by managing the environment and utilizing hearing technology.
- **Listening** is attending to acoustic events with intentionality – activating the pre-frontal cortex.
- “Hearing” must be made available before “listening” can be taught.
- We must know about the “hearing thing” before we can do the “listening thing”.

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Neurological Issues: Listening

- We hear with the brain -- the ears are just a way in! What's the big deal? **(no "earlids")**
- Human beings are rich in auditory brain tissue – *But children can't listen like adults!*
- **Why?** 1) the higher auditory brain centers are not fully developed until a child is about 15 years old, 2) and children cannot perform automatic auditory cognitive closure like adults.
- Therefore, **all** children need a quieter environment and a louder signal than adults.

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Extrinsic vs Intrinsic Redundancy: A Key Concept (James Jerger)

- Extrinsic redundancy refers to the integrity of information from outside the person....."bottom-up" sensory input.
- Intrinsic redundancy refers to the cognitive capacity -- the internal knowledge and attentional resources of the person....."top-down" processing.
- There is an inverse relationship between these two concepts that must be considered for each child.
- Specifically, children do not have the top-down capabilities available to adults.

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Improve Intelligibility of our Spoken Communication to Enhance “Bottom-Up” Sensory Input

- Most adults, including teachers and parents, speak faster than most children (and many aging persons) can process (often faster than 200 words per minute – way too fast!).
- Use “clear speech”slow down (aim for 124 words per minute)....pause...use appropriate suprasegmentals to enhance meaning.
- The talker’s use of “clear speech” can improve the listeners speech discrimination by up to 40%.
- Use technology to improve the SNR.
- These are critical ways to enhance extrinsic redundancy.

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Top Down Capacity (information in the brain) is Necessary For:

- Auditory/Cognitive Closure – filling in the gaps of missed information – taking a guess – “What do you think I said”, or “What did you hear me say?”
- Casual Listening – paying attention even if the person is not looking at you, and you are engaged in other activities
- Repair of Conversational Breakdowns -- by noting what information was not heard
 - “Not understanding” and “misunderstanding” are not the same thing.

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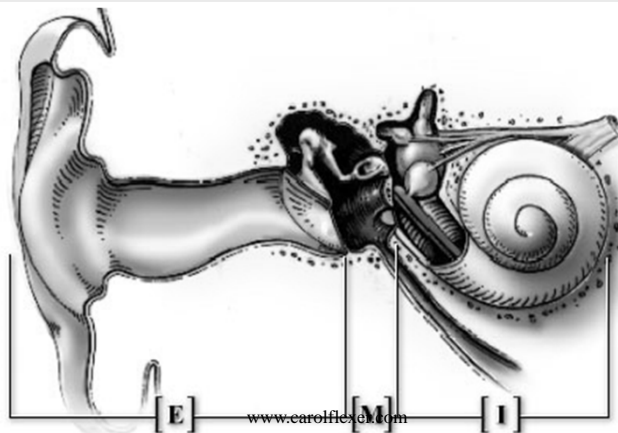
THE EAR

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**First display a picture of the “Brain Ear”,
and then the more traditional picture of the
ear, showing:**

Outer (external), Middle and Inner Ear



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Mainstream Classrooms Are Auditory-Verbal Environments

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“Listening” is the cornerstone of the educational system.

Children spend up to 70% of their school day listening -- to teachers, peers, instructional media/technology, and to their own speech.

Children are the biggest source of noise in the classroom.

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If a child cannot clearly hear and attend to spoken instruction, the entire premise of the educational system is undermined.

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Teach Acoustic – not Visual -- Similarities of Speech Sounds (Pam Talbot, 2015)

- Creating the child's auditory-feedback loop by building auditory folders in their brain
- Sound alikes: S,f,th m,n,ng b,d,g,j p,t,k,ch
- Knowing how these sounds "look" on the lips, will not help the child "hear" acoustic confusions when others say them, or when the child says them.
- Teach the child to hear rhyming words, e.g. pick, tick, kick, chick.
- Have the child speak/read into his/her FM mic.

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What are the negative effects of poor classroom acoustics – for all children?

- Misunderstanding verbal instruction
- Missing verbal information
- Fatigue

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The Science of Acoustic Accessibility: Signal-to-noise Ratio (SNR)

ALSO CALLED SPEECH-TO-NOISE RATIO

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SNR is the relationship between the primary or desired auditory signal to all other unwanted background sounds.

The more favorable the SNR, the more intelligible the spoken message

Everybody hears better in a quiet environment. Quieting the environment is a universal listening condition!

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Adults with normal hearing require a SNR of approximately *+6 dB* in order for their brain to hear the spoken message as consistently intelligible.

The desired signal needs to be about *twice as loud* as background sounds.

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The following populations require a much more favorable SNR in order for their brain to receive intelligible speech -- these groups need the SNR to be approximately +15 dB to +20dB -- *the desired signal needs to be about 10 times louder than background sounds – they need extrinsic redundancy to facilitate “bottom-up” input!*

- Typical children.
- Children with any type and degree of hearing problem including ear infections and unilateral hearing loss.

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- Children with auditory processing problems.
- Children with learning disabilities.
- Children with attention problems.
- Children with behavior problems.
- Children with developmental disabilities.
- Children with visual disabilities.
- Children whose first language is not the language of the speaker.

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Therefore, children require a better SNR than required by adults because they do not have the same “top-down” processing capabilities that adults have

Unfortunately, a typical classroom has an inconsistent and poor SNR of about +4 dB.

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- A classroom's SNR can vary minute by minute from about +5 dB to worse than -20dB, depending on teacher and pupil positions and background noise.

Two Ways to Manage, Improve, and Control the SNR

- Positioning: Remain, physically, as close as possible to the desired sound source -- ideally within 6 inches.
- **Unfortunately**, physical positioning does not work in a classroom environment where teacher and pupils cannot remain in fixed positions.
- **Think “Strategic Seating” for the child with hearing loss!**

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Technologies That Use A Remote Microphone (a Mic placed near the desired sound source...e.g....the teacher's mouth, or the mouth of a peer)

-
- Personal-worn FM system; provides the best SNR for a child with hearing loss
 - Sound-Field system -- FM or Infrared -- also called “*Classroom Audio Distribution Systems - CADS*” replicate the sound, through loudspeakers, for everyone in the room
 - Spatial hearing – children need to know **where** to listen

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Key Reference from The American Academy of Audiology

- HAT Guidelines – Hearing Assistance Technology
- <http://www.audiology.org/publications-resources/document-library/hearing-assistance-technologies>

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Acoustic Accessibility Requires That Classroom Barriers To Good Listening Must Be Removed.

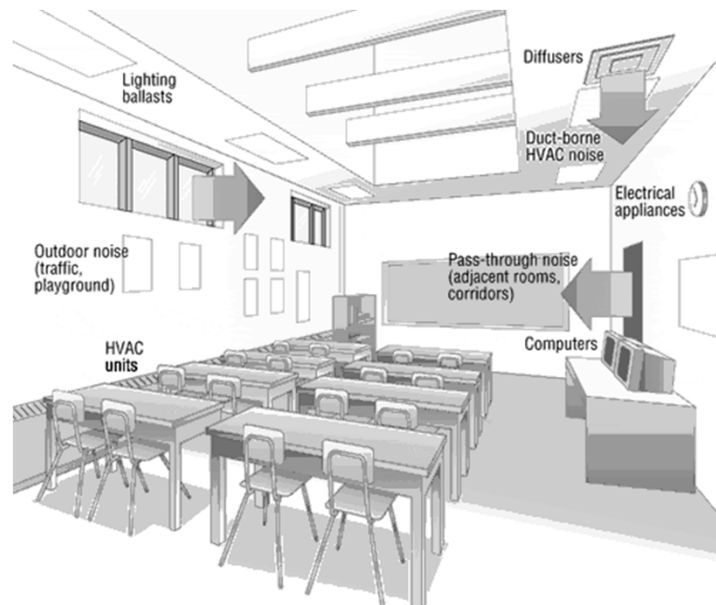
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Barriers -- Physical

- Distracting sound intrusions (horns, airplanes, noisy corridors, band practice)
- Reverberation (speech-masking echoes muddle consonant sounds that define words)
- Background noise (traffic, air conditioning, students) decreases SNR

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Sources of Noise



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Background Noise “Masks” Speech

- Energetic Masking reduces audibility of speech sounds because the speech is partially obscured by the noise.
- Informational Masking occurs when the listener cannot distinguish between two streams of meaningful information.
- Most environments include a combination of both causing the listener to expend more effort to piece together a deficient speech signal to obtain its meaning – called “glimpsing”.

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Picking Speech Out Of Background Noise – Analogy

<http://successforkidswithhearingloss.com/>

I see some beautiful flowers.	+20	
Big dogs can be dangerous.	+15	😊
I like to go to school.	+10	
It is lunch time soon.	+5	
Walk to the library now.	0	
Your brother is not here.	-5	😞

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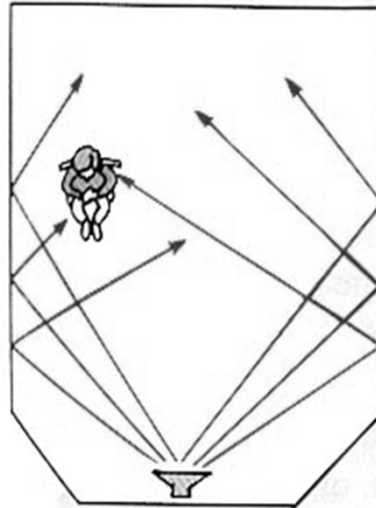
Reverberation

Sounds reflect off of hard wall, ceiling, and floor surfaces when surfaces do not have sufficient absorption ability.

- Excessive reverberation in the classroom is caused by the type of materials used to build the:

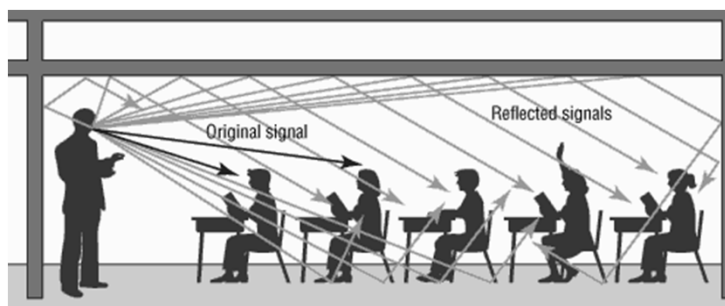
- wall
- ceilings
- floors

- The harder the surfaces, the more likely the sound will bounce off these surfaces resulting in an echo effect that distorts the talker's voice.



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Original/Direct Signals and Reflected Signals



When the talker is distant from the listener, the signal the listener hears may be dominated by reverberation which overwhelms sound energy from the talker. Reverberation causes “overlap” masking.

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Speech Sounds Smear (Overlap) As RT Increases

<http://successforkidswithhearingloss.com/>



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And, What about the Acoustic Environment at home?

- Children with hearing loss are very compromised by noise.
- Turn off noise unnecessary noise sources....TV, computer...unless they are the focus of the conversation.
- When will dishwasher, washing machine, and vacuum noises not interfere with communication?



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Brain, Brain, Brain!!!

The purpose of hearing aids, cochlear implants, personal-worn FM, classroom FM and IR systems, and auditory-based intervention is to access, grow and develop auditory brain centers for language and literacy.



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WHAT ARE KIDS HEARING IN THE CLASSROOM?

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Jackson Hole Wyoming

and

AUDIOLOGY ONLINE

9/2015

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Learning Objectives

After this course, you will be able to:

- Explain the critical nature of classroom listening
- Recognize classroom situations that interfere with listening and learning
- Develop recommendations for improving classroom listening

IMPORTANCE OF ASSESSING AUDITORY FUNCTIONING

- Hearing is a complex function
- Not safe to assume a child has normal speech perception
- Child may respond to some sounds and not hear speech normally
- Child can understand speech in quiet and not in noise
- Auditory processing
- Auditory attention
- Sound sensitivities

WHAT KIDS NEED TO HEAR TO SUCCEED

- Infants and young children
 - Lots of language
 - Incidental listening
- In school
 - Teacher
 - Overhear classroom discussion
 - Playground
 - Lunchroom
- Children need to hear
 - Normal and soft conversation in quiet
 - Normal and soft conversation in noise

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HEARING VS LISTENING VS UNDERSTANDING

- Hearing
 - aware of the presence of sound
- Listening
 - actively attending
- Understanding
 - requires appropriate language and knowledge to permit a child to follow discussion

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WHAT IS NORMAL HEARING?

- Hearing levels
 - No poorer than 15 dB throughout the frequency range
- Speech perception
 - Excellent 90-100% in all conditions
 - Good 80-89%
 - Fair 70-79%
 - Poor < 70%
- Hearing in noise
- Good auditory processing
- No middle ear disease

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FACTORS THAT AFFECT AUDITORY LEARNING

- Hearing
- Speech perception
- Access to auditory information
- Amount of auditory deprivation
 - Hearing loss
 - Middle ear disease
- Good and constant language modeling
- Controlling the auditory environment
 - Noise
 - Distance from the talker

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HEARING FOR LANGUAGE LEARNING

- The world is auditory
- Language is learned by listening
- Incidental learning (overhearing) critical for language development
 - 90% of what kids learn they learn by overhearing
- If kids wear hearing aids 4 hours/day it will take them 6 years to hear what typical hearing kids hear in one year.

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HEARING FOR ACADEMIC LEARNING

- Classrooms are noisy environments
- Academic learning relies on hearing
- If auditory functioning is not adequate
 - language learning will be limited
 - classroom learning will be limited
 - socialization will be limited

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BECAUSE HEARING LOSS COMES IN DEGREES

- If a child responds to sound it does not mean that hearing is normal.
 - If a child has a mild or moderate hearing loss, she will hear some things, even without hearing aids.
 - Some children have good hearing in low and mid frequencies. They will hear some things but miss the important information in high frequencies which gives information about pluralization, possession, and other significant grammatical markers.
 - A child may hear well in quiet but not hear well when there is noise.
 - *Any child who has any problems with speech, language, or learning needs a complete hearing evaluation (not a screening).*

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HEARING AIDS AND COCHLEAR IMPLANTS DO NOT MAKE HEARING NORMAL

- Making hearing aids louder does not make everything sound clear. It may add to distortion.
- While hearing aids and cochlear implants significantly improve hearing, kids with hearing loss still have problems hearing.
 - They are listening through a damaged auditory system so the speech may always not be clear.
 - Even the best technology may not make it easy to hear when there is background noise.
 - The more severe the hearing loss, the harder it is to hear in noise and at a distance

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OTHER AUDITORY DISORDERS

- Other children who have problems with classroom listening
 - Auditory processing disorders
 - Auditory attention disorders
 - Sound sensitivities
 - Learning disabilities

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AUDITORY PROBLEMS ASSOCIATED WITH LEARNING

- Inconsistent responses to sound
- Difficulties in response timing
- Short attention span for auditory stimuli
- Easily distracted by auditory stimuli
- Frequent requests for repetition
- Difficulty with phonics
- Difficulty remembering info learned auditorily
- Difficulty with localization

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IS ONE EAR ENOUGH?

- We need two ears
 - To hear in noise
 - To hear at a distance
 - To localize

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WHAT HAPPENS IF THEY DON'T HEAR WELL

- Degradation in
 - Language
 - Literacy
 - Social skills

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MONITORING HEARING

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RATIONALE FOR ENHANSING CLASSROOM LISTENING

- Classroom is an auditory verbal environment
- Children must hear and attend to teacher and other children
- Speech perception is basic to learning
- Classrooms have poor acoustics
- Hearing loss is an acoustic filter

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KIDS WILL NOT TELL YOU WHEN THEY CANNOT HEAR

- Kids may not know when they miss something that is said
- We would like to believe that kids can advocate for themselves
 - Most kids do not want to call attention to themselves and will not likely tell the teacher if they do not understand.
- Teachers need to be alert
 - They need to watch to see if the child is paying attention.
 - If attention wanders, it is likely that he is not following the discussion
 - Hearing what other kids say matters for learning so teachers need to repeat or use a pass mic.

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LISTENING IS EXHAUSTING

- Even when all the technology is working, kids with hearing loss or auditory processing disorders have to work harder to hear.
- Give them listening breaks during the school day so they can recharge
- Watch them during the day to see if they are hearing, attending, and understanding
- Seat them strategically – so they can both hear and see. Give them permission to move around the room if they are having trouble hearing.

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DO KIDS WITH HL OR APD NEED HELP LISTENING AT OTHER TIMES?

- Children with HL or APD will have problems hearing film, video, computers, lunchroom, playground.
- FM system should be used in those situations'
- Captions should be used with all film to give the children another avenue to understand what is being said.

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ASSESSMENTS BY CLINICIANS & TEACHERS

- Daily checks & therapy notes
- Monitor auditory learning
- Spoken language comprehension
- Phonological awareness
- Receptive language sampling and analysis
- Profiling spoken language comprehension & processing

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WHO IS MONITORING PERFORMANCE?

- Someone must be assigned to monitor hearing
 - Classroom teacher
 - Special Education office?
 - TOD?
 - SLP?
 - Educational audiologist?
- Parents?
- What is the role of the educational audiologist?

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DAILY LISTENING CHECK - SCHOOL

- Have child stand 6 feet away with back turned from the tester
- Stimuli
 - Ling sounds (ah, ee, oo, sh, s, m)
 - Familiar words
 - Sentences
 - Questions
- Quiet and Noise
- Test material needs to be unpredictable
- Keep note of results to report to audiologist and therapists
 - Material will be used to modify technology and to plan therapy

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LISTENING CHECK

Name: Eva_____ Date: 8/15/14_____

Technology: _____ Tester: JMadell_____

	3 Feet	6/10 Feet
ah	✓	✓
ee	aa	----
oo	✓	✓
sh	✓	✓
s	✓	----
m	sh	----

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LISTENING IN NOISE

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CLASSROOM ACOUSTICS

- If a classroom had one 40 watt light bulb, would it be considered adequate lighting?
- Appropriate acoustic treatment in a classroom costs 1-5% of the construction budget
- Only 10-30% of classrooms meet ANSI 2002 standards
- National survey – 30% of classrooms judged too noisy by educators.
 - HVAC and reverberation
- Students under 13 yrs of age are most challenged by noise
- Almost always underestimated by teachers because, as adults, they can handle noise

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CLASSROOM ACOUSTICS

- Because teachers talk loudly to speak over noise they are at 20% greater risk than other workers of damaging their voices
 - Average teacher takes 1 sick day/year due to voice problems
- When a teacher raises her voice
 - Vowels louder
 - Consonants stay weak. (You cannot yell /s/ or /f/)
- Strategic seating
 - To hear 100% of speech, teachers voice needs to be 15 dB louder than the noise
- ESOL students listening in a non-native language – effect is same as 25-40 dB HL

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CLASSROOM ACOUSTICS EFFECTS ON LEARNING

- Rate
 - Most evident when learning new material
- Persistence
 - Children educated in noisy classroom tend to give up faster when faced with learning challenges
- Achievement
 - Children in classrooms next to noise (freeways, subways) have a 1 year drop in grade equivalent achievement scores for every 10 dB increase in traffic noise in the classroom
- No habituation
 - Children in noisy classrooms tend to tune out
- Should ALL classrooms have FM systems?

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ACOUSTIC ACCOMMODATIONS

- HVAC
- Strategic seating
- FM
- Insufficient accommodations result in decreases in performance over time

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HOW DO YOU SOLVE THE PROBLEM OF LISTENING WHEN IT IS NOISY?

- FM systems
 - Reduce the effect of distance and noise
- The talker uses a microphone
 - Placement is important
 - Boom mic best
 - Maximum 6 inches from mouth
- The child has a receiver
 - attached to the hearing aid or cochlear implant,
 - an ear level receiver (looks like a HA)
 - loudspeaker sitting on the child's desk
 - Free standing loud speaker(s)

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WHY FM'S HELP

- Improves speech signal for the student
 - Decreases the effect of distance
 - Decreases the effect of noise
 - Decreases reverberation time (echo)
- Decreases the stress of listening all day
 - Child will not be so exhausted
- Improves auditory attention
- Child will only hear what is said into the FM microphone

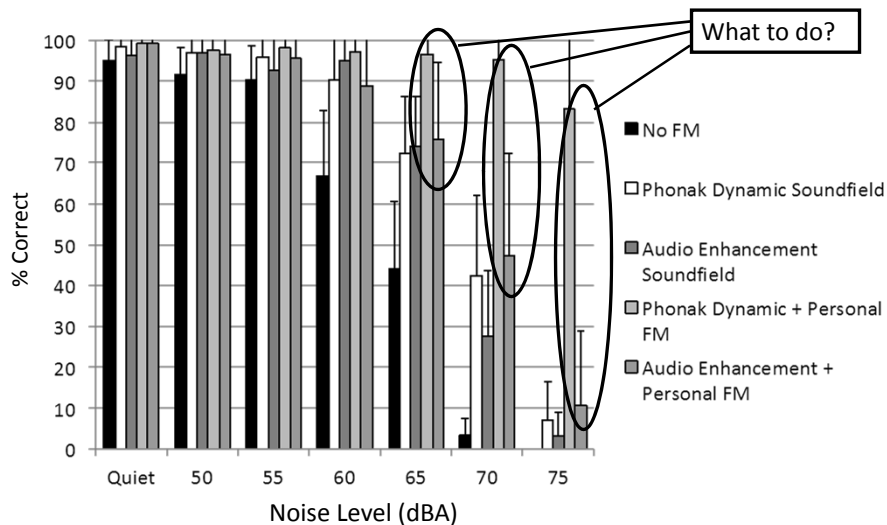
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THE TYPE OF FM IS IMPORTANT

- Soundfield classroom listening systems work well for children with normal hearing
 - They improve listening in the classroom and improve reading and language skills
- Children with hearing loss or auditory processing disorders need personal wearable FM systems to hear well
- Soundfield systems are not acceptable substitutes for children with hearing loss or auditory processing disorders

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Children with Hearing Loss CADS vs. CADS + Personal FM



Jace Wolfe 2012

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PERSONAL FM vs SOUNDFIELD

- Benefit of FM over CI alone

Personal DAI FM	38.0%
Desktop FM	17.1%
Soundfield FM	3.5%

- Results should be similar for children using hearing aids and for children with APD.
- Schafer, E and M Kleineck, 2009. Improvements in Speech Recognition Using Cochlear Implants and Three Types of FM Systems: A Meta-analytic Approach. J. Educ. Audiol, 15; 4-14.

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WILL FM'S LET THE CHILD HEAR OTHER KIDS?

- The FM helps the child hear all the sounds going into the microphone.
- For the child to hear other kids
 - The teacher needs to repeat what is said
 - OR the kids need to use a 2nd microphone, called a pass mic
 - The kids can take turns speaking into the pass mic and then the child with an auditory disorder will hear everything.

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Monitoring FM

- Who will charge the system
- Who will do daily monitoring
 - Who is to be contacted if there is a problem?
- Who sends it out for summer servicing
 - Who checks batteries? (Rechargeable does not mean forever)

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CLASSROOM OBSERVATION

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What To Look For in Classroom Observation

- Is the child following what the teacher says?
- Can he follow directions without assistance?
 - Does he need to peak over neighbor's shoulder?
- Does she volunteer?
 - Are answers appropriate?
 - Are they sufficiently complex?
- Does the child attend to what other student's say?
 - Can he hear them?
- Is the student seated appropriately? Can she move her seat if needed?
- How does the student handle communication breakdowns?
- Does the student appear tired as the day progresses?
- Is the child socializing?

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What To Look For in Classroom Observation

- Is the teacher using the FM mic?
 - Is it appropriately placed no more than 6 inches from her mouth?
 - Does she turn it on and off appropriately?
- Is there a pass mic?
 - Is it used appropriately?
 - Do students wait for the mic to speak?
 - If there us no pass mic does the teacher repeat ALL student comments?
- Is the room quiet?
 - HACV
 - No pencil sharpeners during class
- Does the student need extended test time?

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What To Look For in Classroom Observation

- Where does the student stand academically?
- Are the teacher's goals for the student with HL different than for other children?
- What are the teacher's accommodations for the student with HL?
- Who is conducting the classroom observation?
- How often is classroom observation conducted?

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Using Classroom Observation Information

- Educate the teacher about
 - FM use
 - The need to repeat comments
 - Appropriate expectations
 - What the student is missing
- Observe speech-language services
 - Are they appropriate?
 - Are they focusing on audition?
- TOD services
 - Preview/Review - is it happening?
- Inform Special Education staff about observations

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ASSESSMENTS BY CLINICIANS & TEACHERS

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Indicators that HL May Be Compromising the Student's Performance

- Gives inappropriate answers to simple questions
- Frequently requests repetition
- Poor attention
- Appears isolated from peers
- Is easily fatigued when listening
 - Goes home exhausted at end of school day
- Has low tolerance for frustration
- Has poor reading skills
- Has poor spoken and/or written language.

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CLASSROOM ACCOMMODATIONS



REQUIREMENTS FOR SCHOOL SUCCESS

- For a student with an auditory disorder to learn and master content
 - Needs to understand the teacher
 - Express thoughts and ideas
 - Ask for clarification when information is not clear
 - Interact with classmates

FACTORS THAT IMPACT ACCESS IN THE INTEGRATED CLASSROOM

- Rate and pace of classroom instruction
- Rigor of general education curriculum and expectations
- Ability to learn using incidental listening
- Complexity of language and instruction

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CLASSROOM MODIFICATIONS

- Selecting a classroom
 - Away from playground or busy street
 - Away from bathrooms
 - Enclosed walls (not open classroom)
 - Carpeting
 - Acoustic tiles
 - Stoppers on chairs and tables

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CLASSROOM MODIFICATIONS

- Strategic seating
 - Close to the teacher
 - Away from noise
 - Ability to change seat as the teacher moves

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ACOUSTIC MODIFICATIONS

- Keep doors and windows closed
- Tennis balls or felt tips on chair and table legs
- Area rugs in noisy places
- HCAV systems (heating, ventilation, AC)
- AV equipment, computers, etc

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WHAT DOES SCHOOL STAFF NEED TO KNOW?

- Student's level of competence in listening and conversational skills
- Developmental hierarchy of skills needed to repair communication
- Suggestions for reinforcing these skills in different environments
- Skills for supporting self advocacy

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CLASSROOM MODIFICATIONS

- Teacher style
 - Get child's attention
 - Check that child understands
 - Repeat what other children say
 - Concept of "the Talking Stick"
 - Give "listening breaks"
 - Write assignments on board or in handouts
 - Pre and post teaching

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WHAT TEACHERS CAN DO

- Keep the classroom quiet
 - Only one person talks at a time
 - No pencil sharpening during teaching time
 - Close windows and doors to keep noise down
- Every child with HL or APD would benefit from additional help
 - Pre-view and re-view of academic material
 - Speech, language, listening therapy
 - Ongoing monitoring for all academic areas

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SUGGESTIONS FOR THE TEACHER

- Preferential seating
- Face the student with light on your face
- Speak naturally
 - Don't E-X-A-G-G-E-R-A-T-E
- Provide visual access to information
 - Written assignments
 - Written outlines of information
- Timing is important
 - When pointing to charts, handouts, writing on board pause to allow the student to look at material, then resume speaking



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SUGGESTIONS FOR THE TEACHER CONT.

- Monitor classroom discussion
 - Keep the pace sufficient so children can attend
 - Repeat or rephrase questions and comments
- Provide listening breaks
- Hold the child with hearing loss to the same standard as other children in the class
- Consider assigning a “buddy”
- Use the FM system for all academic work

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TEACHER SUGGESTIONS

- S - State the topic to be discussed
- P - Pace conversation to a moderate speed with occasional pauses for comprehension
- E Enunciate clearly without exaggerated lip movements
- E – Enthusiastically communicate using body language and hand gestures
- CH – Check for comprehension before changing topics

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Teacher Considerations

Using the FM

- Appropriate placement – 6-8 inches from mouth in center (not to side)
- Turn on when talking to the child
 - Off when talking to someone else
- Repeat classroom discussion
 - Consider Pass mic

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- Check with the child
 - Ask a question? (different every day)
 - Develop a system for child reporting problems
- Remember – the problem with a hearing loss is that you do not know what you do not hear.

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ACCESS

- Can the child hear the teacher? Other students?
- Does the child have the vocabulary to understand classroom activities?
- Can child “overhear” sufficiently to benefit from incidental learning.
- Can the child follow other student’s comments?

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IS TECHNOLOGY WORKING?

- More than 50% of technology is not working on any one day.
 - 5 different research articles from preschool through high school
 - Statistic are the same from 1966 to 2011
- Most common problem is dead or weak batteries
- Problems reduced by half if someone in the school checks technology daily.

100

Resources

- Madell & Flexer. (2013). *Pediatric Audiology – Diagnosis, Technology and Management, 2nd edition*. Thieme Medical Publishers.
- Madell & Flexer. (2011). *Pediatric Audiology Casebook*. Thieme Medical Publishers.



THANK YOU



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**An evidence-based approach to managing
auditory processing disorders in children**



PEDIATRIC AUDIOLOGY PROJECT

Jackson Hole Wyoming
and

AudiologyOnline

September 2015

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Goals for this session

- Describe current evidence in cognitive science that supports treatment and management of auditory processing disorders
- List some specific strategies that have an evidence base as being effective in working with children with auditory processing disorders
- Apply current products and tools that have an evidence base as effective in addressing auditory processing deficits in children

Central Auditory Processing Disorders Defined:

A breakdown in auditory abilities resulting in diminished learning (e.g. comprehension) through hearing, even though though peripheral hearing sensitivity is normal

Auditory processing disorders

However, (C)APD may lead to or be associated with difficulties in higher order language, learning, and communication functions. Although (C)APD may coexist with other disorders (e.g., attention deficit hyperactivity disorder [ADHD], language impairment, and learning disability), it is not the result of these other disorders. (ASHA, 2005)

Central auditory processing disorders

- As idiosyncratic as the individuals they affect
- Most do not have origins identifiable at the structural level (rare)
- Brains are individualized and whether APD is developmental or acquired, CANS pathology does not respect functional neurological boundaries

• Phillips, 2002

Role of the auditory system

The auditory system must prepare for the adaptive demands faced by a listener, including processing variations in the speech of individual speakers, grasp auditory information presented in less than optimal listening environments, and comprehending information of varying degrees of linguistic complexity.

To summarize: Must be fast and flexible!!!

Evidence for APD as a disorder?

“...the quality and quantity of scientific evidence is sufficient to support the existence of APD as a diagnostic entity to guide the diagnosis and assessment of the disorder and to inform the development of more customized, deficit focused treatment and management plans”

ASHA, 2005

Evidence

- **Looking at the evidence:**
 - **“The concept of CAPD as a unique diagnostic entity that should be assessed and treated in school-aged children continues to engender controversy.” (DeBonis, 2015)**
 - **Research is “stagnating”? (Cowan, Rosen, and Moore, 2009) or not—Auditory processing research at Acoustical Society Meeting in Indianapolis in 2014**

The management myth

- **There is no such thing as an auditory processing disorder**
- **It can’t be “cured”**
- **We do the same thing for everyone so what’s the point of doing an assessment or developing a management plan**

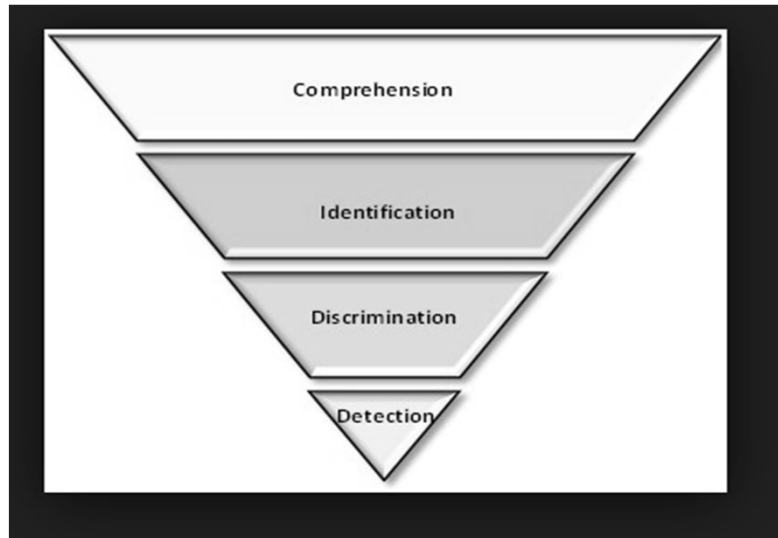
Treatment and management of APD has happened for years...

- It is called aural habilitation/rehabilitation
- Supports the supposition that auditory processing disorders are on the continuum of functional listening disorders that are defined by the term “hearing loss”
 - The children I work with who are more “hard of hearing” than those with “impaired hearing” on an audiogram

Some tenets to address with APD management

- Best evaluated and treated in an interdisciplinary team setting
- APD likely as overlap with other types of disorders
 - Must address functional listening deficits regardless of the etiology
 - Co-morbidity exists for all issues related to hearing
- Can be separate disorder and one that audiologists “own” (one of the comments often made is that APD cannot be assessed clearly...looks like ADHD, however research supports that this is not accurate; Chermak and colleagues)
- Low incidence disorder: Estimates around 3% (2-5% are cited frequently) of the school aged population

Erber's Hierarchy (1992)



Neural Plasticity (“Brain Flexibility”)

- Neural plasticity: alteration of nerve cells to better conform to immediate environmental influences, with this alteration often associated with behavioral changes
- Three types
 - Developmental
 - Compensatory (after lesion)
 - Learning related (Musiek and Berge, 1998)

What we know from auditory plasticity in children

- The central auditory system is “...highly plastic in early childhood” (Cardon, Campbell, and Sharma, 2012)
- First year of life has the greatest promise in plasticity of the cortex is during the first year of life (e.g. success of early intervention)
- Because the cortex is highly plastic, intervention can produce significant positive effects and outcomes
- At least two factors need to be considered: 1) timing of intervention and 2) type of input or stimulus to be used

What we know from auditory plasticity in children

- The positives are obvious but there are some other aspects of development to consider
 - Insufficient stimulation of the auditory system during periods of plasticity can cause abnormalities of the auditory cortex (Sharma in nearly every article)
 - Other questions yet unanswered—without use, does the unused auditory system lose the ability to function normally and mature (Gordon et al, 2011)

What we know from auditory plasticity in children

- Historically, we know that children who lack stimulation of the auditory system due to peripheral hearing loss have hearing loss demonstrate negative cortical changes (Gordon et al, 2011).
- Most audiologists do not assess APD until age 7; often not identified until much older than that
 - Parental concern often much younger
 - Using plasticity evidence to rethink the timeframe of diagnosis in children
 - Need for evidence based testing and treatment that incorporates information about neural plasticity

Auditory development: Foundation for understanding APD

- **Resources**
 - **Gopnik, A., Meltzoff, A.N., & Kuhl, P.K. (2000).** *The Scientist in the Crib: What Early Learning Tells Us About the Mind.* NY: Morrow.
 - **Werner, L.A. and Rubel, E.W. (Eds). (1992).** *Developmental Psychoacoustics.* American Psychological Association.
 - **Werner, L.A, Fay, R.R. & Popper, A.N. (2012) ;** *Human Auditory Development.* NY: Springer

Evidence based auditory training

- Treatment should include the following components: (Smith et al, 2009)
 - Exercises continuously adjust difficulty to user performance to maintain a predetermined percent correct rate
 - Correct trials rewarded: Points, animations, etc.
 - Exercises had stimuli that address the range of auditory/acoustic of interest (e.g. listening in noise, temporal processing, etc.)

Evidence based auditory training

- Treatment should include the following components: (Smith et al, 2009)
 - Training component exaggerates the target for listening
 - Goal is to drive plasticity and increase effectiveness of how the stimuli engage
 - Exaggeration gradually removed to create “real world” listening situation
 - Work consistently on the exercises (daily), which is monitored

Treatment

- **Brain can recognize treatment to better meet auditory processing demands: Posit Science; Lumnosity**
- **Plasticity depends on activity and stimulation...intervention must be initiated in a timely manner**
- **Organized and progressively challenging**
- **Building a better auditory system!**

What doesn't work

- Doing nothing
- Preprinted list of recommendations
- Preferential seating: Please stop recommending this as a “fix” for auditory processing and hearing loss
 - Has no evidence that it changes the acoustic environment for the child (see Leavitt & Flexer, 1991)
 - May have other types of benefits such as logistical access to the teacher and/or visual access

What doesn't work

- Acoustical “modifications” in the classroom
 - The tenet of if it's not measured, it doesn't happen
 - Tennis balls on the bottom of chairs
 - Use of soundfield FM in the classroom
- FM system as a panacea for all

What does work

- Limited evidence and small number of things that have a strong evidence base: This is true in many things associated with communication disorders
- Collect own evidence: Verification and validation
- Use programs that have developed an approach that supports plasticity

Linking assessment to management and treatment

- **Compensatory strategies**
- **Improving the acoustic environment**
- **Direct intervention**

Management issues:

- **Person centered**
- **Context centered**

Key for all aspects of management
and treatment

- **Increase predictability**
- **Increase redundancy**

Customizing a treatment program

- The number of recommendations offered is irrelevant: Want to focus on the ones that are effective!
- Must be linked to deficit areas
 - **Listening in noise**
 - **Dichotic listening**
 - **Spatialized noise**

Individualizing recommendations

- **Myklebust (1954):** addressed the need to provide a differential diagnosis when assessing children with auditory processing issues, in order to address their individual needs

COMPENSATORY STRATEGIES

Building a team

- Support from intervention specialists, speech-language pathologists, teachers of the hearing impaired, etc.: it's all about the team
- Develop understanding of child's strengths and weaknesses
- Encourage child to use visual cues
- Assist child in recognizing "easy" and "difficult" listening situations
- Teacher strategy development

Teacher strategy development

- Teacher strategy development:
 - Impact of rate of speech on comprehension
 - "Clear speech" techniques (Payton, Uchanski, Braid, 1994)
 - Understand signal-to-noise-ratio and facilitate ways to enhance it
- Use of visual and other modality cues

Rephrasing/repeating

- Repetition is good but only if acoustically better presentation than the first presentation (how does one do that...reduce distance, increase the volume, use of clear speech...allows child to be able to fill in missing information)
- Rephrasing: Can be used if information is added that will clarify the original misunderstanding (e.g. vocabulary not familiar to the child)

Auditory fatigue

- Recognize that listening is fatiguing
- Schedule “listening” activities early in the day
- Alternate “listening” activities with those that require less listening
- Provide a quiet place to do work
- Opportunities for physical activity to reduce stress and improve attention
- Current research with focus on listening fatigue and stress in students with hearing loss

Technology tools

- **Speech to text options**
 - **Livescribe pen**
 - <http://www.livescribe.com/en-us/smartpen/>
 - **CPRINT/CC**
 - **Recording lectures**
 - **Guided notes, Powerpoints,etc.**
 - **Who is responsible?**

An evidence based environment

Hearing in noise

- **The ability for CANS development to support processing of complex auditory signals, such listening to speech in a room with a variable noise background, has a complicated developmental progression and extends well into adolescence (Sharma, Kraus, McGee, Nicole, 1997).**

Hearing in noise

- **Johnson (2000) revealed that the more complex the noise listening situation (e.g. addition of reverberation, decrease in linguistic redundancy) of stimulus tasks resulted in a longer developmental trend for speech in noise performance**
- **The typical child in school requires a +6 dB SNR**
- **The “high risk listener” (Johnson, 2000) requires a +12-+20 dB**

Impact of poor acoustics

- **Reduction in speech perception**
- **Reduction in academic achievement**
- **Decrease in attention**
- **Decrease in reading ability**
- **Reduction of “on-task” behavior**
- **Reduction in psychosocial behaviors (Crandall and Smaldino, 2000)**

Evidence: Acoustical standard for classrooms (ANSI)

- Reverberation=less than .4 sec
- Background noise=35 dB or less
- Signal to noise ratio=+10 or greater
- Value of “sound study”
- Value of HVAC consult
- Value of classroom treatment

Know the numbers

- **Easy to make room measurements with sound level apps**
 - **Ostergren and Smaldino (2012)**
- **Don't do something if it doesn't change the measurement**
 - **Tennis balls on chairs**
 - **Preferential seating**

Listening technology options

- **FM/Other assistive technology**
 - **Classroom**
 - **Personal**
- **Hearing aids**

CADS: Technology and APD

- FM is not necessary the primary or only recommendation
- Depends on the type of APD, educational setting, etc.
- Benefits of sound field amplification for ALL has been well documented, much less on addressing personal FM technology for children with APD
 - Soundfield types of systems may not have a significant enough SNR to address individual children with APD
 - Again, need to measure it: BKB-SIN testing as part of assessment AND while trying systems
 - CADS: Classroom Audio Distribution Systems:
<http://www.audiologyonline.com/articles/20q-classroom-acoustics-and-audio-12285>

Considerations with FM technology

- Authentic assessment
 - Specific observations
 - Use of a questionnaire, such as the *Listening Inventory for Education (LIFE-R)* (Anderson, Smaldino, and Spangler, 2011)
 - <http://lifer.successforkidswithhearingloss.com>
 - <http://lifer.successforkidswithhearingloss.com>
- Transparent system—not providing “amplification” per se, but signal-to-noise ratio enhancement only

Personal FM technology

- Superior SNR
- Quality of Sound
- Ease of use
- Fit: Like a hearing aid, corda tubing, domes: Easy to use but someone at school must be comfortable with a hearing aid type of device (e.g. removing wax from the tubing)
- Options on receiver: May keep students using this longer

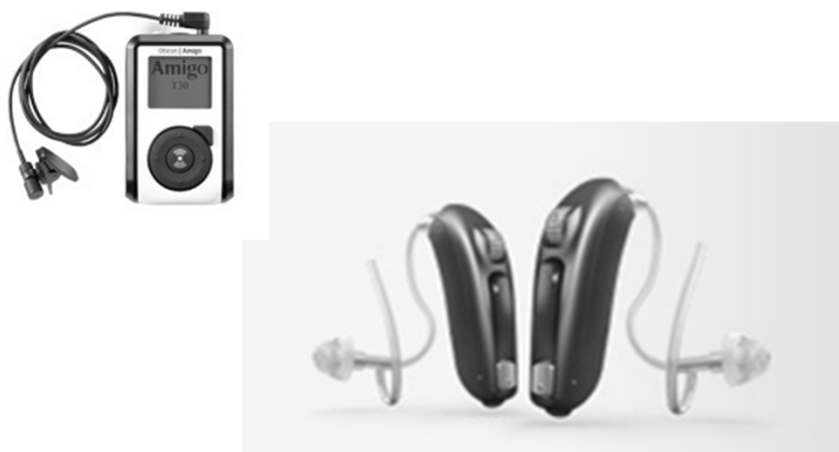
Current options

- Ear level devices specifically designed for those with normal peripheral hearing acuity
 - Phonak Focus (compatible with Roger Pen, Roger inspiro, Clip Mic)
 - Option Amigo Star receiver with T30-31 transmitter

Phonak Focus



Oticon Amigo Star



Hearing aids

- Have used in many teens with incredible success
 - Dodgeball accident
 - Softball patient
- Caution fitting normal hearing acuity
 - Medical clearance: Discuss with physician
 - Real ear measures
 - More “authentic assessment”
 - Data about listening in noise: Set it up in the booth
 - Kuk (2011)

Hearing aids

- FM options are expanded when hearing aids are used
 - Can use FM receiver directly through hearing aid
 - Use streaming device (Oticon Streamer, Widex FM Dex, Phonak ComPilot)

All technology requires training

- Evidence that when people know what they are doing, outcomes are better 😊
- Audiologist should be the one who leads this
- Who provides batteries, domes, etc.

Direct therapeutic approaches

Listening/auditory training

- Recent evidence supports the impact of training on neural plasticity and in turn on functional auditory behaviors.
- Phillips (2003) points out changes in the auditory cortex, representing the neuroplasticity of the system, as a result of behavioral training, have been well documented in animal models.
- Thompson (2000) describes how treatment/therapy enhances the “representational plasticity” of the CANS, resulting in the ability to engage new neural networks post-treatment.

Listening training

- Some of the best evidence for changes in auditory function related to environmental changes and experiences are from both children and adults that have received cochlear implants.
- Improvements in communicative behaviors following implantation appear to be positively influenced by the rate of plastic changes in central auditory pathways (Sharma et al., 2004).

Specifics about this type of auditory training

- **All research, however, points to the need for stimulation or treatment to be :**
 - Varied
 - Challenging
 - and developmentally appropriate in order to capitalize on the experience-dependent neuroplasticity available in the auditory system (e.g. McCall and Plemons ,2001).
- **Significant implications for developing auditory processing skills in young children and to remediate auditory processing disorders in both children and adults**

Specifics about this type of auditory training

- Historically, many of the therapeutic approaches designed to address auditory processing disorders in children, such as completing pre-printed worksheets, have not capitalized on current knowledge of neuromaturation and neuroplasticity.
- May be benefit from this as an informal auditory training to “prime” for the formal auditory training

Specifics about this type of auditory training

- o Clearly, a favorable listening/learning environment may help to address experience-expected types of plasticity
- o Designing auditory training programs which challenge the auditory system and present a varying and progressively difficult task holds great promise in taking advantage of the available plasticity in the CANS

Specifics about this type of auditory training

- o This is the early stages of development of such programs, as is noted with the Fast ForWord program (Tallal, Miller, Bedi, Byma, Wang, Nagarajan, Schreiner, Jenkins, and Merzenich, 1998) and in dichotic listening therapy (Musiek, Shinn, and Hare, 2002), as these programs as a foundation for remediation and auditory training programs
 - o ADAPTIVE—can change with the learning and document this change
 - o Acoustically enhanced
 - o Evidence-based
- o In addition, techniques to measure effectiveness of a given program are needed and will continue to be developed (Jirsa, 2002)

Specifics about this type of auditory training

- o In addition, techniques to measure effectiveness of a given program are needed and will continue to be developed (Jirsa, 2002)
- o Is there a way to measure development/improvement behaviorally or only via electrophysiologic measures?

Formal Auditory training programs: “The beginning”

- Fast ForWord (Tallal and colleagues)
 - Children with specific language impairment/CAPD have difficulty processing brief acoustic events that occur in rapid succession (e.g. running speech) (Sloan, 1998)
 - Adaptive, computer based, CENTER based (time)
- Controversial but established some of the issues that need to be addressed

Formal Auditory training programs: “The beginning”

- Earobics: Earobics.com
 - Addresses range of skills, those noted in ASHA position statement
 - However, product NOW focuses on reading skill development
 - Home and Center based versions

Listening and Communication Enhancement (LACE)

- Listening and Communication Enhancement (LACE) program (developed by Robert Sweetow, Ph.D, distributed by Neurotone <http://www.neurotone.com/>)
 - Initially developed to address listening deficits in adults with peripheral hearing loss
 - Have used effectively with children and teens

LisN and learn

- <http://capd.nal.gov.au/lisn-learn-about.shtml>
- Addresses speech in noise and dichotic listening
- National Acoustics Lab
- Use for students who have deficits with the LisN-S test
- Skills that are addressed: Localization; 3 dimensional listening
- Unique way to both test and address APD: new generation of tests and treatment with strong evidence base

Dichotic listening training

- Dichotic interaural intensity difference training (DIID)—Musiek et al
- Building less dominant ear...promising in ear dominant deficits
- Similar protocol with more data to be commercially available soon from Moncrieff--ARIA

Hear builder

- <http://www.hearbuilder.com/get-hearbuilder/>
 - Phonological Awareness
 - Auditory Memory
 - Sequencing
 - Following directions
- Top down approach
- Functional issues and augment to APD but not likely to address specific auditory processing skills
- Has some of the components of an evidence based listening program

Electrophysiology protocol

BioMARK (formerly known as BioMAP) Biological Marker of Auditory Processing

- Was in Biologic Navigator PRO family of equipment; no longer available
- Developed based on research at Northwestern University
- “...an electrophysiologic response from the brainstem that mimics characteristics of speech with remarkable fidelity.”

BioMARK

- <http://www.communication.northwestern.edu/brainvolts/clinicaltechnologies>
- Additional information regarding temporal processing in this perspective:
Wible B, Nicol T, Kraus N. (2005) Correlation between brainstem and cortical auditory processes in normal and language-impaired children. *Brain* 128: 417 - 423.

Managing/Treating APD

- Empirical question of effectiveness of treatment regimes for APD
 - All learning involves plastic changes in the brain, thus newer training strategies are not unique
 - What may make them “special” is the effectiveness with which they can target an impaired process
 - This link may be as individual as individual listeners
 - Phillips, 2002

Summary

- Significant evidence for plasticity
- How do we create a new future for kids with APD?
- Technology can support the auditory system and enhance auditory development, if we accept that auditory processing is on the same continuum as hearing loss (and a low incidence population)

Summary

- There is evidence that the following work for kids with APD:
 - predictability and redundancy support children with APD
 - technology
 - programs based on development (that use an adaptive approach, train the test, reward, etc.)
- Small number of things on the market but it's growing and we must demand it
 - No longer recommending things that we can measure at the exclusion of things that work (e.g. preferential seating over technology)

Summary

- Thinking outside the box (e.g. the potential benefit of hearing aids) while pushing for new approaches (electrophysiologic measures and programs that support what they measure)
- Growing knowledge of plasticity should allow us to grow in programs that align with weaknesses

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