Assessment and Management of Auditory Processing Disorders (APD)

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

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

 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)

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

- 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

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Recognition of Auditory Processing Disorders in the 1950s

  - "hearing is a receptive sense … and essential for normal language behavior" (p. 11) … "the diagnostician of auditory problems in children has traditionally emphasized peripheral damage. It is desirable that he (sic) also include central damage." (p. 54)
- Donald Broadbent. Developed dichotic listening paradigm in 1956

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

- Bocca & Calearo Myklebust
- Willeford Jerger Katz Kimura
- AMLR studies Musiek Keith
- Task procedures MRI studies
- ASHA Task Force Tallal Kraus
- Bruton APD Conference MRI Earobics AAA Guidelines

Consequences of Late Identification of APD in Children

- Ineffective and inefficient communication
- Reading delay or failure
- Academic underachievement or failure
- At risk for specific language impairment
- Psychosocial problems
- More likely to be special education student or school drop out
- Longer-term and less effective remediation

Dichotic Listening Paradigm

Right Ear:
- Primary Auditory Cortex
- Corpus Callosum
- Right Ear
- air plane
- 1, 3

Left Ear:
- Primary Auditory Cortex
- Left Ear
- base ball
- 5, 9

AUDITORY PROCESSING:
Cornerstone of Language and Literacy (Reading)

- COMPREHENSION
- WRITTEN LANGUAGE
- Reading and Spelling
- PHONOLOGIC AWARENESS
- ORAL LANGUAGE

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Basic Neuroscience Advances in the Decade of the Brain (1990s) Impacted Understanding of APD

- Different regions mature at different rates
  - Maturation occurs along caudal to rostral gradient
- Development of auditory pathways and centers involves
  - Cell differentiation and migration
  - Myelination
  - Arborization
  - Synaptogenesis
- Consistent and typical auditory stimulation (experience) within the first years after birth shapes nervous system development (plasticity)
- Perinatal and childhood factors influence development of auditory processing, e.g.,
  - Neurological risk factors (e.g., asphyxia, hyperbilirubinemia)
  - Conductive hearing loss
  - Environmental deprivation
- Genetic factors play a role in etiology of auditory processing disorders

Confirmation of Brainstem-Level Auditory Processing Deficits with Speech-Evoked Auditory Brainstem Response

- Stimulus: Clicks, Tones, Speech
- Electrodes: Auditory Evoked Response System (computer)
- 0.5 µV
- 8 ms
Auditory Processing Deficits in Language Learning and Reading: Neurophysiological Evidence from Northwestern University


MISMATCH NEGATIVITY (MMN) RESPONSE: Investigations in clinical populations

- Assessment of infant speech perception, including children at risk for disorders, e.g., language (e.g., Loppa and Lyytinen, 1997)
- Hearing aid fitting of infants and young children with speech signals (e.g., Kraus, et al)
- Cochlear implant fitting infants and young children with speech signals (e.g., Kraus, et al)
- Documentation of auditory training and language treatment (e.g., Kujala et al. 2001)
- Description of Alzheimer’s disease (e.g., Pekkonen et al, 1994)
- Electrophysiologic documentation of attention deficit hyperactivity disorder (e.g., Barry, Johnston, Clarke, 2003)
- Prognosis of recovery from coma (e.g., Kane et al, 1993)
- Diagnosis of frontal and auditory temporal lobe dysfunction in schizophrenia (e.g., Mitchell et al, 2000)
- Neurophysiologic documentation of auditory processing disorder (APD) and dyslexia in children

“fMRI” and “Auditory” Medline Citations:
> 700 Peer Reviewed Articles (1)


“fMRI” and “Auditory” Medline Citations:
Hundreds of Peer Reviewed Articles (2)

- Talavage et al. (2013). Auditory neuroimaging with fMRI and PET. Hearing Research, (September)
- Scott SK. (2013). The neurobiology of speech perception and production—can functional imaging tell us anything we did not already know? J Communication Disorders, 45, 419-425
- Lazard et al. (2012). Speech processing: from peripheral to hemispheric asymmetry of the auditory system. Laryngoscope, 122, 167-173
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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): The Multi-Risk Model for Developmental Learning/Language Disorders

- Evidence for “incremental deficits model”
  - 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”
- Ferguson et al. (2011). Communication, listening, cognitive, and speech perception skills in children with APD. J Speech Language Hearing Research, 54, 211-222
Relation Between Auditory Processing Disorders (APD) and Specific Language Disorder

- Murphy CF & Schochat E (2013). Effects of different types of auditory temporal training on language skills: A systematic review. Clinics (Sao Paulo), 68, 1364-1370
- Specht K. (2013). Neuronal basis of speech comprehension. Hearing Research, pre-print

Relation Between Auditory Processing Disorders (APD) and Specific Language Disorder

  - "Some support exists for the claim that auditory and language interventions can improve auditory functioning in children with APD and those with primary spoken language disorder. There is little indication, however, that observed improvements are due to the auditory features of these programs. Similarly, evidence supporting the effects of these programs on spoken and written language functioning is limited."
  - "The review provided by Fey et al. (2011) is limited due to the exclusion of pertinent efficacy studies from their analysis, inclusion of studies that did not employ strictly auditory-based therapies, and lack of well-defined experimental groups in many of the studies cited. Further, the questions posed by their literature review may not have addressed the efficacy of true auditory interventions in the remediation of auditory difficulties in children who have primary deficits in central auditory processing."

Auditory Processing Disorders: Indicators 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)

Auditory Processing Disorders: Indicators in Early School Age Population and Screening for At Risk Children
Auditory Processing Disorders: Indicators in Early School Age Population and Screening for At Risk Children

SCAN-C and SCAN-A (Robert Keith, 1986): Undefined sensitivity and specificity

- Low pass filtered words subtest
  - 40 monosyllabic words (20 for each ear)
  - low pass filtered at 1000 Hz
- Auditory figure-ground subtest
  - 40 monosyllabic words (20 for each ear)
  - multi-talker babble noise at +8 dB SNR
- Competing words
  - 40 monosyllabic words (20 for each ear)
  - inter-word interval of ≤5 ms
  - initial response to right then left ear words
- Competing sentences
  - 15 target and competing sentences
  - initial response to right then left ear sentences

Auditory Processing Disorders in Adults: Some of the Etiologies

- Aging of the central auditory nervous system
  - Longstanding evidence
  - Recent findings
- Combined peripheral and central auditory disorders
  - Central auditory dysfunction with progressive peripheral hearing loss
  - Peripheral hearing loss with progressive central auditory dysfunction
- Dementia and psychiatric/Neurological disorders, e.g.,
  - Neoplasms
  - Cardiovascular disease
  - Dementias (Alzheimer’s dementia)
  - Schizophrenia?
  - Parkinson’s Disease
- Traumatic head injury
  - Motor vehicle accidents
  - Gunshot wounds
  - Military blasts and explosions

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Auditory Processing Disorders in Adults: Risk Factors and Clinical Indications

- Medical history revealing one or more etiologies in previous slide
- Audiological history
  - Communication complaints greater than expected by audiogram
  - Deterioration in communication abilities with stable audiogram
  - Unusually poor benefit from amplification
- Audiological findings
  - Abnormality for crossed versus uncrossed acoustic reflexes
  - Speech audiometry
    - Very poor speech perception
    - Rollover on PI PB functions
    - Problems with speech in noise
  - Slow response time and processing speed
  - Poor benefit from amplification

AUDITORY PROCESSING DISORDERS: Associated Psychosocial Problems

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

- Externalizing Prob: Hyperactivity, Aggression, Conduct Problems
- Internalizing Prob: Anxiety, Depression, Somatization
- BASI: Atypicality, Withdrawal, Attentional Problems

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

- Internalizing Prob: 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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Assessment of APD:
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)

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

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
  - Psychophysical tuning curves
  - 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 CVs
  - Dichotic digits test
  - Dichotic words, e.g., Staggered Spondaic Word (SSW) test
  - Dichotic sentence identification test
We Hear With Our Brain!

Behavioral Test Battery for Assessment of APD
(ASHA, 2005; AAA, 2010)

- 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
    - Synaptic 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

APD ASSESSMENT:
The GIN …. A Creative New Non-Verbal Test Procedure

  - 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 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
  - Phonemic synthesis test
    - Developed Jack Katz
    - 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)

2000 Bruton Consensus Conference on Diagnosis of APD: 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: 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

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."

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Effective Management Strategies and Procedures: 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

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]

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Scientific Learning
- FastForWord
- scientificlearning.com

Cognitive Concepts
- Earobics
- cogcon.com

LindamoodBell Learning Processes
- LIPPS and Seeing Stars
- Lindamoodbell.com

Review of Evidence-Based Research on Effectiveness of Fast ForWord by Coalition for Evidence-Based Policy (www.evidencebasedprograms.org)

“Randomized controlled trial of 512 3rd through 6th grade students reading substantially below grade level in 4 elementary schools in an economically disadvantaged, urban school district. Students were randomly assigned within each school and grade into either a group that used Fast ForWord as an add-on to their regular reading instruction, or a control group that did not.

The school district appears to have implemented Fast ForWord effectively, with teacher training and other support provided by Fast ForWord’s developer. However, just under half of the students in the intervention group fully completed the program.

Effect of Fast ForWord as measured at several points during the year following the intervention:

* No significant effect on students’ reading achievement, as measured by their scores on the state’s standardized reading assessment as well as other researcher-administered standardized tests.*

Intervention for APD: Computer-Based Auditory Therapy (www.cogcon.com)

Earobics comes in two versions:

- Earobics Foundations for pre-kindergarten, kindergarten, and first grade students
- Earobics Connections for second and third grade students, and other struggling readers

Instructions available in 10 languages

Auditory, Phonological, and Pre-Reading Skills Addressed by Earobics Program

- Rhyming
- Phoneme identification
- Blending (combining sounds into words)
- Segmentation (breaking words down into individual 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

Deborah W. Moncrieff*
Diane Wertz

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

International Journal of Audiology 2008; 47:84
Auditory rehabilitation for interaural asymmetry: Preliminary evidence of improved dichotic listening performance following intensive training

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>SNR Improvement (in dB SPL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults (N = 10)</td>
<td>7.5 4.0 7.4 9.5 7.2</td>
</tr>
<tr>
<td>Non-APD (N = 8)</td>
<td>4.7 2.8 4.3 6.5 3.8</td>
</tr>
<tr>
<td>APD (N = 12)</td>
<td>10.5 6.5 10 12</td>
</tr>
</tbody>
</table>

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

FM Technology:
Personal FM Devices and Classroom Amplification

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

BASC II Parent Report Results After EduLink Use (6 to 7 months): APD versus Control Subjects

<table>
<thead>
<tr>
<th>Domain</th>
<th>Normal Findings per Group (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>Aggression</td>
<td>92</td>
</tr>
<tr>
<td>Conduct problems</td>
<td>92</td>
</tr>
<tr>
<td>Anxiety</td>
<td>84</td>
</tr>
<tr>
<td>Depression</td>
<td>92</td>
</tr>
<tr>
<td>Internalizing problems</td>
<td>77</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>84</td>
</tr>
<tr>
<td>Attention problems</td>
<td>92</td>
</tr>
<tr>
<td>Adaptive skills</td>
<td>92</td>
</tr>
<tr>
<td>Functional communication</td>
<td>92</td>
</tr>
</tbody>
</table>

Typical Classroom SNR Range: +5 to -7 dB
Markides (1988); Finitzo-Hieber (1988); Crandell and Smaldino (1995)
BASC II Student Report Results After EduLink Use (6 to 7 months): APD versus Control Subjects

<table>
<thead>
<tr>
<th>Domain</th>
<th>Control (%)</th>
<th>APD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude toward teachers</td>
<td>100</td>
<td>86</td>
</tr>
<tr>
<td>Attitude toward school</td>
<td>100</td>
<td>57</td>
</tr>
<tr>
<td>School problems</td>
<td>100</td>
<td>71</td>
</tr>
<tr>
<td>Conduct problems</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>Atypicality</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Anxiety</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Social stress</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>Depression</td>
<td>100</td>
<td>86</td>
</tr>
<tr>
<td>Internalizing problems</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Sense of inadequacy</td>
<td>100</td>
<td>86</td>
</tr>
<tr>
<td>Parent relationship</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>Self esteem</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

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

APD Management Strategies


Examples of “Top-Down” and Multi-Sensory Reading 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

APD Management (Treatment): ASHA Preferred Practice Patterns for Audiology (1997)

- Treatment plan
  - Assistive listening devices
  - Acoustic enhancement and environmental modification of the listening environment
  - Auditory training and stimulation (including computer-based software programs)
  - Communication and/or education strategies
  - Meta-linguistic and meta-cognitive skills and strategies
  - Documentation of implementation of frequency and duration of treatment
  - Documentation of outcome
Early Auditory Reading Success (EARS): Pilot Study (2002-2003) in Gainesville Florida

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

Early Auditory Reading Success (EARS) Program; Pilot Study

- Conducted at Title I elementary school in Gainesville Florida (free breakfast and lunch for majority of children)
- Funded with $5000 from Harry Heeb Foundation
- 75 kindergarten children
- Screenings performed gratis by Au.D. students and James W. Hall III, Ph.D., including
- Components of EARS program (implemented by end of fall semester)
  - Old used FM systems in each of 3 kindergarten classrooms (donated by Carl Crandell)
  - Earobics installed on used laptops
  - 0.5 FTE speech pathologist for intensive small group instruction

Early Auditory Reading Success (EARS) Program: Screening Protocol

- Auditory status
  - Peripheral auditory system
    - DPOAEs
    - Tympanometry
    - Pure tone screening
  - Central auditory system
    - Staggered spondaic word (SSW) test
- Initial language and reading readiness
  - (ERSI) Early Reading Screening Inventory (Lombardino et al, 1999)
  - All screening conducted by J Hall and AuD students
- Reading readiness and reading outcome
  - Dynamic Indicators of Basic Early Literacy Skills (DIBELS)
  - Screening four times per year conducted independently by reading specialists per state mandate
  - No communication between personnel conducting DIBELS versus other screenings

Staggered Spondaic Word (SSW) Test:
Normative Data for 5 Year Old Children
(Katz, 1985)

<table>
<thead>
<tr>
<th>Age</th>
<th>BOA</th>
<th>PD</th>
<th>DOA</th>
<th>BC</th>
<th>LC</th>
<th>NC</th>
<th>IC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4-5</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4-6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4-7</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4-8</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4-9</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4-10</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes are set at 1 SD poorer than the mean for all age groups except 13-19 years. That's a 2SD.
Based on 49 items total except for 5-year-olds whose means are based on the first 20 IC notes.

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

Left Ear Competing Error Scores

ERSI Scores
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

The Early Auditory Reading Success (EARS) Program: Intensive Intervention by Speech Pathologist (1)

- Phonological Awareness (3 to 5 minutes)
  - Recognizing rhyme, generating rhyme, matching rhyme
  - Phoneme detection
  - Blending (phoneme, syllable, and word level)*
  - Segmenting (phoneme, syllable, and word level)
  - Detection or elision (phoneme, syllable, and word level)
- Alphabetic Understanding (5 to 6 minutes)
  - Vowel review
  - Consonant review
  - Introduce new sound
  - Read words with new sound

* Sound pairs were introduced in the order recommended in the Lindamood-Bell LiPS program

The Early Auditory Reading Success (EARS) Program: Intensive Intervention by Speech Pathologist (2)

- Writing (3 to 4 minutes)
  - Review new letter name and sound
  - Trace new sound
  - Write new sound
  - Write previously introduced sounds
- Spelling (7 to 8 minutes)
  - Segment and blend words (alternate using tiles, letter cards, dry erase)
  - Manipulate sounds within words
- Reading (6 to 7 minutes)
  - Introduce and review sight words
  - Read decodable book

DIBELS (Reading Readiness) Outcome in the Initial (Pilot) EARS Project in 2002-2003

<table>
<thead>
<tr>
<th>DIBELS Outcome</th>
<th>EARS School</th>
<th>Control School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early N = 52</td>
<td>Final N = 63</td>
</tr>
<tr>
<td>Deficit</td>
<td>50%</td>
<td>27%</td>
</tr>
<tr>
<td>Emerging</td>
<td>31%</td>
<td>22%</td>
</tr>
<tr>
<td>Established</td>
<td>19%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Early Auditory Reading Success (EARS) Program

- Proposed and implemented in four Alachua County public elementary schools during 2004/2005 and 2005/2006 academic years
- Funded from various sources as a special project through the Exception Student Education (ESE) Department
- Each school met Title 1 criteria (free breakfast and lunch for majority of children)
- N = 322 children with average age of 5 years
  - 139 male
  - 153 female
- Hearing screenings performed (gratis) by Au.D. students and mentor, James W. Hall III, Ph.D.
Early Auditory Reading Success (EARS): Final Kindergarten Outcome 2005 by DIBELS scores (Williams Elementary School)

<table>
<thead>
<tr>
<th></th>
<th>Control Schools (N = 140)</th>
<th>EARS Schools (N = 295)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten Initial</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>55%</td>
<td>50%</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>46%</td>
<td>57%</td>
</tr>
<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>

*RLI = Recommended Level of Instruction; Initial = low risk of reading failure; Strategic = moderate risk of reading failure; Intensive = high risk of reading failure

Multiple Tiers of Reading Instruction Models: Conventional (e.g., Torgesen, 2005) vs. Early Intervention (EARS)

EARS Program (2005-2006): Early (Kindergarten) Intervention Program for At Risk Struggling Children


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