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Auditory Processing Disorders: Evidence Based Assessment and Intervention (Course #23530)

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- AAA Clinical Guidelines for Auditory Processing Disorders
- Case history and parent/patient survey
- Assessment protocols
  - Peripheral auditory function
  - Central auditory processing
- Listener variables affecting test performance
- Definition of intervention
- Effective Intervention for APD: A Team Approach
  - Audiological intervention strategies
  - Role of the speech-language pathologist
  - Early intervention for APD contributes to reading success
- Wrap up
AAA Clinical Guidelines on Auditory Processing Disorders: A Manual for Evidence Based Assessment and Management (www.audiology.org)

Categories of Research Evidence (ASHA, 2004)

- **1a:** Well-designed meta-analysis of randomized controlled trials
- **1b:** Well-designed randomized controlled trials
- **2a:** Well-designed controlled studies without randomization
- **2b:** Well-designed quasi-experimental studies
- **3:** Well-designed non-experimental studies, i.e., correlational and case studies
- **4:** Expert committee reports, consensus conferences and clinical experience

Evidence-Based Assessment and Management of Auditory Processing Disorders (APD)
Auditory Processing Disorders: Evidence Based Assessment and Intervention

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Assessment of APD: Acquiring History and Background Information

- Parents or patients complete APD history and or 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
  - Reading
  - ADHD
- Previous and current therapy and treatment
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Efficient and Effective Assessment of Peripheral Auditory System Function

Hall JW III. Introduction to Audiology Today. Copyright © Pearson 2014
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)

Measurement of Inner Ear (Outer Hair Cell) Function: Otoacoustic Emissions (OAEs)

[Diagram of OAE measurement process]
Measurement of Inner Ear (Outer Hair Cell) Function: Otoacoustic Emissions (OAEs)

Average DPOAEs for 65 Consecutive Children Evaluated for Auditory Processing Disorders
Tympanometry and 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

Ipsilateral (Uncrossed)
- Sound Right
- Probe Right

Right

Left

Contralateral (Crossed)
- Sound Left
- Probe Right

Ipsilateral (Uncrossed)
- Sound Left
- Probe Left
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Assessment of APD: Central Auditory Test Battery (~ 80 minutes)
We Hear With Our Brain!
Behavioral Test Battery for Assessment of APD
(ASHA, 2005; AAA, 2010)

- **Auditory Discrimination Tests**: Assess the ability to differentiate similar acoustic stimuli that differ in frequency, intensity, and/or temporal parameters, e.g.,
  - Difference limens for frequency, intensity, and duration
  - Phoneme discrimination, e.g., GFW Test of Auditory Discrimination.
- **Auditory Temporal Processing and Patterning Tests**: Assess the ability to analyze acoustic events over time, e.g.,
  - 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 digits test
  - Dichotic words, e.g., Staggered Spondaic Word (SSW) test
  - Dichotic sentence identification test

---

**Dichotic Listening Procedures**

[Diagram showing the Left and Right Temporal Cortices with associated auditory and associated cortex regions, and connections between Left and Right temporal cortices for different auditory stimuli (e.g., hotdog, baseball) via the Corpus Callosum.]
Monaural Low-Redundancy Speech Tests: Assess recognition of degraded speech stimuli presented to one ear at a time (e.g., filtered, time-altered, intensity-altered, e.g.,
- 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: Assess binaural processes dependent on intensity or time differences of acoustic stimuli,
- Masking level difference
- Localization & lateralization, e.g., LiSN-S

- Noise signals with gaps of silence
  - Gaps of different durations and locations within noise
  - Non frequency specific signals
  - Scores not influenced by hearing loss
- Simple button pushing response
  - Signal with either gap or no gap
  - Yes or no response judgment
  - Minimal influence of cognition (for patient and tester)
- Gap detection is a traditional and accepted measure of temporal processing
### APD ASSESSMENT: Creative Test Procedures and Protocols … the LISN-S

- Cameron & Dillon. The Listening in Spatialized Noise-Sentences Test (LISN-S): Comparison of the prototype LISN and results from children with either suspected (central) auditory processing disorder or a confirmed language disorder. JAAA 19, 2008.
  - Virtual sound field simulated under earphones
  - Understanding of a story (continuous discourse) presented at 0° azimuth judged (three alternative forced choice adaptive procedure) as:
    - Easy to understand
    - Just understandable
    - Too difficult to understand
  - Distracter sentences presented at 0° (low cue) or 90° (high cue) azimuth
    - Distracter sentences read by same female speaker or different female speakers
  - Speech perception in competition is a traditional, accepted, and practical measure of auditory processing
  - LiSN-S software available from Phonak

### APD Assessment: Additional Components of Test Battery (as indicated)

- **Auditory Continuous Performance Test (ACPT)**
  - Developed by Robert Keith
  - For children with suspected or diagnosed ADHD
  - 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 at risk for or suspected of reading disorders
  - 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 Evoked with Non-speech and Speech Signals**

- Auditory brainstem response (ABR)
- Auditory steady state response (ASSR)
- Auditory middle latency response (AMLR)
- Auditory late response (ALR)
- Auditory P300 response
- Mismatch negativity (MMN) response
  [Not a clinical test]

**Auditory Processing Disorders: Evidence Based Assessment and Intervention**

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2000 Bruton Consensus Conference on Diagnosis of APD (Jerger & Musiek, 2000): Listener Variables and Test Strategies (1)

- **Attention**
  - Formal assessment for ADHD as indicated
  - Child with ADHD takes medicine on day of APD assessment

- **Fatigue**
  - Schedule APD assessment in the morning
  - Give patient frequent rest periods

- **Hearing sensitivity**
  - Perform complete basic hearing assessment first
  - Manage conductive hearing loss before APD assessment

- **Developmental age and cognitive variables**
  - Formal IQ testing as needed
  - Score APD test results accordingly
  - Consider non-verbal intelligence test if verbal scores are usually low, e.g.,
    - UNIT (Universal Intelligence Test)
    - TONI (Test of Non-Verbal Intelligence)

2000 Bruton Consensus Conference on Diagnosis of APD (Jerger & Musiek, 2000): Listener Variables and Test Strategies (2)

- **Medications**
  - Patient takes regular medications on the APD test day
  - Take into account psychotropic drugs

- **Motivation**
  - Parent explains to child the importance of testing
  - Child is praised often during assessment
  - Most difficult tests are administered toward the end of the assessment

- **Motor skills**
  - Picture pointing tests for children with articulation disorders

- **Native language, language experience, language age**
  - Administer non-verbal auditory tests
  - Administer tests with minimal linguistic loading (e.g., dichotic digits)
  - Rely on objective auditory procedures (e.g., auditory evoked responses)

- **Visual acuity**
  - Child wears glasses during hearing test
Auditory Processing Disorders:
Evidence Based Assessment and Intervention

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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**: “...refers to compensatory approaches (e.g., strategies, technologies) used to reduce the impact of deficits that are resistant to remediation.”
AUDITORY PROCESSING DISORDERS (APDs): Incremental Deficits Model

- > Intelligence
- Normal hearing
- Family support
- Genetics
- Environment
- Auditory stimulation

- < Intelligence
- Conductive HL
- ADD/ADHD
- Genetics
- SLI
- APD

Academic Achiever

Academic Underachiever

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Auditory Processing Disorders (APD): The Multi-Risk Model for Developmental Learning/Language Disorders

- APD is usually not a separate entity or “core deficit”
- Part of multi-component developmental learning/language disorders
- There are multiple risks for auditory function, spoken language, and written language
- Multiple underlying weaknesses reach a “clinical threshold”
- APD often co-exists with
  - Specific language impairment (SLI)
  - Attention deficit hyperactivity disorder (ADHD)
  - Reading disorders (dyslexia)
  - Emotional or psycho-social disorders

Effective Intervention for APD: The Multi-Disciplinary Team (1)

- Audiologist
  - Assessment in Scope of Practice
  - Management in Scope of Practice
- Speech language pathologist
  - Management in Scope of Practice
  - Assessment of language and reading
- Psychologist
  - Psycho-educational assessment
  - Assessment of cognitive function
  - Formal assessment for ADHD
  - Counseling as indicated
Effective Intervention for APD: The Multi-Disciplinary Team (2)

- Occupational therapist
  - Assessment of visual-motor processing
  - Management of children with ADHD

- Otolaryngologist
  - Management of middle ear disorders

- Developmental pediatrician
  - Rule out developmental delay
  - Child development center comprehensive services

- Neurologist
  - Rule out neurological disorders for patients at risk
  - MRI or other studies as indicated

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“A speech processing algorithm was developed to create more salient versions of the rapidly changing elements in the acoustic waveform of speech that have been shown to be deficiently processed by language-learning impaired (LLI) children … LLI children received extensive daily training with listening exercises …”

Computer-Based Auditory Training (CBAT) Programs

- Cognitive Concepts
  - Earobics
  - cogcon.com
- Lindamood Bell Learning Processes
  - LIPPS and Seeing Stars
  - Lindamoodbell.com
- Scientific Learning
  - FastForWord
  - scientificlearning.com
Auditory, Phonological, and Pre-Reading Skills Addressed by Earobics Program

- Rhyming
- Phoneme identification
- Blending (combining sounds into words)
- Segmentation (of words down into sounds)
- Phonological manipulation
- Discrimination
- Auditory performance in competing noise
- Auditory sequential memory

Earobics: Comments from Website (www.cogcon.com)

Earobics is widely considered to be one of the most validated and quantifiable reading intervention programs. States across the country have reviewed the program and approved its use in their schools to quickly and effectively build student reading achievement.

Independent industry reviewers, including the Florida Center for Reading Research (FCRR), confirm these findings. As a vital source for districts and schools, FCRR regularly reviews reading programs to help teachers, principals, and district administrators make informed choices on effective instruction.

Earobics was among the select few programs in the supplemental, intervention, and technology-based program categories to achieve the FCRR’s highest ranking in all five reading areas.

NOTE: FCRR = Florida Center for Reading Research (www.fcrr.org)
Dichotic Intensity Increment Difference (DIID) Tasks

(Discussed in Jeff Weiheing Lecture)

Deborah W. Moncrieff*
Diane Wertz

* Department of Communication
Science and Disorders, University of Pittsburgh, USA

FM Technology:
Personal FM Devices and Classroom Amplification

SNR improvement on the HINT in Normal Hearing Adults and Children Without and With APD: Three different FM system types (Crandell & Hall)

<table>
<thead>
<tr>
<th>Listening Condition</th>
<th>Adults (N = 10)</th>
<th>Non-APD (N = 8)</th>
<th>APD (N = 12)</th>
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<tbody>
<tr>
<td>Head set</td>
<td>7.5</td>
<td>4.0</td>
<td>9.5</td>
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<tr>
<td>Desk top</td>
<td>4.7</td>
<td>3.8</td>
<td>6.5</td>
</tr>
<tr>
<td>Sound field</td>
<td>7.4</td>
<td>4.3</td>
<td>7.2</td>
</tr>
</tbody>
</table>
Phonak EduLink FM System Use Improves Academic Performance and Psychosocial Status in Children with APD


---

Hearing in Noise Test (HINT) Results

*Mean SNR values without and with EduLink*

<table>
<thead>
<tr>
<th>Test Condition</th>
<th>Control</th>
<th>APD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaided in Noise (SNR)*</td>
<td>7.9 dB</td>
<td>6.1 dB</td>
</tr>
<tr>
<td>Aided in Noise (SNR) **</td>
<td>- 0.3 dB</td>
<td>- 4.2 dB</td>
</tr>
<tr>
<td>Advantage in Noise with EduLink</td>
<td>8.2 dB</td>
<td>10.3</td>
</tr>
</tbody>
</table>

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

Typical Classroom SNR Range: +5 to -7 dB
Markides (1986); Finitzo-Hieber (1988); Crandell and Smaldino (1995)
Multiple Benefits of Personal FM System Use for Children with APD

- 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*

Evidence Based Management of APD: Recent Research with FM Technology

  - “Classroom FM technology enhances acoustic clarity”
  - Assessed impact of classroom FM system use for 1 year on auditory neurophysiology and reading skills in children with dyslexia
  - FM system use reduced the variability of sub-cortical responses (speech ABR)
  - Improvement was linked to increases in reading and phonological awareness
  - Matched control group of children with dyslexia didn’t show the effects
  - Conclusion: “Assistive listening devices can improve the neural representation of speech and can impact reading-related skills
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Role of Speech-Language Pathologist: “Top-Down” Intervention Options for Children with APD

- Context-derived vocabulary building
- Visual imagery
- Visualizing and Verbalizing Program
- Auditory closure activities
- Speech/language therapy
- Multi-sensory reading strategies
  - Lindamood Bell Learning Processes (www.lindamoodbell.com)
  - Wilson Reading Program
  - Orton Gillingham approaches
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The Early Auditory Reading Success (EARS) Program: Assumptions

- Auditory processing and language deficits play a role in reading failure.
- “Struggling readers” have weak auditory processing skills that reduce the effectiveness of traditional reading instruction.
- The outcome of screening for auditory processing disorders contributes to detection of children at risk for reading failure.
- Children at risk for reading failure (e.g., impoverished children attending Title I schools) will benefit from:
  - Classroom FM amplification
  - Computer-based training for auditory and pre-reading skills (Earobics)
- Intensive intervention for children with auditory processing and reading readiness deficits is effective in preventing reading failure and in promoting academic success.
- Cost of implementation of the EARS program will be within State of Florida guidelines (< $30 per child) for special instructional programs.
Staggered Spondaic Word (SSW) Test: Normative Data for 5 Year Old Children (Katz, 1985)

**CORRELATION OF APD SCREENING (SSW) OUTCOME WITH RISK FOR READING FAILURE BASED ON FINDINGS OF EARLY READING SUCCESS INDICATOR (ERSI)**

**Significant at p < 0.05**

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**COMBINED NATIONAL SAMPLE 1985**

*C-SSW NORMS (% Error)*

(For Traditional Analysis only)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>RNC</th>
<th>M</th>
<th>SD</th>
<th>NL</th>
<th>RC</th>
<th>M</th>
<th>SD</th>
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<td>7</td>
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<td>13</td>
<td>30</td>
<td>30</td>
<td>17</td>
<td>47</td>
<td>2</td>
<td>8</td>
<td>10</td>
<td></td>
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<td>7-8</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>15</td>
<td>7</td>
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<td>29</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td></td>
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</tr>
<tr>
<td>9-10</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>3</td>
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<td>12-18</td>
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<td>2</td>
<td>4</td>
<td>2</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

N = 107

Norms are set at 1 SD poorer than the mean for all age groups except 12-18 years. Their’s is 2SD. Based on 40 item test except for 5 year-olds whose norms are based on the first 20 ER-items.

---

**Left Ear Competing Error Scores**

Mean = 11.79
SD = 3.11
N = 107

---

**ERSI Scores**

Mean = 27.471
SD = 8.1076
N = 107
**EARS: Screening and Monitoring Reading Readiness with the DIBELS (Dynamic Indicator of Early Literacy Skills)**

- Developed at the University of Oregon (www.dibels.uoregon.edu)
- Details in publications by Roland H. Good III and colleagues
- Required by Alachua County School System (and in state of Florida) to monitor academic progress in kindergarten children
- Four measures of reading readiness skills
  - Initial sounds fluency (ISF)
  - Letter naming fluency (LNF)
  - Phonemic segmentation fluency (PSF)
  - Nonsense word fluency (NSF)
- Administered four times in kindergarten year
  - Early fall semester (September)
  - Late fall semester (December)
  - Early spring semester (January)
  - Late spring semester (May)

**The Early Auditory Reading Success (EARS) Program: Intervention**

- Classroom FM amplification system in each kindergarten classroom
- All children completed Earobics program during their kindergarten school year
- Intensive small group instruction on auditory, phonemic awareness, spelling & writing skills for children with abnormally low SSW scores
Early Auditory Reading Success (EARS): Final Kindergarten Outcome 2005 by DIBELS scores (Williams Elementary School)

DIBELS (Reading Readiness) Outcome Kindergarten to 3rd Grade
(Kindergarten scores include: letter naming fluency, initial sound fluency, phoneme sequence fluency)

<table>
<thead>
<tr>
<th>DIBELS RLI*</th>
<th>Control Schools (N = 140)</th>
<th>EARS Schools (N = 295)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten Initial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial (established)</td>
<td>39%</td>
<td>38%</td>
</tr>
<tr>
<td>Strategic (emerging)</td>
<td>37%</td>
<td>38%</td>
</tr>
<tr>
<td>Intensive (deficit)</td>
<td>24%</td>
<td>24%</td>
</tr>
<tr>
<td>Kindergarten Final</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial (established)</td>
<td>55%</td>
<td>90%</td>
</tr>
<tr>
<td>Strategic (emerging)</td>
<td>21%</td>
<td>6%</td>
</tr>
<tr>
<td>Intensive (deficit)</td>
<td>24%</td>
<td>4%</td>
</tr>
<tr>
<td>3rd Grade (Final Oral Reading Fluency)</td>
<td></td>
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<tr>
<td>Initial (established)</td>
<td>46%</td>
<td>57%</td>
</tr>
<tr>
<td>Strategic (emerging)</td>
<td>30%</td>
<td>27%</td>
</tr>
<tr>
<td>Intensive (deficit)</td>
<td>24%</td>
<td>16%</td>
</tr>
</tbody>
</table>
Evidence-Based Assessment and Management of Auditory Processing Disorders (APD):
Conclusions

- Risk factors facilitate early identification of APD in children and adults
- APD co-exists but can be differentiated from other disorders
- Auditory specific processing disorders can be diagnosed in children and adults following evidence-based clinical guidelines
- Failure to diagnosis and treat APD contributes to communication disorders, academic underachievement, reading failure, and psychosocial problems
- There are evidenced-based intervention strategies for APD
- Reading failure can be prevented with early detection of and intensive intervention for auditory processing deficits