Auditory Processing Disorders (APD) in Children and Adults: Part 2. A Team Approach to Management

- Introduction
- Counseling & Advocacy
- FM technology
- Computer-based auditory training
- Direct auditory remediation
- Language-based options

Auditory Processing Disorders: Scope of Practice
(American Academy of Audiology, 2004)

Assessment and Diagnosis
Assessment of hearing includes the administration and interpretation of behavioral, physioacoustic, and electroacoustic measures of the peripheral and central auditory systems. Assessment of the vestibular system includes administration and interpretation of behavioral and physioacoustic tests of equilibrium. Assessment is accomplished using standardized testing procedures and appropriately calibrated instrumentation and leads to the diagnosis of hearing and/or vestibular abnormality.

Management
The audiologist administers audiologic identification, assessment, diagnosis, and treatment programs to children of all ages with hearing impairment from birth through school age. The audiologist is an integral part of the team within the school system that manages children with hearing impairment, assisting teachers and students with hearing loss with classroom assistive devices, assistive listening systems, and communication problems.

Treatment
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Identification
includes identification and amelioration of noise-hazardous conditions, identification of hearing loss, recommendation for, biofeedback, masking, hearing aids, education, and counseling.

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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."
2010 AAA Clinical Guidelines on Auditory Processing Disorders: Intervention

- Bottom up "stimulus driven" approaches often implemented by audiologists, e.g.,
  - Auditory training, e.g.,
    - Earobics
    - LACE (Listening and Communication Enhancement)
  - Direct auditory skill remediation, e.g.,
    - Dichotic Interaural Intensity Difference (DIID) training
    - Aural Rehabilitation for Interaural Asymmetry (ARIA)
  - Enhancement of listening environment
    - Classroom acoustical modifications
    - Classroom amplification (FM) systems
    - Personal FM systems

- Top down "strategy driven" approaches often implemented by speech pathologists and other professionals
  - Language strategies
  - Cognitive/metacognitive strategies
  - Speaker modifications
  - Instructional modifications and strategies
  - Accommodations in the:
    - Workplace
    - Home
    - Recreational setting
    - Religious setting

Auditory Processing Disorders (APD) in Children and Adults: Part 2. A Team Approach to Management

- Management: Appropriate Referrals
  - Speech language pathologist
  - Language assessment
  - Phonological awareness assessment
  - Reading remediation
  - Top-down therapy
  - Psychologist or neuropsychologist
  - Assessment of cognitive function
  - Assessment of ADHD
  - Professional counseling
  - Diagnosis of other disorders (e.g., developmental disorders)
Auditory Processing Disorders (APD) in Children and Adults: Part 2. A Team Approach to Management

- Management: Appropriate Referrals
  - Otolaryngologist
    - Diagnosis of ear disease
    - Management of middle ear dysfunction
  - Neuro-radiological studies
  - Neurologist
    - Assessment of neurological functioning
    - Rule out neurological disease (e.g., seizure disorders)
  - Occupational therapist
    - Evaluation of visual processing
    - Evaluation of motor processing
    - Assessment of sensory integration disorders

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Psychosocial Function in Children with APD
Psychosocial Function in Children with APD: Initial BASC II Parent Report (Johnston et al., 2009)

Psychosocial Function in Children with APD: Initial BASC II Child Self Report (Johnston et al., 2009)

Patient/Family Counseling and Education in APD

“Knowledge is power.”
(Nam et ipsa scientia potestas est.)

Francis Bacon
(1561-1626)

Meditationes Sacrae [1627]
Essentials of Counseling of Patients with APD and Parents/Family Members

- General guidelines
  - Counsel in a quiet and private venue
  - Include spouse, "significant others", and/or family members
  - Introduce yourself with eye contact and a firm (but comfortable) handshake
  - Use respectful titles (e.g., Mr. or Mrs.)
  - Give patient and family members the impression that you have plenty of time and nothing is more important than talking with them
  - Be accepting of statements, feelings, and attitudes but…
  - Gently clarify any misconceptions with factual information
  - Remember: Knowledge is power!

Essentials of Counseling Applied to APD: Types of Counseling

- "Non-professional" counseling (by audiologists)
  - Informational (content) counseling
  - Personal adjustment counseling
- Professional counseling (by trained counselor, psychologist, or psychiatrist)
  - Identifying unconscious behaviors
  - Managing major personality changes (e.g., clinical depression)

*Research shows that > 80% of audiologists and audiology students focus mostly on content counseling, even when the patient and family members express the need for help with psychosocial aspects of hearing loss.

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SNR improvement on the HINT in Normal Hearing Adults and Children Without and With APD: Three different FM system types (Crandell & Hall, 2005)

<table>
<thead>
<tr>
<th>Listening Condition</th>
<th>Adults (N = 10)</th>
<th>Non-APD (N = 8)</th>
<th>APD (N = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head set</td>
<td>7.6</td>
<td>7.4</td>
<td>6.4</td>
</tr>
<tr>
<td>Desk top</td>
<td>6.5</td>
<td>6.7</td>
<td>6.9</td>
</tr>
<tr>
<td>Sound field</td>
<td>5.7</td>
<td>5.8</td>
<td>5.3</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)
### BASC II Parent Report Results After EduLink Use (6 to 7 months): APD versus Control Subjects
(Source: Johnson, John, Kreisman, Hall & Crandell, 2009)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Control</th>
<th>APD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggression</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>Conduct problems</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>Anxiety</td>
<td>84</td>
<td>100</td>
</tr>
<tr>
<td>Depression</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>Internalizing problems</td>
<td>77</td>
<td>71</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>84</td>
<td>71</td>
</tr>
<tr>
<td>Attention problems</td>
<td>92</td>
<td>71</td>
</tr>
<tr>
<td>Adaptive skills</td>
<td>92</td>
<td>71</td>
</tr>
<tr>
<td>Functional communication</td>
<td>92</td>
<td>57</td>
</tr>
</tbody>
</table>

### BASC II Student Report Results After EduLink Use (6 to 7 months): APD versus Control Subjects
(Source: Johnson, John, Kreisman, Hall & Crandell, 2009)

<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>85</td>
</tr>
<tr>
<td>Internalizing problems</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Sense of inadequacy</td>
<td>100</td>
<td>85</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>

### 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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"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 ..."
Selected Intensive & Computer-Based Programs for Development of Auditory Processing Skills

- Earobics
  - earobics.com
- Lindamood Bell Learning Processes
  - LIPPS and Seeing Stars
  - lindamoodbell.com
- Scientific Learning
  - FastForword
  - scientificlearning.com

Earobics Program (Vendor: )

- 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

Fast ForWord also claims to improve the discrimination of brief sounds. Earobics and Fast ForWord have both been developed in the USA, and Phonomena has been developed in the UK. See Table 2 for a brief description of Earobics, Fast ForWord, and Phonomena and the relevant websites. Further information and costs are available from the websites. Fast ForWord is significantly more expensive and professionals are required to complete a ‘Certified Practitioner’ training course before being able to purchase and use the software.

Table 2

<table>
<thead>
<tr>
<th>Program</th>
<th>Website</th>
<th>Cost and Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earobics</td>
<td>earobics.com</td>
<td>Low, no training</td>
</tr>
<tr>
<td>Fast ForWord</td>
<td>scientificlearning.com</td>
<td>High, Certified Practitioner training</td>
</tr>
<tr>
<td>Phonomena</td>
<td>mindweavers.co.uk</td>
<td>Low, no training</td>
</tr>
</tbody>
</table>

Earobics is underpinned by adaptive training technology to adjust the level of instruction to the child’s level and progress, and primarily uses recorded but real speech. It is recommended that the child use Earobics for 15 to 20 minutes per day, three times a week. Earobics Step 1 is designed for developmental ages 4-7 and features six interactive games with over 300 levels of play. It purports to teach phonological awareness and introductory phonics skills required for learning to read and spell, and to develop general cognitive skills that support learning, such as attention and memory. Earobics Step 2 is designed for developmental ages 7-10 and features five interactive games with nearly 600 levels of play. Step 2 targets the same skills targeted in Earobics Step 1, but at more advanced levels, as well as language processing skills for extracting meaning from spoken language and written text.

Earobics Adolescents & Adults provides sophisticated, game-style, multimedia instruction, designed to appeal to adolescents and adults who are struggling to read. Fast ForWord is a series of computer-based exercises (games) designed to improve auditory, language processing, and reading abilities with the view to “train the brain to process at faster rates and help to create or modify the neural pathways”. It uses both speech and non-speech stimuli that have been acoustically modified to slow and amplify transient sounds. Fast ForWord Language Basics is a program aimed at 4-6 year olds and consists of 3 exercises that help to develop visual attention and auditory discrimination skills and sustained auditory attention, and aims to prepare for Fast ForWord Language. There are a number of products available such as: Fast ForWord Language v.2 (ages 5-12), Fast ForWord Middle & High School (adolescents and older learners), Fast ForWord Language to Reading v.2 (which targets the skills that require to make the link between spoken and written language). Fast ForWord Reading is a curriculum-based reading program. The child will usually work on these intensive computer-based exercises 30 minutes a day, 5 days a week for 3-4 months (or more intensively for a year).

Phonomena is an interactive game, designed to improve auditory discrimination and phonemic awareness, and to build language skills. It consists of game-play and graphics designed to appeal especially to 6-12 year olds, while administrator controls give language professionals additional tools. “Phonomena” uses ‘phoneme contrasts’ which are selected from over 1,000 possible in English. At the start of the game, these ‘sounds of words’ are set as normally found in spoken language. Phonomena’s adaptive learning algorithms change the sounds in response to each player’s performance, making the choice more or less difficult, in order for the client to train at the ‘Edge of Competence’ therefore keeping the training at the ‘Edge of Competence’ therefore keeping the training at...

Table 6. Means and standard deviations for the outcome measures for the four training groups that were significant (p < .05). Table shows the individual measures that showed significant improvement post-intervention.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Control</th>
<th>Training-alone</th>
<th>FM groups 1</th>
<th>FM groups 2</th>
<th>Training-alone FM 1</th>
<th>Training-alone FM 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Language</td>
<td>77.1 (10.0)</td>
<td>80.1 (11.7)</td>
<td>82.3 (15.9)</td>
<td>83.5 (15.2)</td>
<td>80.3 (12.1)</td>
<td>81.6 (12.1)</td>
</tr>
<tr>
<td>Reading</td>
<td>66.2 (13.4)</td>
<td>73.2 (13.8)</td>
<td>74.0 (15.0)</td>
<td>74.3 (13.9)</td>
<td>72.1 (12.0)</td>
<td>72.4 (12.0)</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>37.1 (9.2)</td>
<td>43.2 (10.3)</td>
<td>44.5 (11.2)</td>
<td>44.8 (10.2)</td>
<td>42.3 (10.1)</td>
<td>42.6 (10.1)</td>
</tr>
<tr>
<td>Listening Comprehension</td>
<td>77.0 (11.3)</td>
<td>80.3 (12.1)</td>
<td>82.7 (16.0)</td>
<td>83.3 (15.8)</td>
<td>80.9 (12.2)</td>
<td>81.1 (12.2)</td>
</tr>
<tr>
<td>Memory</td>
<td>73.2 (12.0)</td>
<td>77.5 (13.0)</td>
<td>78.5 (14.0)</td>
<td>79.0 (12.9)</td>
<td>76.1 (12.9)</td>
<td>76.3 (12.9)</td>
</tr>
<tr>
<td>Expressive Language</td>
<td>74.7 (12.4)</td>
<td>77.9 (13.4)</td>
<td>79.2 (15.2)</td>
<td>79.5 (13.3)</td>
<td>76.7 (13.3)</td>
<td>76.9 (13.3)</td>
</tr>
<tr>
<td>Inadecquate Listening Comphrension</td>
<td>75.0 (13.3)</td>
<td>80.0 (14.1)</td>
<td>82.0 (16.0)</td>
<td>83.0 (14.9)</td>
<td>80.5 (14.8)</td>
<td>80.7 (14.8)</td>
</tr>
<tr>
<td>Core Language</td>
<td>90.0 (12.0)</td>
<td>93.0 (13.0)</td>
<td>94.0 (15.0)</td>
<td>95.0 (13.9)</td>
<td>92.0 (14.8)</td>
<td>92.2 (14.8)</td>
</tr>
<tr>
<td>Reading</td>
<td>70.0 (11.0)</td>
<td>75.0 (12.0)</td>
<td>76.0 (14.0)</td>
<td>77.0 (12.9)</td>
<td>74.0 (13.9)</td>
<td>74.2 (13.9)</td>
</tr>
<tr>
<td>Vocabulary</td>
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<td>43.0 (10.0)</td>
<td>44.0 (11.0)</td>
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<td>42.0 (10.0)</td>
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<td>82.0 (14.0)</td>
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<td>79.5 (12.9)</td>
<td>79.7 (12.9)</td>
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</tr>
</tbody>
</table>

Conclusions: Positive results were not limited to the areas specifically targeted for training and FM approaches interact to assist children with APD.
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Dichotic Intensity Increment Difference (DIID)

Selected Papers Reporting Benefit of DIID Auditory Training Programs

Direct Auditory Remediation: Auditory Rehabilitation for Interaural Asymmetry (ARIA)

Diagnosis of amblyaudia in children referred for auditory processing assessment

Evidence of binaural integration benefits following ARIA training for children and adolescents diagnosed with amblyaudia

Conclusions: Results demonstrate...
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Relation Between Auditory Processing Disorders (APD) and Specific Language Disorder

- Specht K. (2013). Neuronal basis of speech comprehension. Hearing Research, pre-print

The Relationship between Central Auditory Processing, Language, and Cognition in Children Being Evaluated for Central Auditory Processing Disorder

DOI: 10.3766/jaaa.16119

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Elizabeth Cash*
†‡
Gail D. Chermak§
Linda Guenette

Gay Masters*
Frank E. Musiek|
Mallory Brown
Julianne Ceruti
Krista Fitzegerald
Kristin Geissler
Jennifer Gonzalez
Jeffrey Weihing*

Abstract
Background: Pediatric central auditory processing disorder (CAPD) is frequently comorbid with other childhood disorders. However, few studies have examined the relationship between commonly used CAPD, language, and cognition tests within the same sample.

Purpose: The present study examined the relationship between diagnostic CAPD tests and “gold standard” measures of language and cognitive ability, the Clinical Evaluation of Language Fundamentals (CELF) and the Wechsler Intelligence Scale for Children (WISC).

Research Design: A retrospective study.

Study Sample: Twenty-seven patients referred for CAPD testing who scored average or better on the CELF and low average or better on the WISC were initially included. Seven children who scored below the CELF and/or WISC inclusion criteria were then added to the dataset for a second analysis, yielding a sample size of 34.

Data Collection and Analysis: Participants were administered a CAPD battery that included at least the following three CAPD tests: Frequency Patterns (FP), Dichotic Digits (DD), and Competing Sentences (CS). In addition, they were administered the CELF and WISC. Relationships between scores on CAPD, language (CELF), and cognition (WISC) tests were examined using correlation analysis.

Results: DD and FP showed significant correlations with Full Scale Intelligence Quotient, and the DD left ear and the DD interaural difference measures both showed significant correlations with working memory. However, 80% or more of the variance in these CAPD tests was unexplained by language and cognition.

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Corresponding author: Jeffrey Weihing, Department of Otolaryngology-Head and Neck Surgery and Communicative Disorders, University of Louisville School of Medicine, Louisville, KY 40202; E-mail: jaweih02@louisville.edu

This research was supported by the Royal Arch Research Assistance (RARA) group.

**Deceased
APD Individualized Management Strategies
(Chermak & Musiek, American Journal of Audiology 1, 1992)

Functional Deficit
- Distractibility/inattention
- Poor memory
- Restricted vocabulary
- Cognitive inflexibility
- Poor listening comprehension
- Reading & spelling problems
- Maladaptive behaviors
- Poor motivation

Strategies:
- Increase SNR
- Meta-language external aids
- Improve closure
- Diversity cognitive style
- Induce formal schema to aid organization & integration
- Enhance multisensory integration
- Cognitive behavior modification
- Internal locus of control attribution retraining

Examples of "Top-Down" and Multi-Sensory Reading Intervention Options for Children with APD

- Context-derived vocabulary building
- Visual imagery
- Visualizing and Verbalizing Program (Lindamood)
- 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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Thank You!
Questions?