# Sorting Out Auditory and Language Processing Disorders!

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# Disclosures

- *Financial*
  - Receive royalties from ProEd publications
    - The Source -Processing Disorders
    - The Source – Development of Executive Functions
    - The Language Processing Test
    - Language Processing Treatment Activities
    - Differential Screening Test for Processing Disorders
    - That's Life Language Cards
  - Receive revenue share from MedBridge courses
  - Receive royalties from Dynamic Resources
- *Nonfinancial*
  - Author of several book chapters and articles on processing
  - ASHA Board of Directors as Immediate Past President

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# Historical Perspective

1954 – Myklebust – "auditory processing" in *Auditory Disorders in Children*

1962 – Vygotsky – "processing" in *Thought and Language:* relation between thought and words not a thing but a process - continuous back and forth movement from thought to word and word to thought

1978 – Weisenberg & Katz – "central auditory processing" in *Neurological considerations in audiology:* ability to receive and integrate auditory information

2005 – ASHA Working Group on Central Auditory Processing Disorders: perceptual processing of auditory information in the CNS and neural activity that underlies that processing

2007 – ASHA Ad Hoc Committee on Role of SLP in APD
2011 - Clinical Forum in LSHSS July 2011

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# Major Points to Consider

- The problem is NOT in reception of signal
- Repeating the signal is minimally helpful
- Individuals process stimuli in different ways

  Cues provide orientation, not the answer
- Processing occurs 'on top' of basic knowledge

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# PROCESSING

**The ability to abstract meaning from an acoustic stimulus**

**Massaro, 1975**

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# Definition: Auditory Processing

- "Refers to the efficiency and effectiveness by which the CNS utilizes auditory information" (ASHA, 2005a).
- "..poor performance in one or more of the following skills
  - Sound localization and lateralization
  - Auditory discrimination
  - Auditory pattern recognition
  - Temporal aspects of audition (e.g., temporal integration, discrimination, ordering, masking)
  - Auditory performance in competing acoustic signals (e.g., dichotic)
  - Auditory performance with degraded acoustic signals"
    (ASHA, 2005b)

*(Central auditory processing disorders: The role of the audiologist:*
*a = Technical report; b = Position statement)*

## Definition: Language Processing

- Ability to interpret or attach meaning to auditorily received information to then formulate an expressive response (e.g., behavior, gesture, verbal, written)

    (Richard, 2017, 2001)

## CAP

- Most are male (75%)
- Normal pure tone hearing
- Trouble following directions
- Short attention span
- Poor memory
- Don't seem to pay attention
- Poor listening in noisy environment
- Trouble locating sound
- Academic deficits
- Behavior problems
- Requests for repetition – "huh"
- Otitis media

## LANGUAGE PROCESSING

- Word retrieval problems
- Neutral generic language
- Similar words
- Original creative words
- Response latency
- "I don't know"
- Rehearsal
- Inconsistent learning
- Recognize but can't fix errors
- Incomplete expressive language
- Pragmatic deficits; behavior problems
- Age commensurate ability

## Characteristics of Processing Disorders

- **Overlap / Similarity in observed behaviors**
- **Same behavioral symptom for different reasons**
- **Differential diagnosis important to determine appropriate intervention approach**

## AUD and SLP = Team Approach

- **Differentiate auditory versus language aspects of disorder**
- **Auditory aspects assessed by audiologist**
- **Language aspects assessed by speech-language pathologist**
- **Need to determine level of breakdown to program effective intervention**
- **Differential diagnosis important to determine appropriate intervention approach**
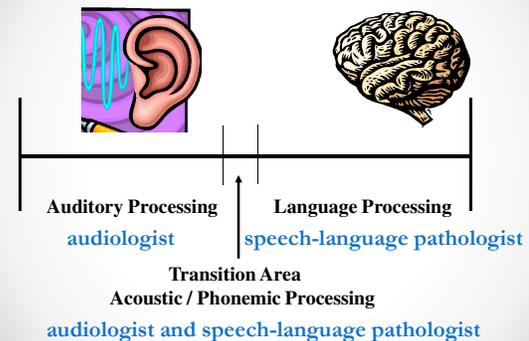
## Problem

**Assessing and/or Treating the multiple aspects of an auditory or language processing disorder is a challenge**

## Adequate Processing Involves Continuum of Skills

- **Intact peripheral auditory system – perceive and receive acoustic stimulus**
- **Intact CANS – transmit through brainstem to upper cortex**
- **Phonemic knowledge to discriminate aspects of the acoustic stimulus**
- **Linguistic knowledge to decode message**
- **Executive function skills to attend, organize, execute behavioral response**

## Continuum of Processing



Auditory Processing
audiologist

Language Processing
speech-language pathologist

Transition Area
Acoustic / Phonemic Processing
audiologist and speech-language pathologist

Richard, 2017, 2001

## Adjunct Problems

"Although abilities such as phonological awareness, attention to and memory for auditory information, auditory synthesis, comprehension and interpretation of auditorily presented information, and similar skills may be reliant on or associated with intact auditory function, they are considered higher order cognitive communicative and/or language related functions and, thus are not included in the definition of (C)APD"   (ASHA 2005a)

## APD vs. CAPD?

- **Myklebust, 1954 – "auditory disorder" – very broad term**
  - Intact peripheral hearing
  - Deficit -ability to listen and meaningfully respond to acoustic stimuli
  - "central deafness" – problem in higher neurological levels of auditory system
  - Auditory agnosia: can't attend or comprehend auditory input
- **Weisenberg & Katz, 1978 – "Central auditory processing"**
  - Post-peripheral auditory deficit
  - Difficulty in ability to receive and integrate auditory information
- **ASHA 2005 working group – (central) auditory processing disorder (C)APD – synonymous terms**

## Consensus Definition of APD?

- Multiple auditory skills encompassed within APD
  - Diagnose by specific deficit skill or global APD?
  - How many auditory skills in deficit = APD?
- Battery of tasks/test for assessment of APD
  - Specific battery not specified
  - Variability among audiologists diagnosing APD
- Lack definitive standard for interpretation of APD test
  - Combination of observed clinical impressions and performance outcomes on assessment tests
  - Recommendation: child perform 2 standard deviations below mean on two or more tests for APD diagnosis
- Issues with specificity and validity of APD assessments
- Need some guidelines for relationship between cognition, language skills, and performance on (C)AP tests (Friberg & McNamara, 2010)

## Relationship of APD and LD?

- **Introduction of APD as clinical entity acknowledged impact of auditory deficits on language development (Myklebust, 1954; Johnson & Myklebust, 1967).**
- **Premise – address auditory perceptual deficits before language**
  - Challenged by Rees (1973) – futile effort to isolate specific auditory abilities as essential to language; artificial effort to make fit
  - Continue to question auditory deficits as significant risk factor for compromised language development (Kamhi, 2011; Watson & Kidd, 2009)
- **Influence of auditory perceptual abilities on language development in pre-literacy skills (e.g., sound-symbol recognition, discrimination)**
- **Acknowledge dynamic interaction between perception of acoustic signal and linguistic decoding to interpret meaning**

## Erroneous Diagnosis of APD?

- Language developmental level influences performance on APD assessment tasks (e.g., directions of dichotic assessment task)
- Referrals from adjunct professional disciplines (e.g., teacher, school psychologist)
  - o Observe deficits in listening, auditory comprehension, discrimination for spelling
  - o Assessment tasks or screening checklists that resulted in APD
- Failure to recognize global profile of child (e.g., ADHD, ASD, EF)
- Early APD in conjunction with developmental delays resolved but diagnosis not changed
- Imperative that AUD and SLP work together to determine primary deficits negatively impacting academic and functional performance (McNamara & Richard, 2012)

## AP Therapy research summary

- Studies note improved performance pre- and post AT in specific auditory skill trained (i.e., "if you drill it, it will come")
- Some evidence of improved phonologic awareness
- Virtually all report improved "hearing" and listening
- Very few reports of generalization of improved auditory-specific processing to academic and/or learning skills
- Some reports of improved language-learning-cognition following use of multi-modal training programs (e.g., IM, BrainHQ)

## Challenges and Controversies

- Definition of auditory processing encompasses a variety of auditory skills (e.g.., auditory discrimination, auditory localization, auditory pattern recognition, temporal aspects, etc)
- Language processing skills begin to overlap with auditory phenomena in upper cortex – difficulty to differentiate at that level
- Functional processing skills involve interpretation, synthesis, comprehension, etc. and are considered higher order cognitive communication or language skills
- Treatment on discrete auditory skills improves those specific skills, but research at present does not support functional outcomes that positively impact language and academic performance
- Is goal of treatment efficacy data to show improvement on discrete auditory skills or functional outcomes in abstracting the encoded linguistic message?

## Acoustic processing

- Encompasses the peripheral and CENTRAL auditory nervous systems and includes:
  - Acuity and signal transformation
  - Binaural interaction
  - Auditory discrimination
  - Temporal processing
  - Dichotic listening

## Ear
## Outer, Middle, Inner



**Peripheral Auditory System**
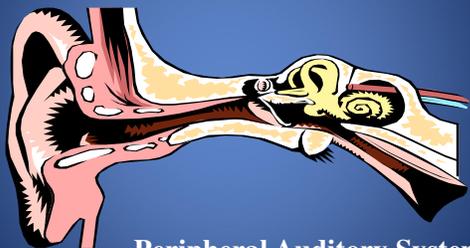
## Peripheral auditory function

- Hearing sensitivity and reflex action
  - Signal collection – outer ear
  - Signal transmission – middle ear
  - Signal detection – inner ear
  - Signal transformation – 8th nerve

## Central Auditory Nervous System (CANS)

- Transfer stimulus from inner ear to cortex
- Extremely complex system
  - Six different points to deal with auditory information
  - Four different pathways
  - Four cross-over points
  - One million cells
  - Eight different cellular responses
  - Six different cell types

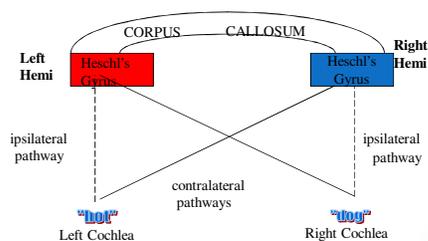---



The Central Auditory Nervous System

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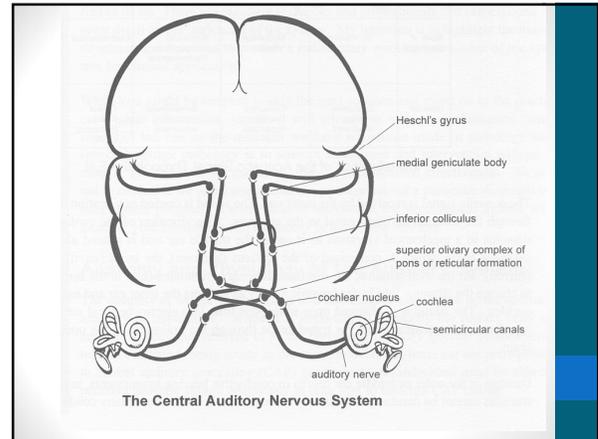
## Philosophy of CAP

- CANS responsible for transferring auditory signal through brainstem to cortex
- Signal reaches brain intact = normal CAP
- Signal distorted or compromised when reaches brain = CAPD

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## Central Auditory Processing

- **Purpose**
  - Assess brainstem and cortical function
  - Stress the system by eliminating redundancy or compromising the signal

- **Premise**
  - Brain looks for consistency in processing auditory signal
  - If confusing signal, abnormal behavioral response
  - Meaning derived from signal not dependent on receiving every formant
  - Acoustic info combines with linguistic context to attach meaning

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### AUDITORY SYSTEM DOMINANCE



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## Example Acoustic Skills

- Binaural processing
  - Auditory Localization
  - Speech in Noise
- Temporal processing
  - Temporal pattern discrimination/recognition
  - Temporal recognition/manipulation of multiple targets
- Auditory Vigilance

## Acoustic Processing – Modifications and Strategies

- Gain visual attention before beginning to present verbal directions
- Position yourself in good light and facing the student
- Eliminate/reduce distracting background noise
- Direct signal enhancement via assistive technology
- Use Clear Speech
- It's all about improving access to acoustic signal

## PHONEMIC/PHONETIC PROCESSING

## Phonetic / Phonemic Processing

- Preliteracy foundation
  - Sound-symbol correspondence
  - Spelling
  - Reading
  - Written Language
- Weak area for this generation
  - Visual learners
  - "Text speak"

## Phonemic Processing Skills

- Auditory Analysis / Segmentation
- Auditory Attention
- Auditory Association
- Auditory Closure
- Auditory Discrimination
- Auditory Figure Ground
- Auditory Localization
- Auditory Memory
- Auditory Sequential Memory
- Auditory Synthesis / Sound Blending/Closure

## Phonemic Processing – Modifications & Strategies

- Use visual phonics or gestures to represent various auditory sounds
- Play games using visual-motor actions to represent auditory sounds or segments
- Play detective to analyze and segment sound aspects of words
- It's about structure and quantity of incoming information

## Example Assessment Instruments for Functional Auditory Skills

- Illinois Test of Psycholinguistic Abilities (ITPA)
- SCAN
- Differential Screening Test for Processing (DSTP)
- Goldman-Fristoe-Woodcock
- Phonological Awareness Test (PAT)
- Comprehensive Test of Phonological Processing (CTOPP)
- Test of Auditory Processing Skills (TAPS)

## Linguistic Processing

- Language Foundation for metalinguistic skills
- Ability to comprehend and express ideas through auditory to verbal modality
- Conceptual basis for higher level, more complex language

## Language processing

- Labeling
- Stating Functions
- Association
- Categorization
- Antonyms
- Synonyms
- Idioms
- Analogies
- Multiple Meanings
- Stating Attributes

## Example Assessment Instruments for Language

- Language Processing Test (LPT)
- Comprehensive Assessment of Spoken Language (CASL)
- WORD
- Bracken Basic Concept Scale
- Test of Problem Solving (TOPS)
- Listening Test
- Test of Language Development (TOLD)

- Caution: Be sure you are assessing temporal lobe/auditory skills; monitor influence of other modalities (e.g., visual, motor)

## Linguistic Processing – Modifications & Strategies

- Repetition, rehearsal, restatement, and confirmation of auditory information
- Provide clear, succinct verbal directions
  - Use clear language
- Supplement verbal with visual stimuli
- Play compare contrast games with visual-motor to supplement auditory input
- Use visual cues or prompts for 'listen' and 'do' to promote careful listening before initiating a task
- It's all about linguistic clarity

## Executive Functions

- Ability to plan, organize, manage, execute response
- Coordinate and integrate the foundation skills from the temporal lobe
- Orchestra analogy

## Executive Functions

- Attention
- Inhibition
- Planning and Organizing
- Initiation and Persistence
- Flexibility Self-Regulation
- Goal Selection
- Problem Solving
- Working Memory
- Impulsivity
- Abstract Reasoning

## Example Assessments for Executive Functions

- Behavioral Rating Inventory of Executive Functions (BRIEF)
- Behavioral Assessment of Dysexecutive Syndrome in Children (BADS-C)
- Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES)
- Stroop Color and Word Test – children
- Diagnostic Analysis of Nonverbal Accuracy 2 (DANVA 2)

## Executive Functions – Modifications & Strategies

- Physical, visual organization in environment
- Use pictures, symbols, words for task sequence/analysis to identify the steps
- Use checklists, chore logs, routines
- Generate a plan of steps BEFORE beginning task
- Role play and practice interactions in various situations
- Prepare student for transitions and distractions

### Neurological Continuum of Processing

|  | Anatomic Structure/Site | Type of Processing |
|---|---|---|
| Peripheral Auditory System | External, Middle, Inner Ear | Auditory Acuity; Reception of Signal |
| Central Auditory Processing | Central Auditory Nervous System ; Auditory nerve thru brainstem | Neurological Transfer of signal; Discrim of acoustic characteristics of signal |
| Phonemic Processing | Heschl's gyrus – temporal lobe | Discrim of phonemic characteristics of signal |
| Language Processing | Temporal Lobe – Wernicke's area and angular gyrus | Discrim of linguistic characteristics of signal; attach meaning using code |
| Executive Functions | Prefrontal/Frontal lobe areas; Motor Strip | Planning and executing response |

### Summary Continuum in Processing Disorders

| Processing Differential Levels | Behavioral Objective / Goal | Example Assessment Tasks | Example Intervention Tasks |
|---|---|---|---|
| **Acoustic (AUD)** | Receiving the signal – intact transmission " Hear it" | * Word Repetition<br>* Tone Discrimination (high- low sequences)<br>* Pattern Repetition (clapping patterns) | * FM System<br>* Preferential Seating<br>* Lip Reading<br>* Tape Recording<br>* Figure Ground |
| **Phonetic/ Phonemic (AUD & SLP)** | Analyzing the signal – discrimination of acoustic segments "Recognize it" | * Word segmentation<br>* Rhyming<br>* Sound Discrimination | * Sound Blending<br>* Word Analysis (first, middle, last sound)<br>* Grapheme-phoneme Correspondence |
| **Linguistic (SLP)** | Understanding the signal – attaching meaning "Understand it" | * Identifying objects<br>* Identifying concepts<br>* Semantic Relationships (synonym, antonym, homonym) | * Concept Development<br>* Word/Object Association<br>* Answering wh questions<br>* Compare/Contrast Tasks |
| **Executive Functions** | Managing and organizing a response to the signal "Use/Respond to it" | * Pragmatic language<br>* Problem solving/reasoning<br>* Prosodic Interpretation | * Role play pragmatic situations<br>* Work on impulse control<br>*Judgment and interpretation |

## Differential Screening Test of Processing

- Screen continuum
- 8 subtests delivered via CD rom
- 3 auditory processing
- 2 phonemic/phonic
- 3 language
- Identifies where to refer and/or spend more time in assessment
- Available from Pro-Ed (LinguiSystems)

- **Management:** the environmental modifications and compensatory strategies that are put in place to *minimize* the adverse effects of the deficit
  - Signal focused (e.g., Assistive listening devices, preferential seating)

- **Remediation:** *improves* auditory skills and teaches compensatory strategies



Remediation

Management
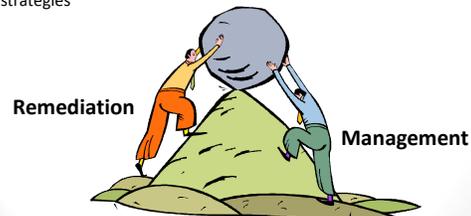
## Goal-APD/LPD Intervention

- Individual needs ability to abstract meaning from auditory stimulus that is linguistically encoded
- Begins with peripheral auditory system, to central auditory system ; subcortical to cortical structures and integration
- Involves continuum of skills (e.g., acoustic, phonetic, linguistic, executive functions)
- Treatment should address discrete auditory and language skills
- Keep data to document efficacy of treatment goals

## Teacher Strategies

- **Introduce information using multi-modality approach for sensory stimulation**
- **Supplement auditory info w/ visual materials**
- **Introduce new material in context rich associative environment; Use stories and examples**
- **Provide cues, prompts, hints to help focus student and facilitate retrieval**
- **Allow"thinking time" and monitor external pressure when latencies occur**
- **Shorten assignments to focus on accuracy rather than efficiently**
- **Limit timed tasks; provide extra time**

| Game | auditory processing or related skill(s) |
|---|---|
| A Rhyme in Time® | speech sound discrimination, auditory closure |
| Battleship® | active listening, visual patterning, integration |
| Blind Man's Bluff | localization, binaural interaction |
| Boggle® | pattern recognition, integration |
| Bopit®, Bopit Extreme® | integration, vigilance |
| Brain Warp® | vigilance, integration, problem-solving |
| Card games (e.g., Rummy) | pattern recognition, sequencing |
| Catch Phrase® | integration, vocabulary development, output |
| Clever Endeavour® | metalinguistic strategies, critical listening |
| Feely Bag | interhemispheric communication |
| Hanna's last-sound game | auditory discrimination |
| Mad Gab® | temporal patterning, metalinguistic skills |
| Marco Polo | localization, binaural interaction |
| Musical Chairs (also Cake Walks) | vigilance |
| Name that tune | interhemispheric transfer of function |
| Password® | vocabulary building, metalinguistic skills |
| Plexers® | metalinguistic strategies |
| Rags to Riches | metalinguistic skills (idioms) |
| Read My Lips® | lipreading/speechreading |
| Red Light- Green Light | vigilance, active listening |
| Rummikub® | patterning, problem solving, integration |
| Scattergories® | vocabulary building, metalinguistic strategies |
| Scrabble® | integration, linguistic skills, visual patterning |
| Simon® | auditory-visual patterning |
| Simon Says | vigilance, active listening |
| Taboo® | vocabulary building, metalinguistic strategies |
| Telephone game | attention, active listening, discrimination |
| Twister® | integration, critical listening |
| UpWords® | integration, visual patterning |
| Wheel of Fortune® | auditory closure |

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## Computer Applications

- Auditory Discrimination
  - HearBuilder  www.hearbuilder.com; www.superduperinc.com
  - cLear – Customized Learning: Exercises for Aural Rehabilitation www.clearworks4ears.com
  - Fast ForWord  www.scilearn.com
- Temporal Processing
  - Zoo Caper Skyscraper dichotic listening program www.acousticpioneer.com
  - CAPDOTS dichotic listening training www.capdots.com
  - Insane Earplane www.acousticpineer.com
- Listening Skills
  - www.smartyearsapps.com
  - www.hamiguchiapps.com
  - www.interactivemetronome.com

*The practical importance of making a correct diagnosis is that children having different types of problems vary significantly in their needs and unless a differential diagnosis is made, their potentialities are lost.*

**-H. Myklebust, 1954**

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