Sorting Out Auditory and Language Processing Disorders

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Speaker Disclosure

- **Financial**
  - Honorarium and Travel Expenses paid by Utah State University
  - Receive royalties from ProEd (LinguiSystems products) ([www.proedinc.com](http://www.proedinc.com))
  - Language Processing Test
  - Differential Screening Test for Processing
  - The Source: Development of Executive Functions
  - Language Processing Treatment Activities
  - That’s Life Language Cards
  - Receive royalties for Dynamic Resources ([www.dynamic-resources.org](http://www.dynamic-resources.org))
  - The Source for ADHD
  - The Source for Syndromes
  - The Source for Autism
  - Revenue share from MedBridge courses
- **Nonfinancial**
  - Author of several book chapters and articles on processing

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 *Neuropsychological 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 – LSHSS July Clinical Forum
Clinical Forum – LSHSS 2011

- Kamhi – not a definitive clinical entity
- Wallach – processing layers – need to peel back and address functionally
- Medwetsky – auditory phenomena

Impact of Processing on Learning

- 1967 - Johnson & Myklebust: LD as disturbance in processing interfering with language comp. & verbal expression
- 1966 - Cruickshank: most LD result of processing deficits
- 1981 - Gerber & Bryen: processing difficulties result in school failure
- 2005 – ASHA Working Group: processing deficits may lead to or be associated with difficulties in learning

Major Points to Consider

- The problem is not in reception of the signal
- Repeating the stimulus is minimally helpful
- Individuals process stimuli in different ways
- Cues provide orientation, not the answer
- Processing occurs “on top” of basic knowledge
Auditory Processing Defined

- Efficiency and effectiveness by which CNS utilizes auditory information (ASHA, 2005a) characterized by...
- 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 abstract meaning from an acoustic stimulus (Massaro, 1983)
- 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)

PROCESSING MODELS

Top - Down

Bottom - Up
**Language Processing / Top Down**

- Language info in mind of listener, not auditory signal.
- Listener uses knowledge of language and world to interpret speaker’s message.
- Process acoustic signal using lexical/semantic knowledge:
  - familiar processed quicker
  - discriminate significant features

**Auditory Processing / Bottom Up**

- Auditory processing is a “pre-linguistic” skill with acoustic info processed before linguistic.
- Acoustic signal processed before being influenced by higher order knowledge.
- Sound identification necessary prerequisite to speech-language development.
- Tallal research: children with LD have deficits in rapid transition of both linguistic and non-linguistic signals.

**Resolution**

- Processing is actually INTERACTIVE.
- Type of processing depends on task:
  - Times when focus on signal with minimal linguistic processing needed.
  - Times when hear message but can’t understand message.
- Most processing involves both signal processing & higher order processing:
  - Continual fluctuation between signal (auditory) and cognitive (language).
- Different processing styles.

Duchan & Katz, 1983
TOP DOWN

Language Processing
Knowledge of language & world to interpret
Semantic knowledge
Stress comprehension and intake

BOTTOM UP

Auditory Processing
Acoustic Information before linguistic interp
Acoustic knowledge
Stress production and output

“Language shapes culture, language shapes thinking — and language shapes brains. The verbal bath in which a society soaks its children arranges their synapses and their intellects; it helps them learn to reason, reflect, and respond to the world.”


Neuropsychology:
Science of brain-behavior relationships

- All behavior mediated by CNS
- CNS composed of brain, brainstem, spinal cord
- Impairment in CNS will interfere with learning
- Brain dysfunction = interference in behavior
  - neurological model of diagnosis more objective
  - intervention only as effective as diagnosis
  - need to understand interference to remediate
Functional Organization of the Brain

- Brain structures all play highly specific role & all under coordinated control
- Every mental activity affected through joint activity of discrete cortical systems
- When one system fails, behavior fails - but other parts secondarily resume that function
  - Behavior returns in limited way
  - Localization in diagnosis/remediation
- Individual differences as opposed to labels
FIRST FUNCTIONAL UNIT = RETICULAR FORMATION
- Neurological readiness to interact with environment
- Energy system for cortex
- Brainstem = midbrain, pons, medulla oblongata
- Maintain attentive state to incoming signals
- Awakens brain; keeps it alert; directs neural traffic

SECOND FUNCTIONAL UNIT = PARIETAL, OCCIPITAL, TEMPORAL LOBES
- Posterior two-thirds of cortex
- Isolate neural impulses into discrete areas for analysis, storage, coding, organization
  - Visual stimuli = Occipital
  - Tactile stimuli = Parietal
  - Auditory stimuli = Temporal
- Each cortical section further delineated into three zones

THIRD FUNCTIONAL UNIT = FRONTAL LOBES
- Anterior one-third of cortex, including frontal lobes, motor/pre-motor cortex
- Active response through motoric expression to stimuli processed in second functional unit
- Planning and execution, managing of person’s behavior in relation to perceptions and knowledge - through motor response
PRIMARY ZONE

- Reception of incoming neural impulses
  - Visual stimuli = Occipital
  - Tactile stimuli = Parietal
  - Auditory stimuli = Temporal
- NOT involved in interpretation of meaningfulness of stimuli; only sensory analysis/sensation
- Impairment = sensory/perceptual impairment; not deficit in higher order processing

SECONDARY ZONE

- Organize incoming information according to rules of language - attach meaning to input
  - Visual meaning = Occipital
  - Tactile meaning = Parietal
  - Auditory meaning = Temporal
- Interpretation through coding, organizing, associating, storing
- Integrate into meaningful experiences
**TERTIARY ZONE**

- Multisensory neural integration among sensory secondary zones
  - Integrate newly organized stimuli with stored information
  - Integrate discrete neural impulses between modality areas
- Coordinate higher level processing
  - Integrate information from all cortices
  - Transfer passive receptive input into active expressive output

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**Second Functional Unit – Left Temporal Lobe**

<table>
<thead>
<tr>
<th>PRIMARY</th>
<th>SECONDARY</th>
<th>TERTIARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory/ acoustic perception</td>
<td>Attach Meaning</td>
<td>Integration/ synthesis</td>
</tr>
<tr>
<td>Auditory Integration</td>
<td>Use linguistic code</td>
<td>Cortical Integration</td>
</tr>
</tbody>
</table>

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**Diagram:**
- Diagram A: Sensory Zones
- Diagram B: Multisensory Zones
- Diagram C: Tertiary Zone
MODEL CONCLUSIONS

- Model supports hierarchical integration of processing following neuromaturational order of zones
- Zones develop maturationally in order: primary, secondary, tertiary
- Tertiary zone last to mature and most fragile
- Progressive attachment of meaning to stimuli supports contribution of each level in hierarchy
- Concept integrates entire nervous system in thinking process

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
- Labels add confusion rather than clarity
  - Auditory processing
  - Central auditory processing
  - Language processing
- Differential diagnosis important to determine appropriate intervention approach

Assessment

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
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

Continuum of Processing

Challenges in APD Assessment

- "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)
- Assessing and/or treating the multiple aspects of an auditory or language processing disorder is a challenge
- (central) auditory processing disorder (C)APD and auditory processing disorder APD– synonymous terms
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

The Auditory System
- Peripheral system
  - Hearing sensitivity
  - Acoustic reflexes
- Brainstem system
  - Acoustic reflexes
  - Binaural interaction
- Cortical system
  - Discrimination
  - Dichotic listening
  - Temporal processing

Peripheral Auditory System
- 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

Central Auditory Processing

- Purpose
  - CANS responsible for transference of auditory signal through brainstem to cortex
  - 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
  - Signal reaches brain intact - no APD
  - Signal distorted or compromised when enters cortex - APD
CAPD Test Battery

- Minimize influence of language, cognition & other sensory skills on performance

- Maximize function of CANS

- Results examined re:
  - central auditory processes being taxed
  - anatomical sites subserving those skills

CAPD Test Battery

- Binaural Separation
  - Tap cortical level separation skills
  - Provide information re neuromaturatation
  - Competing sentence tests
  - Pattern recognition
  - Phoneme discrimination
  - Phoneme manipulation

- Binaural Integration
  - Tap cortical level integration between ears
  - Dichotic digits, CVs
  - Dichotic rhyme
  - Staggered spondaic words
  - Competing words
  - Speech in noise
  - Auditory localization

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?
- 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)
  - Observe deficits in listening, auditory comprehension, discrimination for spelling
  - 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)

Summary of AP Assessment
- Assessment and diagnosis by an audiologist
- Evaluation will include battery of tests
  - Peripheral system
  - Central auditory nervous system
  - Cortical system
- Minimize language and meaning; maximize signal variables
- Neurological maturation and integrity when transferring an acoustic stimulus from peripheral system to upper cortex
SLP Assessment Concerns

• Does child accurately receive signal?
• Does signal accurately transfer through the Central Auditory Nervous System to upper cortex?
• Can child retain signal long enough to analyze signal (e.g., identify sound segments)?
• Does child comprehend/understand what the signal means?

SLP Assessment

• Audiology has been neurological in assessment approach
• Speech-language pathology has been very behavioral in assessment approach
• SLP needs to become more neurological in approach; realize that brain mediates behavior

Processing Assessment

• Receptive Language Developmental Level
• Primary Zone - Functional Auditory Skills
• Secondary Zone - Hierarchy of Language Complexity
• Tertiary Zone - Integration of Language into Executive Functions
• Supplemental - Memory; Word Retrieval
SLP Assessment

- Auditory only; visual adds compensatory
- Begin in overlap area
  - If fail, refer for central auditory assessment
  - Assess phonemic awareness of signal
- Hierarchy of language complexity
  - Begin simple and discrete
  - Increase language demand
- Battery of tasks/tests

Phonetic /Phonemic Processing Skills

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

- 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

Example Assessment Instruments for Functional Auditory Skills

- Illinois Test of Psycholinguistic Abilities (ITPA)
- SCAN Screening test for auditory processing
- 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 Skills

- Labeling
- Stating Functions
- Association
- Categorization
- Concepts
- Antonyms
- Synonyms
- Idioms
- Analogies
- Multiple Meanings
- Stating Attributes
- Language Foundation for metalinguistic skills
- Ability to comprehend and express ideas through auditory to verbal modality
- Conceptual basis for higher level, more complex language

Sample Secondary Zone Hierarchy – Language Processing Test

- Labeling – nouns
- Functions – verbs
- Association
- Categorization
- Similarity
- Difference
- Multiple Meaning
- Attributes

Secondary Zone Assessment

- Language Processing Test
- WORD
- Comprehensive Assessment of Spoken Language (CASL)
- Bracken Basic Concept Scale

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

Tertiary Zone Assessment

- Test of Problem Solving
- CELF
- Listening Test
Executive Functions Skills

• Ability to plan, organize, manage, execute response
• Coordinate and integrate the foundation skills from the temporal lobe
• Under frontal lobe, pre-motor, motor cortex control


Third functional unit

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)
Adjunct Areas of Assessment

- Auditory Memory-related/unrelated
  - ITPA: Auditory Sequential Memory
  - TOLD, CELF – Sentence Imitation/Repetition
- Word retrieval
  - Test of Word Finding
  - Informal

LP Assessment Summary

- Language develops in hierarchy of cognitive complexity, progressing from concrete to more abstract; discrete to integrated tasks
- Language processing is imposed 'on top of' basic language foundation
- Language processing assessment begins in the phonemic overlap area and moves through the functional units as complexity increases
- Language tasks should be auditory only when assessing the primary and secondary zones; only want to temporal lobe involvement
- Tertiary and third functional unit tasks are multimodality input
- Language processing continues to develop and refine throughout life
- Language processing can affect and be affected by sensory processing and executive skills

Differential Screening Test of Processing

- Screens 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 www.proedinc.com
Listen carefully!

- Did you hear that?
- Can you repeat it?
- Can you tell me the first sound you heard?
- Can you tell me another sound you heard in the phrase?
- Can you tell me what the phrase meant?
- Will repeating it multiple times help?
- Will amplifying the phrase help?
- Will saying it slower help?

If yes....

If no....

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**Neurological Continuum of Processing**

<table>
<thead>
<tr>
<th>Anatomic Structure/Site</th>
<th>Type of Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral Auditory System</td>
<td>Auditory Acuity; Reception of Signal</td>
</tr>
<tr>
<td>Central Auditory Processing</td>
<td>Neurological Transfer of signal; Discrimination of acoustic characteristics of signal</td>
</tr>
<tr>
<td>Phonemic Processing</td>
<td>Discrimination of phonemic characteristics of signal</td>
</tr>
<tr>
<td>Language Processing</td>
<td>Use linguistic characteristics of signal; attach meaning using code</td>
</tr>
<tr>
<td>Executive Functions</td>
<td>Planning and executing response</td>
</tr>
</tbody>
</table>

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**Confluence of Processing Disorders**

- CAPD only
- PPD only
- LPD only
- CAPD & PPD
- CAPD & LPD
- PPD & LPD
- CAPD, PPD, & LPD
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

Intervention for Processing Disorders

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
Auditory Processing Remediation

- Test results help professionals develop deficit-specific management strategies
- Effective intervention of CAPDs includes:
  - Remediation
  - Management
  - Neuroscientific foundations

  - Modification of the communicative environment
  - Use of compensatory strategies
  - Minimizes adverse effect of disorder of client’s life
  - Formal and informal therapy to develop deficient skills AND
  - Teach compensatory strategies
  - Designed to reduce or resolve deficit
Focus on the listener: remediation
- Based on neural plasticity research
  - Plasticity is brain's ability to organize/reorganize in response to stimulation
- Includes bottom-up programs to improve specific skills and top-down programs to teach/reteach compensatory strategies

Remediation for CAPDs
- Auditory skills training: bottom-up therapy
  - based on plasticity theory
  - stimulus-driven, adaptive, repetitive
- Teaching strategies: top-down therapy
  - based on neurocognitive theory
  - concept-driven, use metacognitive and metalinguistic strategies

For most CAPDs - will likely use a combination of bottom-up AND top-down therapies
Example Acoustic Skills

- Binaural processing
  - Auditory Localization
  - Speech in Noise
  - Dichotic listening
  - Interhemispheric integration
- Temporal processing
  - Temporal pattern discrimination/ recognition
  - Temporal recognition/manipulation of multiple targets
- Auditory Discrimination
  - Frequency related tasks
  - Timing related tasks

Improving auditory discrimination

- Designed to improve auditory system’s ability to extract acoustic cues from within speech spectrum
- Targets include CV/VC, words, spondees/trochees, multisyllabic words, words in sentences, nonsense and real sentences, connected discourse, nonspeech targets
- Uses adaptive minimal pairs discrimination, identification and recognition training with targets altered to “tax” system
  - Temporal and/or frequency discrimination, recognition in noise
- Computer-assisted programs
  - Fast ForWord
  - Earobics and HearBuilder
  - Customized Learning: Exercises for Aural Rehabilitation (cLEAR)
  - Listening and Communication Enhancement (LACE)

Resources for therapy

- [www.linguisystems.com](http://www.linguisystems.com) - Differential Processing Training Program – auditory, phonologic and linguistic goals
- [www.acousticpioneer.com](http://www.acousticpioneer.com) – dichotic listening and temporal patterning training
- [www.neurotone.com](http://www.neurotone.com) – LACE: Listening & Communication enhancement – for adults
- [www.clearworks4ears.com](http://www.clearworks4ears.com) – activities that enhance an array of auditory & related skills
- [www.brainHQ.com](http://www.brainHQ.com) – activities to enhance auditory, visual and thinking/reasoning skills
Computer Applications

- Auditory Discrimination
  - Clear – Customized Learning: Exercises for Aural Rehabilitation [www.clearworks4ears.com]
  - Fast ForWord [www.scilearn.com]

- Temporal Processing
  - Zoo Caper Skyscraper dichotic listening program [www.clearworks4ears.com]
  - CAPDOTS dichotic listening training [www.capdots.com]
  - Insane Earplane [www.acousticpioneer.com]

- Listening Skills
  - [www.interactivemetronome.com]
  - [www.smartyearsapps.com]
  - [www.hamiguchiapps.com]

Focus on the environment

- Noise & reverberation (echo)
- Distance & lighting
- Direct signal enhancement via assistive listening technology (ALDs)

Focus on the message

- Clear speech
- Visual cues
- Clear Language
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

Effective intervention of CAPDs Summary

- Deficit in skills subserved by CANS
- Can affect academics, communication, well-being and can co-exist with other conditions
- Diagnostic results help define nature and clarify impact of deficit
- Intervention MUST be deficit-specific AND include modifications, compensation, remediation to be effective
- Should reassess skills at periodic intervals to monitor

CAP 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 (Fey, et al., 2011)
- Some reports of improved language-learning-cognition following use of multi-modal training programs
Language Processing Remediation

Language Processing Components

Lower Level Processes
- Semantics
- Syntax
- Phonology
- Pragmatics

Higher Level Processes
- Printed Pragmatics
- Intentions
- Presuppositions
- Conversation Rules
- Conversation Violations
- Metalinguistic Awareness
- Degree of Directness
- Honor
- Idioms
- Polite Forms
- Figurative Language
- Knowledge of Grammar
- Discourse
- Everyday
- Printed
- Informal

Phonetic/Phonemic Processing Skills

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

Linguistic Processing Skills

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

- Work from multiple modality to one
  - Motor, visual, verbal
  - Visual, verbal
  - Verbal only
- Don't drill the deficit; remediate
- Develop competency in language skill, not one specific task
  - Categorization Example
- Evaluate the hierarchy of language demand
Build Foundation, not Tower

- Inferences
- Homophones
- Homonyms
- Idioms
- Analogies
- Antonyms
- Synonyms
- Categorization
- Concepts
- Association
- Functions
- Labeling

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 Skills

- Ability to plan, organize, manage, execute response
- Coordinate and integrate the foundation skills from the temporal lobe
- Under frontal lobe, pre-motor, motor cortex control
- Attention
- Inhibition
- Planning and Organizing
- Initiation and Persistence
- Flexibility Self-Regulation
- Goal Selection
- Problem Solving
- Working Memory
- Impulsivity
- Abstract Reasoning

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

Language Processing Remediation

• Determine level of language processing develop
• Begin at earliest level of difficulty
• Use entire second functional unit for intervention
• Order language goals in cognitive complexity hierarchy
• Start with discrete – work toward integrated
• Think “hierarchy” – level of language difficulty
• Use neuropsychological model to guide goals
• Use compensatory cues & strategies
• Examine therapy materials carefully

Bloom’s Taxonomy

Knowledge
Comprehension
Application
Analysis
Synthesis
Evaluation
Memory and Recall
• Memory is a process, not a fixed thing or singular skill or location
• Nerve cells are signaled to store memory as short term or permanent in long term
• The retrieval process activates dormant neurons to trigger memory; cannot separate memory and retrieval
• Best way to trigger recall is by association

RETRIEVAL
• Highly dependent upon state, time, & context
• Variety of ways we store and retrieve information
• Type of memory determines how it is retrieved

MEMORY PATHWAYS
Explicit
- Short term & working memory (5-20 sec)
  - Semantic
    - Words, symbols, stories
  - Episodic
    - Locations, events, circumstances

Implicit
- Procedural
  - Physical skills, manipulatives, body-learning
- Reflexive
  - Automated, nonconscious learning
  - Conditioned
  - Emotional
Steps in Memory Storage Process

- **Stimulus**
  - Conscious & unconscious stimuli, millions of bits per second
  - Temporary storage buffer
  - 10-20 seconds

- **Sensory Register**
  - Conscious & non-conscious stimuli
  - Active processing

- **Short Term Memory**
  - Conscious & non-conscious stimuli
  - Temporary storage buffer
  - 5-20 seconds

- **Active Processing**
  - To retain declarative knowledge, must actively process
  - Explicit memories & implicit learning

- **Long Term Memory**
  - Conscious & non-conscious stimuli

Strategies for Memory Skills

- **Explicit Declarative Strategies**
  - Rhymes, visualization, mnemonics
  - Keep chunks below 7 units
  - Acoustics (first letter)

- **Episodic Strategies**
  - “Mark” learning with places, circumstances, field trips
  - Match learning and testing states
  - Practice quizzes

- **Procedural Strategies**
  - Teach with movement
  - Embed emotion in learning
  - Celebration

- **Reflexive Strategies**
  - Fill in the blanks

RETRIEVAL

- Highly dependent upon state, time, & context

- Variety of ways we store and retrieve information

- Type of memory determines how it is retrieved
Teach Compensatory Cueing

Cues for Word Retrieval

- Additional Time
- Stimulus Repetition
- Questions Prompts
- Additional Information
  - Category
  - Description
  - Initial Sound
- Multiple Choice
- Naming
Case Presentations

Play detective on deficits skills to determine most appropriate treatment options

Applying the model in the real world: Deficit specific case management

Language Evaluation

Cassie C.A. = 8.8

Referral: poor short term memory yet strong functional memory skills; strong visual memory; history of MEE, no tubes.

<table>
<thead>
<tr>
<th>Test</th>
<th>Age Eq</th>
<th>Percent</th>
<th>Stand Sc</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPT</td>
<td>7-9</td>
<td>27</td>
<td>90</td>
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<tr>
<td>TOPS</td>
<td>7-8</td>
<td>31</td>
<td>95</td>
</tr>
<tr>
<td>TWF</td>
<td>Fast &amp; Accurate</td>
<td>80</td>
<td>112</td>
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<tr>
<td>ITPA</td>
<td>Sound Bl</td>
<td>2-4</td>
<td>Scaled 15</td>
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<tr>
<td>Aud Clos</td>
<td>8-9</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Seq Mem</td>
<td>7-7</td>
<td>53</td>
<td></td>
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</tbody>
</table>
Cassie - CAP evaluation

- Low-pass Filtered Speech: below normal each ear
- Time Compressed Speech: below normal each ear
- Dichotic Digits Test: normal each ear
- SSW Test: below normal right ear
- Competing Sentences Test: normal each ear
- Pitch Patterns Sequencing: normal each ear

Caleb, 10 years

- School testing indicated auditory processing disorder with difficulty following multi-step directions
- Poor performance on CELF and TAPS
- Student “doesn’t get stuff”
- Receiving SL services

Caleb - CAP evaluation

- Low-pass filtered speech: normal each ear
- Time compressed speech: normal each ear
- Dichotic Digits: normal each ear
- SSW Test: below normal each ear
- Competing Sentences: below normal each ear
- Pitch Patterns Sequencing: normal each ear
## Language Evaluation

<table>
<thead>
<tr>
<th>Test</th>
<th>Age Eq</th>
<th>Percent</th>
<th>Stand Sc</th>
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<tbody>
<tr>
<td>LPT</td>
<td>7-8</td>
<td>24</td>
<td>85</td>
</tr>
<tr>
<td>TOPS</td>
<td>7-10</td>
<td>28</td>
<td>92</td>
</tr>
<tr>
<td>TWF</td>
<td>Slow &amp; Accurate</td>
<td>56</td>
<td>102</td>
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<tr>
<td>ITPA</td>
<td>Sound Bl Aud Clos Seq Mem</td>
<td>Above</td>
<td>Scaled 43 35 42</td>
</tr>
</tbody>
</table>

### Rachel, 9yrs-4mos

- Referred by neuropsychologist due to failure to thrive academically
- Average intellectual potential
- Grade at time of test: 2.5
  - WIAT reading level: 1.4
  - WIAT written language: 1.8
  - WIAT spelling: 1.7
  - WIAT math: 2.5
  - Phonological segmentation and word finding issues

### Rachel – CAP evaluation

- Low-Pass Filtered Speech: normal each ear
- Time compressed Speech: normal each ear
- Dichotic Digits Test: right ear normal, left ear below normal
- SSW Test: right ear normal, left ear below normal
- Competing Sentences Test: right ear normal, left ear below normal
- Pitch Patterns Sequencing: normal mimicking, abnormal labeling
Rachel (9y.4m)- Language Evaluation

Referral: Failure to thrive in educational setting; repeated kindergarten; currently in 2nd grade. Taking Concerta. Slow to respond in testing.

<table>
<thead>
<tr>
<th>Test</th>
<th>Age Eq</th>
<th>Percent</th>
<th>Stan Sc</th>
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<tbody>
<tr>
<td>LPT</td>
<td>7-6</td>
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<tr>
<td>TOPS</td>
<td>6-1</td>
<td>2</td>
<td>56</td>
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<tr>
<td>TWF</td>
<td>Slow &amp; Inaccurate</td>
<td>Below 2</td>
<td>Below 10</td>
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<tr>
<td>ITPA</td>
<td>3-0</td>
<td>2</td>
<td>15</td>
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<tr>
<td>Aud Com</td>
<td>4-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seq Mem</td>
<td>4-10</td>
<td></td>
<td></td>
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</tbody>
</table>

Caroline, 12 yrs-2mos

- New to district – previous CAP report indicated dx of CAPD based upon poor SSW and speech-in-noise scores
- Fast ForWord and ALD had been recommended
- District requested re-eval prior to new IEP
- Reported difficulty sustaining attention during social conversations
- SL eval done by private SLP – not available at this testing
- ADD diagnosed at age 10

Caroline – CAP evaluation

- Low-pass filtered speech: right ear below normal, left ear normal
- Time compressed w/reverb speech: normal for each ear
- Dichotic Digits: normal for each ear
- SSW Test: normal for each ear
- Competing Sentences Test: normal for each ear
- Pitch Patterns Sequencing: normal for each ear
### Caroline – Language Evaluation

<table>
<thead>
<tr>
<th>Test</th>
<th>Standard Score</th>
<th>Percentile Rank</th>
<th>Age Equivalency</th>
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<tbody>
<tr>
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<td>97</td>
<td>22+</td>
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<tr>
<td>CASL - total</td>
<td>91</td>
<td>27</td>
<td></td>
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<tr>
<td>Antonym</td>
<td>110</td>
<td>86</td>
<td>14.9</td>
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<tr>
<td>Gram. morph</td>
<td>92</td>
<td>30</td>
<td>10-8</td>
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<tr>
<td>Sentence comp</td>
<td>98</td>
<td>45</td>
<td>10-8</td>
</tr>
<tr>
<td>Nonliteral lang</td>
<td>93</td>
<td>32</td>
<td>10-10</td>
</tr>
<tr>
<td>Pragmatic judge</td>
<td>72</td>
<td>2</td>
<td>7-8</td>
</tr>
<tr>
<td>Ambiguous sent</td>
<td>72</td>
<td>15</td>
<td>7-8</td>
</tr>
<tr>
<td>Inference</td>
<td>50</td>
<td>10</td>
<td>3-0</td>
</tr>
<tr>
<td>OWLS - Written Expression</td>
<td>93</td>
<td>32</td>
<td>10-3</td>
</tr>
</tbody>
</table>

### Teacher Compensatory Strategies for LPD
- Introduce information using multi-modality approach for sensory stimulation
- Supplement auditory info w/ visual materials
- Introduce new material in context rich associative environment
- Provide cues, prompts, hints to help focus student and facilitate retrieval
- Allow “thinking time” and monitor external pressure when latencies occur
- Limit timed activities and performance tasks; provide extra time
- Vary type of responses expected on exams and class discussion
- Shorten length of assignments to promote focus on accuracy rather than efficiency
- Refresh stimuli with repetition, re-phrasing, and expansion clarifications
- Teach with stories and examples to associate main points of auditory information

### Student Compensatory Strategies
- Request additional time when needed
- Request cues, prompts, associative info
- Ask specific questions rather than generic
- Apply strategies taught in therapy that work to facilitate retrieval
- Learn to state what you know, then the source of confusion
- Tape record for repetition or permanent record of lecture
- Learn to use rehearsal, paraphrasing, and writing key words to keep processing on track
- Be an active learner, rather than passive
- Be patient; take your time and don’t give up or become frustrated
- Seek out study buddies to check information
Team Work - Collaboration

- Audiologist might complete testing
- Speech-language pathologist must interpret and provide appropriate intervention
- Classroom teacher – literacy / phonics skills
- Listening Skills ?

Thirty great games/books to enhance auditory processing and related skills  

<table>
<thead>
<tr>
<th>Game</th>
<th>Processing skill taxed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Rhyme in Time</td>
<td>sound discrimination, auditory closure</td>
</tr>
<tr>
<td>Battleship</td>
<td>listening, visual patterning, integration</td>
</tr>
<tr>
<td>Blind Man's Bluff</td>
<td>localization, binaural interaction</td>
</tr>
<tr>
<td>Boggle</td>
<td>pattern recognition, integration</td>
</tr>
<tr>
<td>Boggle</td>
<td>integration, vigilance</td>
</tr>
<tr>
<td>Brain Warp</td>
<td>vigilance, integration, problem-solving</td>
</tr>
<tr>
<td>Card games</td>
<td>pattern recognition, sequencing</td>
</tr>
<tr>
<td>Catch Phrase</td>
<td>integration, vocabulary, output</td>
</tr>
<tr>
<td>Clever Endeavour</td>
<td>interhemispheric communication</td>
</tr>
<tr>
<td>Feely Bag</td>
<td>auditory discrimination</td>
</tr>
<tr>
<td>Finding sound game</td>
<td></td>
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<tr>
<td>Mad Gab</td>
<td>temporal patterning, language</td>
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<tr>
<td>Marco Polo</td>
<td>localization, binaural interaction</td>
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<tr>
<td>Musical Chairs</td>
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<tr>
<td>Name that tune</td>
<td>interhemispheric integration</td>
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<tr>
<td>Password</td>
<td>vocabulary, linguistic skills</td>
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<tr>
<td>Plexers</td>
<td>metalinguistic strategies</td>
</tr>
<tr>
<td>Rags to Riches</td>
<td>metalinguistic skills (forums)</td>
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<tr>
<td>Read My Lips</td>
<td>lipreading/speechreading</td>
</tr>
<tr>
<td>Red Light-Green light</td>
<td>pattern recognition, integration</td>
</tr>
<tr>
<td>Rummikub</td>
<td>vocabulary building, linguistic strategies</td>
</tr>
<tr>
<td>Scramble</td>
<td>integration, language, visual patterning</td>
</tr>
<tr>
<td>Simon</td>
<td>auditory-visual patterning</td>
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<tr>
<td>Simon Says</td>
<td>vigilance, active listening</td>
</tr>
<tr>
<td>Taboo</td>
<td>vocabulary, metalinguistic strategies</td>
</tr>
<tr>
<td>Telephone game</td>
<td>attention, active listening, discrimination</td>
</tr>
<tr>
<td>Twister</td>
<td>integration, critical listening</td>
</tr>
<tr>
<td>UpWords</td>
<td>integration, visual patterning</td>
</tr>
<tr>
<td>Wheel of Fortune</td>
<td>auditory closure</td>
</tr>
</tbody>
</table>

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Treatment Recommendations

- Current research provides little definitive direction for treatment of A/CAPD
- Language disorders common in APD - Evaluate and include language goals with AP treatment
  - Don’t treat auditory deficits in a vacuum
- Use auditory therapies in conjunction with language, communication, and academic goals
  - Evaluate top-down/bottom-up skills and check compatibility with child’s learning style and deficit type
  - Don’t force-feed academic knowledge “teaching to the test”; stimulate the brain with interesting and challenging activities
  - Most listeners with “bottom-up” specific auditory impairment will need top-down teaching to compensate

Practitioner

- Apply info from variety of sources
- Adapt procedures and techniques to meet individual needs
- Be creative; Beware of “cookbook” approaches; simplistic solution for complex problem
- Need more research on screening and assessment tools as well as treatment efficacy for specific types of CAP/LP problems
- Neither CAP nor LP occur in a vacuum – neither should the assessment and management process

Summary Treatment Comments

- CAP – starts auditory only
  - LP – starts multiple modality

  - CAP – emphasis on acoustic signal
  - LP – emphasis on comprehension

  - CAP – bottom-up approach to treatment
  - LP – top-down approach to treatment
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?

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

Research needs

• Well-controlled treatment outcome studies
  • Better defined experimental groups for A/CAPD, SLI, SLD
  • Efficacy and effectiveness studies for quantifiable outcome measures
  • Studies specifically examining AT generalizability to academic/communicative skills
  • Improved assessments of AP skills will lead to clearer intervention/training goals
“More subtle forms of language deprivation do not show up in such dramatic ways, but may ultimately affect abilities to think abstractly, plan ahead and defer gratification, control attention, and perform higher order analysis and problem solving – the very skills so much at issue in American schools today.”

Jane Healy,
Endangered Minds
Cassie

- Difficulty on degraded speech tasks taxing auditory closure
- Greater difficulty on linguistically loaded dichotic task (SSW) with normal scores for digits task
- Able to label tonal patterns

**Auditory Decoding Deficit** - Phonemic skills with support for acoustic level

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Cassie

**Recommended Modifications & Compensations**

- Preferential classroom seating
- Noise abatement at school & home
- Direct signal enhancement via FM system
- Repetition of info as needed
- Adjusted class schedule to minimize auditory overload
- Pre-teaching new info, especially vocabulary
- Multisensory environment – verbal info supplemented with written/graphic cues

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Cassie

**Direct Remediation Activities**

**Phonemic Focus**

- Bottom-up auditory training: discrimination training, noise tolerance training,
- Top-down therapy: auditory closure, schema induction, attribution and self-advocacy training
- Work on phonological auditory decoding skills
  - Segmentation
  - Analysis
  - Discrimination
  - Rhyming
  - Sound Blending
  - Earobics
Caleb

• Difficulty on linguistically loaded dichotic tasks (SSW, CST) AND performance difference for filtered words depending upon wordlist used BUT

• NO evidence of primary auditory dysfunction – results consistent with likely language processing deficit

Caleb - recommendations from Audiologist

Environmental modifications & compensations

• Rephrasing and clarification
• Avoidance of ambiguous language
• Pre-teaching rules and vocabulary
• Waiver of second language requirement
• Assess using both language-biased and non-language-biased IQ instruments (e.g., TONI)
• Books on tape, study guides, and Cliff's Notes

Caleb - Direct remediation activities

• Language processing therapy
  o Secondary Zone – build discrete skills
  o Tertiary Zone – integration, problem solving
  o Word retrieval – maintain accuracy, work on speed
• Speech-to-print skills training
• Dichotic listening training
• Metalinguistic/metacognitive skills training
Rachel

- **Auditory**
  - Excessive LE suppression on dichotic listening
  - Difficulty labeling tonal patterns
  - Normal pattern mimicking

- **Speech-Language**
  - Problems across the continuum – primary
  - secondary, tertiary, EF
  - Specific skills as well as integration problems

Rachel – Recommendations from Aud

**Recommended modifications & compensations**
- Look or listen
- Repeat with associated cue, demonstration, model
- Told task demands “up front”
- Present information sequentially, pre-teach
- Untimed/extended time tests & assignments
- Notetaker
- Books on tape, study guides, Cliff’s notes
- Verbal rehearsal
- Self advocacy

Rachel – recommendations from SLP

- Primary zone weak
- Secondary zone – better at discrete language tasks
- Tertiary – integration poor
- Memory poor
- Retrieval – slow and inaccurate
- Compensate for memory and retrieval
- Make sure signal redundant and clear
- Build language foundation
- Work multi-modality to strengthen integration
- Work on functional integrated language tasks
Caroline

- No pattern of auditory processing dysfunction
- Reported difficulty in conversations related to a possible language or attention problem
- Not CAPD

Caroline

- Communication profile consistent with Asperger
- Intervention Suggestions:
  - Social pragmatic
  - Nonverbal cues
  - Discourse
  - Situational strategies
  - Problem-solving /reasoning
  - Fine motor compensation
  - Routines
  - Sensory breaks/movement/exercise during school day
  - Classroom modifications to insure comprehension