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Auditory Processing Disorders: A Time Compressed Overview

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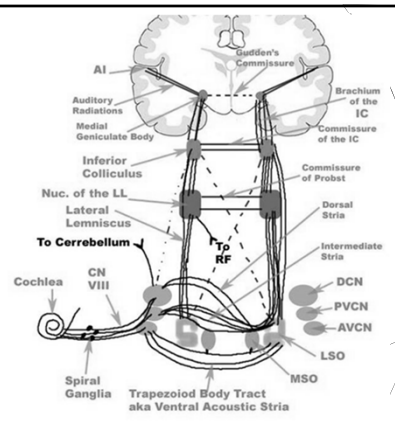
Auditory Processing Disorders: A Time Compressed Overview

REBEKAH F. CUNNINGHAM, PH.D
MARCH 13, 2013
AUDIOLOGY ONLINE

Auditory Processing Disorders

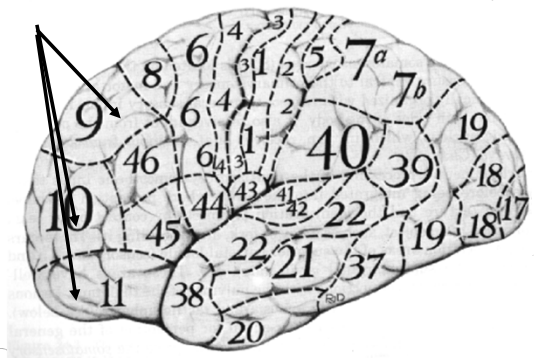
- Anatomy and Physiology
- Definitions
- Assessment/Tests
- Interpretation
- Management



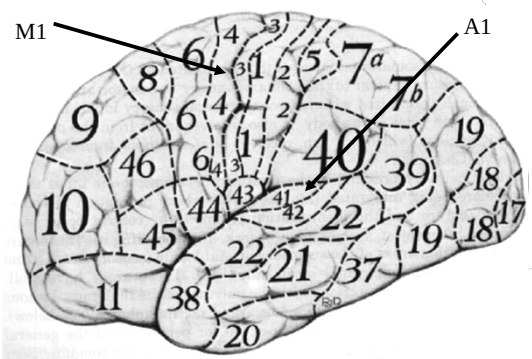
Dominant hemisphere
for comprehension and production of language

	Dominant Hemisphere (%)		
Handedness	Left	Right	Both
Left or mixed	70	15	15
Right	96	4	0

Frontal and Prefrontal Areas



Brodmann's Areas - Lateral View



Neuroanatomy and Neurophysiology of the Central Auditory Nervous System

- Ultimate comprehension relies on the extraction of information at various stages of processing
- Complex interactions between sensory and higher-order cognitive/linguistic operations occur both simultaneously (parallel) and sequentially (distributed) throughout the system

Neuroanatomy and Neurophysiology of the Central Auditory Nervous System

- The neurophysiologic encoding of auditory signals from the auditory nerve to the brain is referred to as “bottom-up” processing
- “Bottom-up” denotes those mechanisms and processes that occur in the auditory system prior to higher order cognitive and linguistic operations at the cortical level

Neuroanatomy and Neurophysiology of the Central Auditory Nervous System

- However, bottom-up factors are themselves influenced by higher-order factors such as attention, memory, and linguistic competence (top down) through the presence of complex feedback and feedforward mechanisms

Information Processing Theory

- Information processing theory states that both *bottom-up factors* (sensory encoding) and *top-down factors* (cognition, language, and other higher order functions) work together to affect ultimate processing of auditory input

What is APD?

- " It's like pornography; difficult to define, but you know it when you see it." (author unknown)

Definitions of APD

- Bruton Consensus
- ASHA 2005
- Katz
- Tallal
- Chermak
- Flexer
- Bellis
- Keith

Definitions of APD

- Bruton Conference 2000
  - APD is "a deficit in the processing of information that is specific to the auditory modality. The problem may be exacerbated in unfavorable acoustic environments. It may be associated with difficulties in listening speech understanding, language development, and learning. In pure form, however, it is conceptualized as a deficit in the processing of auditory input (Jerger & Musiek)

Definitions of APD

ASHA 2005

- " auditory processing refers to the efficiency and effectiveness by which the central nervous system (CNS) utilizes auditory information…"

Definitions of APD

ASHA 2005

- difficulties in the perceptual processing of auditory information in the CNS as demonstrated by poor performance in one or more of the following skills:
  - Sound localization and lateralization
  - Auditory discrimination
  - Auditory patter recognition
  - Temporal aspects of auditory
    - Including temporal integrations and discrimination

Definitions of APD

Tallal

- "An inability to accurately perceive auditory signals of brief duration when presented at rapid rates"

Theory of Intrinsic and Extrinsic Redundancy

Signal	Subject	Discrim
Normal	Normal	Good
Reduced	Normal	Fair
Normal	Reduced	Fair
Reduced	Reduced	Poor

Definitions of APD

- Chermak
  - Neurobiological Connections are Key to APD
- Katz
  - What we do with what we hear

Definition of APD

Flexer, 1994

- "…A central auditory processing disorder is not really a hearing impairment of reception and reduced hearing sensitivity. Instead, a central auditory problem causes difficulty in understanding the meaning of incoming sounds…Sounds get into the auditory system, but the brain is unable to interpret efficiently or at all, the meaning of sounds…in an extreme case, meaningful sounds can not be differentiated from non-meaningful sounds. "

Definitions of APD

Bellis

- Although the notion of complete modality-specificity of CAPD is neurophysiologically untenable when one considers the complex nature of information processing the brain, it is recognized that APD is *primarily* an auditory disorder
- Individuals with APD present with difficulties, documentable deficits, and complaints that are more pronounced in the auditory modality, and in some cases, auditory modality specific findings may be demonstrated

Definitions of APD

- CAPD is defined as the inability or impaired ability to attend to, discriminate, recognize, remember, or to comprehend auditory information even though the individual has normal intelligence and hearing acuity (Keith, 1994).

Test Principles

Take into Consideration:

- Developmental Age
- Cognitive abilities
- Level of language functioning
- Motivation
- Level of alertness
- Potential for fatigability during testing
- Cultural background
- Native Language
- Hearing sensitivity
- Patient's presenting complaints and auditory behaviors
- Sensitivity & specificity
- Age and intellectual functioning
- Include non-verbal & Verbal Test
- Use behavioral and electrophysiological test measures

Test Principles

Other Professionals: Their Role in APD Assessment

- Co-morbidity of other cognitive and linguistic disorders in persons with APD
- Complete additional assessments prior to APD testing
  - Leads to more accurate interpretation
- Cautionary note should be included in report in cases when testing could not be completed prior to APD

Test Principles

Things to keep in mind

- Administer tests which require greater attention and mental effort early on in test session
- Allow for breaks when necessary
  - Continuously monitor patient's alertness, energy level, and motivation throughout the test
- Two test sessions may be necessary
- Patients who are being medicated for cognitive and/or behavioral conditions should be appropriately medicated during testing.

Test Principles

Realize...

- Testing is completed in a sound-treated booth with minimal extraneous distractions
- Patients often come in well-rested and medicated

What does this mean…

- Test results may not fully reveal the effects of APD on the individuals ability to function in everyday conditions

Therefore…

- The assessment should include behavioral and systematic observation of the individuals performance in daily activity
  - Classroom and teacher/parent questionnaires

Choosing a Test Battery - Bellis

- Recommendation: The components of the comprehensive central auditory test battery be chosen from the following areas

Choosing a Test Battery - Bellis

- Dichotic listening task involving directed attention
- Dichotic listening task that involves report of both ears
- Temporal patterning test
- Test of monaural low-redundancy speech
- A temporal gap detection test (temporal resolution)
- A binaural interaction test
- Electrophysiologic measures

Review of Processes

Four general auditory processes/behaviors

- **Binaural Separation (BS)**
  - Example: competing sentences
- **Binaural Integration (BI)**
  - Example: competing words
- **Monaural Separation/Closure (MSC)**
  - Example: low-pass filtered speech
- **Auditory Pattern Temporal Ordering (APTO)**
  - Example: frequency or duration patterns

Review of Processes

Binaural separation

- refers to the ability to process and auditory message coming into one ear while ignoring a disparate message being presented to the opposite ear at the same time

Binaural integration

- the ability to process information being presented to both ears simultaneously with the information presented to each ear being different

Review of Processes

Monaural Separation/Closure (MSC)

Monaural separation

- the ability to listen to a target message when presented to the same ear as a competing signal
  - Rarely occurs in everyday life

Auditory Closure

- Ability of normal listener to utilize intrinsic and extrinsic redundancy to fill in missing or distorted portions of the auditory signal and recognize the whole message
  - Plays an important role in everyday listening

Review of Processes

Auditory Pattern Temporal Ordering (APTO)

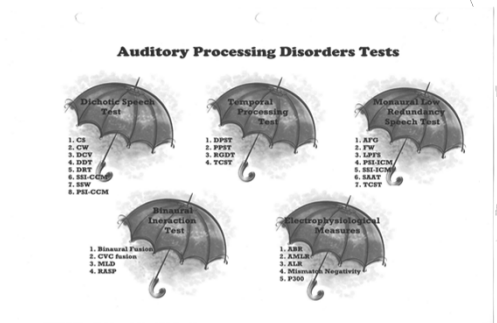
- Listener's ability to recognize acoustic contours
- Several auditory processes contribute to this ability
  - discrimination of auditory stimuli
  - sequencing of auditory stimuli
  - gestalt pattern perception
  - trace memory

Review of Processes

Auditory Pattern Temporal Ordering (APTO)

- Being able to recognize acoustic contours of speech helps us to extract and utilize certain prosodic aspects of speech, such as rhythm, stress and intonation
  - Examples:
    - "Y*ou* can't go with us" vs. "You can't go with *us"*
    - "He saw the *snowdrift* by the window" vs. "He saw the *snow drift* by the window"

Umbrellas/Categories



Dichotic Tests

Test	Process	Sensitive To
Dichotic Digits DD	Binaural Integration	Brainstem, cortical, and corpus callosal lesions
Staggered Spondaic Word SSW	Binaural Integration	Brainstem, and Cortical Lesions
Competing Words Test	Binaural Integration	Neuromaturation
Competing Sentences Test CS	Binaural Separation	Neuromaturation and language processing
Synthetic Sentence Identification SSI-CCM	Binaural Separation	Cortical vs. brainstem lesions
Pediatric Speech Intelligibility PSI-CCM		

Temporal Tests

Test	Process	Sensitive To
Duration Pattern Test DPT	Auditory Pattern Temporal Ordering APTO	Cortical lesions, interhemispheric transfer
Frequency Pattern Test FPT	Auditory Pattern Temporal Ordering APTO	Cortical lesions, interhemispheric transfer
Random Gap Detection RGDT	Temporal Resolution	Cortical, particularly left temporal lobe lesions
Gap in Noise GIN	Temporal Resolution	Cortical, particularly left temporal lobe lesions

Monaural Low- Redundancy Speech Tests

Test	Process	Sensitive To
Low Pass Filtered Speech LPFS	Monaural Separation Closure MSC	Brainstem and cortical lesions especially 1st auditory cortex
Time Compressed Speech Test	Monaural Separation Closure MSC	Brainstem and cortical lesions
Synthetic Sentence Identification SSI ICM	Monaural Separation Closure MSC	Low brainstem lesions
Auditory Figure Ground AFG	Monaural Separation Closure MSC	Low brainstem, cortex
Selective Auditory Attention Test SAAT	Monaural Separation Closure MSC	Low brainstem
Pediatric Speech Intelligibility	Monaural Separation Closure MSC	Low brainstem

Binaural Interaction

Test	Process	Sensitive To
Masking Level Difference		Low brainstem
Rapid Alternating Speech Perception		Low brainstem

Review of Behavioral Tests

Dichotic Listening

- Information presented to the **left ear must traverse the right hemisphere** and the CC in order to be perceived an labeled
  - the language-dominant hemisphere is usually the left
- Information presented to the **right ear is directly transmitted to the left hemisphere** without the need for right hemisphere or interhemispheric processing

Review of Behavioral Tests

Therefore…

- Processing information from either ear ultimately relies on the integrity of the left hemisphere

However…

- Dysfunction of the right hemisphere or the CC would be expected to impact the message presented to the left ear only

Review of Behavioral Tests

Dichotic Listening

- Kimura 1961
  - Theorized that the contralateral pathways are stronger and more numerous than are the ipsilateral pathways
- When dichotic (competing) auditory stimuli are presented, the ipsilateral pathways are suppressed by the stronger contralateral pathways

Dichotic Listening

Right Ear Advantage (REA)

- Ear asymmetry in which scores for the right ear are consistently higher than the scores for the left ear
- Typically apparent only upon dichotic stimulation or other challenging auditory tasks*
- REA is greater as linguistic content increased from CVs to sentences
- REA is maintained on directed right and directed left listening instructions

Dichotic Speech Tests

- **Dichotic Digits Test (DDT)**
- **Dichotic Consonant Vowel Test (CV)**
- **Staggered Spondaic Word Test (SSW)**
- **Competing Sentences Test (CST)**
- **Dichotic Sentence Identification Test (DSI)**

Dichotic Speech Tests

- **Synthetic Sentence Identification with Contralateral Competing Message (SSI-CCM)**
- **Competing Words subtest of the SCAN-3 (C or A)**

Temporal Processing

- Skill is needed for speech and music perception
  - Speech: necessary for the discrimination of subtle cues such as voicing and discrimination of similar words.
    - Voicing begins earlier in the word *dime* than in the word *time*
    - Distinction between boost and boots depends on discrimination of consonant duration and temporal ordering of the final two consonants of each word.

Temporal Processing

- Skill is needed for speech and music perception
  - Music: need to perceive the order of musical notes/chords and to determine if the frequencies of the notes/chords are ascending or descending with respect to the adjacent notes/chords
- Despite its importance in speech and music perception very few tests are available for widespread clinical use

Temporal Processing Test

- **Random Gap Detection Test (RGDT)**
- **Gaps In Noise Test (GIN)**
- **Frequency Patterns Test (PPST)**
- **Duration Patterns Test (DPST)**

Monaural Low-Redundancy Speech Tests

- Oldest tests used to assess the CANS
- Administered monaurally with degraded stimuli
  - How do we degrade the signal?
    - Frequency/spectral = Low pass filtering
    - Temporal = Time compression
    - Intensity = speech in noise
    - Reverberation
- Degrading reduces the inherent redundancy of the signal

Monaural Low-Redundancy Speech Tests

- Degree of redundancy associated with speech stimuli affects performance of listeners on intelligibility tests
  - Low redundancy – non-sense syllables
  - High redundancy – sentences – much more intelligible

Monaural Low-Redundancy Speech Tests

- Extrinsic redundancy
  - Arises from multiple and overlapping acoustic and linguistic cues inherent in speech/language(phonemic, prosodic, syntactic cues, etc.)

Monaural Low-Redundancy Speech Tests

- Intrinsic Redundancy
  - Due to structure and physiology of CANS
  - Multiple and parallel pathways concurrently and sequentially transmit information within auditory system

These allow a listener to achieve closure and make auditory discriminations even when a portion of the signal is missing or distorted.

Monaural Low-Redundancy Speech Tests

- **Time Compressed Sentence Test (TCST)**
- **Low-Pass Filtered Speech**
- **SSI-ICM (Speech in Noise)**
- **PSI and SAAT (Speech in Noise)**
- **Auditory Figure Ground of the SCAN 3**

Monaural Low-Redundancy Speech Tests

Remember…..

- Even though MLRSTs are only moderately sensitive, they are useful in that they mimic real-life situations (like a classroom) and therefore provide information regarding functional deficits

Binaural Interaction

- Not widely used clinically
- Different from dichotic listening in that:
  - Stimuli presented sequentially not simultaneous
  - Information presented to each ear is composed of a portion of the entire message

Binaural Interaction

- Primary responsibilities of the auditory brainstem are:
  - Sound transmission
  - Binaural integration of sound
  - Control of reflexive behavior
  - Localization and lateralization

Binaural Interaction

- What are tests we can use to assess the low brainstem?
  - ABR
  - MLD
  - Acoustic reflex paradigms

Binaural Interaction

- Therefore, the need for additional behavioral tests of brainstem integrity is questionable at this time… but…
  - **Rapidly Alternating Speech Perception**
  - **Binaural Fusion Tests**
    - **Ivey: spondaic words**
    - **NU-6: words**
    - **CVC Fusion: segmented CVC words**

Should electrophysiologic tests be included in the APD battery?

- Electrophysiologic can validate the results of behavioral data when abnormalities are shown in both behavioral and electrophysiological tests
- EPs elicited with non-speech signals permits the validation of APDs independent of language status
- Must verify peripheral hearing is normal

Electrophysiology in APD

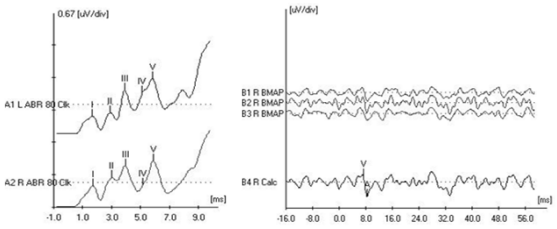
Electrophysiology Tests

- ABR – Auditory Brainstem Response
- AMLR- Auditory Middle Latency Response
- ALR- Auditory Late Response
- MMN – Mismatched Negativity
- P300 -

BioMark

- Stimulus :
  - Speech syllable/sounds
- Major waveforms & Latencies
  - D = 20 msec
  - E = 30 msec
  - F = 40 msec
- Clinical use:
  - Assists in the selection of children candidates for auditory-based intervention training
  - Assess the changes brought about by this training

BioMark



Auditory Middle Latency Response (AMLR)

- Generators: auditory thalamus, A1, temporo parietal, reticular formation, lemniscal auditory pathways
- Affected by maturation
  - Adult waves forms not present till 8-10 years of age
- Latency is less sensitive than amplitude when it comes to detection of auditory dysfunction
  - The difference in amplitude between the two ears is most important in determining abnormal AMLR recordings

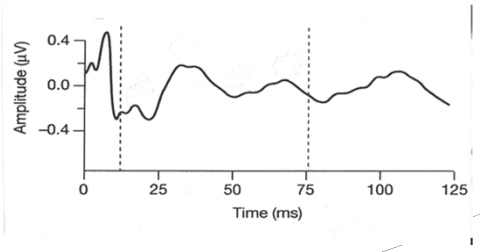
Auditory Middle Latency Response (AMLR)

- Major waveforms & Latencies:
  - Approximately 10-80 msec
    - Na, Pa, Nb, Pb
- Clinical use:
  - documentation of auditory CNS dysfunction above the level of brainstem
  - frequency specific estimation of auditory sensitivity

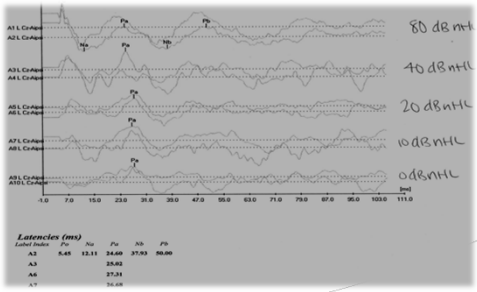
Auditory Middle Latency Response (AMLR)

- Exogenous evoked potential
- Response negatively affected by
  - Noise, drugs, sleep, and sedation
- PAM –Post Auricular Muscle
- Not present in all normals

Auditory Middle Latency Response (AMLR)



AMLR- Threshold search



AMLR and APD

Research is conflicting…

- Some research has shown AMLR to be different in children with specific language impairment (Arehole et al)
- Some studies have shown no significant difference in the detection, latency or amplitude values of the Pa component in children with language disabilities or language impairment (Kraus et al)

AMLR - Literature

- However, typically, children with APD will present with an AMLR having a prolonged latency and a reduction in amplitude for the Na and Pa components with an electrode over one or both cerebral hemispheres
- *Among evoked responses, the AMLR and P300 are abnormal most often in patients referred for an APD assessment*

AMLR and APD

Stability of AMLR in young children is questionable

- Waveforms not adult-like until after about 10 years of age
  - The very population we see most often for APD assessment
- Sedation and sleep affects the AMLR significantly, so that is not a solution!

Auditory Late Response (ALR)

- Generators: probably from A1, precise anatomic generators unknown
- Major waveforms & Latencies
  - Approximately <100 – 300 msec
    - P1, N1, P2, N2

Auditory Late Response (ALR)

- Clinical use:
  - Frequency specific information of hearing sensitivity in cooperative children and adults
  - Assessment of higher level auditory CNS function
  - Hearing aid and cochlear implant benefit

Auditory Late Response (ALR)

- Exogenous evoked potential
- Response negatively affected by
  - Drugs, sleep, and sedation
  - Noise is not as much of a factor as with AMLR
- Assessment of higher-level auditory CNS functioning

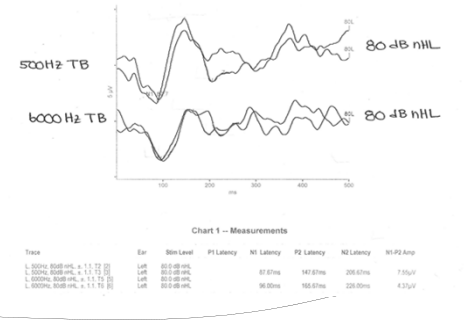
ALR - Literature

- Both the latency and morphology of the P1 response can serve as biomarkers for the developmental status of central auditory pathways (Sharma 2005)
- Increased latency of ALR responses have been noted in children with APD (Tremblay et al 2001)

ALR - Literature

- Cortical evoked potential can have a significant role in APD test battery
- Overall the latency, amplitude, and morphology of the auditory late response can serve as an indication of APD (and other disorders)

Auditory Late Response (ALR)



P300

- Generators: medial temporal lobe (hippocampus and other centers within the limbic system), auditory regions in the cortex, and frontal lobe
- Major waveforms & Latencies
  - P3 – approximately 300 msec (range between 250-400 msec)

P300

- Clinical use:
  - Assessment of higher level auditory processing
  - Documentations of effectiveness of medical/nonmedical management for different disorders ex. ADHD, APD
  - Useful in patients with Schizophrenia, Alzheimer's, individuals with Autism (persons with these disorders often demonstrate APD)

P300

- Endogenous evoked potential
- Recorded when a person attends or listens for rare (oddball or target) stimuli
- 80% sensitivity in detection of CANS lesions
- Abnormalities are typically described as delayed latency and reduced amplitude

P300

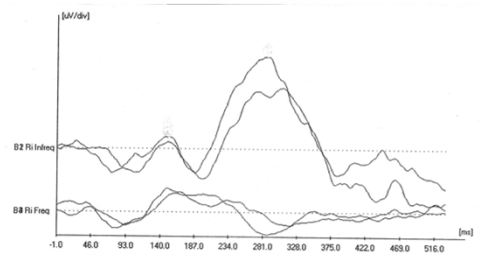
Important…

- attention to the oddball, not the frequent is important
- Instructions to the subject regarding the listening task produce marked effects on the type of response recorded

Profoundly affected by…

- alterations in subject state of arousal, sleep stage and drugs

P300



P300 - Literature

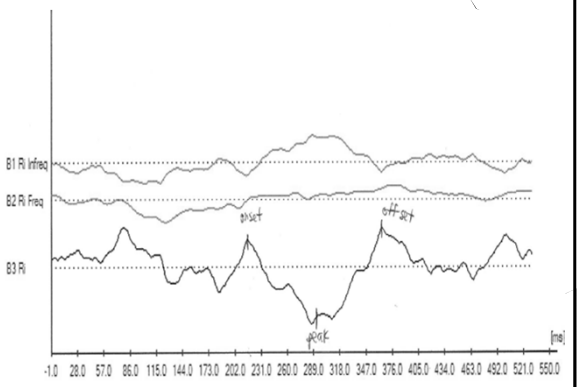
- Pre-intervention P300 recorded and compared to post-intervention P300; found that this measure serves as an excellent tool to monitor the therapy process
- When children were tested after treatment their P300s were found to have shorter latencies and higher amplitudes (Jirsa 2010)

Mismatch Negativity (MMN)

- Generators: left and right auditory cortex, sub-cortical generators, such as auditory thalamus and hippocampus, frontal lobe
- Major waveforms & Latencies
  - MMN – 100-300 msec (Peak)
  - Also measure onset, offset, duration, and sometimes, AUC

Mismatch Negativity (MMN)

- Clinical use: Questionable??
  - Diagnosis of auditory dysfunction, neurological disorders
  - Documentations of developmental and intervention-induced changes in neural function
- MMN response is a reflection of the brain's unconscious detection of a difference between the standard and the deviant stimulus (uses oddball paradigm)



APD?

- The behaviors characteristic of children with APD can be similar to those of the child with ADHD, LD, language problem, etc.
- The similarities in the behavioral manifestations of APD and ADHD or APD and LI have led some to question whether or not these disorders may reflect a single developmental disorder

Differential Diagnosis of (C)APD

- Distinguish APD from:
  - ADHD, language impairment, cognition, memory, PDD, chronological age, ETC!!!

(can YOU do it?) ☺

Interpretation of AP Assessment Results

- Data from a AP assessment may be analyzed for the following 4 general purposes (Bellis)
  - ID of the presence or absence of APD
  - ID of underlying processes that may be disordered
    - MSC, APTO, BI, BS, Gap Detection, Binaural Inter.
  - Site-of-lesion (or site-of-dysfunction) information
  - Development of a APD sub-profile (in conjunction with academic and other measures)

Bellis/Ferre

Profile	Region of Dysfunction
Auditory Decoding	**left auditory cortex**
Prosodic	**right auditory cortex and associated areas**
Integration	**transfer via the corpus callosum**

Katz

- Decoding
- Tolerance Fading Memory
- Integration
- Organization

Neuroplasticity and Remediation

- CNS is plastic, and capable of cortical reorganization by experience
- Brain plasticity greatest and most obvious during development, but remains malleable throughout the life span
- Neural plasticity gives the opportunity for functional change only when intervention is begun in a timely fashion

Implications of neuroplasticity for Rehabilitation

- Intensive training seems to accelerate the remapping/relearning process
- Due to our inability to quantify how much time it takes for the remapping to take place, when to change or maintain a certain therapy becomes complicated

Management for Children with APD

APD management in the educational setting may be divided into 3 main categories

-focus on changing the environment

-remediating the disorder (direct treatment)

-improving learning and listening skills (compensatory strategies)

Management for Children with APD

- Environmental
  - acoustic and non-acoustic
- Improving Learning and Listening Skills
- Compensatory Strategies
  - Self-A**d**vocacy
- Cognitive, Metacognitive, and Metalinguistic Skills and Strategies

Gauging efficacy (how do we know it works?)

- Educational performance
- Behavioral speech perception testing
- Functional assessments
  - SIFTER
  - LIFE
  - CHAPS
- EPs
- Re-evaluation
- Journaling

Factors that influence success

- Treatment schedule
  - Time of day?
  - Length of each session?
  - Duration and frequency of training?
- Auditory Environment
  - Headphones
  - FM system
  - Quiet room
- Motivation

Computer Assisted Management

- FastForward www.scilearn.com
- Earobics www.cogcon.com
- Lindamood www.Lblp.com
- Braintrain www.braintrain.com
- Minddabble.com

Case 1 - JM

- 10 year old male
- No significant Hx of OM
- Difficulties with math and reading. Repeated 1st grade. Has had tutoring services and current teacher modifies in-class assignments
- Dx with ADD – takes an herbal medication for this
- Complete psycho-educational evaluations scheduled both through his school and at local children's hospital to determine need for services

Case 1 - JM

- Auditory processing testing was normal for:
  - **SCAN-C (all subtests)**
  - **TCST (right ear)**
  - **RGDT**

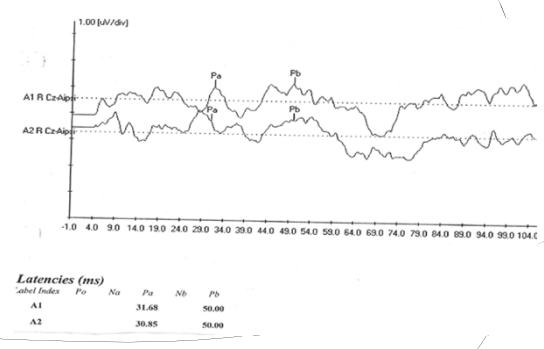
Case 1 - JM

- Auditory processing testing was outside normal limits for:
  - **DPST**
  - **TCST (left ear)**
- Difficulties with rapid speech when presented to left ear (typically the weaker ear in most individuals) and with recognizing duration differences; these weaknesses can sometimes cause difficulty understanding rapid speakers and with pragmatic language abilities

Case 1 - JM

- During the **DPST** patient was unable to respond correctly to any stimuli verbally (which engages language). When he hummed the response (no language), although his score was abnormal, he was able to get approximately half correct

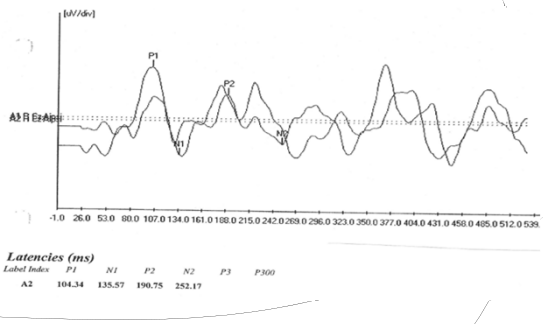
AMLR - JM



Latencies (ms)

Label Index	Po	Na	Pa	Nb	Pb
A1			31.68		50.00
A2			30.85		50.00

ALR - JM



Latencies (ms)

Label Index	P1	N1	P2	N2	P3	P300
A2	104.34	135.57	190.75	252.17		

Case 1 - JM

- Poor morphology ALR and especially AMLR
- EP results taken with behavioral test results indicate that JM does have auditory processing difficulties in specific areas/processes (temporal domain)

Case 1 - JM

- Recommendations included language evaluation, private tutor and suggestions for home and at school to increase comprehension (speak in clear, modulated voice, reduce distractions, pragmatic language skill-building, repeat, rephrase, visual augmentations in the classroom, etc.)

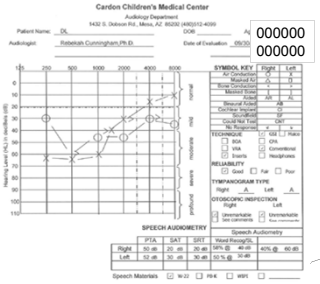
Case 2 - DL

- 12 y.o. female seen for ABR
- Referral from neurotologist
- Primary complaint inability to hear in noise
- Difficulty localizing sounds
- Tinnitus left ear
- Hearing loss (inconsistent audiograms with poor reliability)
- Migraines
- Increased academic difficulties in public school after being home-schooled

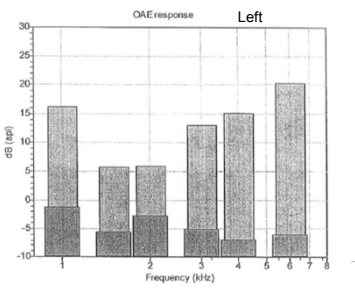
Case 2 - DL

- Did not speak until 3 years of age; all other developmental milestones appropriate
- No significant Hx of OM, or familial Hx of HL
- Unremarkable MRI

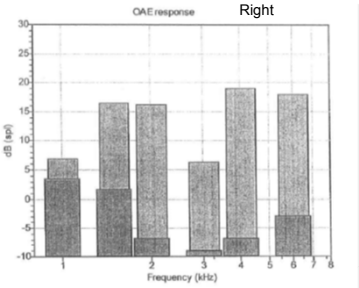
Case 2 - DL



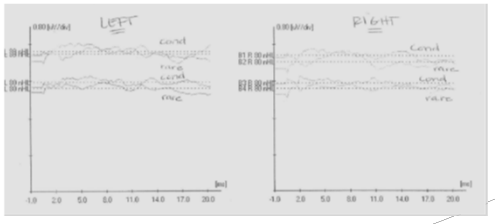
Case 2 - DL



Case 2 - DL



Case 2 - DL



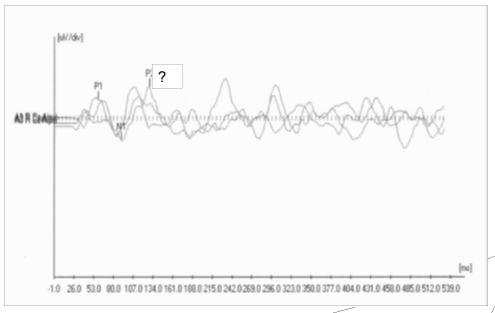
Case 2 - DL

- Auditory processing testing was <u>normal</u> for:
  - RGDT
  - DDT (right ear)
  - DPST (binaural)

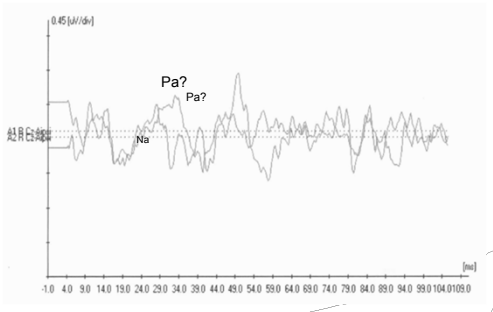
Case 2 - DL

- Auditory processing testing was outside <u>normal limits</u> for:
  - SCAN-A (all subtests)
  - DDT (left ear)
  - TCST (at 40%...60% was not attempted)

Case 2 - DL



Case 2 - DL



Case 2 - DL

- ABR – absent waveforms bilaterally at 80dB nHL
- Normal tympanograms and OAEs bilaterally
- Middle ear muscle reflexes absent bilaterally in the ipsilateral and contralateral conditions

Case 2 - DL

- Asymmetrical hearing loss – low frequency moderate hearing loss rising to borderline normal hearing at 8000 Hz.
- Spondee thresholds that did not correlate with pure tones
- Poor word recognition bilaterally

Case 2 - DL

- Recommendations:
  - Trial with FM auditory trainer
  - Speech reading programs
  - Communication strategies
  - Computer based auditory training
  - Referral back to neurotology and neurology for workup for ANSD

Case 3 - SI

- 9 y.o. female
- No significant Hx of OM
- Referred for APD by SLP – has been in speech and language therapy for approximately 2 years
- Average academic performance, with difficulties in reading comprehension, excels in math
- Reported difficulties in background noise at school and home

Case 3 - SI

- Auditory processing testing was normal for:
  - **SCAN-3 (AFT +8, FW, CS, CW-FR)**
  - **DPST**
  - **DDT (left ear)**
  - **MLD**

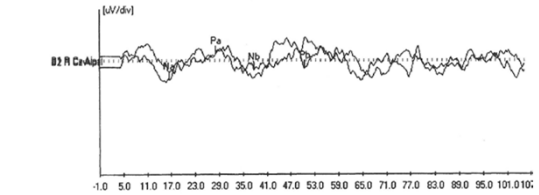
Case 3 - SI

- Auditory processing testing was outside normal limits for:
  - **SCAN-3 (AFG +0, CW-DE, TCS)**
  - **DDT (Right Ear)**
- A Left Ear Advantage was noted for:
  - **FW**
  - **CW-DE (right and left)**
  - **CS**
  - **TCS**

Case 3 - SI

- LEA is rare in a child of any age
- Can indicate *reversed cerebral dominance*
- Associated with neurologically based processing problem, and often causes language and learning delays/disorders

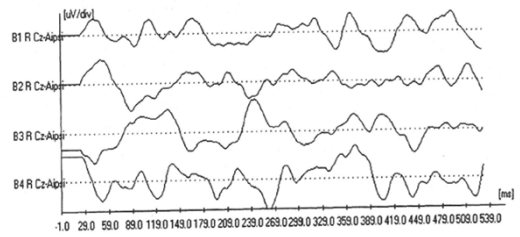
AMLR - SI



Latencies (ms)

Label	Index	Po	Na	Pa	Nb	Pb
B2			16.48	28.14	37.93	50.63

ALR - SI



Case 3 - SI

- Poor morphology of AMLR
- Absent ALR
- Suggestive of involvement of the thalamo-cortical pathways

Recommendations

- Preferential seating with left ear towards teacher (when possible), continue in speech/language therapy and implement exercises to assist with binaural integration, reduce distractions in classroom and at home, repeat, rephrase, quiet area for study/tests, add vision as a second modality for learning, etc.

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