Auditory Processing Disorders (APD) in School Age Children: Identification, Assessment & Management

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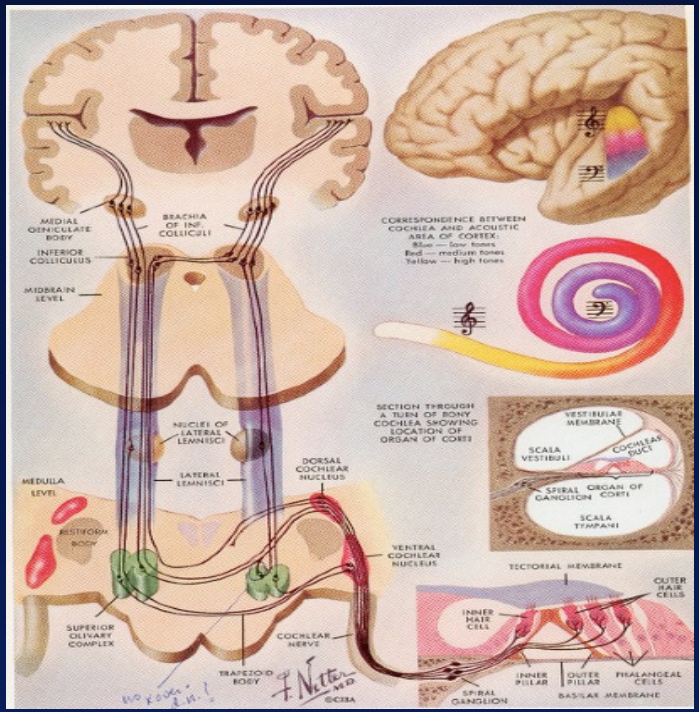
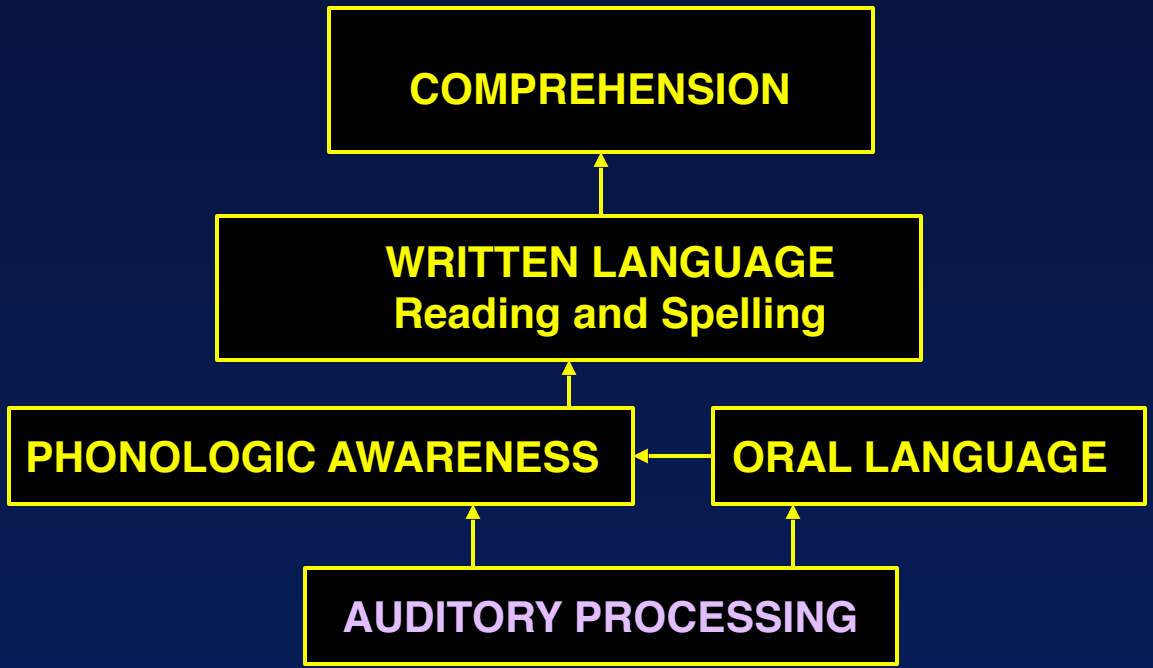
Our Ears are Important …
But We Hear With Our Brain!



Auditory Processing in Children:
Cornerstone of Language and Literacy (Reading)



APD in Children:
A Common and Serious Problem

- Poor school performance
- Reading disorders (dyslexia)
- Psychosocial problems, e.g.,
  - Frustration
  - Anger
  - Behavioral problems
  - Poor self esteem
  - Depression
- Reduced quality of life
- School drop out
- Crime and imprisonment

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- Definition of Auditory Processing Disorders (APD)
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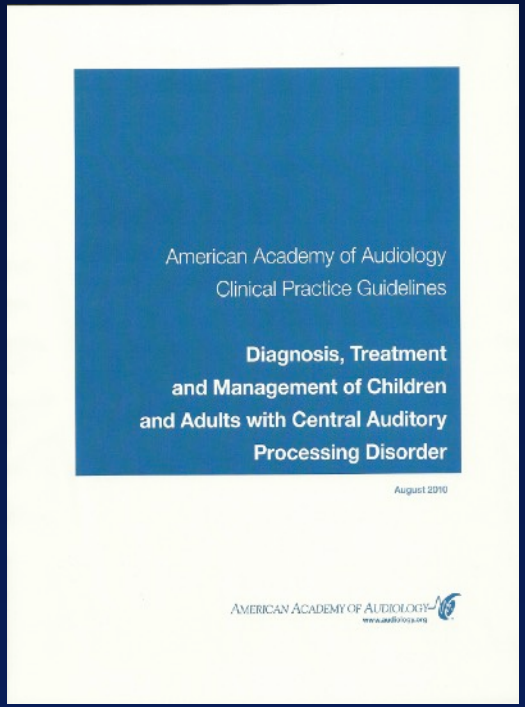
- Evidence-Based Test Battery for Assessment of APD
- Effective Intervention for APD: A Team Approach

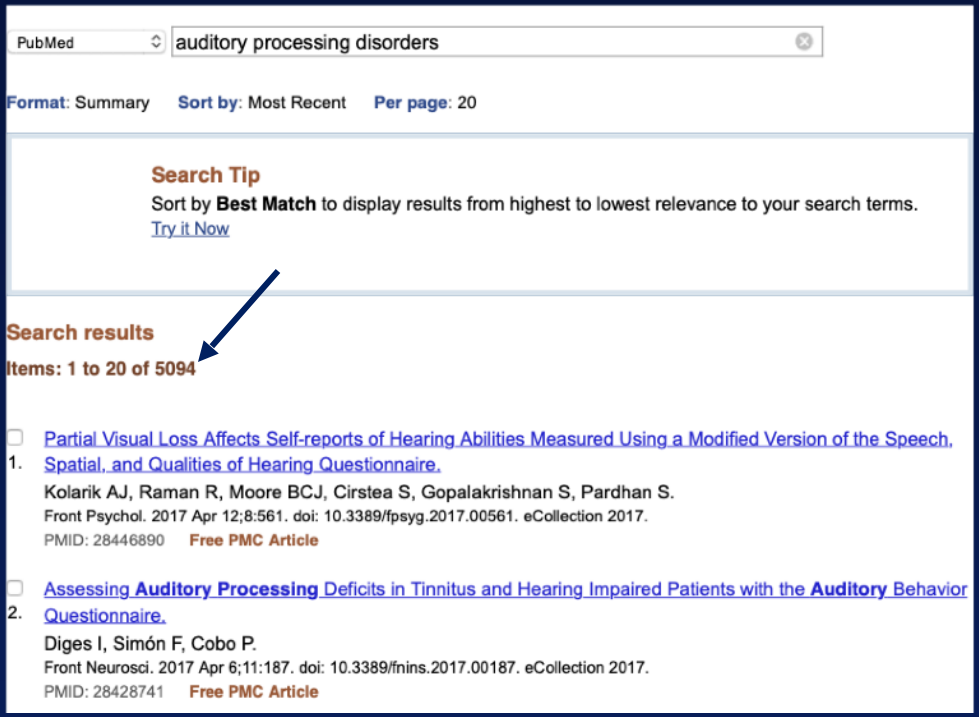
Definitions of Auditory Processing Disorders (APD)

- "APD is broadly defined as a deficit in the processing of information that is specific to the auditory modality."
  (Bruton Conference in Dallas, Jerger & Musiek 2000)
- Auditory processing is "the efficiency and effectiveness by which the CNS utilizes auditory information." *(ASHA, 2005)*
- "(C)APD is seen in a wide array of populations, including children and adults. It can be the result of a number of different etiologies that involve deficits in the function of the central auditory nervous system. Neurological involvement ranging from degenerative diseases to exposure to neurotoxic substances can result in (C)APD"
  (AAA, 2010)

AAA Clinical Guidelines on Auditory Processing Disorders: A Manual for Evidence Based Assessment and Management *(www.audiology.org)*



Auditory Processing Disorders:
A Large and Rapidly Growing Literature
(www.nlm.nih.gov)



Auditory Processing Disorders (APD) in Children:
Evidence in Support of Identification, Diagnosis, and Management

- Clinical research findings for 40+ years
- Evidence-based clinical practice guidelines
- Neurophysiological documentation since 1990s in hundreds of peer-reviewed publications
  - Speech evoked ABR findings
  - Auditory middle latency response
  - Auditory late response
  - P300 response
  - MMN response
- Neuro-imaging evidence (e.g., MRI)
- Within audiology scope of practice
- International clinical practice guidelines

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Auditory Processing Disorders: Differential Diagnosis

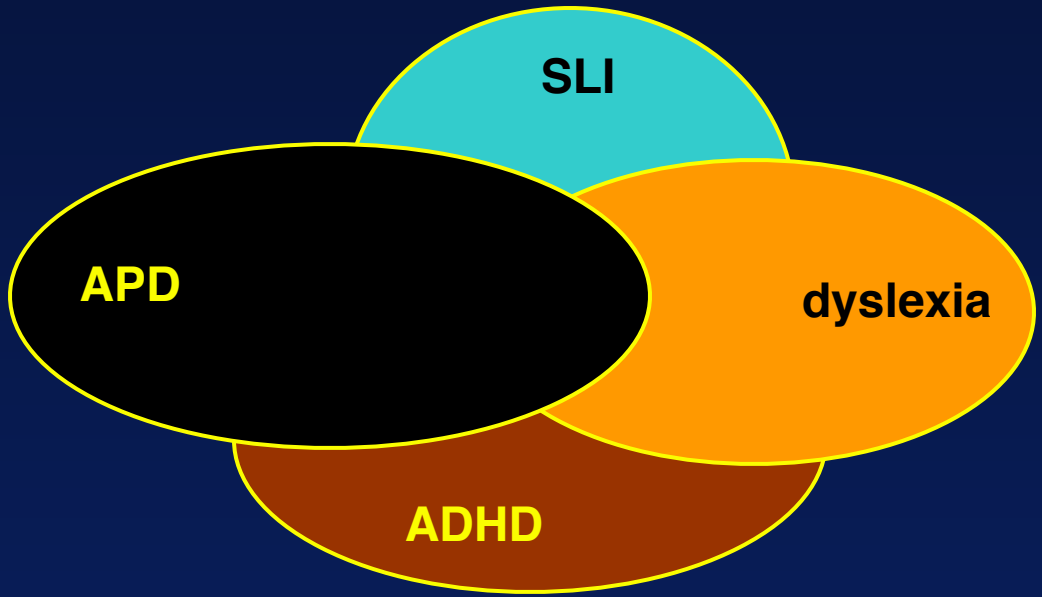
"**Differential Diagnosis:**

Diagnosis based on comparison of symptoms (signs) of two or more similar diseases (disorders) to determine which the patient is suffering from."

AUDITORY PROCESSING DISORDERS: Co-existing Disorders (Co-morbidity)

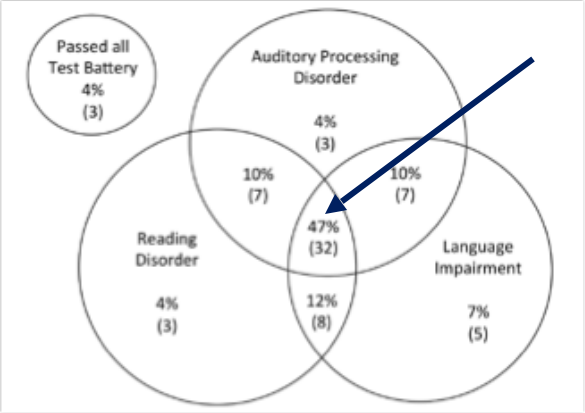
- Peripheral (conductive and sensory) hearing loss
- Specific language impairment (SLI)
- Learning disabilities (LDs)
- Reading disorders (dyslexia)
- Attention deficit/hyperactivity disorder (ADHD)
- Emotional and psychological disorders
- Developmental delay
- Seizure disorders
- PDD, autism, and autism spectrum disorders

AUDITORY PROCESSING DISORDERS (APDs): Co-existing Disorders (Co-morbidity)



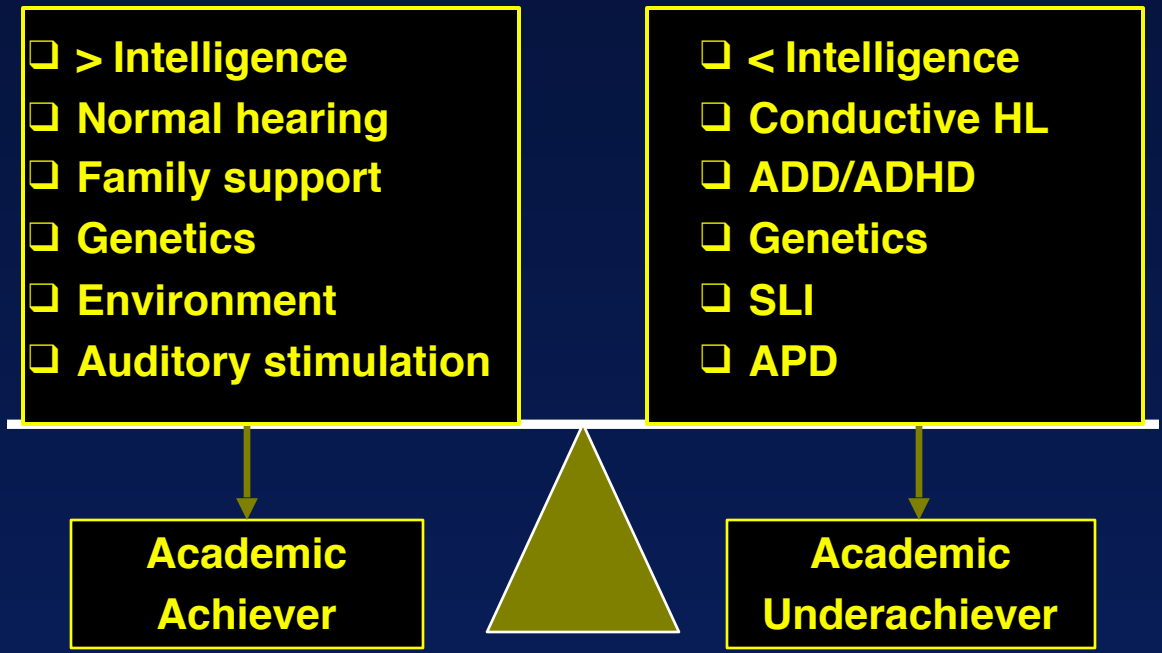
APD in Children: Co-Existing Disorders (Co-Morbidity)

Figure 1. Comorbidity of auditory processing disorder (APD), reading disorder, and/or language impairment.



Note. From "Comorbidity of Auditory Processing, Language, and Reading Disorders," by M. Sharma, S. Purdy, and A. Kelly, 2009, *Journal of Speech, Language, and Hearing Research, 52,* p. 714. Copyright by the American Speech-Language-Hearing Association. Reprinted with permission.

AUDITORY PROCESSING DISORDERS (APDs): Incremental Deficits Model



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Auditory Processing Disorders: Risk Factors in Early School Age Population (e.g., Kindergarten)

- Neurological dysfunction and disorders
  - Neonatal risk factors (e.g., asphyxia, CMV)
  - Head injury
  - Seizure disorders
- Chronic otitis media in preschool years
- Academic underachievement or failure
- Family history of academic underachievement
- Behavior typical of peripheral hearing loss, but normal audiogram
- Scatter in results on psychological and language tests, with weakness in auditory domains
- Verbal IQ score lower than performance IQ score
- May have poor musical skills
- Problems with fine and/or gross motors skills
- Teacher and/or parent concern about hearing and listening abilities (and the audiogram is normal)

Identification of APD in Children: *A Short Reference*

AudiologyOnline

How Young can APD be Identified in Children?

James W. Hall III, PhD

June 23, 2014

Question

How young can auditory processing disorder (APD) be identified in children?

Answer

There's debate about the answer to this question. The 2010 AAA Clinical Guidelines suggest that a young age limit of 7 to 8 years

Identification of APD in Children: *Formal Screening*

J Am Acad Audiol 26:355–369 (2015)

Screening for Auditory Processing Performance in Primary School Children

DOI: 10.3766/jaaa.26.4.4

Mona Mourad*
Mona Hassan†
Manal El-Banna‡
Samir Asal*
Yasmeen Hamza*

Abstract

Background: A deficit in the processing of auditory information may underlie problems in understanding speech in the presence of background noise, degraded speech, and in following spoken instructions. Children with auditory processing disorders are challenged in the classroom because of ambient noise levels and maybe at risk for learning disabilities.

Purpose: 1) Set up and execute screening protocol for auditory processing performance (APP) in primary school children. 2) Construct database for APP in the classroom. 3) Set critical limits for deviant performance. Our hypothesis is that screening for APP in the classroom identifies pupils at risk for auditory processing disorders.

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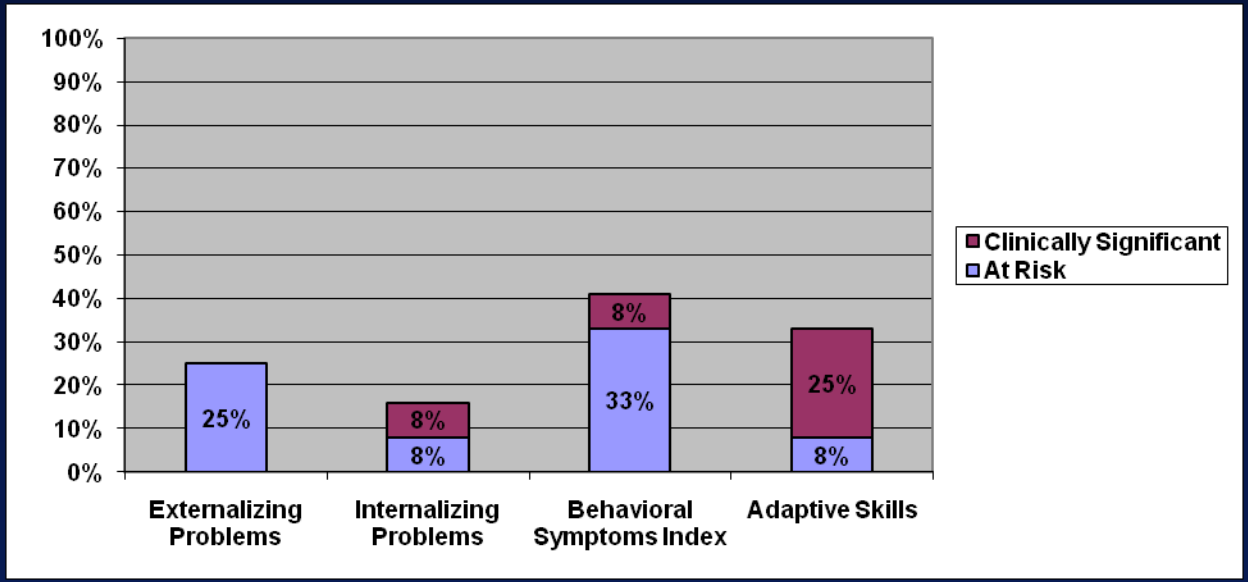
AUDITORY PROCESSING DISORDERS:
Associated Psychosocial Problems in Children

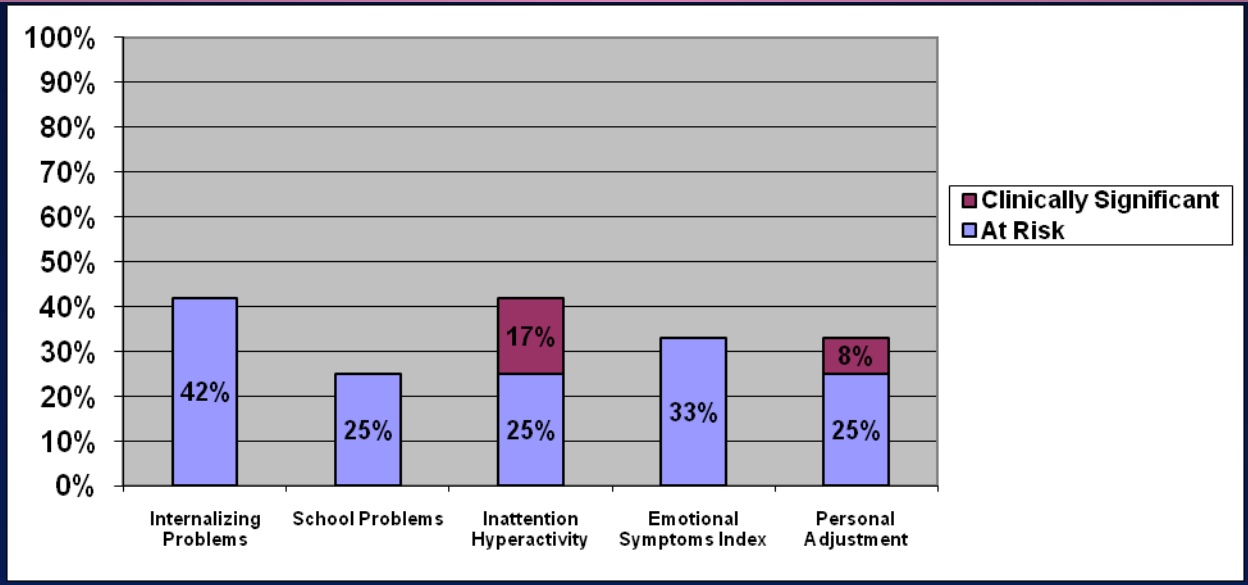
- Johnston K, John A, Kreisman N, Hall JW III & Crandell CC. (2009). Multiple benefits of personal FM system use by children with auditory processing disorder (APD). *International Journal of Audiology, 48*, 371 – 383
- Kreisman N, Johnston K, John A, Hall JW III & Crandell CC. (2012). Psychosocial status of children with auditory processing disorder (APD). *Journal of the American Academy of Audiology, 23*, 222 - 233

Psychosocial Function in Children with APD: Initial BASC II Parent Report



- ***Externalizing Prob:*** Hyperactivity, Aggression, Conduct Problems
- ***Internalizing Prob:*** Anxiety, Depression, Somatization
- ***BSI:*** Atypicality, Withdrawal, Attentional Problems
- ***Adaptive Skills:*** Adaptability, Social Skills, Leadership, Activities of Daily Living, Functional Communication

Psychosocial Function in Children with APD: Initial BASC II Child Self Report



- *Internalizing Prob:* Atypicality, Locus of Control, Social Stress, Anxiety, Depression, Sense of Inadequacy, Somatization
- *School Prob:* Attitude to School, Attitude to Teachers, Sensation Seeking
- *ESI:* combination of Social Stress, Anxiety, Depression, Sense of Inadequacy
- *Personal Adjustment:* Relations with Parents, Interpersonal Relations, Self-Esteem, Self Reliance

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Diagnosis of and Intervention for Central Auditory Nervous System Dysfunction Requires a Team Approach

- Audiology
- Speech pathology
- Psychology (e.g., neuropsychology)
- Physical and occupational therapy
- Medical specialties
  - Otolaryngology
  - Neurology
  - Psychiatry
  - Radiology
  - Physical medicine/rehabilitation

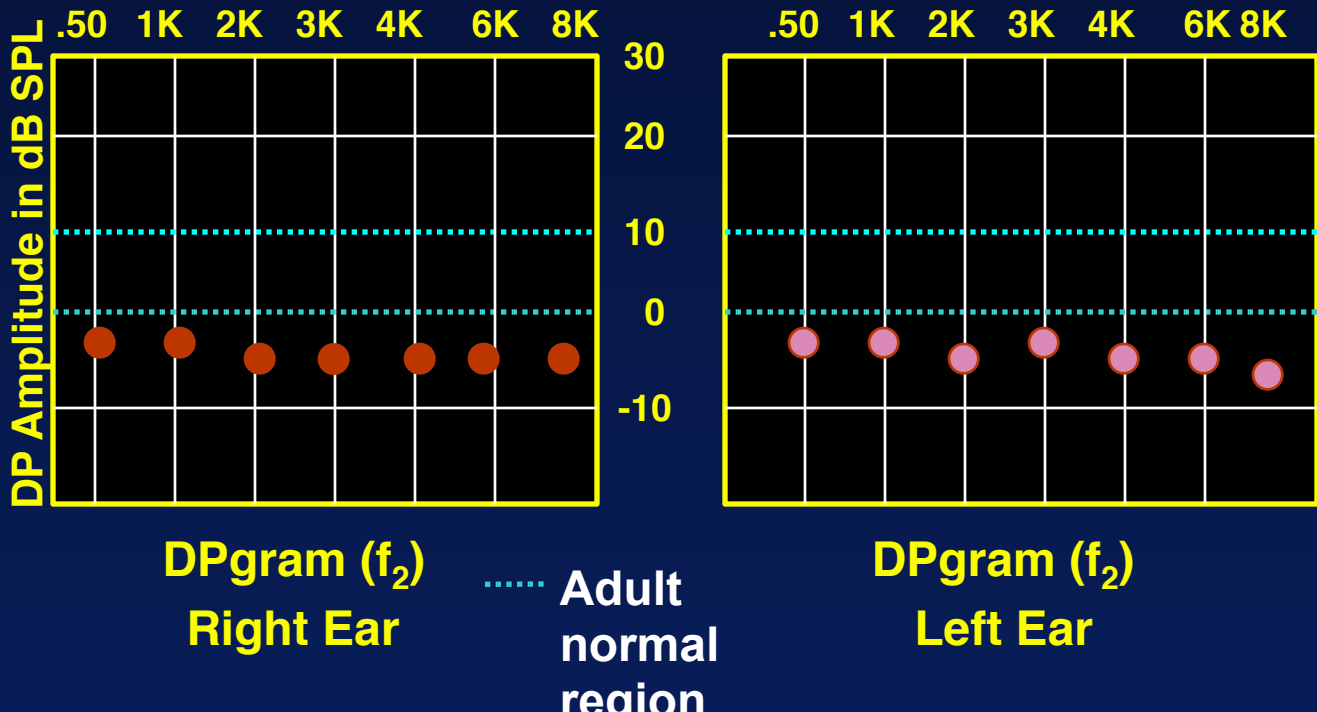
Assessment of APD in Children:
Acquiring History and Background Information

- Parents complete APD survey
- Middle ear disease?
- Neonatal risk factors?
- Co-existing disorders?
- Medical management for auditory or neurological disorder
- Previous assessments, e.g.,
  - Speech language
  - Psychological and psycho-educational
  - ADHD
- Previous and current therapy and treatment

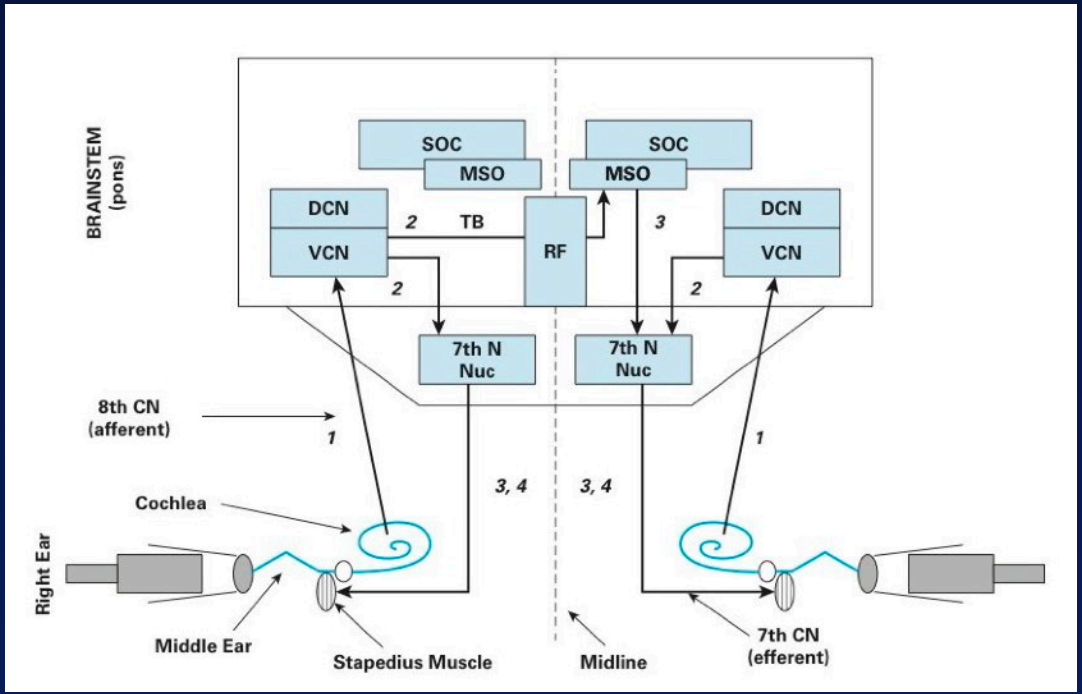
Assessment of APD: Peripheral Test Battery (< 20 minutes)

- Otoacoustic emissions (OAEs)
  - Diagnostic protocol, e.g.,
    - ✓ 500 to 8000 Hz
    - ✓ ≥ 5 frequencies per octave
  - OAEs are abnormal in 35% of children undergoing APD assessment
- Aural immittance measures
  - Tympanometry
  - Acoustic reflexes
    - ✓ *Crossed vs. uncrossed conditions … initial measure of CNS function*
- Pure tone audiometry
  - Inter-octave frequencies (e.g., 3000 and 6000 Hz)
  - High frequency (> 8000 Hz) audiometry as indicated
- Speech audiometry
  - Word recognition (recordings with 10 most difficult words first)

Average DPOAEs for 65 Consecutive Children Evaluated for Auditory Processing Disorders



Acoustic Reflex Measurement: Objective Information on Peripheral Auditory System and Auditory Brainstem

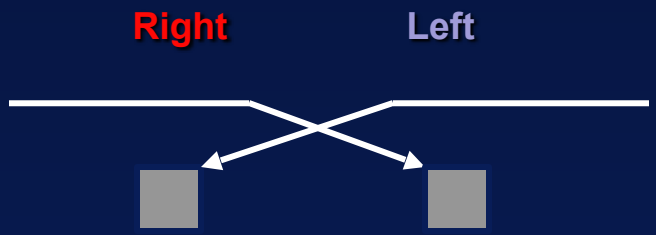


Acoustic Reflex Confirmation of Central Auditory Nervous System Dysfunction

Abnormal Acoustic Reflex

Horizontal pattern

- Brainstem auditory dysfunction



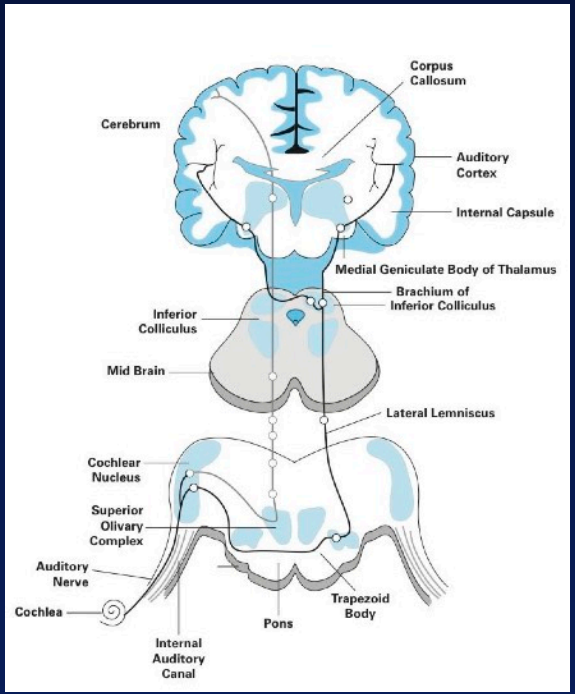
Contralateral (Crossed)
Sound Right
Probe Left

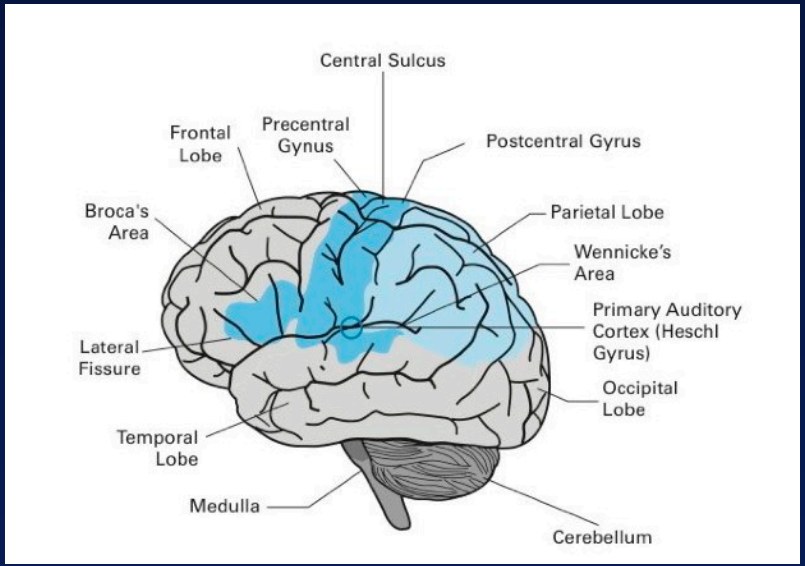
Contralateral (Crossed)
Sound Left
Probe Right

Ipsilateral (Uncrossed)
Sound Right
Probe Right

Ipsilateral (Uncrossed)
Sound Left
Probe Left

Assessment of APD:
Central Auditory Test Battery (~ 80 minutes)

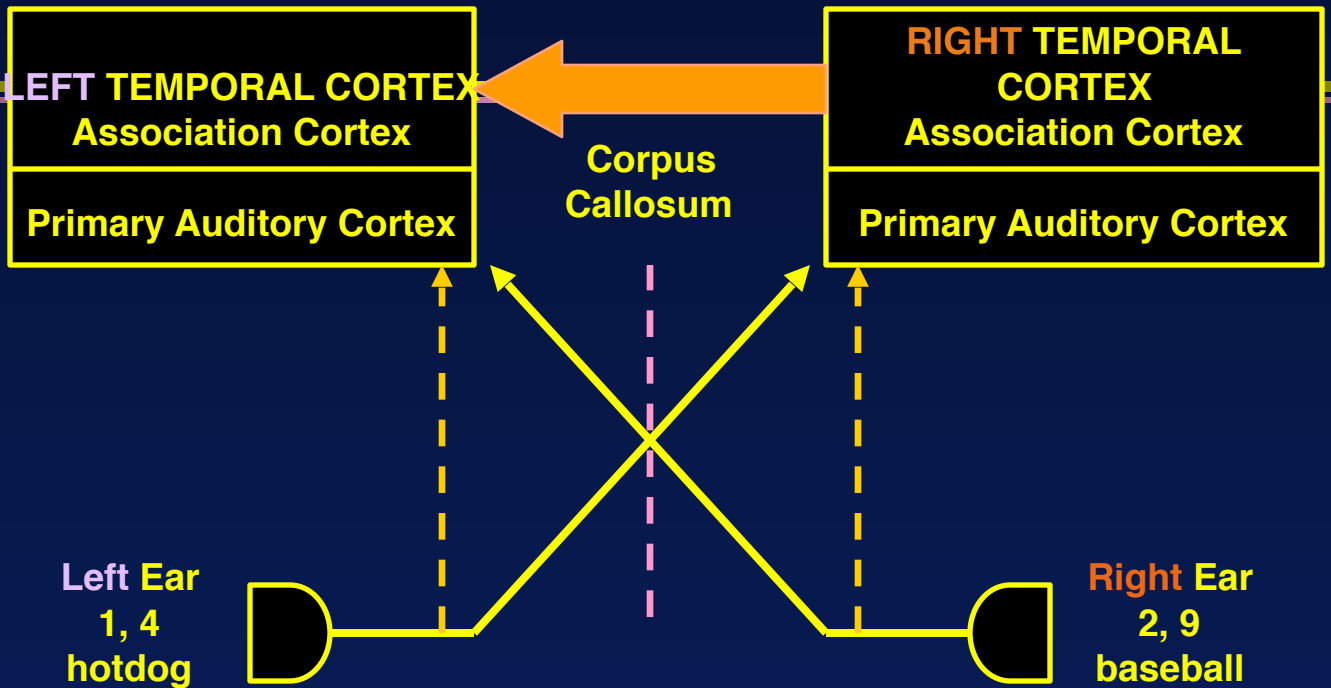




We Hear With Our Brain!
Behavioral Test Battery for Assessment of APD
(Highlighted tests are non-verbal. Do not use language materials)

- Auditory Discrimination Tests:
  - Difference limens for frequency, intensity, and duration
  - Psychophysical tuning curves
  - Phoneme discrimination, e.g., GFW Test of Auditory Discrimination.
- Auditory Temporal Processing and Patterning Tests:
  - Sequencing and patterns, e.g., Pitch Pattern Test
  - Gap detection, e.g., Gaps in Noise (GIN) test)
- Dichotic Speech Tests: Assess the ability to separate (i.e., binaural separation) or integrate (i.e., binaural integration) disparate auditory stimuli presented to each ear simultaneously, e.g.,
  - Dichotic CVs
  - Dichotic digits test
  - Dichotic words, e.g., Staggered Spondaic Word (SSW) test
  - Dichotic sentence identification test

Dichotic Listening Procedures



We Hear With Our Brain!
Behavioral Test Battery for Assessment of APD
(ASHA, 2005; AAA, 2010)

- Monaural Low-Redundancy Speech Tests:
  - Performance-intensity PI-PB functions
  - Speech-in-noise or speech-in-competition
    - ✓Synthetic sentence identification with ipsilateral competing message (SSI-ICM)
    - ✓Listening in Spatialized Noise (LiSN) procedure
  - Hearing In Noise Test (HINT)
  - Speech In Noise (SIN or QuickSIN) test
- Binaural Interaction Tests:
  - Masking level difference
  - Localization & lateralization, e.g., LiSN-S

Speech Audiometry with Modern Diagnostic Audiometers

GSI AudioStar Pro

- Spanish language speech audiometry tests are available digitally on the GSI AudioStar Pro audiometer
- Patient can control presentation of test materials for briefer test time
- Additional speech tests can be downloaded onto GSI AudioStar Pro upon request

Speech Audiometry with AudioStar Pro Audiometer

Speech Perception in Noise

Spanish Language Verbal Tests Battery for Assessment of APD

https://auditec.com/category/spanish/

- ❑ Spanish SSW (Staggered Spondaic Word) test
- ❑ Spanish dichotic digits test
- ❑ Spanish dichotic word test
- ❑ Spanish filtered speech test
- ❑ Spanish binaural fusion test
- ❑ Spanish speech-in-noise test
  - + 10 dB SNR
  - 0 dB SNR
- ❑ Spanish time-compressed sentence test

NOTE: Age referenced normative data for all tests

Spanish Language Verbal Tests Battery for Assessment of APD
Hearing in Noise Test (HINT)

University of Navarre, Pamplona, Spain

Introduction

Spanish is the third most commonly spoken language in the world, after English and Mandarin (Graddol, 2006). The 400 million Spanish speakers are widely dispersed in the western hemisphere. There are substantial variations in the spoken form of the language in the 20 countries where Spanish is the official language. Castilian Spanish is the official language in Spain, and this report summarizes the development of the Castilian Spanish HINT.

Method and Results

Preparation of test materials

Two native speakers of Castilian Spanish, an audiologist/medical doctor and a speech pathologist, constructed a set of 745 simple sentences that were translated and adapted from the 714 original sentences of the American English version of the HINT (Nilsson, Soli, Sullivan, 1994). These sentences were short, so that they do not require extensive memory. The syntax was not complex. The vocabulary syntax and usage was 'natural', as

was measured at −5 dB S/N ratio, a S/N ratio that produced approximately 65% intelligibility in pilot testing, with noise fixed at 65 dB A. The RMS level of sentences with mean word intelligibility scores outside the range of 65% ± 15% was adjusted using the slope of the PI function. After three rounds of testing, 240 sentences were scaled to an average of −5 dB S/N ratio, with 81.8% of sentences having levels within ± 2 dB of the average level for all sentences.

Formation of sentence lists

The 240 sentences were phonemically transcribed by two speech pathologists and divided into twenty-four 10-sentence lists using a software tool that allowed rapid trial and error modifications to the lists. The sentence materials were comprised of a total of 4509 occurrences of the 25 phonemes used to transcribe the sentences (Uraga & Pineda, 2002). The phoneme distributions in the matched lists after adjustments were within ± 2.5% of the overall mean phoneme distributions for the entire set more than 99% of the time.

Reception thresholds for sentences (RTSs) were obtained

Spanish Language Verbal Tests Battery for Assessment of APD
Hearing in Noise Test (HINT)

informa
healthcare

Short Report

International Journal of Audiology 2008; 47:362–363

The Latin American Spanish Hearing in Noise Test

Clemencia Barón de Otero[*]
Graciela Brik[§]
Lilian Flores[‡]
Silvia Ortiz[‡]
Carolina Abdala[#]

[*]Fundación Santa Fé de Bogotá, Bogotá, Colombia
[§]Centro de Investigaciones Otoaudiológicas, Buenos Aires, Argentina
[‡]Grupo Multidisciplinario de Implantes Cocleares Hospital General de México, Hospital Infantil de Mexico, Instituto National de Enfermedades Respiratorias, Mexico
[#]Cochlear Americas, Englewood, Colorado, USA

Introduction

The development of the Latin American Spanish HINT

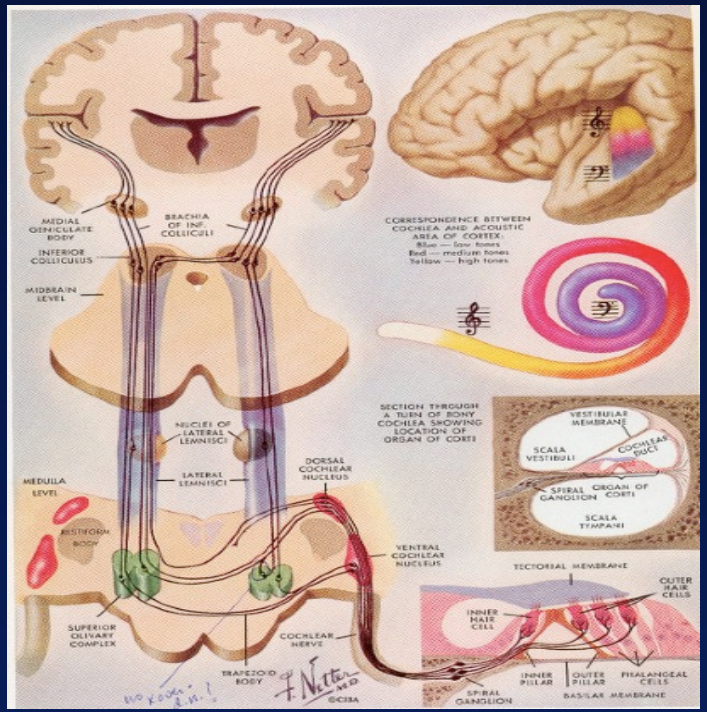
commonly used words and recirculated for additional review. Once consensus was reached on the vocabulary, the sentences were rated on a five-point scale, where 1 = 'very natural' and 5 =

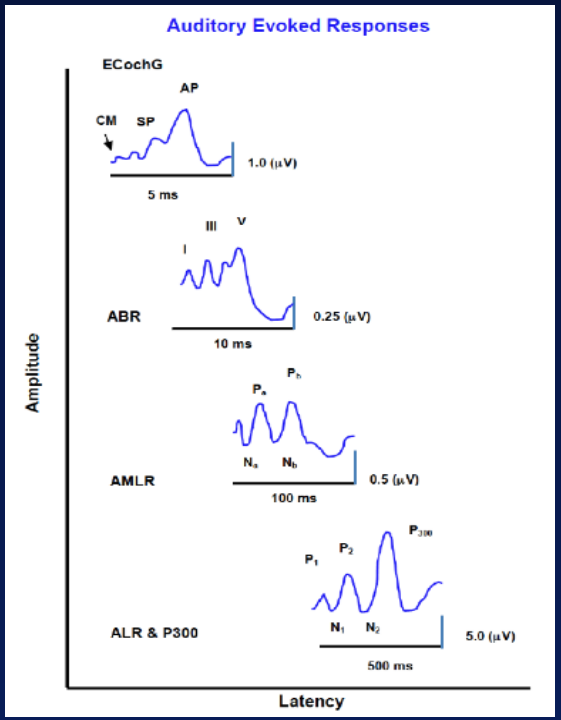
APD ASSESSMENT:
Additional Components of Test Battery (as indicated)

- Auditory Continuous Performance Test (ACPT)
  - Developed by Robert Keith
  - For children with suspected or diagnosed AD/HD
  - Rapid presentation of words
  - Task is to respond to target word "dog" only
  - Analog to visual continuous performance tests
- Screening of phonologic awareness skills
  - For children with suspected dyslexia (reading delay)
  - Test of Auditory Analysis Skills (TASS)*
    - ✓ Say the word *baseball* … now say it again but don't say *base*
    - ✓ Say the word *smack* … now say it again but don't say */m*

** Below normal performance requires further assessment, e.g., CTOPP (Comprehensive Test of Phonemic Processing)*

Auditory Evoked Responses in the Assessment of Auditory Processing





More Information About Auditory Evoked Responses?
Workshops: Viernes 2:00 – 6:00 pm & Sabado 8:00 am to 12 Noon

IONAL DE AUDIOLOGIA Y EXPO 2017						
GRAMA ACADEMICO						
VIERNES				**SABADO**		
8:00	Practical Hearing Aid: Programming for power and dynamic range/ PhD. Chris Halpin			8:00-12:00 Salon AR1	TALLER AMPLIFICACION OSEA/ PhD. Luis Andres Serrano	8:00- 12:00 Salon AR2
9:00	Auditory Processing disorder in School age Children: identificacion, Assessment and Management/ PhD. James					
10:00	**Cofee Break- Muestra comercial**					
10:45	Oline Educational Opportunities for practicing Audiologists: An international perspective/ PhD.					
11:45	Potenciales evocados relacionados con la amplificacion por vía ósea/ PhD. Luis Andres Serrano					
12:45	**Almuerzo Libre**			12:00	**CLAUSURA DEL EVE**	
2:00-6:00 Salon AR1	TALLER AMPLIFICACION OSEA / PhD Luis Andres Serrano	2:00-6:00 Salon AR2	TALLER ELECTROFISIOLOGIA AUDITIVA / PhD James Hall			
7:00	Te esperamos en el Salon Armonia					

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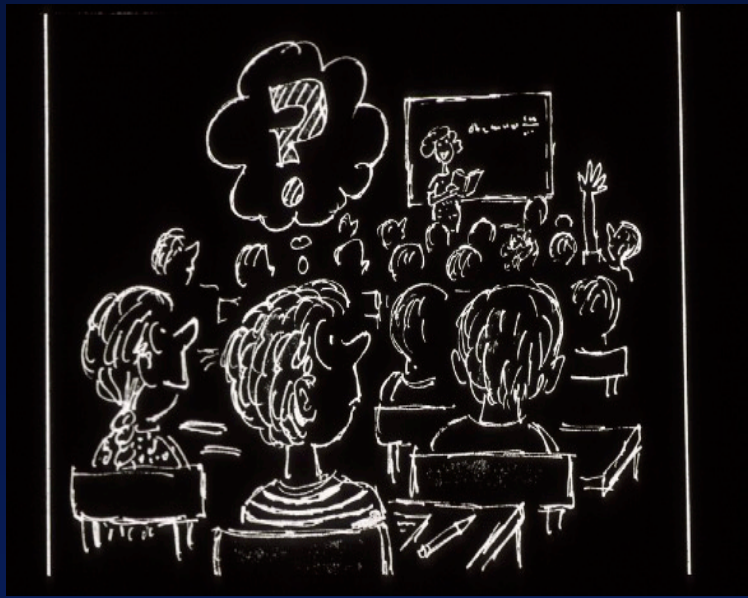
Effective Management Strategies and Procedures for APD in Children: *Early, Appropriate, and Intensive Intervention*

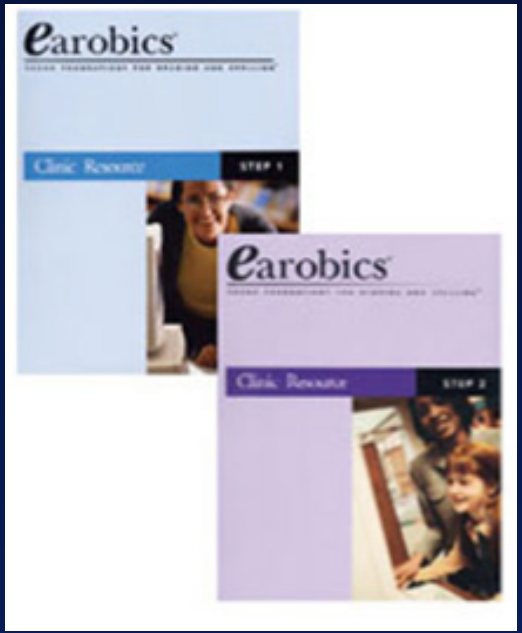
- Management of peripheral auditory dysfunction
- Computer based auditory training
- Targeted auditory training
- FM technology
- Multi-disciplinary bottom-up and top-down approaches



2010 AAA Clinical Guidelines on Auditory Processing Disorders: Terminology for Habilitation/Rehabilitation

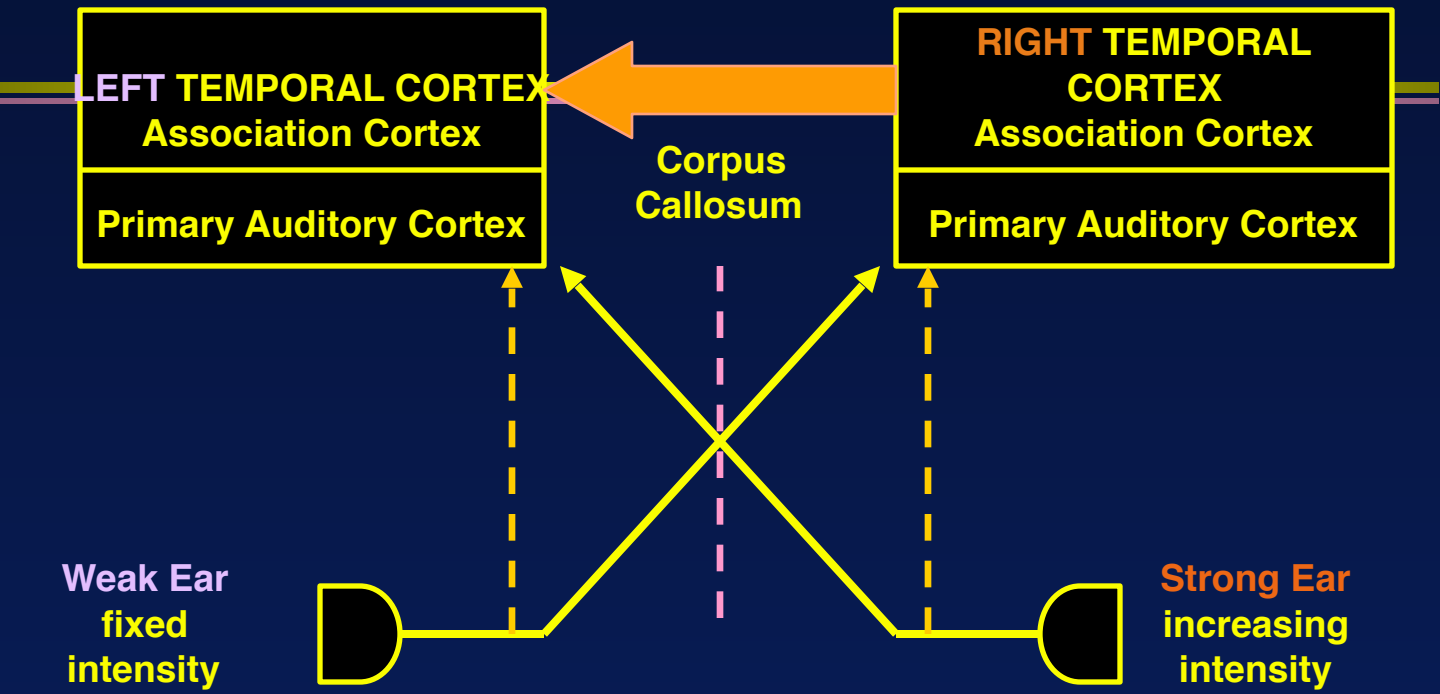
- **Intervention**: "…encompassing term referring to one or more actions taken in order to produce an effect and to alter the course of a disease, disorder, or pathological condition."
- **Treatment:** "…any specific procedure used to prevent, remediate (I.e., cure), or ameliorate a disease, disorder, or pathological condition."
- **Management**: "…referes to compensatory approaches (e.g., strategies, technologies) used to reduce the impact of deficits that are resistant to remediation."

An Intensive & Computer-Based Program for Development of Auditory Processing Skills



- Earobics
  - Spanish language version Janelle Publications https://www.janellepublications.com/6142.shtml
- Skills
  - Rhyming
  - Phoneme identification
  - Blending (combining sounds into words)
  - Segmentation (breaking words down into individual sounds)
  - Phonological manipulation
  - Auditory discrimination
  - Auditory performance in noise
  - Auditory sequential memory

Dichotic Intensity Increment Difference (DIID) or Auditory Rehabilitation for Interaural Asymmetry (ARIA)



Auditory Rehabilitation for Interaural Asymmetry (ARIA) Treatment (https://www.dichoticsinc.com)

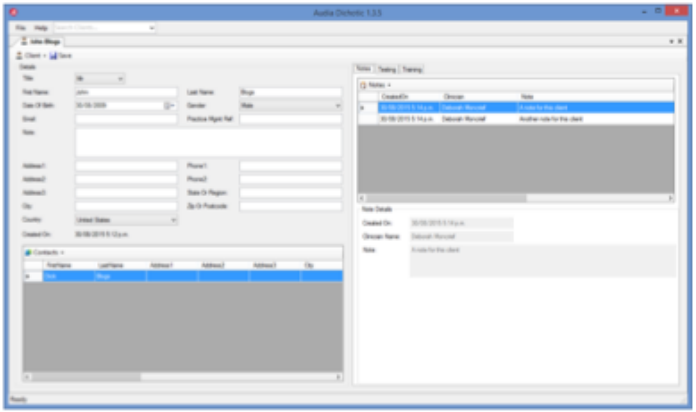
- Moncrieff DW & Wertz D (2008). Auditory rehabilitation for interaural asymmetry: Preliminary evidence of improved dichotic listening performance following intensive training. *International Journal of Audiology,* 47, 4
- Moncrieff D, Keith W, Abramson M & Swann A (2017). Evidence of binaural integration benefits from ARIA training in children and adolescents diagnosed with amblyaudia. *International Journal of Audiology,* 56, 580-588

Auditory Rehabilitation for Interaural Asymmetry (ARIA)

(https://www.dichoticsinc.com)

Software

Our windows desktop software enables you to assess for amblyaudia.



Advantages of Our Software

- ✔ Sound files integrated for the Dichotic Words Test and Randomized Dichotic Digits Test
- ✔ Scores patient responses with automatic conversion to percent correct
- ✔ Measures magnitude and direction of ear advantage as test progresses
- ✔ Compares results immediately to age-related normative information for each test
- ✔ Makes an interpretation of each individual test result
- ✔ Makes a final interpretation based on a minimum of two tests
- ✔ Generates a report with a table of scores and interpretations

FM Technology:
Personal FM Devices and Classroom Amplification

(Photographs Courtesy of Phonak)

Phonak EduLink FM System Use Improves Academic Performance and Psychosocial Status in Children with APD

Johnston, John, Kreisman, Hall & Crandell. (2009). Multiple benefits of personal FM system use by children with auditory processing disorder (APD). *International Journal of Audiology, 48*, 371 - 383

EduLink Receivers

Campus S

Transmitter

Mini-Boom Microphone

Hearing in Noise Test (HINT) Results
(Mean SNR Values Without and With Personal FM System)

Test Condition	Group: Control	Group: APD
Unaided in Noise (SNR)*	7.9 dB	6.1dB
Aided in Noise (SNR) **	- 0.3 dB	- 4.2 dB
Advantage in Noise with EduLink	8.2 dB	10.3

** t = p < .08; ** t = .002*

Typical Classroom SNR Range: +5 to -7 dB

Markides (1986); Finitzo-Hieber (1988);

Multiple Benefits of Personal FM System Use for Children with APD

(Johnston, John, Kreisman, Hall, Crandell. 2009. International Journal of Audiology, 48, 371-383

- APD in school age children can have significant negative impact on:
  - Academic performance
  - Psychosocial status
  - Quality of life
- Early intervention for auditory processing deficits is indicated for all children, despite the age of identification
- The Phonak EduLink system is a feasible option for FM technology with adolescents (and persons of other ages)
- Management of APD with FM technology (enhancing the signal-to-noise ratio) improves:
  - Speech perception in noise (with EduLink FM system
  - Academic performance
  - Psychosocial status
  - *Speech perception in noise without the benefit of FM technology*

Auditory Processing Disorders (APD) in School Age Children: Identification, Assessment & Management

Conclusions

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- Risk factors facilitate early identification of APD in children
- APD co-exists but can be differentiated from other disorders
- Auditory *specific* processing disorders can be diagnosed in children following evidence-based clinical guidelines
- APD can be diagnosed in children with non-verbal tests and Spanish language verbal tests
- There are evidenced-based intervention strategies for APD
- Failure to diagnosis and treat APD in children contributes to communication disorders, academic underachievement, reading failure, and psychosocial problems