

Central Auditory Processing Disorders (CAPD)

Fact or Fiction

Hugh Bases, MD
 Clinical Associate Professor of Pediatrics
 Program Director, Developmental-Behavioral
 Fellowship
 New York University School of Medicine
 Developmental Behavioral Pediatrics

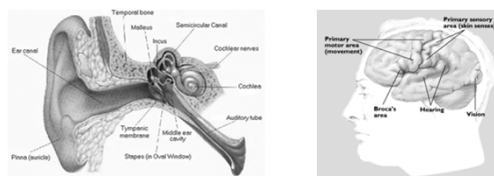
Function of the central auditory systems

- Blending: form words out of separately articulated phonemes
- Discrimination: determine whether 2 acoustic stimuli are same or different, and recognize differences between phonemes
- Closure: perceive whole word or message when parts are omitted
- Attention: persist in listening over a reasonable amount of time
- Association: establish a correspondence between non-linguistic sound and its source
- Cognition: establish a correspondence between non-linguistic sound and its meaning

Disclaimer

- I am **not** an audiologist
- I am **not** a speech pathologist
- I **am** a Developmental/Behavioral Pediatrician
- Trying to help parents who want to
 – “make sure there’s nothing else going on..”

- A complicated system, integrating information (auditory, phonemic, visual, memory, experiential etc.) in milliseconds

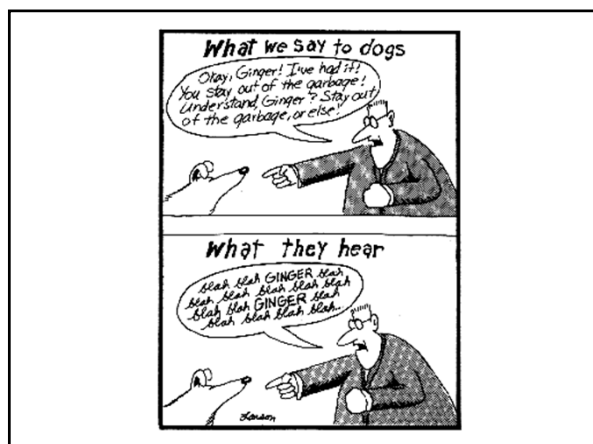


Function of the central auditory systems

- Localization: locate the source of the sound
- Binaural synthesis: centrally incomplete stimulus patterns presented simultaneously or alternatively to opposite ears
- Binaural separation: listen with one ear and ignore stimulation of opposite ear
- Figure-Ground: identify a primary signal in presence of competing sounds
- Memory: store and recall auditory stimuli and order of auditory stimuli

Definition

- Inability or impaired ability to attend to, discriminate, recognize, remember or comprehend information presented through the auditory channels, even though the child has normal intelligence and hearing sensitivities
 - i.e., not the result of other higher-order cognitive, language, or attentional and/or related disorders. American Speech/Language Hearing Association (ASHA)



Criteria for Testing CAPD

- Often a component of a multidisciplinary assessment of school based problems (language, learning, and attention)
 - Normal peripheral hearing
 - FSIQ \geq 80
 - Native speaker of English
 - \geq 1st grade
 - If diagnosed with ADD and managed with medication, child must take meds as directed prior to testing
 - Copies of any outside reports (SLE, psych, DPS, educational eval., etc.) should be furnished prior to scheduled appointment for review by audiologist.

Types of CAPD Tests

- low-pass filtered speech (auditory closure)
 - Subtract mid-high frequency
- dichotic digits
 - 2 #'s presented to each ear
- pitch patterns
 - Series of high/low (e.g. high/low/high etc..)
- duration patterns
 - Long/short/long etc...
- speech in noise (figure ground)
 - What's being said with background noise
- phonemic synthesis
 - "ch...air...chair"
- auditory fusion
 - 2 beeps with a gap between...say whether it's 1 or 2 beeps
- masking level difference
 - Listen to beeps during background noise
- time compressed speech
 - Words with subtracted bits of time...sounds faster...what is the word
- gaps in noise
 - Steady noise and acknowledge when there's a pause

Differential diagnosis

- Focal Neurological Disorder
 - Tumors, TBI, stroke, metabolic, seizures
 - Landau-Kleffner
 - Loss of language b/w 3-9 years- receptive and expressive language
 - Normal route to language learning is blocked and impaired capacity to process language
- Developmental abnormalities
 - ADHD
 - Learning Disability
 - Reading
 - Arithmetic
 - Written expression
 - Communication Disorder
 - Mixed expressive/receptive language disorder
 - Phonological disorder
 - Stuttering
 - Autism
- Maturation Lag of central auditory pathway
 - Myelination continues for years in higher auditory pathways
 - Frequent Otis Media

• Screening Measures

- Children's Auditory Performance Scale (CHAPS)
- Fisher Auditory Checklist
- Screening Instrument for Targeting Educational Risk (SIFTER) Academics, Attention, Communication, Class Participation, School Behavior, Teacher comments

What do they look like?

- Misunderstood what is said
- Inconsistent response to auditory stimuli
- Ask for information to be repeated
- Poor auditory attention
- Difficulty listening with background noise
- Easily distracted
- Problems with phonics and discrimination of speech sounds
- Poor auditory memory
- Poor speech/language skills
- Have trouble paying attention to and remembering information presented orally
- Have problems carrying out multistep directions
- Have poor listening skills
- Need more time to process information
- Have low academic performance
- Have behavior problems
- Have language difficulty (e.g., they confuse syllable sequences and have problems developing vocabulary and understanding language)
- Have difficulty with reading, comprehension, spelling, and vocabulary



So here's the problem....

- Diagnosing CAPD is complicated by:
 - Other types of childhood disorders may exhibit similar behaviors
 - adhd, learning, language d/o's, autism, low IQ
 - Some audiological procedures fail to differentiate them from children with other problems
 - During assessment, other factors may confound interpretation
 - motivation, cooperation, comprehension

The rationale to evaluate for CAPD's in school-aged children is based on the assumption that:

- A deficit in auditory perception can be the underlying basis of many school based problems, including language, learning, and attention disabilities
- OR
- Language, learning, and attention disabilities are associated with deficits in auditory perception.

There is disagreement in the literature

- Because this an entity whose presence is difficult to test given the inability to extract the auditory mechanism from other modalities (language, learning, and attention)

Researchers have questioned...

- Is it the co-occurrence of 2 distinct disorders?
OR
- Variant expression of a single disorder?
OR
- Difficulty with differential diagnosis because both attention and auditory processing are necessary to perform CAP tasks?

A Pilot Study

- Peck HD, Gressard RP, Hellerman, Sp *J Dev Behav Pediatr.* 1991 Oct;12(5):324-6
 - 24 children (6-8 years, mean FSIQ 97, Normal hearing)
 - Chief complaint: short attention span, hyperactive, learning problems, behavioral problems
 - Neurodevelopmental, psychological, language, learning evaluations
 - None referred because of concern about CAPD
 - Standard battery of CAP testing

A Pilot Study

- 2 (9%) normal CAP scores
- 17 (71%) had “abnormal CAP” scores
 - >1 SD below the mean
- There were **no clinically significant** correlations between CAP scores and
 - data from other neurodevelopmental evaluations
 - speech/language scores
 - IQ
 - learning profile
 - behavioral characteristics as described by parents and teachers

Etiological Factors

- Otitis Media:
 - 29% APD -vs- 10% of non-APD
 - ?trend toward higher rates of OME among children with APD than general population, though no difference in the proportion of children with hx of chronic OME between APD and non-APD’s
- Obstetric complications
 - No difference between groups for toxemia or obstetric complications
 - “the cord was wrapped around his neck”
- Family History
 - Not a significant predictor of APD group membership

A more recent study...

- “sought to describe presenting features and investigate etiological factors for children diagnosed with CAPD compared to children for whom CAPD had been ruled out...”
 - all the children were referred for APD testing because of unexplained listening difficulties
 - assessment was carried out following the ASHA recommendations

Table 2 Incidence and type of reported symptoms for children diagnosed with APD and those for whom APD has been excluded

Symptom	APD (N = 32)	Non-APD (N = 57)
Difficulties with speech in noise	20 (64%)	42 (76%)
Reading problems	15 (47%)	18 (32%)
Difficulties with spoken instructions	11 (34%)	28 (49%)
Spelling problems	12 (37%)	17 (30%)
Concentration problems	7 (22%)	12 (21%)
Memory problems	7 (22%)	14 (25%)
Hyperacusis	6 (19%)	13 (23%)
Needs TV loud	6 (19%)	3 (5%)
Pragmatic/social problems	4 (13%)	11 (19%)
Average number of symptoms reported	3.4 (1.8)	3.8 (1.8)

These symptoms were not specific to children with APD’s. There were no significant differences in occurrence of any symptoms between APD and non-APD children. The average number of reported symptoms was similar

– Dawes P, Bishop DV, Sirimanna T, Bamiou E *Profile and aetiology of children diagnosed with auditory processing disorder (APD) Int J Pediatr Otorhinolaryngol.* 2008 Apr;72(4):483-9

- 149 patients referred to auditory processing clinic
- Tested for CAPD (SCAN, Random Gap Detection, Gaps in Noise, Pitch Patterns, Duration Patterns Sequence Test)
- 32 children met criteria (14 girls, 18 boys) for APD
- 57 children non-APD (17 girls, 40 boys)
- Dependant variables
 - Presenting symptoms – based on parental report
 - Children’s Auditory Performance Scale (CHAPS) and Fisher’s Auditory Checklist
- Etiological Measures
 - Otitis Media: chronic OM if child had one or more sets of PE tubes
 - Obstetric complications
 - Family History

Profile and aetiology of children diagnosed with auditory processing disorder 487

Table 3 Incidence and type of co-morbid conditions for children diagnosed with APD and those for whom APD has been excluded

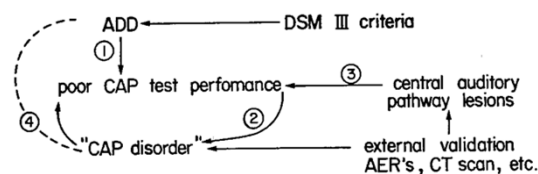
Condition	APD (N = 32)	Non-APD (N = 55)	General population estimate
Dyslexia	8 (25%)	7 (12%)	5.3–11.8% [22]
Seen a SLT for language	4 (13%)	6 (11%)	7.4% (SLI) [23]
Articulation problem	0	4 (7%)	3.8% (at age 6) [24]
ADHD	3 (9%)	5 (9%)	6% [25]
Dyspraxia	2 (6%)	7 (12%)	12.5% [26]
Autism/ASD	3 (9%)	5 (9%)	<1% [27,28]
Genetic syndrome*	1 (3%)	3 (5%)	<1% (Gaucher disease)
Epilepsy*	4 (13%)	3 (5%)	<1% (lysosomal storage disorders in total) [29]
Co-morbid conditions (two or more of the above)	7 (22%)	11 (20%)	<1% [30]

* Note: Children with epilepsy and Gaucher disease were referred for APD testing as part of other GOSH research studies. Children with epilepsy and genetic syndromes may thus be over-represented.

Proportion of children whose parents also reported they had a co-morbid condition. A significant proportion in both groups (20%) had multiple conditions. There was no significant differences in the incidence of any condition for the APD and non-APD subgroups

The author's conclude:

- Among children referred for investigation of APD...
- There were no differences between those who did and did not receive an APD diagnosis, either in symptoms or co-morbid conditions.
- A high proportion of both APD and non-APD's had co-morbid conditions, (language/literacy).
- Overall, APD and non-APD children did not differ in any respect apart from performance on tests of auditory processing.



1. ADHD causes poor central auditory processing test performance
 2. The separate existence of a "CAP disorder" is inferred from poor central auditory processing test performance
- There may be central auditory processing disorders as discrete entities, but if so, they are rare and should be definable by other test criteria than central auditory processing test performance

The author's conclude:

- It is possible that for some children, auditory processing difficulties may co-exist with and exacerbate learning problems. However, if this is the case, there seem to be no readily identifiable differences in case history or behavioral symptoms that can discriminate between those with and without auditory problems"

Same or Different?

- Studies have looked at CAP measures and children with ADHD
 - Ludlow et al: hyperactive group did significantly poorer on signal detection than other group and controls
 - Gascon et al: high concordance b/w CAP testing, ADHD, and response to stimulant medication
 - Keith et al: significant improvement on auditory vigilance and processing with medication
 - Tillary et al: medication improved tests of attention, but not certain AP tasks

ADHD and CAPD

- Controversy in the literature as to whether these are indistinguishable or separate disorders.
 - ADHD: an output disorder- difficulty inhibiting behaviors
 - CAPD: input disorder- impedes selective and divided auditory attention
- Highly co-morbid
- **Very** few children with only CAPD and nothing else.

CAPD and ADHD

- May have distinct profiles, but **overlap** in regard to: inattention and distractibility
 - Both ADHD and CAPD are associated with inattention
 - Children with ADHD perform more poorly than non-disabled children on CAPD tasks
 - When children with ADHD are on stimulant medication, they improve in CAP processing ability
 - There is high co-morbidity between ADHD and CAPD

The Debate Goes On.....

- In the Audiology and Speech literature
- Yet, there are very few citations in the medical literature, and
- Physicians are responsible for making decisions

Are there interventions?

- Behavioral Interventions
- Auditory Listening programs
 - Fast ForWord
- FM systems

What to do?

- “...the empirical evidence supporting the modality specific nature of CAPD is extremely limitedthere is no theory, no formal statistics on incidence or prevalence, and no standardization format on diagnosing the problem...recent consensus statements fail to describe how the specificity of the deficit should be determined. Therefore, it is not surprising that this disorder remains controversial and is not recognized as a unique entity affecting school-aged children” - Cacace & McFarland



Central Auditory Processing Disorders.....



.....“A riddle wrapped in a mystery inside an enigma” - Winston Churchill

Classroom Guidelines for Intervention

- S-P-E-E-C-H. The following mnemonic device entitled "SPEECH" has been found helpful by teachers and parents over the past few years when communicating with children with central auditory processing weaknesses.
 - S = State the topic to be discussed.
 - P = Pace your conversation at a moderate speed with occasional pauses to permit comprehension.
 - E = Enunciate clearly, without exaggerated lip movements.
 - E = Enthusiastically communicate, using body language and natural gestures.
 - CH = Check comprehension before changing topics.
- (Adapted from R. Peddicord, Ph.D.)

Classroom Guidelines for Intervention

- 1) **Rephrase and Restate.** Encourage children with auditory processing problems to indicate when they do not understand what has been said. Keep instructions relatively short.
- 2) **Visual aids** help children with limited auditory skills by capitalizing on strengths in visual processing and thus providing the auditory/visual association often necessary for learning new concepts and language.
- 3) **Preferential seating** (within 10 feet of the teacher) is essential. Factors to be considered in seat assignments include corridor or street noise, ventilating systems and/or proximity to centers of activity such as pencil sharpeners or rest rooms.
- 4) **"look and listen"** to the instructor. Individuals with listening weaknesses perform better when they can both see and hear the speaker at all times.
- 5) **obtain the child's attention** prior to beginning long or complicated instructions. It may be appropriate for the teacher to be positioned in close proximity to ~~~~ in order to improve his comprehension.
- 6) **check in** comprehension should be checked frequently by requiring demonstrating an understanding of the discussion.
- 7) **Key vocabulary** should be listed on the board at the start of each lesson. Assignments should be presented in written form whenever possible.
- 8) **"buddy system"** by giving a classmate the responsibility for making certain child is aware of the assignments made during the day.
- 9) **Allow extra time** to process information presented.
- 10) **orally repeat** direction back to you once he has heard it.
- 11) **Use gestures when** giving directions to (i.e., point to the door as you say open the door).
- 13) When new subject matters are being taught, **pre-teach** with vocabulary, etc.

- All 4 groups improved significantly on certain language tasks- not one group was more effective than the other
- FFW was not more effective at improving general language skills or temporal processing skills than non-specific comparison treatment or specific language intervention

Fast ForWord

"Fast ForWord software develops and strengthens memory, attention, processing rate, and sequencing—the cognitive skills essential for learning and reading success."

"Wiring the Brain for Academic Gain"

- A single use license covers one child on one product for 12 months.

- Fast ForWord Language Basics \$100 (preschool level)
- Fast ForWord Language \$900 (elementary school level)
- Fast ForWord Language to Reading \$900 (elementary school level)
- Fast ForWord to Literacy \$900 (mid/high school level)
- Fast ForWord to Literacy Advanced \$900 (mid/high school level)
- Fast ForWord to Reading Prep \$600
- Fast ForWord to Reading 1 \$600
- Fast ForWord to Reading 2 \$600
- Fast ForWord to Reading 3 \$600
- Fast ForWord to Reading 4 \$600
- Fast ForWord to Reading 5 \$600

Fast ForWord

- Gillam R et al **The efficacy of Fast ForWord Language intervention in school-age children with language impairment: a randomized controlled trial.** *J Speech Lang Hear Res.* 2008 Feb;51(1):97-119.
- 216 children with language impairments
 - Randomized controlled trial to one of 4 treatment arms
 - Fast Forword (FFW)
 - Academic enrichment (AE)
 - Computer assisted language intervention (CALI)
 - Individualized language intervention (ILI)
 - 100 minutes, 5 days/wk, 6 weeks
 - Language and auditory processing measured by blinded raters before, during and 3 months after treatment

FM Systems

- Teacher wears a microphone...child wears an earpiece or has amplifier on his/her desk.
- Used to help boost essential auditory stimuli from background noise.
- An FM system will help anyone.
- The recommendation for an FM system is usually one of last resort.
- If the child continues to struggle after the implementation of all the recommendations, an FM may be beneficial, particularly if s/he has difficulty hearing in the presence of competing background noise.
- They're expensive >\$1000

The Big Question

- Are Central Auditory Processing Disorders real?
 - Yes
 - Under the right conditions, there are children who will perform poorly on CAP testing.

What to do?

- Common school based difficulties do not stem from a single disorder, therefore,
- Start with a Developmental/Behavioral Pediatrician
 - Neurodevelopmental evaluation, physical, neurological examination.
- Add appropriate evaluations as needed:
 - Learning Assessment
 - Academic achievement (reading, written expression, math)
 - IQ
 - Intellectual potential
 - Speech
 - Receptive and expressive language skills
 - Other

But is testing for them clinically relevant and useful?

- Results are difficult to interpret
 - There's no Gold Standard for testing
 - Diagnostic criteria are not featured in DSM-IV or ICD-10, but the condition is widely diagnosed
- Even if it is diagnosed, most frequently prescribed interventions:
 - Preferential seating, classroom modifications, repetition of instructions, are non-specific and benefit nearly all children
- Cost \$500-600 to test
- 1 ½ hours to complete
- FM trainers are expensive/stigmatizing

- What about CAP testing?
- From the perspective of a Developmental/Behavioral Pediatrician, you may find different opinions.
- Given today's discussion, I don't feel CAP testing is a useful component to evaluating school based problems
 - May help confirm a suspected problem
- More research is needed to define exactly what CAP testing is measuring and what its clinical significance is in the population of pediatric patients with learning, language and attentional problems.

- Cost-benefit ratio of a battery tests whose exact clinical relevance is uncertain and whose resulting management recommendations are not specific is questionable
- An abnormal result on a CAPD test cannot be the sole means of diagnosing a CAPD deficit
 - There must be other clinical signs and symptoms

