Auditory Processing Disorders

The Functional Significance of Diagnostic Tests

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Children, their families, our clinical colleagues

WHAT IS REQUIRED OF A CHILD'S AUDITORY SYSTEM?
Real World Needs

- Recognize familiar sounds quickly
- Learn new sounds
- Tolerate noise and stimulus degradation
- Form auditory objects and position them in space
- Listen to one sound and ignore another

What is Required of the Auditory System?

- Signals must be audible
- Basic acoustic processing (discrimination and resolution) must be good: spectral and temporal clarity
- Binaural hearing must be functioning
- Selective, sustained and focused attention must be good
- Many signals must be well learned and predictable
- Integrity of the auditory nervous system must be intact

Perceptual Development

- Factors
  - Quality of sensory encoding
  - Ability to attend to and explore that encoded information
  - Prior experience and knowledge
  - Environment
- Most easily recognized stimuli are those that are familiar and well learned – why?

Gibson, E.J. 2000
Processes of Perceptual Development

- Neural patterns are reinforced in response to frequently occurring stimuli (imprinting)
- Allows for rapid perception even with degradation
- Increased control over attention – selective and sustained (attentional weighting)
- When coded with prior knowledge stimuli are strengthened and thus can be degraded (unitization)
- Over time a finer level of detail is perceived (differentiation)

Goldstone, R., 1998

What do pediatric audiologists have to help them?

CURRENT CLINICAL ASSESSMENT BEYOND AUDIBILITY

Auditory Skills

- Sound localization and lateralization
- Auditory discrimination
- Auditory pattern recognition
- Temporal resolution, masking, integration, and ordering
- Auditory performance decrements with competing or degraded signals
- Memory and attention

Asha, 2005
Comprehensive Assessment Recommendations

- Thorough case history
- Non-standardized but systematic observation of auditory behavior (e.g. checklists)
- Behavioural evaluation of
  - Temporal process (ordering, discrimination, resolution and integration)
  - Binaural processes (localization and lateralization)
  - Perception of low redundancy (filtered, compressed, degraded) and dichotic speech
- Electrophysiologic evaluation
- Speech-language assessment

Clinical Practice, Emanuel et al., 2011, AJA

Of the 195 respondents, # reporting use always or sometimes

Dichotic
  - SSW - 144
  - Digits – 115
  - SCAN,CS – 100
  - Competing Sentences – 91

Monaural low redundancy
  - SCAN – AFG 101; FW 104
  - Speech in Noise – 132

Temporal Processing
  - Pitch Pattern – 138
  - Random Gap – 68
  - Duration Pattern - 55

Binaural Interaction
  - Binaural Fusion – 38
  - MLD – 29

Electrophysiology
  - ABR – 23
  - MLR, Corticals - 13

Our experiences with this battery...

COGNITION, BRAINSTEM
NEURAL INTEGRITY,
DISCRIMINATION SKILLS, ETC.
63 Children Referred for APD Evaluation

**Behavioral**
- Staggered Spondaic Word Test (SSW)
- Auditory Fusion Test – Revised, a test of gap detection
- Filtered Words
- Pitch Pattern Sequence Test
- Competing Words (words in noise)

**Objective**
- Click evoked ABR at slow and fast rates
- Auditory Fusion Test – Revised, a test of gap detection
- Filtered Words
- Pitch Pattern Sequence Test
- Competing Words (words in noise)
- APD = 2 tests > 2 sd below expectations

Basis Auditory Abilities

- 23 Children with no APD diagnosis
- 40 Children with APD diagnosis

APD Test Results

- Staggered Spondaic Word Test
- Auditory Fusion Test - Revised
- Other Central Auditory Tests
RELATION TO COGNITIVE SKILLS

Intelligence (WISC) & Achievement (WRAT)

Language (OWLS) & Phonology (CTOPP)
Language Diagnosis By APD Diagnosis

Typically developing

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<th>Not APD</th>
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Attention (TEA-Ch) and Memory (WRAML)

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<table>
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<tbody>
<tr>
<td>Standard Score</td>
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RELATION TO OBJECTIVE MEASURES – BRAINSTEM NEURAL INTEGRITY
RELATION TO SUPRA-THRESHOLD DISCRIMINATION

Frequency & Level Discrimination
APD & Non-APD

Maxon & Hochberg (1982)
Jensen & Neff (1993)
He, Dubno & Mills (1998)

Temporal Resolution
APD & Non-APD

Irwin, Ball, Kay, Stilman, & Rosser (1985)
Fitzgibbons & Wightman (1982)
Spectral Resolution
APD & Non-APD

Threshold (dB SPL)

Age (years)

Flat
Notched

Veloso, Hall, & Grose (1990)
Hall & Grose (1991)

Masking Level Difference
APD & Non-APD

Thresholds

MLD

$S_0 N_0 - S_0 N_0 (dB)$

Age (Years)

25 30 35 40 45 50 55

Other projects using this diagnostic criterion

TYPICALLY DEVELOPING CHILDREN AND THOSE WITH APD
Speech Evoked ABR /ya/ with Rising and Falling Intonation

Follow Up: Acoustic Reflexes Growth Functions

Factors causing shallower ARGF
a. Decreased static compliance
b. Retrocochlear, brainstem pathology

Shallower Growth in Contralateral Reflexes for Children with APD
Inhibition of OAEs

Butler et al., IJA, 2011

Temporal Integration at Threshold

Children with APD

Adults & Typically developing children

REFLECTIONS ON OUR DIAGNOSTIC BATTERY

Summary and final comments
How Useful is a Diagnosis of APD Made Based Upon This Conventional Battery?

- Results only loosely related to the skills/abilities important to perceptual development.
- Co-morbidity with other disorders is going to be high.
- Underlying auditory neural integrity is often compromised, both with and without the diagnosis.
- Basic encoding abilities and often reduced, with and without the diagnosis.