Central Auditory Processing Disorders

What’s in Store

• Define (C)APD
• How does (C)APD work in the body?
• Assessment Prior to Testing
• Audiological (C)APD Testing
• Types of (C)APD
• Recommendations and Remediation
• Follow up
• Questions

What Is (C)APD?

• Broad - Central Auditory Processing (C)AP refers to the efficiency and effectiveness by which the central nervous system (CNS) utilizes auditory information
• Narrow – (C)AP refers to the perceptual processing of auditory information in the CNS and the neurobiological activity that underlies that processing and gives rise to electrophysiological auditory potentials.

What we do with what we hear!

Typical Symptoms

• Difficulty Understanding Speech in Noisy Environments
  • Classroom, Cafeteria, Sports
• May behave as if a Hearing Loss is Present
  • Difficulty distinguishing between speech sounds, following directions, etc.
  • Asks for repetition or clarification
  • Poor Localization
  • Easily Distracted
  • Poor Music Abilities or Lack of Appreciation for Music
• In school – Difficulty with
  • Reading, Spelling, Understanding Verbal Information/ Instruction

These symptoms are also shared with ADHD, Specific Language Impairment, Asperger’s Syndrome and other Autism Spectrum Disorders.
Cognition

- A Child’s Cognitive Function Play a Factor in Diagnosis
- Key to Diagnosis is Confirming NORMAL Cognitive Function
  - More on this later...
- Maturational Effects
  - Typically do not test below 7 years old
- Typically Do Not Test Children with Cognitive Disorders
  - ADHD
  - Spectrum Disorders
  - Dyslexia
  - Language Impairment

Auditory Pathway

“Crossover” or “Decussion”
Assessment

• Neuro/psycho educational testing
• Speech-Language Evaluation
• Electrophysiological Testing (When Possible)
• Peripheral Assessment (Hearing Assessment)
• Case History
• Central Auditory Processing Testing
• (Re)Habilitation / Remediation

Psychoeducational Testing

• Assess cognitive function
  • Intelligence
• Educational Testing
• Measures of Adaptive Behavior
• Tests and Measures of Attention
  • ADHD

Object:
Rule Out Cognitive Disorders

Speech-Language Evaluation

• Assess for Speech and Language Disorders
• Review of auditory, visual, motor, and cognitive status (screeners)
• Standardized and/or non-standardized measures of
  • Speech
  • Spoken and Non-Spoken Language
  • Cognitive-Communication
  • Swallowing function

Object: Rule Out Speech / Language Disorders
Electrophysiological Testing

- **Auditory Brainstem Response (ABR)**
  - Measures Approximately 5 Points Along Auditory Pathway
  - Not typically useful for C[APD] Testing as Someone with Normal Hearing Sensitivity Should Yield Normal ABR Wavelengths
  - Only Tests Level of Brainstem
  - Subject must be asleep or VERY still for accurate results

- **Middle Latency Response (MLR)**
  - Measures Thalomo-Cortical Pathway and Auditory Cortex
  - Matures to Adult Latency around 10 years
  - Could See Delayed Latencies, Poor Morphology, or Reduced Amplitude
  - Affected by noise, drugs, sedation/sleep, and post-auricular muscle movement
  - Tested over both temporal lobes and compared for differences

Peripheral Auditory Assessment

- **Basic Hearing Assessment**
  - Tympanometry
  - Acoustic Reflexes
    - Assess Lower Brainstem
    - Acoustic Reflex Decay (If Available)
  - Pure Tone Testing
    - Air and Bone Conduction
  - Speech Testing
  - Speech-in-Noise Testing

Acoustic Reflex and Decay

Acoustic Reflex — (Stapedial Reflex) an involuntary muscle reflex that occurs in response to a high-intensity acoustic stimulus

Reflex Decay — measurement of the strength of the stapedial muscle contraction as a result of high-intensity stimulus (Acoustic reflex) useful for identifying retro-cochlear pathology.
Everything Must Be Within Normal Limits to Proceed

(C)APD Domains
• Temporal Processing (Ability to recognize order or pattern of non-verbal signals)
  • Temporal Timing
  • Temporal Resolution
• Localization, Lateralization, and Binaural Interaction
• Monaural Low-Redundency Speech Tests
  • Speech in Noise Testing
  • Low Sensitivity
  • Demonstrates Real-World Situations
• Auditory Closure
  • Ability to "Decode" whole word after only hearing part of it
  • Child must be able to distinguish a word and repeat it after hearing it presented as a degraded signal

(C)APD Battery
• SCAN 3 – C(hildren) (Musiek)
  • 5.0 years - 12.11 years
• SCAN 3 – A(dolescents and Adults) (Musiek)
  • 13.0 years and older
• Supplemental Testing for Each Domain
• Administered through Audiometer
  • Not Mandatory
  • At 50 dB HL or MCL
  • Test/Retest Reliability
Temporal Processing

- Random Gap Detection Test (Diagnostic)
  - Child must distinguish whether there is 1 or 2 beeps
  - NO LANGUAGE COMPONENT
- Pitch Pattern Sequence Test
  - Child must distinguish a pattern (e.g., High-low-High, Low-low-high, etc)
  - NO LANGUAGE COMPONENT
  - Child may answer "HIGH-LOW-HIGH" or sing/hum/gesture the answer
  - If child can only sing/hum/gesture the pattern but not respond with words
    - Indicates Left Hemisphere Deficit (REMEMBER: Left = Language, Right = Patterns)

Localization and Lateralization
(Spatial Processing)

- Lack of Testing Materials for this Domain
- Typical C1APD Battery Does not Assess This Domain
- LSN-S (Cameron and Dillon @ NAL-Australia)
  - Distributed by Phonak
    - Ability to separate stimuli from distracting stimuli that arrive from other directions
    - Remediation Program Available for use at home or school
Dichotic Listening

- Staggered Spondaic Word Test (SSW)
  - Tests Decoding, Tolerance-Fading Memory, Binaural Integration, and Binaural Organization
  - Must be Presented via Audiometer
    - Presented to each ear 50 dB above its PTA
  - Used as Site of Dysfunction (Site of lesion) test or Measure of CAP
  - When using as Measure of CAP
    - Relies on Maturity of CNS
      - Age Specific Norms for under 12 years of age

- Dichotic Digits
  - Child is asked to listen to 4 numbers (2 to each ear) at MCL
  - Child is then to repeat all numbers in any order
  - Tests one’s ability to separate multiple auditory stimuli presented simultaneously to both ears
    - Indicates Hemispheric differences (right/left ear advantage or disadvantage)
    - Can indicate hemispheric superiority for speech perception
    - Can indicate hemispheric pathologies
    - Corpus Callosal Pathology

Right Ear Advantage

- Indirect effect of brain asymmetry for speech processing (Kimura, 1961)
- Dichotic Digits (Kimura, 1961a)
  - Left TL Pathology reports fewer correct digits than Right TL Pathology
- Kimura hypothesized that crossed auditory pathways are more effective than uncrossed pathways for accessing left temporal lobe
  - Right ear has advantage for speech perception (left hemisphere)
  - 97% population
  - Beware of Left-Ear Superiority for Speech
- Testing with non-verbal stimuli (laughing, coughing, etc.) does not show REA
- Testing with music or environmental sounds yields Left Ear Superiority

Diagnosis

- Should be Multi-Disciplinary
  - Involves Results from All Testing...Not Just (C)APD Battery
    - Classroom and Home Observation
    - Speech-Language Pathology
    - Psychological / Psychoeducational
    - Audiological and (C)APD
- Based on Normative Date for Each Test
  - Preferably Gathered from Local Population
  - As Little as 10 subjects – Better with Higher Population (20+)
  - Develop a “Normal” for Your Area and Compare to Those Norms
“Treatment from the APD Trenches”

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Diagnosis -> Treatment

"Intervention for (C)APD should be implemented as soon as possible following the diagnosis to exploit the plasticity of the CNS, maximize successful therapeutic outcomes, and minimize residual functional deficits.”


Management of (C)APD

Environmental Modification

- Increase Access to Target Sounds (TEACHER)
  - FM technology
- Improve Classroom Acoustics
  - Lower Signal-to-Noise Ratio
  - Carpeting / Window Treatment
  - Acoustic Tiles on Ceilings/Walls
  - Monitor Noise Level
- Preferential Seating
- IEP: Provide Class Notes, Pre-Teach, Written Instructions or Visual Aids
Compensatory Strategies

- **Teach Child to Self-Advocate and NOT HIDE**
  - **CHILD SHOULD**
    - Check for Understanding – If Not... ASK
    - Ask for Rephrasing if unsure
    - Practice Active Listening
  - **PROFESSIONAL SHOULD**
    - Teach Active Listening
    - Check for Understanding
    - Make Sure to Rephrase Rather than Repeat (more context)
    - Help Child to Build Vocabulary
    - Metalinguistic Training (How to Organize, Adjust, and Discuss Language)
    - Increase Redundency of Learning Environment

Direct Intervention / Auditory Training

- **Detection**
  - Localization
  - Temporal Processing
  - Auditory Discrimination
  - Dichotic Listening

Detection

- **Ability to Identify the Presence/Absence of Sound**
  - Brain cannot process what it cannot hear
  - Sensory Deficits Cannot be Remediated through Therapies
  - Cannot Teach Someone to Hear Normally
  - If a Hearing Loss is Present it MUST be Addressed
    - Hearing Aids
    - Assistive Listening Devices
    - FM Systems

Auditory Discrimination

- **Ability to Perceive Subtle Differences in Sound**
- **Assessed through**
  - Auditory Closure and Auditory Figure-Ground
- **Training for Auditory Discrimination**
  - Computer Programs
  - Near / Far, Loud / Soft, High / Low
  - Follow the Sound (in Quiet and Noise)
  - Referral to SLP or Aural Rehabilitation
    - Phonological Training
    - Minimal Contrast Pairs

Auditory Processing Activities Without Spending a Dime!

Temporal Processing

- Ability to Process Different Rate of Speech as well as Process Gaps Between Speech Sounds for Accurate Perception and Understanding
- Computer Software Training
- Referral to SLP or AR
  - Temporal Resolution Training
  - Prosody Training

Spatial Processing

- 
- ...or Localization
- Essential for Understanding Speech in Noise
- Typically Not a Main Complaint and Not Part of a Typical Battery
- BUT...
- Testing and Diagnosis
  - LiSN – S (Cameron & Dillon – Distributed through Phonak)
- Intervention
  - LiSN & Learn Auditory Training Software (Cameron & Dillon)
- Available from NAL-Australia website
- Soon To Release an iPad app called “Sound Storm”

Benchmarks for Intervention
http://www.asha.org/aud/Articles/Central-Auditory-Processing-and-the-Common-Core/

Dichotic Listening Therapies

- Targeting Weaker Side
  - Think of Amblyopia...
    - Treatment Involves Forcing Brain to Pay Attention to Images of the Amblyopic Eye so that Vision in Weaker Eye Gets Stronger
- Auditory Rehabilitation for Interaural Asymmetry (ARIA) (Moncrieff & Wertz)
- Constraint Induced Auditory Training (CIAT) (Hurley & Davis)
- Dichotic Interaural Intensity Difference (Musiek & Shochat)

Which Intervention to Choose?

- Must be Based on Deficits Found on (ALL) Testing
- Tailored to Patient’s Needs
- Based on Funding, Space, Equipment
- Must Take Time into Consideration (During School, After School, Etc)
- Measuring Productivity
- Formal vs. Informal Intervention
- How to Maintain Motivation
Follow Up

- Retest Deficits
- Immediately Following Intervention
- 6-Months
- 1-Year
- Annually
- Maintain Outcome Measures from Testing / Intervention

- Do Not Let "(C)APD Diagnosis" be End-All-Be-All!
  - Remediation
  - Maturation
  - Attention
  - Etc.

Questions?